research based education 2016

Volume Two



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aae2016 International Peer-reviewed Conference on 'Research Based Education' hosted by The Bartlett School of Architecture, University College London, UCL, UK, 7-9 April 2016

Volume Two

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aae2016

Hosted by *The Bartlett School of Architecture, UCL* in collaboration with the *association of architectural educators* (aae), **aae2016** is an International Peer Reviewed Conference on 'Research-Based Education' which runs from 7 to 9 April 2016.

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Contents

Volume 1

Introductions

Alan Penn, Dean, The Bartlett, UCL's Faculty of the Built Environment 18

Professor Bob Sheil, Director, The Bartlett School of Architecture 20

The aae 22
Victoria Farrow

curiosity

Keynote

Curiosity 24
Izaskun Chinchilla

Papers

Pedagogic poetics 26
Marjan Colletti, The Bartlett School of Architecture, UCL, UK and University of Innsbruck, Austria

Space & play time - the value of the speculative act in architectural design (education) 34
David Short, University of Nottingham, UK

Fieldwork 44
Simon Herron, Susanne Isa, University of Greenwich, UK

A series of 'happy accidents' 50
Victoria Farrow, Birmingham City University, UK
Stephen Garrison, Marywood University, USA

Learning environments in design studio culture: exploring the student experience 58
Julian Williams, University of Westminster, UK

The studio as site: Exploring the positionality of the designer in the creative process 66
Matt Ozga-Lawn, James A. Craig, Newcastle University, UK

Design Research in Architecture: The Path towards Research-Based Education 80
Professor Murray Fraser, The Bartlett School of Architecture, UCL, UK

Collective agency: the architectural collective as an emerging model for education and practice in Brazil and the UK 86
Jane Hall, Royal College of Art, UK

Design prototype 96
Claudia Pasquero, Bartlett School of Architecture, UCL
Emmanouil Zaroukas, University of East London, UK

Drawing from curiosity: The role of reflective drawing in architectural design, research and learning 109
Dr. Miguel Jaime, Department of Architectural Engineering, Alhosn University, UAE and **Dr. Eugenia Lopez Reus**, Department of Architecture and Design, Abu Dhabi University, UAE

production

Keynote

Production 120
Achim Menges

Papers

The robot and the swallow: sustainable practice in a digital world 122
Guan Lee & Eleanor Morgan, The Bartlett School of Architecture, UCL, UK

RAF | A framework for symbiotic agencies in robotic – aided fabrication 130
Alicia Nahmad Vazquez & Dr. Wassim Jabi, Welsh School of Architecture, Cardiff University, UK

Design-research by making: an educational hands-on approach to design-research through manual/robotic processes 150
Ioanna Symeonidou, Renate Weissenböck, Institute of Architecture and Media, Graz University of Technology, Austria

Design methods: deep agencies for spatial production 162
Perry Kulper, Taubman College of Architecture and Urban Planning, University of Michigan, Michigan, USA

Hybrid design workflows of digital crafting and material computation 174
Soomeen Hahm, Igor Pantic, The Bartlett School of Architecture, UCL, UK

Research-based teaching as a search for novelty in architectural education 184
Derya Yorgancioğlu, Istanbul Kemerburgaz University Dept. of Architecture, Asst. Prof. Dr., Istanbul, Turkey

Between design and digital: bridging the gaps in architectural education 192
Shelby Doyle, Nick Senske, Iowa State University, USA

Material / tooling / prototyping: the production of full-scale models in architectural education 210
Evan Greenberg, Architectural Association, School of Architecture, UK

Crafting skins: spatial and structural properties of laminated surfaces 218
Michael Budig, Singapore University of Technology and Design, Singapore and **Dishita Turakhia**, Massachusetts Institute of Technology, USA

From continuous to discrete fabrication 231
Gilles Retsin, Manuel Jimenez Garcia, Vicente Soler, The Bartlett School of Architecture, UCL, UK

Volume 2

Workshops

Framing your live project within a design research methodology 262
Jane Anderson, Oxford Brookes University, UK
Ruth Morrow, Queen's University Belfast, UK

How computational agent-based models trigger creative insights into architectural and urban design education 266
Kinda Al Sayed, Bartlett School of Architecture, UCL, UK

risk

Keynote

A risky business 282
Lesley Lokko

Papers

Code-breaking: curiosity through the critical examination of 'cultural software' in architectural education 284
Luke Pearson, The Bartlett School of Architecture, UCL, UK

Palimpsestuous design: playing with architecture 297
Paula Craft-Pegg, University of Portsmouth, UK

The freedom of the sketch and the tyranny of the digital image 309
Douglas Gittens, Amanda Hufford, Nottingham Trent University, UK

About the process of design 318
Toby Lewis, University of Bath, UK

Education for uncertainty 326
Lorraine Farrelly & Flora Samuel, School of Architecture, University of Reading, UK

Negative capability in the design studio 338
Sandy Litchfield, University of Massachusetts Amherst, USA

Goodbye Mister Bond: 007's critical advocacy for feminism & modernism 348
Dr. Harriet Harriss, Royal College of Art, London, UK

Tactics developed in times of economic crisis applied in design studios 358
Kirill Jedenov, University of Western Australia
Filipe Afonso, Chinese University of Hong Kong

Liquid states and concrete uncertainties 372
Olivier Ottevaere, The University of Hong Kong/Double(o)studio, Hong Kong

A certain degree of uncertainty: embracing risk in the thesis project via the 'creative survey' 382
Carolyn Butterworth, The University of Sheffield, UK

participation

Keynote

Participation and professional education in the 21st century 394
Etienne Wenger

Papers

Take the red pill: a journey into the rabbit hole of teaching informed research 396
Dr Charlie Smith, Liverpool John Moores University, UK

#Mcgillarchitecture: design education in the age of instagram 407
Annmarie Adams, McGill University, Canada
Basem Eid Mohamed, Abu Dhabi University, UAE

Towards a connected curriculum in architectural education: research-based education in practice 416
Brent Carnell, Centre for Advanced Learning and Teaching, UCL, UK

Architecture and engineering: interdiscilplinary education 427
Dr. Rachel Cruise, School of Architecture, University of Sheffield, UK

A combined approach to engineering and architectural education 439
Alastair Mcdonald, Faculty of Engineering and the Environment, University of Southampton, UK

Nurturing the citizen designer: re-defining participatory frameworks for professional re-alignments 452
Arunava Dasgupta, School of Planning and Architecture, New Delhi, India

Human computer interaction systems and educational strategies to support design participation 468
Robert Aish, The Bartlett School of Architecture, UCL, UK

Digital tools beyond aesthetics: mass creativity and the enablement of emergence 481
Dimitrie A. Stefanescu, The Bartlett School of Architecture, UCL, UK

Insights from ntnu live studio 490
Elena Archipovaite, Hans Skotte, Steffen Wellinger, Faculty of Architecture and Fine Arts, Norwegian University of Science and Technology, NTNU

Living architecture: currencies between architectural pedagogy and time-based media performance 503
Ava Fatah Gen Schiek, Bartlett School of Architecture, UCL, UK

WORKSHOP:
Framing your live project within a design research methodology

Jane Anderson, Oxford Brookes University, UK
Ruth Morrow, Queen's University Belfast, UK

ABSTRACT

In architectural Live Projects (also known as Design Build, Service Learning, Extension Projects, 1:1 Projects), students and academics work with external organisations and communities to generate projects. This enables investigation of the experiential, technical, ethical, social, political, economic and cultural implications of architectural design decisions in ways that are not possible in the conventional academic design studio or commercial architectural practice.

Architectural Design Research methodologies offer possibilities for live project educators to tap the research potential of their work. As defined by Fraser, in this methodology "architects use the creation of projects… as the central constituents in a process which also involves… more generalised research activities" (Fraser, 2013).

Live Projects and Design Research are both relatively recent innovations in the discipline of architecture. This workshop explores their potential to work together to create innovative and authentic research outcomes and enrich the learning and research derived from live project activity.

HYPOTHESIS

1. Architectural live projects are an emerging method to generate innovative and authentic research findings with impact that cannot be achieved via conventional means.
2. Architectural live projects deploy research-led, trans-disciplinary, co-design, not-for-profit negotiated methodologies that are alternative to those used by conventional architectural, urban and spatial practice and research, particularly in response to urgent issues such as sustainability, scarce resources, ethics, wellbeing and vulnerability (Anderson, forthcoming).

WORKSHOP OBJECTIVES

The objectives are to explore design research methodology as a means to unlock the research potential of live project activity and outcomes. The workshop will draw upon examples from the workshop leaders' live project experience. It is aimed at live project initiators, educators, researchers and collaborators who wish to expand their current understanding of research within a Live Project context.

WORKSHOP STRUCTURE

1. Case study presentation: a spectrum of case studies from the Live Projects Network (Anderson and Priest, 2012) and current live research projects running at Queen's University Belfast will be discussed in relation to the different research activities and outcomes that they have produced.
2. Question for workshop participants: What research emerges from your Live Projects? Subsequent questions to be posed during a whole group discussion: What research methodologies could you employ? Is there a conflict with required teaching outcomes? What potential do Live Projects have for innovative research?
3. Drafting up research objectives for future Live Projects: "Design research should never be something that just happens at the beginning of a project" (Fraser, 2013). Using this model of design research as a continuous activity, working in small groups, what other potential research outcomes can you identify from your Live Project?

DISCUSSION

In architectural live projects, students and academics work with external organisations and communities to generate projects (also known as Design Build, Service Learning, Extension Projects). These transformative projects bridge the gap between research and practice (Dodd et al., 2012), ranging from urban masterplans and design strategies to prototypes and completed buildings.

Live projects are transformational and respond to diverse challenges such as innovative construction for impoverished rural communities, participatory design and informal settlements. Despite the innovation of these projects and their sound basis in the latest inter-disciplinary academic and practice expertise, most scrutiny has been given to their pedagogical and material benefits for students and communities. (Harriss and Widder, 2014)

Architectural live projects straddle education, research and practice boundaries with academics, students and external collaborators undertaking real projects in the real world. Live projects create new ways to generate, test and apply research in authentic contexts, yet these benefits to research are not widely recognised (Dodd et al., 2012).

This workshop aims to identify live project research methodologies and territories, stimulating their potential for innovation, authenticity and expansion of existing definitions of research. This workshop operates within a context where not only is this potential unrecognised among many live project participants, but where the closest field of research, architectural research by design, is being contested in terms of methodology and external recognition (Fraser, 2013).

The ambition of the workshop is to facilitate live project educators in the expression of their work as research in a way that is recognised by research assessment structures, stimulating recognition, quality and dissemination of live project research.

SIGNIFICANCE

Live Projects and Research by Design are both recent innovations in the discipline of architecture (Benedict Brown, 2012). Architectural design is suited to both research by design as well as the more established scientific, humanities, social sciences and text-based research methodologies. Architectural researchers must become expert in these multiple methodologies and must wrestle with all the difficulties of internal and external recognition



that this brings (Fraser, 2013). This can create negative consequences when work is being peer-reviewed by those with expertise in different or conflicting methodologies. The situation becomes critical when systems (Research Excellence Framework, REF in UK, Excellence in Research for Australia, ERA, tenure track in USA) are created to measure research excellence across disciplines as a means to rank and fund research. Rather than a barrier to development of research in the field of live projects, this situation presents an opportunity to identify and devise relevant and innovative research methodologies. Findings will inform architectural research in general and live project research in other disciplines too.

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BIOGRAPHIES

Jane Anderson is an architect and Programme Lead for Undergraduate Architecture at Oxford Brookes University, UK. She runs OB1 LIVE, a programme of live projects designed by students in the School of Architecture in collaboration with local community clients. She is co-founder of Live Projects Network (www.liveprojectsnetwork.org), an online international resource for academics, students and clients. She is the author of Architectural Design (2010), has written on live projects and pedagogy in the journals Charrette, JEBE and contributed a chapter to Architectural Live Projects: Pedagogy into Practice. (Harriss and Widder, 2014). She is a National Teaching Fellow.

Ruth Morrow. As a student Ruth learned though live projects, and throughout her career has taught through live projects. She established the live project, Street Society, in Queen's University Belfast in 2009 as a one-week pedagogical event involving 1st year undergraduate and 1st year postgraduate students. In March 2016, having been framed as a research project, funded by the Strategic Investment Board and the Dept of Culture and Leisure, Street Society, will draw UG, PGT and PhD students from architecture, music and anthropology to respond creatively to community generated briefs in five critical urban areas in Northern Ireland. Ruth is Professor of Architecture at Queen's University Belfast.

WORKSHOP:
How computational agent-based models trigger creative insights into architectural and urban design education

Kinda Al Sayed
The Bartlett School of Architecture, UCL, UK

ABSTRACT

With the increase in the complexity of built environment systems, computational modelling has become an integral feature in the design process. Teaching design computation offers an opportunity to explore the boundaries between designers' form-finding rationale and how computational decision support systems might contribute to the analysis and synthesis of designs. This paper reflects on these processes, and offers some insights into the use of cognitive agent-based models in form-finding and decision-making, both on an architectural scale and an urban scale. Following this logic, a bottom-up approach in design and decision-making is conveyed through experiential object-based learning, and through the use of computer-aided design tools. In the context of hands-on workshops, participants are introduced to simple mathematical rules of agent-based modelling through group activity. The mathematical rules are devised in design exercises that involve both form-finding techniques and decision-making processes. A design experiment starts from simple principles of how human-like agents might move in a layout setting, to explore how this movement builds up into aggregate patterns that shape built form. The aim is to regulate and externalize decision-making during design in order to reveal how designers' internal reasoning might influence potential user behaviour in a designed environment. The innovative dimension could be explored through introducing creative variations on design outcomes that satisfies a maximized correspondence between users and the spatial form that envelopes their activities.

INTRODUCTION

Architectural design can be considered as a practice of human cognition in which designers retrieve information from the material environment and reconstruct this information into built form. In this process, designers may retrieve information from built artefacts, from previous designs, or possibly from nature. The utilization of knowledge and experiences into design might involve many domains, including; engineering, arts, computation, cognition, economics and technology. This makes the subject of design a fertile ground for speculations and experimentation. Of interest is how designers' decisions might influence user behaviour in buildings and in urban environments.

In architectural education, there seems to be a divide between analytical

approaches in built environment research and experimental design-centred approaches. Research-centred approaches in architectural education present a top-down view of the built environment, its performance and its social habitat. The focus is often on building quantitative and qualitative models of how buildings and cities operate, rarely accounting for how analytics might be adapted as an integral feature in design rationale. The nature of design process might also play a role in defining the relationship between the subjective intentionality of a designer and the constraints defined by objective knowledge, seeing that designers, unlike researchers, tend to be selective about when and where knowledge might be incorporated in decision-making. Designers can have different preferences about the criteria they reason with. While the criteria might be determined partially by the design problem; background knowledge might also play a non-trivial part in shaping the design course of actions. This in itself is presenting a problem, given that for a design to satisfy different criteria it must involve different types of knowledge in different capacities. Unlike research-centred pedagogies, design-centred approaches would be more focused on the experiential part of learning. Designers are often sceptical about aligning their work to a normative pre-determined approach, given the difficulty in accounting for all the variables that make designs possible and the specificity of a design brief. There is also the argument that design in architecture relies mostly on intuition and is largely an irrational process, and yet designers do feed information learnt from research-based architectural education to support design reasoning. It is suggested that an awareness of the consequences of design decisions on the social and economic performance of the built environment need to be embedded in architectural design curricula to help bridge the gap between research and practice. A reflective account of architectural education might present an opportunity to verify the fuzzy boundaries between rational and subjective actions in design through observing students' performance tackling a pre-defined set of design tasks.

In observing design behaviour, it is important to attend to the ill-defined nature of architectural design problems, to be distinguished from well-defined engineering design problems (Simon, 1984). For a well-defined problem, an automated process can be adapted to seek optimum solutions. For an ill-defined problem, designers seek solutions that satisfy certain criteria by means of heuristic methods (trial and error). Due to the uncertain nature of architectural and urban design problems, the boundaries for rational and irrational reasoning cannot be clearly identified. As Simon defines the boundaries between rational and irrational actions in design thinking; 'bounded rationality', he grounds his theory on the subjectivity of a designer, and the cognitive limitations presented by a design situation and background knowledge (Simon, 1957). The identification of these boundaries can only be done with extra caution by isolating the logics of a designer, a situation and the external parameters that influence the design.

In this paper, we reflect on students' performance in four workshops. In designing these workshops, the intention was to externalize the process of decision-making in design and align it to a procedural set of actions that correspond to a sequence of design tasks. We report on the workshops design, the intended learning outcomes, and what we learnt from our observations. The workshops were mostly part of two postgraduate programmes at the Space Syntax Laboratory, The Bartlett School of Architecture, University College London. Some of these workshops were also delivered independently at the University of Sofia.

SPACE SYNTAX LABORATORY AS A RESEARCH ENVIRONMENT

The concept of 'bounded rationality' presents itself in the pedagogical practice of teaching architecture in higher education. This concept becomes more visible where the

epistemologies of science and art meet, and where there is divergence between analytical and synthetic methodologies. This is exemplified by the varied demands of the curriculum in the post-graduate courses offered by the Space Syntax Laboratory; *MSc Architectural Computing* (AC) and *MSc Spatial Design: Architecture and Cities* (SDAC), at the Bartlett School of Architecture, UCL.

The MSc AC was founded over the last decade. It offers a place where creative approaches towards architecture are explored through computation. Teaching on this course entails exposing students to a wide range of scientific theories and knowledge paradigms. Over the years, this mode of teaching and learning has proven to be a very challenging task given the diversity and intricacy of the subjects in this domain. The main challenge comes from the fact that within one year students transform their state of knowledge and their design practices from qualitative descriptions and passive utilization of computer-aided design tools (coming mostly from architecture) to quantitative descriptions and logical reasoning that are enabled through programming and computation. It is in this realm, where a social and cognitive theory becomes vital to explaining the nature of design and the nature of architectural artefact. Whilst such theories are embedded in the curriculum of the MSc AC, the programme opens up opportunities to explore other interpretations and representations of built form.

Over the last three decades, the MSc SDAC was directed towards outlining and testing an analytical theory; namely that of Space Syntax (Hillier and Hanson, 1984). Students who successfully apply to this course enter a specific type of "*community of practice*" (Lave and Wenger, 1991); that is the Space Syntax community. Research within the framework of Space Syntax outlines a knowledge-based model that interprets the architecture of buildings and cities sociologically, as agents of social reproduction. The course has a history of evolving pedagogies and has succeeded in establishing a unique culture of architectural research into the science of architectural and urban space (Conroy Dalton and Vaughan, 2008). Students on this course come from a variety of educational backgrounds; architects, planners, designers, anthropologists and others. Depending on their background, they are likely to take different perspectives on Space Syntax; whilst maintaining a shared identity as a community of practice in their future career. It is thought that a research environment that is bound by a pre-defined framework may induce scientific 'fixation'. The risk of fixation is high, where predefined theoretical or technical frameworks allow for old theories to frame and influence new contributions. This might be limiting, particularly when facing the challenges of uncertainty in design, hence the need to find pathways for experimentation and innovation in teaching analytical and elaborative models in the context of design.

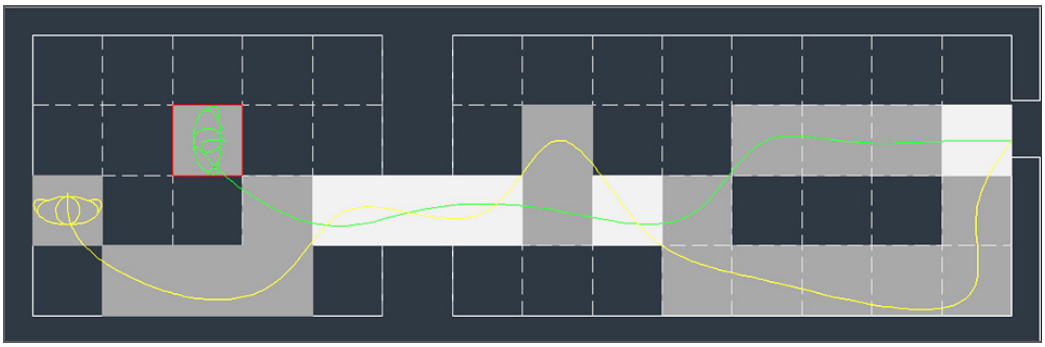
In 2010, the course changed its agenda to incorporate strategic architectural design and urban design (Al_Sayed, 2012; Karimi, 2012; Griffiths, 2014). This change necessitated new strategies for teaching graph theories as instrumental techniques to aid design thinking. For this purpose, hands-on architectural design workshops are being delivered at the beginning of each academic year and throughout to help architects learn basic mathematical principles of graph theory by applying them in design thinking (Al_Sayed et al., 2015). The workshops are also delivered separately in independent teaching activities overseas (MSc ATC at UACEG, Sofia) to help architects grasp Space Syntax principles more easily. In the following sections, we will explain some of these workshops, the philosophy behind them, and will reflect on students' performance in the context of a loosely-supervised studio environment.

RESEARCH-BASED EDUCATION TO RENDER THE NON-DISCURSIVE DISCURSIVE IN ARCHITECTURE

Over a period of one academic year, the MSc AC and the MSc SDAC courses present a unique pedagogical environment where architecture is researched and explored on all scales. The theories and methods introduced on the courses are intended to question the architecture of the built form by positioning this in a broader social context. In many architectural pedagogical practices the scientific understanding of architecture is seen to be separate from the art of making architecture. For the courses to succeed in bridging the gap between research and design whilst actively engaging theory into practice, design teaching needs to incorporate a process of knowledge externalization that is open for self-criticism and for external assessment. Knowledge assimilated by students in a "*learning cycle*" (Kolb, 1984) can be deepened through emphasizing multimodal learning. For that, teaching should aim at engaging mental and physical capacities by exposing students to experiences that stimulate different sensory-motor channels. Within that planned framework, knowledge accumulated from observations can be directly implemented and externalized through visual representations. This externalization would enable a reflective practice in the form of "*reflection-inaction*" that engages active learning through design (Schön, 1983; 1987).

The knowledge externalization process aims to render the 'non-discursive' qualities of architecture discursive. Hillier made this argument with reference to theoretical and explanatory models of architectural phenomena (1996). This argument was verified in the context of architectural design (Al_Sayed et al., 2010; Al_Sayed, 2014a). A follow-up on this approach would be particularly valuable in pedagogical contexts. One might argue, for example, that design progresses from the universal towards the particular following a prioritized structure model. In the suggested model, designers follow a linear pathway from the general whilst gradually narrowing the universe of design solutions in search of a design that satisfies all the requirements (Al_Sayed, 2014b). It is argued that the presence of an explanatory theory of architecture where designers become more self-conscious of the implications of their actions is key to any sensible design approach. A systemic approach to externalizing design knowledge would consequently ease the assessment of design as a process. With a systematic approach in action, we assume that architects will be more specific when defining the relationships between the spatial components of their solutions and will allow for creative variations on the features of design solutions.

In an approach to rendering the non-discursive discursive in architectural education, four workshops were designed to engage architecture students with cognitive agent-based models through devising a learning strategy that would stimulate mental imagery and cognitive capacities. The workshops were designed to prompt constructive learning through doing, as to facilitate "*bottom-up higher order learning*" (Biggs and Collis, 1982). Students were guided through a process of experiential learning (Kolb, 1984) where experience, perception, cognition and behaviour are all brought together to leverage a maximised gain of the intended learning outcomes. Following this initiative, students construct knowledge starting from simple principles to form representational models of the physical space. Students were left thereafter to construct different interpretations of the representational models, and utilize elaborative model and analytical techniques to inform design decisions and trigger new forms of creativity. In what follows, a description of the workshops will be made, starting from a theoretical introduction to the methods and tools used in these workshops. We will reflect on the procedural set of tasks that were implemented in these workshops, keeping in mind that the purpose is to direct the course of design without imposing its conduct. After discussing the workshops experience, we will briefly reflect on our observations.



▲ Figure 1 Aggregating movement probabilities of cognitive agents to demonstrate the base model for predicting natural movement potentials

A THEORETICAL INTRODUCTION TO COGNITIVE AGENTS

As an alternative to a representational scheme of architectural and urban space (Hillier and Hanson, 1984), Turner and Penn (2002) developed a theoretical and modelling description of cognitive agents - an elaborative model of automata representing sighted humans. Both Space Syntax and cognitive agent theories aim at predicting and modelling natural movement behaviour (Turner, 2003). Much effort has been invested in teaching Space Syntax over decades (Vaughan et al., 2007; Conroy Dalton and Vaughan, 2008; Al_Sayed, 2012; Karimi, 2012; Griffiths, 2014), however; little progress has been made in teaching cognitive agents.

Unfolding the intricacies of the cognitive agent-based model to architecture students on the MSc SDAC course can be challenging. Hence one needs to follow a specific structure to reinforce the intended learning outcomes ILOs, which are to do with reinforcing the use of elaborative models in design to support decision-making. Such approaches would offer students the opportunity to construct new perspectives on modelling and simulating the social performance of the built environment. The cognitive agent model can be simplified and conveyed starting from the simplest units of representation; that is the grid points that represent permeable spaces in a layout (Figure 1).

Through the use of such methods, students can accumulate a basic understanding of the agent model that would enable them to devise it in simulations and design. To explain the theoretical introduction to cognitive agents, the ILOs as well as the preliminary observed learning outcomes (OLOs) were broken down in Table 1. After the first 15 minutes of the lecture students are presented to a software demonstration on agent simulation to direct their attention to possible applications of the theories they were introduced to during the lecture. Following the lecture, a physical demonstration of how agents move and make decisions is conducted in the form of a hands-on workshop (Workshop 1). The workshop aids students learning by applying the theories into practice.

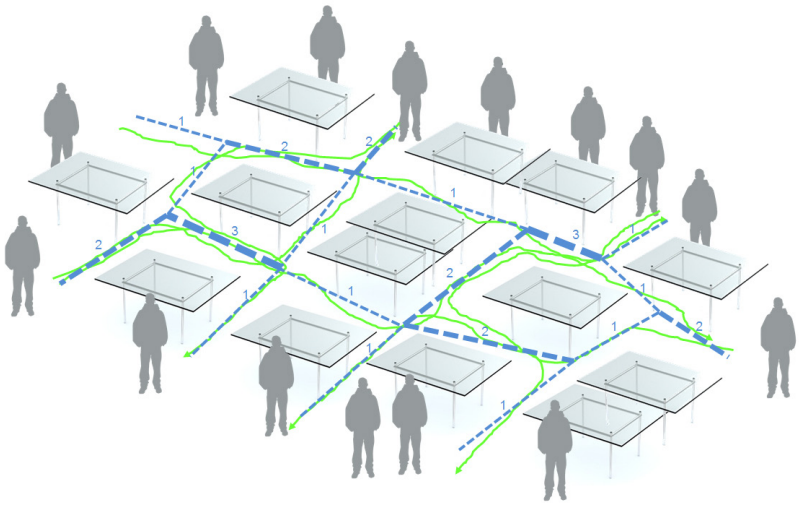
WORKSHOP1: HOW SIMPLE ELABORATIVE MODELS MIGHT SUPPORT DESIGN REASONING

Following a theoretical introduction to cognitive agents, a hands-on workshop was intended to answer questions that might arise about how a theory on person-space interactions might feed into design thinking and reasoning to reinforce the relationship between potential user behaviour and a designed layout. The hands-on workshop was scoped in such a way as to encourage students to exercise their design experience whilst

Structure	ILO	OLO
Falsification of previous theories	*Questione* prior knowledge	Students frustration and frequent questions are signs of engagement
	Be ready to reconstruct new knowledge	
Proposal and inspiration	*Reframe* knowledge to fit an alternative explanation of a phenomenon	Students understood the difference and were worried about linking to a new theory
Theoretical ground	*Reconfigure* the man-environment paradigm	Students were still trying to grasp the new theoretical paradigm
	Replace an AI model by an AL model?	
	Question post-modernism	
	Critic the experiential explanation	
applications	*Associate* the theory with the application	The interface was attarctive to begin with, but occasionally was distractive from the content
	Stimulate thought by demostrating likely use	
Experiments on inteligent agents	*Examine* the outcome of evolved decisions	Students did not appear to understand the difference very well between basic, evolved and learning agents.
	Examine the outcome of introducing memory	
	Evaluate how learning animats perform better	
Agent mechanism And evaluation (theatric performance of how agents move was included)	*Comprehend* agents mechanism	Two students asked questions about the deep mechanisms of the model indicating a high level of understanding
	Stimulate analogical reasoning by mimicing agents movement during the lecture	
	Evaluate the agent performance	
A comparison between agents and network-based models	*Distinguish* the divergent approaches and theories behind the two models	Students were able to distinguish between the two models, some were more willing to expore, most of them were in favour of what they know already
	Evaluate how -in effect- the two models meet and correspond	
Summary	*Reflect* on how the agent model introduces a cognitive dimensionality to Space Syntax	Students were not properly introduced to cognitive sciences in previous lectures so they could not appreciate the contribution of the agent model
	Follow up with reading through the key literature to expand on the subject	

▲ Table 1 The structure of the theoretical introduction on cognitive agent-based models, MSc SDAC course

acquiring the basic principles of graph theory and agent-based modelling. The aim was to explore how simple mathematical models might support design reasoning. In doing so, the workshop helped students structure their design thinking by establishing principles and priorities for design reasoning. The urban design task was intended to be an experiential learning process (Kolb, 1984). The experience is driven by a collaborative approach through which students interface with different modes of representation. The phases where representations reflect the direct experiences into abstract manifestation reveal a real-time and context-driven materialization of thoughts into actions. By limiting interaction to the direct environment of the class, we were able to ensure a neutral assessment of



▲ **Figure 2** A model representing the workshop settings by a skeletal representation of spaces in-between tables

students' learning capacities at an early stage in the course. The capacity of learning would be described as the depth to which students can reach in their progressive learning from recognizing pre-structures onwards to the making of relational structures (Biggs and Collis, 1982). This is accounting for the methods of representation and theorization that are particular to the design process.

SETTING THE SCENE FOR A COGNITIVE AGENT PERFORMANCE

The workshop described in this section, is taught regularly on the MSc SDAC at UCL, and is also offered as part of a one week module on the MSc *ATC* at UACEG, Sofia. In this workshop, participants are asked to arrange their tables in a random way in the teaching room leaving spaces in-between the tables and at the peripheries to allow participants to move through. This arrangement was drawn on a large sheet. A linear network representation of the spaces in-between the tables was then drawn to expose the spatial structure of the void left by the tables. Students were asked to stand at the peripheries of this arrangement. Each student was asked to choose a random path to move through the tables; starting from the point where he/she is standing to a destination of his/her choice. Each time a student chose to walk through one space represented by one linear segment the segment will be assigned a score of one, this number will add-up if another student chose that space again (Figure 2). After finishing the experiment, the scores that each linear segment hit are summed up. The resulting numbers represented the aggregate movement potentials for that particular spatial segment.

FROM MOVEMENT PERFORMANCE TO MOVEMENT ECONOMIES: AN URBAN DESIGN EXPERIMENT

Following the cognitive agent performance, students were asked to work in groups of four and redraw the spatial structure defined by the table pattern. The spatial structure was to be used to design an urban area as an envelope for that structure; the spatial structure might be considered as equivalent to the street structure. Students were advised to use the scores they have accumulated for observed movement as parametric rules to assign certain land uses and three-dimensional features to urban form. For example; it was suggested that where there are higher records of movement, there is more likelihood

for retail activity, wider streets and high-rise buildings (Figure 3). The design propositions were then presented (Figure 4), and discussed by the tutor and fellow colleagues.

Judging on the design outcomes in Figure 3, it was difficult to tell which design was more advanced, since all designs presented a mature stage of analogical reasoning where abstract descriptions of space became occupied by a more realistic urban context. The design performance might be judged upon the ability of designers to cast their own interpretation of the analysis, to synthesize solutions, to show evidence for creativity, strategic thinking, and to communicate that verbally and visually through their sketches and annotations. Judging upon these criteria, design outcome (2) presented an interesting case where students proposed a typical planning proposal that signifies social segregation and territoriality at its utmost level. This indicates an advanced level of understanding and reasoning. Design outcomes (2) and (3) have also indicated an advanced level of representation where students shifted from a 2D abstract representation of their teaching space to a 3D description of an urban scheme. Design outcome (2) was a materialization of user-centred experience. The verbal transcripts of the final presentation indicated that students reflected upon their user-based experience of an urban environment to support their decisions about where to place green spaces, high-rise buildings, and how to allocate land uses. Design outcome (3) established an original association between the probabilities of movement through a street space and the symbolic presence of certain types of retail brands. In general, the use of graph theoretic and agent-based principles was taken to a higher dimension in the designs proposed by MSc SDAC students to demonstrate associations between realistic urban contexts and abstract descriptions of urban form.

OBSERVED LEARNING OUTCOMES

During the course of this workshop (1 hour in total), students were able to learn principles of:

- Agent-based modelling (Turner and Penn, 2002; Turner, 2003).
- The application of Network theory on urban space; namely that of Space Syntax (Hillier and Hanson, 1984)
- The theoretical and technical framework of "cities as movement economies" (Hillier, 1996)
- Systemic movement traces observation techniques.
- Basic arithmetic and graph theoretic.
- A novel application of the abovementioned theories and models in the realm of urban design.

Beyond the tangible learning outcomes, there are tacit learning qualities that were achieved through this experiment; some are to do with learning in a situated social context and through group work (Lave and Wenger, 1991), learning through doing (design), and object-based learning (Lyon, 2012). It is suggested that by aligning architectural pedagogies to this mode of teaching and learning, it is possible to achieve a *"Higher Order Learning"*, one that involves creating knowledge rather than transmitting knowledge (Duhs, 2010).

WORKSHOP 2: DEVISING COGNITIVE AGENTS IN FORM-FINDING

The workshop presented in this section was delivered as a computer-aided design approach to MSc *ATC* students at UACEG, Sofia. This workshop was broken into two phases (figure 4);

- **An analytical phase** where students were to use DepthmapX software to analyse their designs using visibility graph analysis and agent analysis.
- **A simulation and visualization** phase where students used both SketchUp and 3D

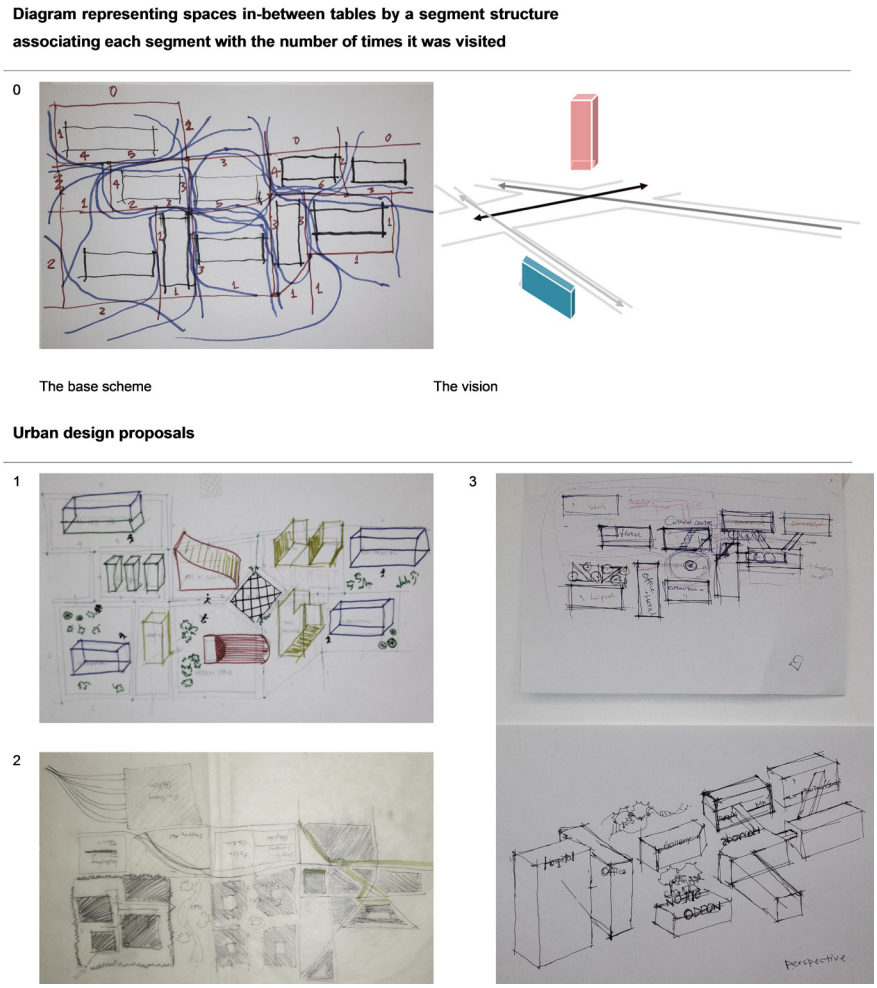


Figure 3 (0) Schematic representation of the spaces between the tables illustrated in figure 2. (1, 2, 3) Examples for three urban design propositions based on the cognitive agent performance. Students were to construct urban space using a selected set of rules. Design decisions are made considering a hypothetical relationship between movement in street spaces, investment in retail and high-rise development, building density, and the parameters of street spaces and block size. The designs were produced by MSc SDAC students 2015/16, Bartlett School of Architecture, UCL.

Studio MAX software to visualize the aggregate movement patterns of the automata (standard cognitive agent analysis).

In a procedural process, students started with an overview of the methodologies underlying agent analysis in DepthmapX. 2D and 3D demonstrations of agent analysis and simulation were offered in a group tutorial context. The tools enabled users to generate different predictions for aggregate movement potentials by controlling the parameters and rules in the toolbox window. The 3D simulation allowed users to view how standard agents move in relation to space. The 3D view helped understanding how individual movement behaviour of standard automata/agents builds into aggregate patterns that might then be compared to human behaviour in space. Following the technical tutorial, students were asked to generate designs for an apartment layout, and run agent simulation to analyse

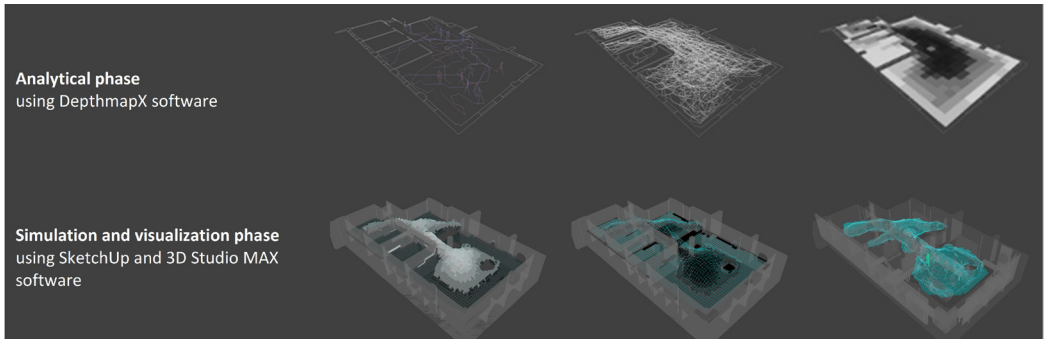
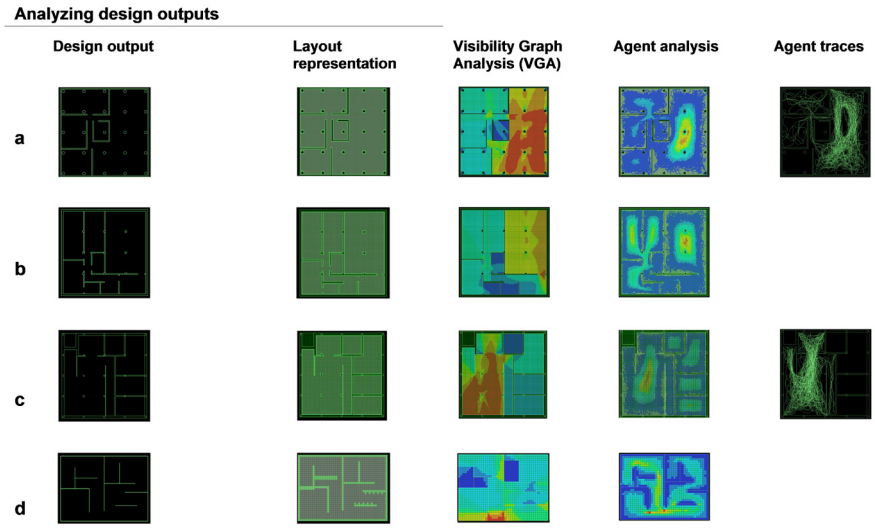


Figure 4 The structure of the computer aided design workshop, including both; an analytical phase and a simulation and visualization phase



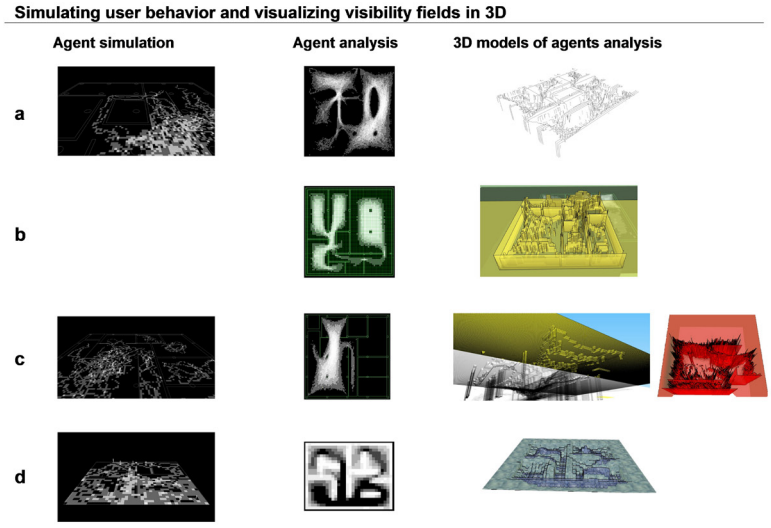


Figure 5 How aggregate movement patterns of cognitive agents (produced in DepthmapX) were used to produce 3D visualizations using SketchUp and 3D Studio MAX. The layouts were designed by MSc ATC students, Sofia.

their design outcomes. The 2D outcomes of agent analyses were then used to produce 3D Mesh configurations using the "Bitmap to Mesh" SketchUp extension.

The visualization can be thought of as an assistive technology in design, and could be used in form-finding and conceptual design development (Figure 5). Students were able to generate some very interesting variations on the analytical outcomes of agent simulations, quoting Milla Zlatanova and Konstantina Hristova (both students at the MSc ATC course, Sofia):

> *"Agent-based simulations could be perceived not only as a methodology to explore environment in terms of habitat but also to implement the outcomes in a conceptual development of a project. The graphical representation of movement suggests a substantial source of inspiration. For example, several congested layers of trails with fluctuating parameters would give us nodes and paths to explore and to implement into a future design; a 3D model of the agents' movement resembles a topography, it could be translated into urban environment or a map of public attractions."*

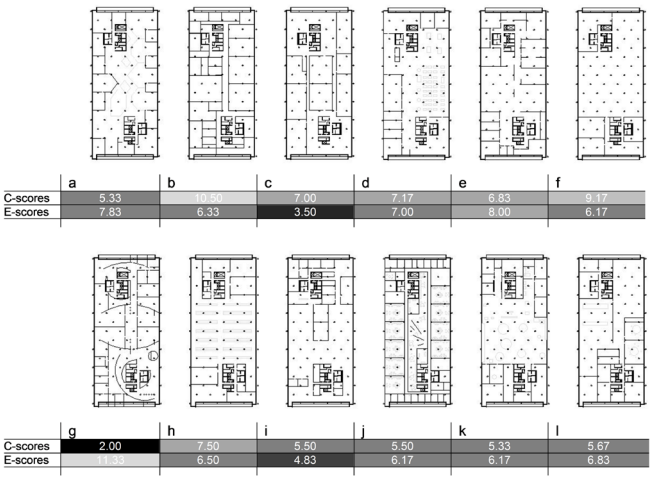
WORKSHOP 3: HOW CREATIVITY AND EFFICIENCY LINK TO VISIBILITY PERFORMANCE OF LAYOUTS

In this workshop, MSc SDAC students were to assess a set of design proposals for an architectural practice in terms of 'creativity' and 'efficiency'. The judgment is based on their 'expert knowledge' as architects. The exercise was scoped to increase students' self-awareness of what they recognize as 'creative' and 'efficient', and to test that against potential design performance through agent-based simulations. The experiment was, therefore, intended to increase learners' self-consciousness of their own judgment criteria and the implications of that on the configurations of their design proposals, attending to how these configurations might restrict or enable circulation and movement in a building layout.

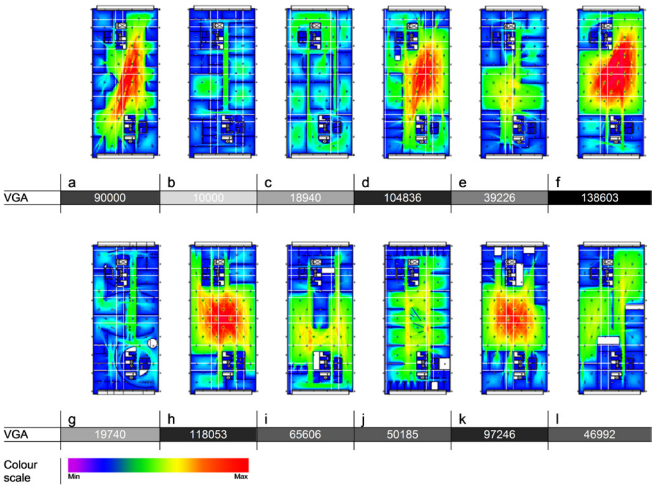
Based on the judgment criteria of six participants, the average scores yielded proposal [g] as the most creative design proposal, marking the highest average 'creativity' score (C-score), whilst design proposal number [b] was reported as the least creative (Figure 6). The average efficiency scores (E-scores) presented different preferences; students were more in favour of proposal [c] as the most efficient design. Remarkably, the most creative design proposal [g] came up as the least efficient one.

These results are compared to visibility graph configurations (through-vision analysis) that is basically the look-up table that cognitive agents use to make choices about where move next (Figure 7). It was noted that design [g], which was chosen as the most creative and least efficient design presented lower average through vision values (i.e. spaces in this design are less interconnected visually). However, design [b] and [c], marking the least creative and most efficient designs respectively corresponded to lower levels of through movement. With that finding, we concluded that the relationship between what students recognized as 'creative' and 'efficient' designs and the visibility performance of these designs was not discernible.

During this exercise, students developed skills to assess designs both subjectively and through evidence-based methods. It would be interesting in the future to compare their evaluation before and after analysing space. It is thought that through spatial analysis, students will develop better appreciation of the value of designing spaces as opposed to designing solid partitions.



▲ **Figure 6** Average 'creativity' scores (C-scores) and average 'efficiency' scores (E-scores) based on designers' expert knowledge. The scores (1-12) are averaged based on 6 observations; where higher scores indicated lower creativity/efficiency and lower scores indicated higher creativity/efficiency



▲ **Figure 7** Average 'creativity' scores (C-scores) and average 'efficiency' scores (E-scores) based on designers' expert knowledge. The scores (1-12) are averaged based on 6 observations; where higher scores indicate lower creativity/efficiency and lower scores indicate higher creativity/efficiency

WORKSHOP 4: COGNITIVE AGENT-BASED SIMULATIONS TO INFORM INTERACTION DESIGN

This workshop was part of the "Thinking Networks in Design and Research" project (2012-2013) funded by the Teaching Innovation Grant (UCL Vice Provost Education). Participants came from MArch GAD, MSc Architectural Computing (AC) and MSc Spatial Design Architecture and Cities (SDAC), The Bartlett, UCL. The delivery of the workshop tutorial was supported by a UCL lecturer, a lecturer from the University of Applied Arts Vienna and a number of postgraduate teaching assistants.

EXPECTED LEARNING OUTCOMES

The physical computing workshop took place between the 7-13 of January 2013 at The Bartlett, UCL. The title of the workshop was Demystify-Remystify. Its main objective was to demystify technology by using free hardware, electronic parts, resistive material such as graphite or velostat and various sensors in new and innovative ways, re-purposing electric circuits and learning about re-active art through reverse engineering and rapid prototyping. Above and beyond that, the workshop was to trigger students' interest in the impact of technology on human cognition and behaviour, in that it incorporated the interaction between humans and installations from a user-centred design perspective. The initial aim of the workshop was to demystify circuits and hidden systems within everyday technologies, the indirect aim was to complement the loop of learning by encouraging students to evaluate the impact of their learning outcomes on environment and behaviour in architectural layouts. This has informed them about possible ways to enhance the usability and attractiveness of their projects.

TECHNOLOGIES AND METHODS OF TEACHING

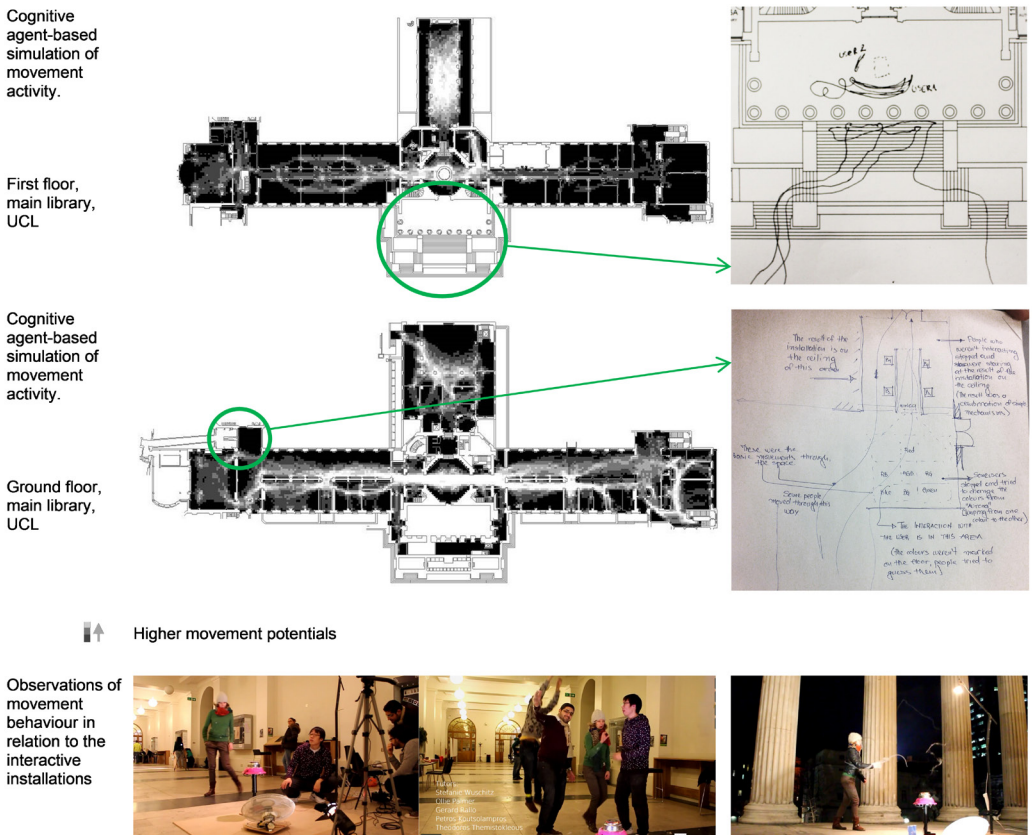
As part of the workshop, sensors, microcontrollers and actuators were introduced to students. Once a fundamental understanding of these tools was established, students worked in interdisciplinary groups to produce 5 installations which were tested in sites around the UCL's main campus (Main Library and North Cluster). Most of the installations were associated with library and exhibition objects, both from a spatial and conceptual framework perspective, as the learning objective was to reinforce the relationship between the designed objects and existing elements in the building layout (Duhs, 2011). The final element of experimentation was directed to observe how technologies become part of the social sphere of human experience, and test that through the use of cognitive agent simulations. Thus, students were to explore the relationship between digital and material practices in building responsive environments. They took photos, made documentation videos, observed how the library users would approach their installations and encouraged interactions with their project. With knowledge and experience accumulated in this user testing phase each group designed a poster and produced a short movie, some movies were posted online using the Vimeo platform.

OBSERVED LEARNING OUTCOMES

Students chose locations in the UCL building layouts using the agent-based simulations, in such a way as to maximise the visibility of their installations, and then reported on the observed user interactions with their interactive installations through sketches (Figure 8). As a result of these observations, students became more aware of how spatial configurations might influence users' behaviour and interactions. They were able to separate the role of different sensory information; light, colour, movement dynamics of the installations, and learn about the temporal dynamics of interactions. Some groups decided to amend their installations, in order to narrate their performance and synchronise it with different scenarios of users' movement in the immediate environment.

CONCLUSION

The workshops discussed in this paper presented an attempt to devise computational techniques and technologies in design and decision-making. They did so by exposing students to mathematical representations that would inform their design decisions. In this learning process, the level of engagement was evident in the general explorative design trend, and demystified in the learning outcomes. Design originality arose through a systemic and procedural set of actions where a new task is only declared after the completion of the former one. Following this logic, the instrumentalization of knowledge



▲ **Figure 8** Screenshots of observed user behaviour in relation to installations (e.g. "AeroCandyFloss" project). The installations are placed considering simulated cognitive agent-based movement patterns in the library layouts

and past experiences in design thinking was externalized to distinguish between subjective evaluation of designs and rational knowledge-based reasoning.

In what concerns rendering the non-discursive discursive in architecture (Hillier, 1996), the designed pedagogies have led to the following key learning outcomes.

- In Workshop 1, students developed analogical descriptions of urban form and function learning from past experiences and design knowledge and assigned these descriptions to abstract representations of street networks.
- In Workshop 2, students explored how a procedural design course of actions that gradually shifts from analysis to synthesis might be approached differently by each designer.
- In Workshop 3, students explored how an increase in designers' self-awareness of their judgment criteria - exemplified in how they assess creativity and efficiency in designs - might be related to layout visibility configurations.
- In Workshop 3, students have also become more aware of the value and aesthetics of space design as opposed to designing solid partitions.
- In Workshop 4, students developed an understanding of how digital installations might be embedded in a building environment, and how users might interact with their installations.

In observing design activity, it was proving to be difficult to distinguish between designers' subjective evaluation and knowledge-based reasoning, despite the effort to externalise design knowledge. The uncertain nature of design might allow for the thought that absolute objectivity is unrealistic. However, there were non-trivial advantages in discursive practices of design thinking that allowed for improved Observed Learning Outcomes (OLOs). It is therefore suggested that embedding such practices in architectural education would help reinforce the research-design loop.

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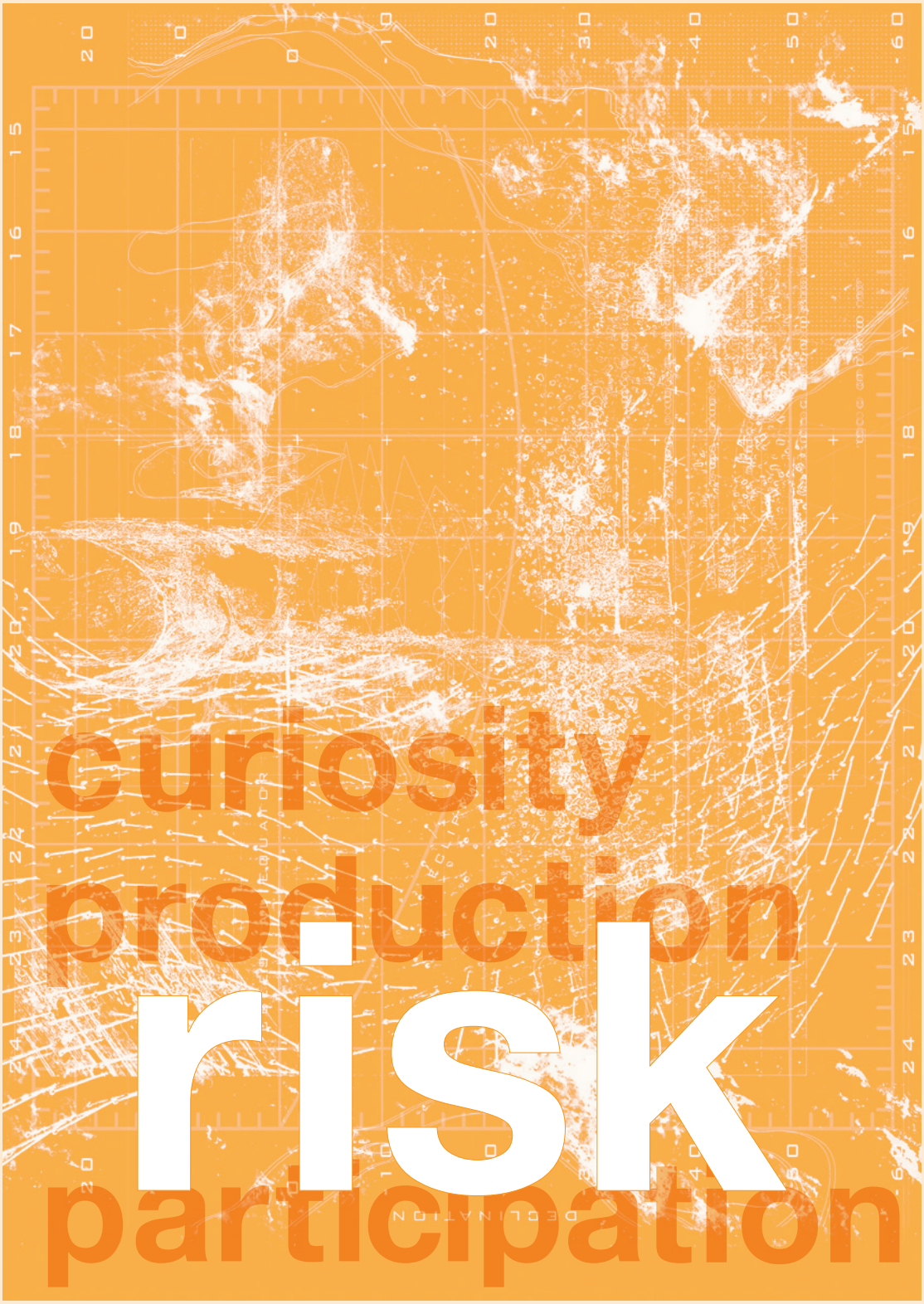
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curiosity
production
risk
participation

Keynote

Lesley Lokko

A risky business

‘Are we simply fighting over the past because of our inability to build a future?’

It’s a strange, unsettling and yet exhilarating time to be in architectural education, especially in Africa. Globally, insofar as one can glean from anecdotes and e-mails, the talk is of change, risk, opportunity, shift. Here, in contrast, students are up in arms. They throw sh*t at statues, they set buildings and cars alight and they’ve successfully brought the Minister of Education to his (metaphorical) knees. #FeesMustFall began life as #RhodesMustFall, the campaign to topple Cecil Rhodes’ statue outside theUniversity of Cape Town. He did fall, and fairly promptly, too. But that was only the beginning.

The upcoming AAE conference is framed around four main themes: ‘curiosity’, ‘risk’, ‘participation’ and ‘production’. Each of these has special resonance and relevance in the complex and often contradictory relationship between South African society at large and its built environment. In South Africa, the very idea of a shared culture or values-in-common that might transcend the specificities of place, language, history and ‘race’ remains an ever more elusive pipedream. The question of what and how we might teach our current and future young architects is equally elusive. African schools of architecture have yet to attempt – never mind resolve – the profoundly complex translation of indigenous, pre-European built environment beliefs, histories, relationships and ways of seeing the world into a functioning, relevant and accessible architectural curriculum. One poignant reading of the fervour surrounding the #RhodesMustFall campaign is provided by Ferial Haffajee, the editor of the weekly City Press. ‘Are we simply fighting over the past because of our inability to build a future?’

In her wonderful interrogation of the American literary imagination, the African American writer Toni Morrison speaks of the importance of recognising a writer’s notions of ‘risk’ and ‘safety’, and of being aware of the writer’s ‘sweaty fight for meaning and response-ability.’ Last year, at the University of Johannesburg, embracing such a fight, we began a rather risky experiment. We brought the Unit System to Africa and believe me, that’s not hyperbole. It was fraught with risk: from finding the right teachers to placating disappointed students, sourcing support and funding in unending, limitless measure. In two years, the graduate programme went from 12 to 90 students. It’s too early to tell if it’s worked. There’s a reason why political terms and accreditation visits happen at four- or five-year intervals. Change is a slow, complex and unpredictable business and few institutions will take the risk, least of all a new university in one of Africa’s most problematic cities with its violent history of spatial segregation. But equally, nowhere in the world (at least to me) is the call for ‘new forms of knowledge’ more urgent than it is in Africa. If we’re not in the business of producing new knowledge and taking the odd – or even major - risk, then why are we here?

◀ Lucille Jacobs: Year 5, Unit 12, GSA 2015

Code-breaking: curiosity through the critical examination of 'cultural software' in architectural education

Luke Pearson
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ABSTRACT

As computational technologies continue to proliferate in architectural education, from digital fabrication and parametric design to BIM, the underlying socio-political implications of the software used every day by students is rarely questioned. This paper will call for architectural educators and their students to examine where our reliance on software of all forms is leading the profession. Lev Manovich's writings on new media have exposed how the type of creative software packages we teach students to use, which he terms *cultural software*, have developed on a trajectory that both simulates and subsequently extends traditional modes of representation. Manovich defines how Photoshop has affected visual tradition, transforming the collage from a radical statement performed through pictorial juxtapositions to the smoothed and blended apolitical imagery we see in the contemporary architectural rendering. Likewise, the proliferation of software for leisure such as social media and videogames and the influence they have on the politics of the user has been discussed in the works of Manovich, Ian Bogost and Alexander Galloway, however not with a specific focus on their meaning for architectural education and practice.

This paper considers the ways in which architectural students can become more curious about the software they use to design, communicate and mediate the city around them, and how they can shape the politics of the profession through this attitude. The paper will introduce a series of case studies, outlining strategies for curiosity through reference to design projects including work produced by students of my studio. One case study involves investigations into popular mapping technologies such as Google Earth, and how the 'glitches' within the algorithmic application of photographic textures onto 3D geometry can be seen as a new digital vernacular. A further example will examine the role of Minecraft as a non-specialist tool for architectural design, and question what impact recent movements to use the game for public engagement with city planning processes might have on the profession. Other case studies explored in the paper include the potential role of free game engine software such as Unity3D and low-budget virtual reality systems including Google Cardboard in allowing architects to produce fully navigable virtual spaces and how this provokes curiosity through the enabling of spatial and atmospheric prototyping. The paper will argue that we can use the new media theories of Manovich, Bogost and Galloway to outline design methodologies for students promoting the curiosity to question, reject, or break the software and interfaces they are

typically trained to be proficient in. I argue that despite institutional drives towards the technological 'cutting-edge', much of today's most technically and politically engaged student work will come from those who seek to peel apart the technologies we might dismiss as every-day - our free tools for seeing the world around us, for consuming, generating and communicating pop culture or for creating interactive fictional spaces and stories.

PAPER

We can say with some certainty that any architectural student undertaking their education today will at some point produce work using software. Whether or not they choose an institution or studio that aligns itself with 'computational design', or instead pursue agendas that privilege say, hand drawing or live-site work, it is highly likely that some form of software will be learned and used in the production of a project. This might be an *Autocad* drawing for fabrication, a Photoshop visualisation, or the production of a portfolio on *Indesign*.

These applications are what media theorist Lev Manovich (Manovich, 2013) has termed *cultural software* – "certain types of software that support actions we normally associate with 'culture.'". This software does not necessarily require knowledge of code, and typically utilises a Graphic User Interface (GUI). Yet as Manovich points out: "Given that today the multi-billion dollar culture industry is enabled by media applications, it is interesting that there is no single accepted way to classify them." Manovich's attempts to categorise these programs and frame their impact might leave an impression on how we understand the relationship between architectural design and software. What I believe to be key for education is how we interrogate our day-to-day operation as designers today. As Manovich says, this concerns our use of software on many levels:

> "Therefore, if we want to understand how software has already re-shaped media both conceptually and practically, we have to take a close look at the everyday tools used by the great majority of both professional and non-professional users – i.e. application software, web based software, and, of course, mobile apps."

In looking at cultural software we may also be forced to admit that the energy of Internet communities and the creativity of 'amateur' designers (if that definition holds) challenges the boundaries of the profession. When the Smithsons (1956) said "But today we collect ads" they positioned themselves in the lineage of Gropius' interest in grain silos and Le Corbusier's fascination with aviation. But advertisements were different from industrial technology, representations designed to create impulses in popular culture. The Smithsons declared that architects could learn from the 'pace-setting' of the advertising industry and its engagement with ordinary people. Reyner Banham (1981) was similarly documenting the effects of mass produced pop cultural *gizmos* and media on our landscapes. Contemporary writers and artists such as Douglas Coupland and James Bridle give us some sense of the current situation – Coupland's *Generation X* (1996) and pixelated Orca whale statues and Bridle's blog-cum-art-movement *The New Aesthetic* (2011) becoming a repository for the collected debris of our digital realms, ironically brought together under one snappy title.

It seems none of these projects were necessarily defining the 'epochal' architectural style of our time but were about elucidating links between architecture and technology through everyday technologies that affect most people. *Reddit* can be a hive of questionable internet culture, and a platform via which the US President can communicate. The virtual city of *Los Santos* in *Grand Theft Auto V* can have over 54 million visitors in two years

(Loveridge, 2015) and 48 minute daily cycles. Do we as educators retreat from the intensity and diversity of activities taking place on blogs, feeds and forums, in free paint programs or in videogame worlds - or embrace them, like the Smithsons or Banham would have?
By fostering curiosity towards how such cultural software has altered traditional methods and media of architectural design, we can encourage learning that embraces all the contradictions and conflicts of our technological world, rather than aligning ourselves to one camp of 'digital design'. Drawing from the work of media theorists such as Manovich and Alexander Galloway, and game theorist and designer Ian Bogost, this paper will attempt to outline ways in which we might we encourage the curiosity to question and subvert the tools that mediate our modern cities. To do this I will introduce some case studies of student work that I feel is beginning to 'code-break' some of the logics of digital pop-culture and derive architectural agendas from it. These examples would not be considered 'digital design' in our typical understanding of the term - instead they peel apart cultural software conditions and discover how architecture might exploit these new situations.

REMEDIATING REPRESENTATION

In *Software Takes Command*, Lev Manovich outlines a history of 'cultural software'. He uses a set of pioneering computer engineers as reference points, in particular the *Sketchpad* work of Ivan Sutherland (Manovich, 2013) to create "a communication system between two entities: a human and an intelligent machine." He demonstrates software that first 'remediates' existing media (for instance, pen on paper) and then extends its capability (for instance repositioning vertex points along a line in CAD).

CAD remediates and extends the line drawing. *Photoshop* remediates and extends painterly and drawn effects, as well as photomontage and collage. 3D modelling software encompasses both planes and (in software such as *ZBrush*) a sculptural process of hewing form from a material, extending into rendering and fabrication. BIM remediates the organisation and interpretation of drawn materials and adds the functionality to quickly export further media from a master model.

Manovich makes clear that we cannot entirely divorce our work in cultural software from history:

> 'These new media would use as their raw "content" the older media which already served humans well for hundreds and thousands of years – written language, sound, line drawings, and design plans – and continuous tone images (i.e. paintings and photographs). But this does not compromise the newness of new media. Computational media uses these traditional human media simply as building blocks to create previously unimaginable representational and information structures, creative and thinking tools, and communication options.' (Manovich, 2013)

Every time a student or practitioner constructs a collaged view in Photoshop, or produces a site map using GIS data, we are utilising programs that take many of their principles and symbolism from non-digital media that came before. But this does not mean they have not changed them irrevocably – becoming tools of "permanent extendibility" (Manovich, 2013). Manovich questions whether Photoshop may have turned the photomontage from a political device into one that smooths over difference, the tool used by architects and students the world over to obfuscate undeveloped parts of the scheme that did not meet the deadline.

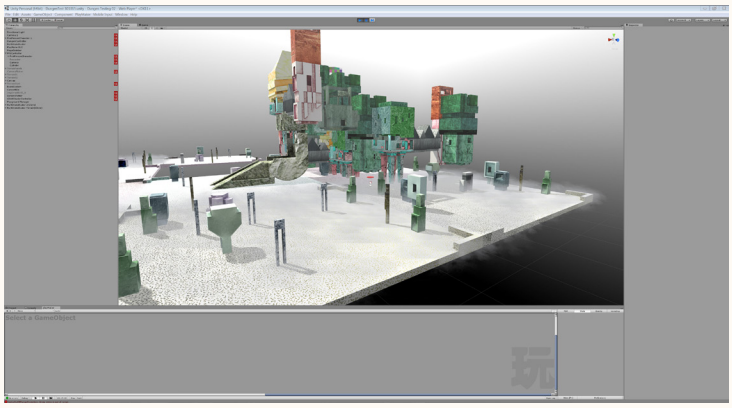


Figure 1 Author's own screenshot, Unity 3D Game Engine. 2015

To see the seductive images of an end-of-year show or in an international competition is often to see Photoshop wielded in such a way, a texture applied here, a contrast adjustment there, a generic tree or a person smoothed into the context and equalised. But can we encourage the use of these remediating and extending tools in different ways, to reintroduce idea of the rupture as a tactic? Being critical about software is doubly important when we use the same techniques in study or research as in commercial work.

Manovich has previously described virtual "navigable space" as a form of *new media*, and he holds off committing to whether this is a remediation of physical architecture or not. With the rise of easily obtainable game engine software, the ability to produce virtual spaces has become simpler, with engines able to import 3D models from standard architectural modelling programs. If game engines do remediate and extend architectural space, they do this through logic, physics and rendering systems. But if one makes a building model and uses a game engine for a *walkthrough*, it will appear differently on *Unity 3D*, *Unreal* or *Cryengine*.

We can also add rules and protocols to interactions in our virtual building that allow us to design the ways the user can engage with it. These are the rules can make arguments that Bogost (Bogost, 2007) terms "procedural rhetoric." The virtual navigable space allows us to extend architecture through the application of rules and representations directly into it. Clearly the simulated space is a representation in itself. But their internal collapse of the gap between representational rule and experiential space seems to open up new opportunities for design.

With low cost VR technologies such as Google Cardboard we can imagine this enmeshing becoming much more obvious, as one can have a 1:1 equivalent viewpoint into a 3D navigable space. Is there then the potential to 'inhabit' a space mediated by representational rules – do game engines offer us the chance to *live the drawing*?

I would suggest that the future of architectural 'code-breaking' might not be in photorealistic walkthroughs, but in students becoming curious to exploit the aesthetic possibilities of videogame space for speculation. By combining the procedural and representational, game engines appear to be the cultural software that may allow us to encode persuasion and politics into navigable space. But if this might be the preserve of new speculative projects to come, what does cultural software *currently* do to our physical world?

GLITCHING SPACE

Our conception of the 'site' is now under the pull of technologies for the 'remote viewing' of space. Student projects and competition submissions sited across the world utilise *facsimile* versions of the built environment, the spatial information brought to hand through various cultural software. These interfaces are undoubtedly useful, even liberating in the possibilities they offer to traverse and comprehend remote locations. But they are by no means devoid of politics or potential inconsistency. As Mark Dorrian (Dorrian, 2013) argues, if the famous 'Blue Marble' photograph of the earth taken by the Apollo 17 astronauts framed the planet as a "single organism", then the "suturing" of multiple images together into the Google Earth globe – as he puts it – demonstrates a globe under the logic of surveillance imagery and algorithmic processing.

While it may appear architects now have the ability to explore a site from wherever in the world, it is not without its errors. The 2012 release of Apple Maps was accompanied by copious screenshots detailing the glitches that saw freeways melt into hills, monuments become flattened and cities moved hundreds of miles. Sites such as http://theamazingios6maps.tumblr.com/ popped up to document this weird new urban realm of glitch and half-truth. As with much cultural software activity the identification and communication of these errors was firstly through Internet communities and social media users. Through their exposure of the everyday glitch these users opened up new lines for architectural curiosity that question the status of the site itself.

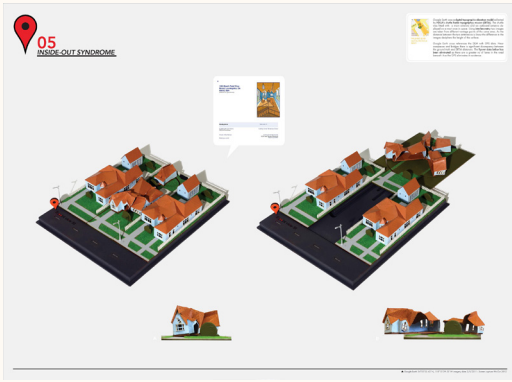
But as these slippages and meshes that take place in software are also clearly sited in reality – are there new hybrid sites with which to engage? Away from the rarefied atmosphere of the pavilion or prototype, cultural software such as Google Earth demands our curiosity because it reframes real places and turns layers of our cities into new sites. As Bogost points out, the algorithm does not work in a vacuum:

> "It's not just mapping software running via computer—it also involves geographical information systems, geolocation satellites and transponders, human-driven automobiles, roof-mounted panoramic optical recording systems, international recording and privacy law, physical- and data-network routing systems, and web/mobile presentational apparatuses." (Bogost, 2015)

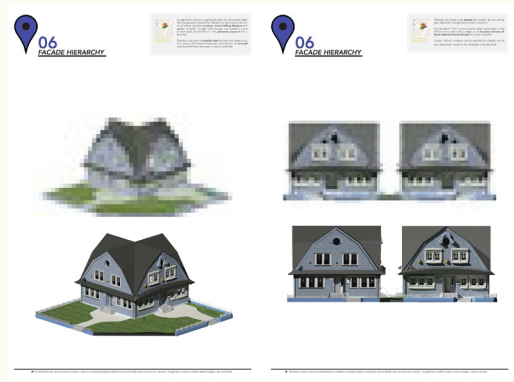
We can see many layers to the real world that are being pushed and pulled by their virtual framing. Roofscapes become the primary elevations for architectures viewed by satellites. Dubai already expresses its economic and political hubris through buildings designed to be seen from space. To explore the aesthetics of *Google Earth* is to question these layers of digital "scrim" (Crandall, 1999) combining with physical sites. This is about new values placed upon our towns and cities by such cultural software. As educators it seems important to reflect that the computational and digital are *never* isolated from the world they inhabit.

My first case study is an undergraduate student Chiara Barrett, whose work tackled precisely these issues – that our built environment is being mapped and recorded in new ways, and that we, as architects should interrogate this.

Chiara's research was entitled *The Tenets of Google Picturesque*, and was produced as part of a project we ran called *Facsimile* in 2012. We asked students to critique the tools they would use to remotely understand a city and propose modes of engagement from afar before visiting it on a field trip. Her project sought to peel apart the ways in which



▲ Figure 2



▲ Figure 3

Google Earth combined modelled geometry and texture mapping in its three dimensional cartographic representations. As explained by Clement Valla (2012), this combination is automated through a patented algorithm called *The Universal Texture*, and Chiara's research sought to unpeel how physical architecture placed into a city may provoke this algorithm into certain behaviours through its design. In this case then, an algorithm used by millions every day as part of a cultural software program is seen as something architecture could react to in physical space, a form of site context.

Studying the city of Los Angeles, Chiara developed a classification system for the different types of glitches that appeared while traversing a representation of the city using *Google Earth*. As an algorithm applied to representations of cities, she identified how *The Universal Texture* behaves in certain ways in particular situations, thereby establishing a series of typologies for cause-and-effect scenarios within which an architect might engage.

In one example of behaviour, *Façade Hierarchy*, [Figure 02], the quality of mapped imagery varied between the size and perceived importance of roadways – main roads had higher quality mapping, producing buildings that had 'slippages' between different resolutions across their facades. Taking a house in the Pico-Union district as a case study, she proposed disruptions to one face of the building, distorting and abstracting its joinery and ornamentation within a gap that Google Earth opened through the resolution slips of its texture mapping. Another typology *Inside-Out* [Figure 03] dealt with how the algorithm appeared to collapse buildings and turn them inside out producing strange interior conditions. And a further study, *Vessel Distortion* [Figure 04] explored how buildings might react to the precise height and position of the Google *Streetview* car photographing elevations. In these cases, the behaviour of the *Universal Texture* algorithm gave Chiara new sites for engagement, that slipped between virtual and the real.

The study trip becomes particularly important, allowing one to judge the situation on the ground and make comparisons with the represented version of a city viewed remotely. Being able to scale and record a site, seeing its cultural and physical context with our own eyes, allows us to remain critical of the mediated versions of reality that we are given by the proprietary systems of Google, Bing or Apple. For a curious student, perhaps there now exists three sites, the real site, the mediated equivalent, and the ruptures or gaps between the two. Of course, the glitches Chiara observed in 2012 have now most likely been smoothed over.



Figure 4



Figure 5

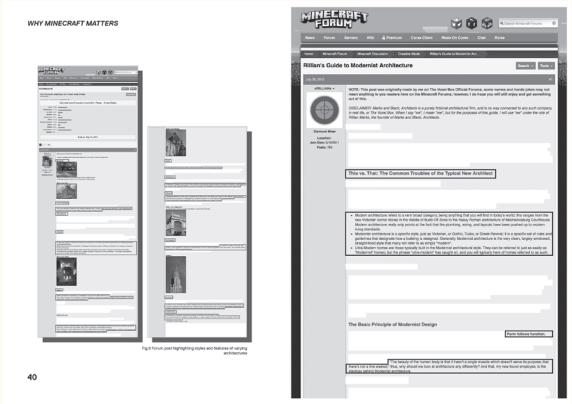


Figure 6

This was not a 'digital' project in the conventional sense yet it was predicated on exploiting the gaps between the version of reality we are presented by cultural software and physical conditions – drawing the algorithm out of its isolation and into a context. I believe our role as educators in this process is not to just dispense paradigmatic approaches towards the digital, but encourage a healthy desire to question what we are being offered by 'progress.' After all, nothing is free, Google's cultural software blurs boundaries between consumer and producer further by offering open services in exchange for monetising our personal information.

In Chiara's case, the exploitation of glitches became a methodology for the production of further projects, designing a governmental building and questioning ruptures between the illusion of transparency and security.

In blurring boundaries between a building and its facsimile, I believe she developed an architecture critiquing Galloway's (2012) version of our society of control: "Reflective surfaces have been overthrown by transparent thresholds. The metal detector arch, or the graphics frustrum."

If our perception of physical context has been changed by cultural software, and can offer new ways of thinking about digitality, then the next case study explores how a social context might grow and blur the divide between 'professional' and 'amateur' architectural practitioners.

CRAFTING COMMUNITY

When we examine how cultural software might affect architectural practice what sources might we draw from? Platforms such as *Tumblr* or *deviantART* provide the ability to showcase and transmit designs, being flexible enough to run from a blog of reposted memes to a primary portfolio of work. If cultural software such as *Google Earth* has given

us new gaps in space to exploit, then online communities may make us question our social context.

My second case study is a Masters Thesis student I supervised, Marcus Stockton, whose study *Importance of the Block: Why Minecraft Matters* (2015) attempted to outline what impact the popular videogame might have on architectural design. Minecraft (Mojang, 2011) is possibly the most well-known videogame in the world, a landscape of colourful blocks where one literally mines cubes of terrain and crafts using particular material combinations to produce a whole range of different built elements.

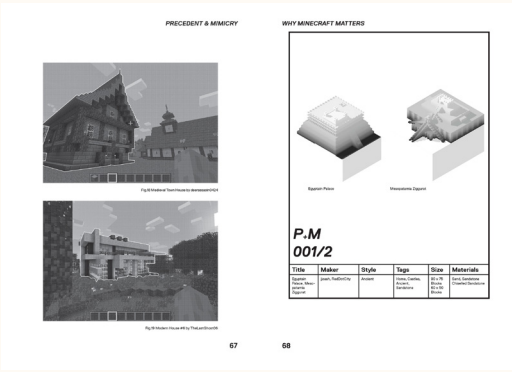
Its saturated visual style melds *generation Y* videogame nostalgia with the world of Lego, and has turned *voxelisation* into a trend reflected by cultural software such as *Qubicle* (Minddesk, 2015).

Minecraft has a 'Survival' mode that is notionally the 'story' where the player must make shelters in order to protect themselves from monsters emerging at night. But it is the free reign to build spaces and construct communities that has elevated it from a small-scale 'indie' game into a global phenomenon. Throughout this process the feature-set of the game has grown, as has the user base, and the wealth of its creator, Markus 'Notch' Persson. But many of the decisions on the feature set and logics of the game were developed through close conversation between Persson and the Minecraft community on internet forums.

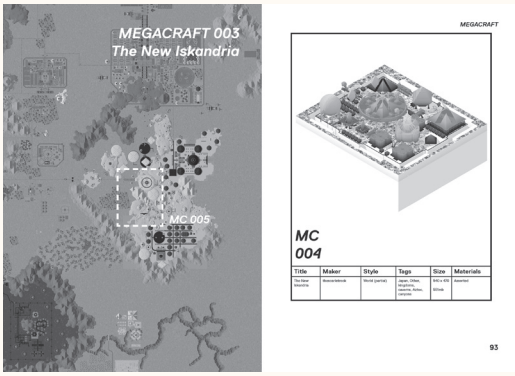
The game spent two years from its initial release in Alpha and Beta as a growing, unfinished product. During this time the community expanded and participated in this testing process, contributing their ideas to the software. As such, in initial conversations with Marcus it became clear to us that the only way he could adequately judge the growth of this game, and its impact on architecture, was through using the websites on which they congregated as a source itself and participate in that community.

Minecraft has a large community exploring the possibilities the game offers as an ersatz architectural tool. As Marcus discovered, it was the second most searched term in Youtube in 2014 (Stockton, 2015), and there is a huge number of people sharing video tips and tricks for building structures within the game. Alongside this, there is a large number internet forums such as *Minecraft Builders Inc.* with complex manuals for the constructions of certain building typologies and strategies for success in exploiting the randomly generated environments that Minecraft provides at the start of the game.

Furthermore, Marcus' research utilised some of the gamut of *freeware* programs designed to transfer information to and from Minecraft itself. These modifications extend Minecraft from a game into a cultural software under Manovich's terms - for reading and writing information. *Chunky* is a freeware program for rendering within Minecraft giving users to the ability to create high quality imagery of their creations from multiple viewpoints. *Mineways* is another program for exporting terrain from the game into file formats for full colour 3D printing. This has since extended into *Printcraft*, which claims to be "the world's first 3D printing multi-player Minecraft server". Users can log onto a specific multiplayer server with a landscape cultivated for free building. Here, the cultural software extends into the built fabric of the navigable game space itself: "Build something inside the plot. When you are ready press the PRINT button on the control panel. This will send you model off to be processed and write a web link into the Minecraft chat. Click on this link to open the model on www.printcraft.org." (www.printcraft.org)



▲ Figure 7



▲ Figure 8

Printcraft is but one collaborative system for the production of designs within Minecraft. Through participating in Minecraft communities and utilising their tools Marcus was able to build a system for categorising different types of behaviour within the community in order to understand how this cultural software worked for them. Identifying typologies allowed him to demonstrate certain approaches or techniques that players adopted in order to create structures within the game, offering insight into what their motives might be. In Marcus' case, these examples varied from small shacks designed to ward off monsters through to the "Precedent and Mimicry" [Figure 7] of real world structures (Stockton, 2015), and onto huge collaborative cityscapes, "Megacraft" [Figure 8] with their own laws and governments. Played in a first person perspective, Minecraft also relies on elaborate choreographies from the user, for instance jumping and placing blocks beneath oneself to act as a form of ladder. These techniques would be shared, as communities explored the limits of the game together. The locomotive constraints of the virtual avatar present architectural challenges within the game that the community has overcome in many creative ways.

As Marcus discovered, to delve into the Minecraft community was to reveal the game as a popular tool for ersatz architectural design – which he termed 'Rise of the Amateur' (Stockton, 2015). While Minecraft's voxelised world with its procedural generation sets the basis for its material composition - what can be *mined* - it is the creativity of its user base that has turned it into cultural software proper. Despite no statistical evidence, it is fair to assume that the vast proportion of Minecraft users (numbering over 100 million) are not qualified architects or training to be. What he ultimately found, is a large community of 'non-experts' producing structures that are communicated via web forums, *YouTube* or *Twitch* with a reach in terms of hits and views that an architect could only dream of. Indeed, a video of the very first build of Minecraft still sits on ***YouTube*** with 9.9m views (Persson, 2009).

We can already see Minecraft being adopted as a tool for architects and planners because it provides a very direct way to engage with people. Marcus cited the ***Blockholm*** initiative by the Swedish Centre for Architecture and Design in 2013, which used the game to engage with citizens having transcribed the city of Stockholm into the game. (ArkDes, 2014) Or *Block by Block* where Minecraft developer Mojang collaborated with the United Nations to provide a tool for residents to decide on changes to their villages and towns, beginning with a playground in Nairobi (Mojang, 2012).

It is clear then, that the game has grown and spread into a piece of cultural software that is being applied strategically by architects, but what was so interesting in Marcus' study from the position of an educator, was the curiosity to look into the emergent communities that effectively helped build the phenomenon in the first place. Within these places, Marcus found all manner of 'amateur' creativity taking place – computational pop culture growing into a social and spatial tool.

To turn again to the Smithsons (1956), here we see an incredible 'pace-setting' – large communities inventing and extending cultural software in order to use Minecraft as a tool for spatial design, whether or not they fit within the confines of the architectural profession. Marcus produced a thesis through virtual site work and reportage, exploring conditions on the ground so to speak. As educators surely we need to recognise that new generations of architects will be ever more familiar with cultural software and their online communities – what possibilities for creativity they present, how they challenge the notion of expert and push at the boundaries of what architecture might be.

CARICATURES AND COMMODITIES

One of the main powers of videogames as cultural software (or product of) is that they twist versions of reality under their rules, and those rules can say something – much as Minecraft's rules instigated a landscape of free creativity. Ian Bogost argues that all algorithms "take a complex system from the world and abstract it into processes that capture some of that system's logic and discard others" (Bogost, 2015). For Bogost, videogames are the sole type of algorithms which celebrate the fact they are caricatures, and this is their potential power as a critical tool. Indeed, Bogost himself has written at length in *Persuasive Games* (2007) about how videogame rules promote certain behaviours in players. So if we move on from Marcus' study of Minecraft as a platform for 'amateur' expression – are there other games that students might study for their persuasive qualities, and what it is that a computational caricature might give back to us as architects?

For my final case study I would like to introduce the work of Agostino Nickl which was produced as part of a 6-week workshop entitled *Pressure Drop* in 2015. For Agostino a first interest in the suburban drift of Chicago led to the search for studies or representations of these spatial conditions from which to develop a design agenda. One of the most culturally pervasive but curiously abstracted representations of suburban life - with its economy of mass production and commodification - is *The Sims* by Maxis – a 16 year old series of 'life simulator' games. In an autobiographical move, Agostino chose to analyse the original *The Sims* (2000) because it was a game he played as a child, a virtual dolls house for a new generation of architects.

The Sims is arguably a consumerism simulator, Sims work to make money, and their happiness metrics are determined by objects placed within their suburban homes. Although we see our Sims day to day lives, we never see the world from their perspective like Minecraft, but from a disembodied 'god' view. Watching a virtual life unfold from this close, yet detached view is – as Michael Nitsche (2008) argues – akin to our obsession with reality TV.

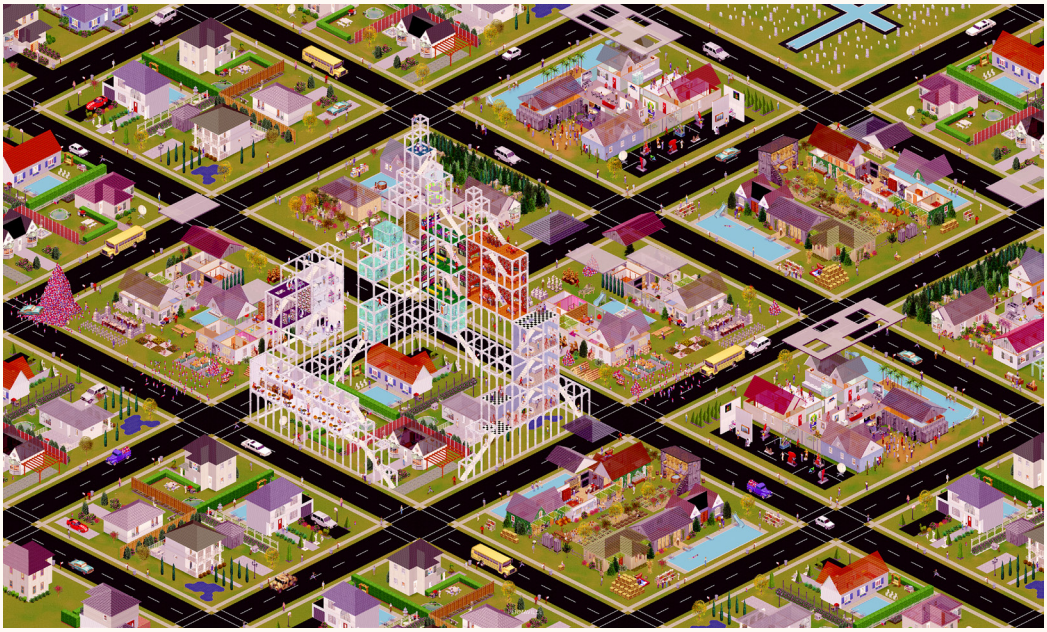
If The Sims is a caricature of suburban life, then Agostino was interested in how the suburban home and its objects contributed to these metrics of happiness, and how its cartoonish logics may be persuading us towards certain behaviours. In Bogost's terms, the game is *persuading* us to make our Sims into productive citizens, who get a better job, to earn more money, to consume more, and repeat. Because this is a videogame it wears its



▲ Figure 9



▲ Figure 10



▲ Figure 11

caricature status on its sleeve (Bogost, 2015). Agostino developed a series of tactics for disrupting its systems – to the extent of exposing them to the physical world.

In order to draw out the suburban logics of *Pleasantville*, Agostino had to play it. And in doing so, he rediscovered its critical agency and relocated some of The Sims' *persuasive* (Bogost, 2007) aspects back into the real world. Through a series of calculations, Agostino revealed that the typical daily cycle of a Sim leaving for work to earn money and returning in the evening to spend it on commodities could be reversed. In fact, self-employment and working from home were more efficient ways to create wealth. He identified *garden gnomes* as Pleasantville's most efficient economic activity. Through playing the game Agostino found that a Sim at the maximum 'crafting level' could produce 21 gnomes per day, netting themselves an income of $2100.

Gnomes are a serious business. As they also are in the original town *The Sims* caricatures. On April 17th 2014 the Levittown police logged the theft of a *Philadelphia Eagles* themed

gnome (Sofield, 2014). With an estimated value of $25 in reality, one quarter of the in-game value, it appears *The Sim*s really has privileged the importance of gnomes to its economic system. As such, his proposal, entitled *Permaville*, sought to rebalance the spaces of suburbia through collective living predicated on the gnomic economy.

The gnome became emblematic of *The Sims*' economy – and ironically it seems, is not too dissimilar to our real working situations. As Galloway (2012) argues: "It is impossible to differentiate cleanly between non-productive leisure activity existing within the sphere of play and productive activity existing within the sphere of the workplace." This reinforces the fact that technology cannot be separated from politics or indeed frivolity – we might encourage students to marvel at Amazon's advanced algorithms for picking objects out of a warehouse, but as Bogost (2015) argues, to see how multitudes of people are involved in the chain we only have to look at the world. For instance, the CHINA photography of Edward Burtynsky, or recent revelations about *Sports Direct*. Having revealed gnome-making as a lucrative profession – Agostino set out to compare this digital caricature to reality, by becoming a gnome maker himself.

Agostino constructed three gnomes to compare with the material economy of The Sims. One was carved by hand from timber, one 3D printed and one CNC machined. [Figure 9] By producing a time lapse film, *Reality Check*, he was able to relate the rates of production between a handmade object, an object that requires formatting in cultural software in order to be machined, and how quickly a Sim would do an equivocal job. [Figure 10] The gnome becomes an artefact that straddles the digital and the hand crafted, each displaying a different quirk unique to its method of production. He then developed Permaville into a townscape [Figure 11], drawings composed using screenshots from the game - where suburban plots were allowed to develop in different directions according its logic of suburban productivity, a once idyllic landscape overflowing with gnomes. For Agostino, The Sims and its caricature of suburbia gave him a route into a critique of real logics of mass produced and commodified architecture.

If this seemed an ironic application of videogame logic onto a suburban townscape, writers such as Galloway (2012) remind us that it is not so different from reality. Young people in China genuinely do farm gold in *World of Warcraft* as a new form of networked menial labour. Agostino's application of the gnome reminds us that cultural software bridges the gap between the computer and the physical artefact, and that there might be embodied symbolism and politics in the objects that emerge through our fabrication machines – if we encourage students to look deep enough.

Code-Breaking

To teach, or study, architecture today, is to be implicitly engaged in the use of software. In the case studies I have shown, I have attempted to outline methods and projects set up to expose other avenues in which technology has had an impact. To ignore the massive changes in popular culture caused by computation, to chase the tail of the 'avant-garde', will miss the chaotic, contradictory, symbolic and emergent properties of digital culture today, from software *modders* to grandmothers on *Facebook*. Just as the Smithsons were attempting to code-break advertising in order to understand how desire was mainlined into the population, so today we should encourage our students to break their tools, to find glitches between digital and physical and to develop Frankenstein architectures that remix, mashup and caricature.

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Palimpsestuous design: Playing with architecture

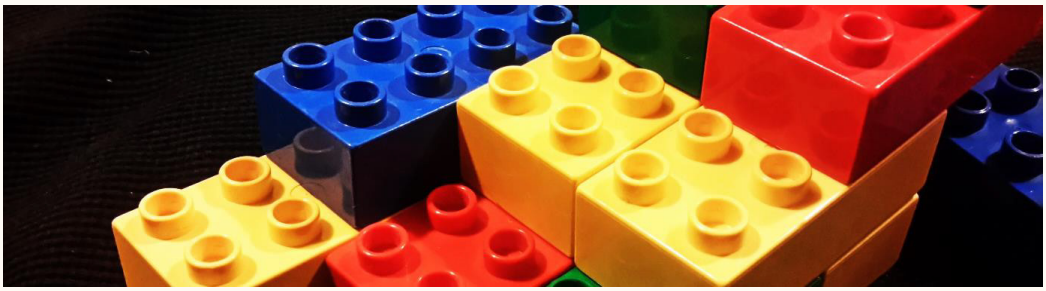
Paula Craft-Pegg
University of Portsmouth, UK

"The contrast between play and seriousness is always fluid. The inferiority of play is continually being offset by the corresponding superiority of its seriousness. Play turns to seriousness and seriousness to play. Play may rise to heights of beauty and sublimity that leave seriousness far beneath." – Huizinga, *Homo Ludens* (1938).

INTRODUCTION

Play of light, play of shadow, play of architecture… the role of play is part of our enculturation, central to our development as children, and forms a part of our enjoyment of spaces and places throughout our lives. Curiosity, risk and participation are part of this play, structured by the rules of games - from the physical and digital through to the academic lens of ludic architecture. Game design is based on the key principles of intrinsic and extrinsic motivation, with objectives, activities and accomplishments. Given the complexity of architectural education, and the palimpsest of influence and experience embedded in every aspect of the profession, this paper will explore how we can use game design pedagogy as a lens to potentially transform architectural education and practice, and as a tool to encourage curiosity and risk, to educate and inform. A brief summary of key play and game design principles will be used a framework to discuss some historic and contemporary examples of projects for in studio and professional practice.

Why is this important? Because most of our students will have played more games, and specifically video games, than we can imagine. They have a different framework for learning, and through playing games - take risks, receive immediate feedback, and rewards. What does this mean for us as educators? If you begin playing games, following the same principles of design, from the age of six, and continue to play them, more and more and more… the principles of game play can be formative. Recent research, but the UK Education charity Nesta, suggests that game play and game design can both work as teaching tools. Case studies conducted by Nesta, demonstrate the design of games help develop creative and critical thinking, and stimulate higher functioning skills. Critical thinking is developed through the critique of existing and peer developed games, collaborative skills are enhanced when working in pairs, and research skills are developed through the both the type of game and game content and topic, creativity skills in the design, and problem solving skills in working out how to make a game more challenging (Ho, 2013).



▲ **Figure 1** Lego play as free and meaningful activity

DEFINING PLAY AND PLAYING GAMES

Theories of play and games overlap into many disciplines – from a history embedded in behavioural psychology, sociology and cultural anthropology, through to recent developments in computer game design, "gamification" and serious play. Many contemporary researchers looking to define these terms, refer back to the *Homo Ludens* (1938) by Dutch historian Johan Huizinga, and *Man, Play and Games*, by Roger Caillois (1958), and these remain a common reference in books and articles on game design.

In *Homo Ludens*, Huizinga defined play as *"a free and meaningful activity, carried out for its own sake, spatially and temporally segregated from the requirements of practical life, and bound by a self-contained set of rules that hold absolutely."* Caillois tested and expanded on cultural aspects related to play, and linked these to the intrinsic qualities of games. Of particular relevance to architecture, Caillois categorized play into two main groups: *paida*, spontaneous play, and *ludus*, structured play. These were further subdivided into types of games and activities: "*agon*", activity utilizing skill, "*alea*", games of luck, "mimicry", activities of impersonation and simulation, and "*ilinx*", play in pursuit of vertigo and sensation. In his discussion on games of skill, Caillois emphasized the importance of risk for the player, and the threat of defeat, without which the game would no longer be pleasing. This included games which consist of the need to find or continue at once a response, which is free within the limits set by the rules. Caillois related these types of games to verbal expressions such as the playing of a performer, or the play of a gear. He states *"In fact, the game is no longer pleasing to one who, because he is too well trained or skilful, wins effortlessly and infallibly"* (1958). Caillois' definition of play can be expanded to include aesthetic and experiential qualities of architecture – from delight in concepts, through to play of light, play of shadow, play of architecture.

In their studies on serious gaming, Rodriguez (2006) and Andreotti (2002) analyse the work of surrealist, situationist and avant-garde artists and writers in relation to Huizinga's concepts of play. The fundamental values of exploratory learning are curiosity and risk taking, through experimentation. The importance was in the act of design by the student or participant, and not in the transmission of skills – in opposition to modern art schools of their time. Play was in the process, and in the experience of the audience, as evidenced in the work of artists such as Asger Jorn and Guy Debord's *Mémoires*, *dérives* and psychogeographies of Paris. Rodriguez suggests that *"Playing can be part of the learning process because the subject to be learnt is, at least in some respects, essentially playful. The use of serious games in the learning process therefore illuminates the fundamental nature of the subject being taught."* While it is perhaps easy to see closer historical relationships between play, games and art, the relevance to architecture and urban design is increasing with advancing technology.

In Toward a Ludic Architecture (2010), Steffen Walz explores the importance of kinesis, real or virtual movement, to play. Referencing the work of the Dutch psychological anthropologist F. J. J. Buytendijk, and psychologist Kurt Lewin's research on play from childhood through to adults, Walz focuses on the to-and-fro movements and rhythm generated in play. With the assertion that in every play situation, time-based space is created by the interactions between play elements, Walz makes direct links to architecture. He describes play as sculpting an architectural and conceptual play space, and this concept is used to analyse architectural and urban spaces. This links back to Walz's earlier work in *Space Time Play: Computer Games, Architecture and Urbanism: The Next Level* (2007), which raises the call for contemporary architects to grasp the new typologies of space, emerging from the virtual world, where space, time and play converge.

Balancing between the work of Huizinga and Caillois, and contemporary texts on game design, this paper will work with the following definitions as a starting point for discussing play and games. Play describes fun, meaningful and voluntary activities, which are contained within limits of locality and duration, and can be open-ended or bound by the rules and resolution of games. Games provide players with goals, rules, feedback, participation, boundaries and specific ways of problem solving. The terms "gamification" and "serious games" have been used in recent years to further define the exponential growth of education and commercial game applications. The use of games in architectural education tend to fall under the term "gamification", or the use of the principles of game design in non-game contexts (Deterding, 2011). The philosopher and political activist Shiv Visvanathan, sets out a clear distinction between games and play, noting that *"A game is a bounded, specific way of problem solving. Play is more cosmic and open-ended. Gods play, but man unfortunately is a gaming individual. A game has a predictable resolution, play may not. It allows for emergence, novelty, surprise."* (Visvanathan, 2007).

ARCHITECTURE AND GAME DESIGN – OVERLAPPING PEDAGOGIES

A typical thirteen-year-old today, could be considered an expert at computer games, playing between 4-10,000 hours, by the time they reach University. Immersion in a game realm of risk, reward, exploration, experimentation, consequences and immediate feedback has the potential to change expectations in the real world (McGonigal, 2011). These expectations are also filtering into education. It is not only architecture students developing these expectations, but clients too. How are we, as educators, researchers and practitioners, adapting to these culture changes? How can play and game design and theory inform architectural education and practice? – and what are the possibilities for the future?

One of the most striking differences between textbooks on game design and textbooks on architecture, is the importance of research in cognitive and behavioural psychology as a starting point for game design, followed by demographics and consumer research. In the standard game design text, *21st Century Game Design*, authors Bateman and Boon use demographics and Myers-Briggs Dichotomies to define user groups and target markets, and Flow and Temperament Theory to introduce students to the fundamentals of game design. The overriding factor for the successful game is motivation and engagement, or what is often referred to as "flow".

Direct links to psychology and game play come from the work of the Hungarian psychologist Csíkszentmihályi's work on the concept of "*flow*", or optimal experience. In "flow" an individual could feel complete, with an energized focus on an activity, with enjoyment and

fulfilment. Csíkszentmihályi considered the lack of design and consideration of "flow" in education, work and everyday environments as a social failing. Csíkszentmihályi wrote *"Games are an obvious source of flow and play is the flow experience par excellence,"* and considered the lack of "flow" in education, work, design and everyday environments a failing of modern society (Csíkszentmihályi, 1975; McGonigal, 2011).

Malone suggests that instead of viewing intrinsic motivation as an absence of reward, it can be seen as a positive need for competence and self-determination, a search for psychological incongruity, and the experience of "flow" (Csíkszentmihályi, 1975). "Flow" is the channel between anxiety and boredom, achieved through immersive experience. Csíkszentmihályi identified the following common traits for the experience of "flow": an activity which is achievable and/or can be completed, focussed concentration, clear goals, direct feedback, sense of effortless involvement, sense of control of the activity, and an experience of altered time. Of particular note is the need to present clear goals (and in game design clear short-term goals) and providing feedback as properties of the activity. Case studies show that a desire to know what one is expected to do is a common trait among all players, but is not always the case that the goal if the main source of motivation (Bateman and Boon, 2006).

While goals in themselves can be the source of motivation for activities, the enjoyment and fun of both learning and game play are often linked to extrinsic and intrinsic rewards (Deci and Ryan 1985). Self-determined learner behaviour can stem from both intrinsic motivation (i.e., students engage in an activity because it is interesting or enjoyable) and from extrinsic motivation (i.e., students engages in the activity because they desire a specific outcome and value it as important).

Extrinsic rewards may come in the form of points and scores in games, or provisional marks and positive feedback in studio. Intrinsic rewards relate to the sense of personal achievement and ideally enjoyment, supported with elements of challenge. Most models for educational games emphasize intrinsic motivation, and focus on motivation to perform tasks coming from participation itself (Malone, 1980). In his early work on the cognitive psychology and learning with computer games, Thomas Malone (1980) proposed that the primary factors that make an activity intrinsically motivating are challenge, curiosity, and fantasy. Although extrinsic rewards can be less effective than intrinsic motives, both intrinsic and extrinsic motives play a role in determining learner behaviour.

Drawing on the work of Csíkszentmihályi, many of the texts on game design start with the key **principles of goals, rules, feedback and participation, and game design theory expands on how these relate to behavioural and cognitive psychology.** In the influential computer game design book *Reality is Broken: Why Games Make Us Better and How They Can Change the World* (2011), Jane McGonigal explores these principles to explain the potential power of games to change real world issues. Goals provide a sense of purpose, which is both achievable and yet challenging enough to focus players' attention. The rules set the boundaries and lay out potential routes for problem solving, and feedback lets players know how close they are to achieving their goals. Participation is voluntary – and ideally engaging, so that *"players knowingly and willingly accept the goals, rules and feedback"*, establishing a common ground for groups to play together. There are parallels with writing studio design briefs and learning outcomes, and to an extent these principles can be overlaid onto the concept design brief or architecture proposals.

The principles of game design are clearly set out, and it is important to note they do

not specifically include rewards. The motivation to play must be inherent in the design of the game, goals and feedback. McGonigal explain several key principles, which by understanding how games work, may help us understand what our student expect in terms of feedback.

- *"By removing or limiting the obvious ways of getting to the goal, the rules push players to explore previously uncharted possibility spaces. They unleash creativity and foster strategic thinking.*
- *The feedback system tells players how close they are to achieving the goal. It can take the form of points, levels, a score, or a progress bar. Or, in its most basic form, the feedback system can be as simple as the players' knowledge of an objective outcome: 'The game is over when…' Real-time feedback serves as a promise to the players that the goal is definitely achievable, and it provides motivation to keep playing.*
- *Knowingness establishes common ground for multiple people to play together. And the freedom to enter or leave a game at will ensures that intentionally stressful and challenging work is experienced as safe and pleasurable activity"* (McGonigal, 2011).

Although McGonigal referred to Tetris in her book, these principles can be poignantly demonstrated if one thinks about *Candy Crush*. As you successfully align the candy pieces, you get three kinds of feedback: visual—you can see row after row of pieces disappearing with a satisfying poof; quantitative—a prominently displayed score constantly ticks upward; and qualitative—you experience a steady increase in how challenging the game feels. In the three dimensional world of *Minecraft*, players visually see their structures take form, they quantitatively achieve challenges, find materials and survive, and in a survival mode can meet greater and greater challenges.

As we reflect on the successes and shortcomings of architectural education, the parallels with game goals, feedback and flow are prescient, and have clear relationships to the work of Donald Schön, and debates on experiential and constructivist learning styles (Lainema and Saarinen ,). The use of educational games or the integration of "gamification" concepts, is developing and changing rapidly. A quick internet search on "gamification" will reveal a growing industry of online educational game companies, offering to instantly provide or develop projects for schools, universities, industries and professions. What is surprising is the low profile and/or absence of architecture in current debates on educational and serious gaming discussions.

PALIMPSESTUOUS DESIGN – GAMES FOR ARCHITECTURE

The following case studies have been chosen to demonstrate how games and game theory have been used in architectural education and practice – implicitly and explicitly. There are many potential layers to the use of games in architectural design – from the technical through to the aesthetic. The game of architecture lies not only in the design of the building, but in expectation of conceptual engagement and rigor, cultural, social and environmental considerations – what I have termed **"palimpsestuous design"**. Given a brief to design a music studio, a first year student who designs a building which looks like a guitar will fail in a studio review, but a building designed to use the concepts of a guitar – experientially, aesthetically, materially and/or technically, is far more likely to receive positive feedback. Is this because the student developed a more refined game for the audience? Or because the student is able to play the game of architectural education?

The development of digital and online games for architecture is rapidly developing, from Minecraft and SimCity, through learning engineering principles in games like



▲ **Figure 2** Studio without Tutors, Dice Studio Game

PushmePullme and *Catastrophe* by Expedition Workshed. These are being developed in parallel with immersive and collaborative games for sustainable development and crisis management, like those being used by the Red Cross and Red Crescent Climate Centre. There has been significant press on the use of *Minecraft* and Lego in design contexts, and current research on the use of these incredibly popular game tools in education is already beginning to shape the future of games as pedagogic tools for learning. The philosopher Bernard Suits (1978), wrote, "*Playing a game is the voluntary attempt to overcome unnecessary obstacles,*" which has resonance with the design of architecture. I have chosen the following case studies to demonstrate games outside of the contemporary commercial sphere, with the aim to open future discussions on more implicit use of games, "*gamification*", game pedagogy and game theory in architectural education and practice.

IN STUDIO

Most architecture students will experience the use of "gamification" – through scenarios for learning, from design project briefs, through to contract and professional practice situations. By reframing studio exercises through game design principles of goals, rules, feedback and participation, we have the potential to use these tools more effectively in our teaching, and enabling our students to use these tools in their designs.

Starting with the simple game of dice, we can engage students with the language and concepts of architecture. The use of dice, as a tutorial device, questions the expectations of students and the roll of tutors, while exploring common student design issues, and the varied interpretation of architectural dialogue. The dice are what Caillois referred to as "*alea*", games of luck, with the potential to include "mimicry" (Caillois 1958). Both the making of and the playing of the dice offer interesting educational opportunities. The interpretation of the dice, or feedback, can challenge the user to consider issues of intention, hierarchy and interpretation of their rules of design.

First and second year students at the University of Portsmouth analyse a series of iconic buildings as a method of exploring and understanding design principles. The Dissection Project– a three-week exercise in Year 2, engages small groups of students in the analysis of iconic buildings. The first phase is to work as a group to research

and identify strategic design motives and/or constraints, and building a scale model of the building and site, which through its materiality or construction (of the model) reflects these concepts. The second phase is for individual students to analyse and unpick the palimpsest of design considerations – a treasure hunt, and a game of skill. Although the project was not explicitly designed as a game, one can map its success to the use of game principles. Students are given goals (uncovering rules of design used by the original architect), rules (using drawings and models so uncover the layers, rules and concepts), feedback through tutorials and reviews), and participation (extrinsic and intrinsic motivation). Students are introduced to the conceptual design, palimpsest, hierarchy, proportion, site analysis, and context, structural and environmental considerations. While "playing" the dissection in small groups, then pairs, then as individuals – they also strengthen their skills for collaboration, timekeeping, representation and communication.

The 2007 book, *Space Time Play: Computer Games, Architecture and Urbanism: The Next Level* (Borries, Walz & Böttger, 2007), brought together a wide range of academics and practitioners interested in the design and application of computer games in architecture. Now, nearly a decade old, although some of the case studies reveal how rapidly technology has advanced to surpass our expectations, the core discussions on the use of play in the design and experience of architecture are still relevant. Ludger Hovestadt's essay, *Why Games for Architecture?*, delves into the emergent technologies and reflects on the potential for games, with systems, subsystems and levels to liberate current architectural paradigms, where *"the virtual systematically supports the real. The real is systematically enhanced by the virtual. A subdivision is no longer conceivable."* This view of a post-digital world has continued to evolve in research and studios at ETH Zurich CAAD programme. Game Engine, a current elective at ETH headed by Mathias Bernhard is testing the use of game based augmented and virtual reality in relation to client and user experience of space. Although advances in computer aided design, computational design and the internet of things lie outside the focus of this paper, it is important to consider the limited dissemination and trickledown effect of this work to smaller and less technologically equipped universities and schools of architecture. In Ian Borden's essay, *Tactics for a Playful City*, and Neil Leach's *Play Stations*, remain poignant discourses on the need to consider play as more than a partner to technology, but as a fundamental aspect of social life. Play holds the potential to reveal humanitarian and egalitarian views, as well as the latent aggression and competitiveness which fuel the development of our cities.

The work of Lindsay Grace and Christopher Totten, at the American University Game Lab, have been exploring the boundaries between architecture and art and computer design through teaching and design across disciplines (Gamelab, 2015). With a background in both architecture and game design, Totten's thesis and studio projects set students with the task of developing games to explore both the psychology of users as well a tool for generating a brief and design of architectural spaces (Totten, 2008). Totten set up a design project for students using first-person 3D environments as a presentation tool to clients. By structuring the game with horizontally structured teams, and studying the effect of play-based design methods on creativity, Totten was able to test and observe both team dynamics, levels of student engagement and output. Students were able to use the game to design and develop their class projects



▲ **Figure 3** Part 3 Snakes & Ladders, University of Portsmouth

with equal opportunities to make changes. Totten found that "*The students reported experiencing more cooperative group dynamics than in the typical studio structure based around having one or two lead designers. They also reported that the relaxation of playing design as a game resulted in a greater pool of creative ideas to work from*" (Totten, 2011).

IN TAUGHT COURSES

In the Part 3 Course at the University of Portsmouth, we are using two types of games to deliver and help students revise Part 3 curriculum. This game was developed to provide students with experiential learning opportunities, promoting deeper understanding and application of principles. A scenario based contract workshop is run each year, as a full day immersive game. Students are placed into small "practices" of 3-4 no. students. Their goal is to successfully administer a construction project from briefing through to completion over the course of a day – and to be the first team to complete the contract. The project is run over the intranet, with two tutors acting as real-time clients and contractors, and support tutors helping groups tackle project issues which arise throughout the life of the project. The game requires real-time interaction through emails and completion of instructions and certificates, with a leader board showing progress throughout the day. Rules of the game are set within the parameters of practice and professionalism, project timing, and the construction contract. Students are often in "the flow" of the game throughout the day. Students will go through approximately 20 mini-scenarios through the day, receiving feedback for each scenario before progressing. Rewards come from points on the leader board, achievement and competition, as well as small prizes, like chocolates or book tokens for the winning team. Student feedback identifies this as one of the most valuable experiences of the course, providing the opportunity to engage and experience aspects of contract and practice administration often not open to students. This game is currently a mix of online group dialogue, paper and verbal feedback. We are currently developing a digital version of the game.

Demonstrating knowledge and understanding across the wide scope the ARB Criteria is often daunting for students, and we have introduced a snakes-and-ladders style game to help students with revision. Playing in cooperative teams of 2-3 no. students, the game is a mix of skill and chance, enabling students to work together to answer



▲ Figure 4 Different learning approaches and connections: Eames House of Cards & The Endless Landscape

criteria based questions in order to roll dice, and move up the board. The questions are practice management focussed, but also touch on other legislation and issues faced in practice. As in practice, there are ladders up (competition wins) and snakes down (unpaid invoices and complaints). This game is introduced as a short workshop in the Course, and like the Contract Workshop, receives excellent feedback from students. Students are able to use the questions and printout of the game in revision sessions outside of the Course. We are currently working to develop a combined version of this game and the contract workshop as an online resource for use in education and professional contexts.

IN PRACTICE

The recent Eames exhibition at the Barbican is a testament to the importance of play and experimentation in design. Charles Eames once said of the work done out of the Eames Office, "*We work because it's a chain reaction, each subject leads to the next.*" Play was a creative part of the office philosophy, the creating of products promoting play for clients, the architecture and their pedagogy. The Eames' *House of Cards*, *the Toy*, *and 'Score' for A Rough Sketch for a Sample Lesson for a Hypothetical Course* (1952-53), all reflect their pervasive approach to serious play as a way to reveal and create connections, "*the breaking down of barriers that have grown up between fields of learning*" (Eames, 2016). These projects bridge between Callois' paida and ludus, free play and structured play, creating and revealing connections in intention and meaning for the players.

In the 1960s, Buckminster Fuller set out to develop the *World Game*, which would "*facilitate a comprehensive, anticipatory, design science approach to the problems of the world*" (Buckminster Fuller Institute, 2015). The purpose of the game, using the Dymaxion map developed by Fuller, focussed on the growing pressures of global population and limited natural resources. Players work cooperatively to world based scenarios, with an emphasis on holistic and cooperative approaches to decision making. Originally introduced for the teaching curriculum at Southern Illinois University, the concepts behind the game and its development became the World Game Institute in 1972.

In its description of the *World Game*, the Buckminster Fuller Institute, emphasizes

Fuller's decision to call it a "game", making it accessible to everyone, and not just the elite individuals in power and politics (Buckminster Fuller Institute, 2015). The game was both about social inclusion and subversion – making data, statistics and information accessible to everyone, outside of political, social and economic hierarchies and boundaries. Conceived before the age of the internet, the World Game that Fuller envisioned was a game were competition and cooperation could be played out to: *"Make the world work, for 100% of humanity, in the shortest possible time, through spontaneous co-operation, without ecological offense or the disadvantage of anyone."*

Using computational game theory as a premise for design, Mzo Tarr Architects (Principle, Adam Tarr) have developed a unique approach to brief and concept development in practice. Games, game design and game theory have been used to inspire a number of their projects, from their Tetris House in Chiswick, to the detailed design of interactive installations for Battersea Power Station and Dublin City University (Mzo Tarr, 2015). Mzo Tarr's website describes game theory as *"the mathematical study of decision-making between people in situations of conflict or cooperation."* Using their interest in game theory as a key marketing tool, the practice's website explains their briefing process in relation to the iconic game of Prisoner's Dilemma. Two prisoners, incarcerated without evidence for conviction, are offered the opportunity to confess or blame the other and go free. The range of consequences and alternatives, create dilemmas – and flesh out decision making and optimum solutions for complex decisions. Mzo Tarr use similar game related questions and strategies to gather information to quantify requirements and experiential satisfaction. They identify four key ingredients to successful game theory and decision making: players, strategy, information and consequences/payoff (Mzo Tarr, 2015).

CONCLUSION

Architectural education does and can more effectively draw on concepts, principles, processes and techniques from the world of analogue and digital gaming. The use of games for briefing and consultation continues to grow, and is being advanced in the fields of engineering, science, human resources and health care – but there remains limited research and experimentation on the use of games in architecture, analogue or digital. This may be due in part to the fact that the application of games in these fields have clearer or more defined objective and subjective components, and to the strong studio culture in architectural education. The case studies above suggest that "gamification", game design theory and pedagogy, can be developed to help students achieve and engage in learning aims and objectives across architectural criteria and curricula. In practice, games and "gamification" have the potential to expand conceptual and technical architectural design, and develop client relationships.

There are, of course, controversial aspects to games, and in particular a shift to digital and on-line games over experiential, physical, interpersonal and collaborative working. The efficacy of using games and game design pedagogy in architecture is directly related to their appropriateness, clarity and success in achieving learning objectives and outcomes. In Jesse Sell's critique of video games for academic learning (2014), he raised the fundamental issue of pedagogic intentions, noting that as educators, *"we need to stop looking at games for the content they teach us and instead look at*

how the games teach us to learn. We need to focus on what games teach us when we aren't asking to be taught." The importance of the game is not always in the content, but can reside in the skills learned to play and potentially win the game. Along with classic pedagogical approaches like Bloom's Taxonomy, the theory and research into human psychology and sociology which make games fun and successful, can be used to make architectural education and practice more engaging, more successful and more fun.

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The freedom of the sketch and the tyranny of the digital image

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Much of the existing literature surrounding the status of the digital studio, process and production, is focused on its role in the design process and how it is received by the jury during assessment of student work. Complementary to many of the existing studies this thesis aims to evaluate the content and function of architectural graphics within presentation of student work in the academic studio as the tangible artefact and outward expression of student design activity. The aim of this review of literature is to contextualize digitally produced visual architectural artefacts within broader phenomena.

It is important to consider design protocol from both a paper-based and digital position. Although many well-known CAD applications aim to mimic paper-based design functions, the physiological processes are vastly different and therefore may affect cognitive experiences as well. The following empirical studies focus on protocol and cognitive activity during the design process and the approach to problem-solving that is unique to the 'designerly' way of thinking. Cross (2001) reviews a selection of empirical protocol studies from the point of view of both paper-based and multi- modal approaches to design activity. Cross' (2001) survey found that during traditional studio based design activity, where participants were presented a design problem brief and example of typological precedent, advanced student designers appeared to be 'fixated' on the example design provided with the brief producing solutions which contain many identical elements from the precedent sample. Thus, suggesting that such 'fixation' hinders conceptual design development in preventing the designer from considering all of the relevant knowledge and experience that should be brought to bear on the design problem. These designers may be too ready to re-use features of known precedent rather than exploring the problem and generating new design features and solutions (Cross, 2001). This view is shared by Al-Qawasmi (2005) arguing that the phenomenon goes further and that identity is lost as students begin to design for the global 'techno-identity' by not engaging in brief and context specific queries.

A second form of 'fixation' discussed by Cross amongst the designers is an attachment to early concept ideas fostering a resistance to progressive iteration of problem-definition and solution. Cross discusses generative reasoning and creative leap arguing that good designers are able to modify their concepts fluently and easily as difficulties are met during the design process and are open to exploration of alternative concepts unlike those with a propensity towards 'fixation' and over-reliance on precedent. Suwa

and Tversky (1997; Carter, 1993; Cross, 2001) argue that paper- based design activities facilitate problem-solving and understanding during the design process including 'generative processes' introduced by Cross (2001). In particular, paper-based sketching facilitates inference, problem-solving and understanding by encouraging exploration of visually plausible inference solutions (Suwa and Tversky, 1997). Suwa and Tversky point out that traditional paper-based modes are superior to CAD techniques in so far as they encourage reflexion by suggesting that while sketching designers become aware of unanticipated relationships that foster the revision of ideas. Further, Suwa and Tversky bring an awareness to the reader that these ideas are favourable to the current trends of thinking in the cognitive sciences (1997).

The academic studio is embedded in tradition while simultaneously embracing innovation. Therefore, its nature is one of conflict in theory, discourse, and practice. Gore (2006) discusses a way of studio teaching that emphasizes a direct experience with tangible materials arguing that it is the space in which innovation occurs. This practice reflects Cross' (2001) argument for generative reasoning as students build and rebuild their projects for critical review before an outcome is achieved. Allen (1998) recognizes that speed is fundamental to the rhetoric of the computer and that it is processing speed and not disk capacity that is the limiting factor of CAD applications and, in fact, these physical technological challenges or faults are reminiscent of the modernist ideals of efficiency and productivity contradictory to the postmodern promise of a future fully integrated with technology and a promised to recover what had been destroyed by modernity in the first place. Allen's anxiety about speed is different but not entirely autonomous from the concerns raised by Cross and Carter drawing on the work of Paul Virilio who distinguishes between the inconsistency of metabolic speed, that of the living being, and the artificial technological speed. The technological speed of the computer is invisible in its working and only visible as an effect. Thus, the computer in the design studio simultaneously provokes extravagant claims and high levels of anxiety (Allen, 1998). Allen views the computer as a tool, with very specific capabilities and constraints, particularly in the studio.

1.

The time-honoured traditions of sketchbook practice are becoming an endangered species within the digital environment of the contemporary academic design studio and professional design office. Increasingly, the manipulation of a digital image acts as a tabula rasa from which a built artefact emerges, a process that is essentially an end in own right, leaving no tracings of the intellectual and creative journey towards such an end. The digital image can be perceived as a *fait accompli*, possessing qualities intrinsic to its nature which suggest that the built artefact appears as a scripted readymade, materialising as a finished and thoroughly complete object. It is as if the finished artefact has been decided before those affected have knowledge of it, leaving few options but those of acceptance and acquiescence.

The designer's sketchbook and its contents, by contrast, are a far soupier, messy affair. At its heart, the sketchbook celebrates and encapsulates the unfinished, the unscripted, and the temporary. Its primary role is that of exploration, experimentation, and the storing up of emerging ideas, one leading to the development of another, and then onto towards yet another idea or iteration. At the core of this process lies a questioning spirit, a will to ask how or why things might be.

Moreover, the sketchbook offers up the possibility of becoming a fluid transient space, since it functions as a gateway through which creative purposes can find their fix in the

world. It presents the designer with an immanent field of potentiality whereby the virtual can find expression in the actual. Between its sheets it channels the virtual – the nearly as – into the world of ideas and artefacts, allowing for the discovery of infinite ascribable possibilities. Furthermore, the sketchbook supports the reclamation of the original notion of 'virtuality', being of a kind quite other to the algorithmic 'virtuality' associated with digital design technologies.

The contemporary use of the word 'virtual' is almost exclusively bound to the domain of digital technologies, its context now synonymous with the digital environments of virtual reality, virtual gaming, virtual friendships, virtual sex, virtual tourism, virtual communities, and so on. By contrast, in referencing Henri Bergson's theory of duration, Deleuze portrays the virtual as latent potential yet to become or to become actualised. For Delueze, the virtual is as real as the actual, for the '…virtual is fully real in so far as it is virtual… .' Indeed, the virtual must be defined as strictly a part of the real object - as though the object had one part of itself in the virtual into which it plunged as though into an objective dimension.' (Ballantyne, 2007). Essentially, the virtual is in every sense real, though yet to become material.

In terms of design praxis, the activities associated with keeping a sketchbook (as one might do with a diary) make it an effective tool for formulating an alternate mode of design-orientated processes. More specifically, it is an incubator for prioritising the unscripted, the temporary, and the disposable. The sketchbook is *modus operandi* for effecting an instantaneous, vigorous, and intuitive engagement with the materialization of ideas, concepts, and new ways of thinking. Moreover, such an engagement rekindles the original meaning and significance of the term 'virtual' as a central part of sketchbook-praxis, reasserting both the original meaning of the word and its theoretical importance to Deleuzian philosophy.

2.

The possibilities and potentiality of a sketchbook are infinite. Whilst observing its clean pages, it becomes clear that the only apparent restrictions are contractual arrangements formed through personal consciousness and praxis. The latent potential of the sketchbook, coupled to the private nature of the content, draws the practitioner to commit not only their embryonic ideas to paper, but also map out their observations, thoughts and questions concerning the world they operate within.

The empty sketchbook presents its creative user with an untamed, unmapped field of possibilities, a vista into which the designer lays out new pathways and connections as circumstances allow. Overtime this topography is mapped and, as the last page is filled, the sketchbook's potential may take on a different trajectory as ideas re-emerge, sometimes many years later, becoming further iterations of dormant potentialities awoken once more.

When the integral potential of the sketchbook is comprehended, it provides the user with a limitless horizon of possibilities, a complex, and interwoven mesh of ideas that might emerge, or become, because of the forces at play within it pages. Such fluidity and potential is often evaporated during the production of more fixed or completed artefacts. In its most flexible condition, the sketchbook is analogous with the conceptual metaphor of Gilles Deleuze and Felix Guattari's "*rhizome*" (Deleuze and Guattari, 1988), in that it seeks to form connections and extensions in ways that differ from more orthodox patterns of design development. Rhizomic plants bifurcate for Deleuze and Guattari, growing their

roots in a fundamentally different manner to that of other plants, yielding shoots and grasses in unexpected locations. Their root networks split and divide, producing alternative and unexpected pathways through the darkness of the earth where normative boundaries and restrictions become irrelevant. The unknown and unplanned nature of this activity mirrors divergent thought patterns commonly found in sketchbook praxis.

Following Deleuze and Guattari's allegorical analysis of the rhizome and the tree (where the rhizomic plant offers limitless and often surprising outcomes whilst the tree remains fixed and rooted) it is possible to form analogies within the production of architectural images. For Deleuze and Guattari, by way of comparison to the rhizome, the tree remains fixed in structure, its potential limited to the restrictions of trunk, branch, twig, and leaf, "*… where everything branches out from a central trunk – the little twigs branch out from larger ones, and so on, back to the central core.*" (Deleuze, 1994). In a likewise fashion, the same metaphor helps to illuminate the essential difference between the unscripted nature of the sketchbook and the scripted nature of a computer generated image . One is fluid, the other fixed. Whilst the sketch is unfinished, unscripted, and open to change and mutation; the digital image is complete, scripted, closed to change, and therefore resistant to further evolution. One representation is in a state of becoming, whilst the other is a fait accompli. For Deleuze and Guattari, such a condition is endemic throughout the entirety of Western thought and culture, stating

> "*…we're tired of trees. We should stop believing in trees, roots, and radicles. They've made us suffer too much. All of arborescent culture is founded on them, from biology to linguistics. Nothing is beautiful or loving or political aside from underground stems and aerial roots, adventitious growths and rhizomes.*" (Deleuze and Guattari, 1988).

Although such a comparison is an intellectual leap (for Deleuze and Guattari have much more on their minds than the trauma of the disappearing sketchbook) the preceding analogy serves to illuminate an important point here; the freedoms offered up by a simple sketch have no place in a polished computer generated image. Moreover, a computer-generated image solution is an end itself, its inherent graphical projection and representational presence being its primary goal. A sketch, buried away in a sketchbook, is an idea in becoming, a vehicle for imaginative manipulation. Moreover, it becomes apparent that a sketchbook nurtures rhizomic modes of design related thinking and action. In its raw form, a sketchbook is not immediately predisposed to becoming an arborescent root and branch configuration, but rather, its inherent potentiality suggests the formation of the opposite kind of engagement, an approach more akin to that of the rhizome. Whilst there might be a passing resemblance to a homogenised structure whereby each idea is a further expression of the same exploration, these are passing moments in a far more expansive and interrelated network of ideas, observations, thoughts, statements, appointments, 'to do' reminders and even shopping lists (Deleuze and Guattari, 1988). Rather than merely being a controlled catalogue of past or old works, the design sketchbook is a dynamic network that allows for the free flowing of theoretical and imaginative applications enfolded within a process of incubation.

3.

The creation of a designed artefact, irrespective of the discipline within which it is executed, is defined by the methodological constraints imposed upon it by the means of production. This is particularly true in the case of designed images and the realisation of complex artefacts, buildings, and machines. Commercial designers and architects, by

the nature of their practice, have to conform to all manners of commercial influences and compromises that are normal to the production of designed items. The complexities and rigour of commercial production inevitably define and shape any initial design vision as the needs of users, clients, budgets, and the modes of production always manipulate the final iteration of the designer's primary conception. In effect, the nature of production leads to the formation of pre-determined habits of practice; ones that are worthy, reliable modes of production and as such can endure the rigours of the commercial environment.

The practice of keeping a sketchbook, however, engages the individual designer in a soupier, far messier affair than the systemic logistics of commercial production. They allow free thinking, sporadic and untimely propositions beyond the rigidity of the design 'for client' process. The contents of a sketchbook have a propensity for meandering, coupled with an inherent appetite for finding lines of flight steering away from fixed modes of thinking and doing. Engagement with the sketchbooks propensity for negotiating other, less rigid and confined avenues of thought, encourages its user in the development of unconventional modes of operation and eccentric forms of expression. The sketchbook offers up immediacy in its latent potentialities, it is 'too hand' and primed for action in ways that digital devices and software only offer limitations.

4.

Standardized architectural graphics associated with orthographic and perspective drawing have evolved since the Renaissance; however, their principles remain intact and applicable to image making processes synonymous with contemporary architectural practice and the academic studio. Despite an overwhelming discourse that prioritizes the architectural image over that of the lived experience of a building; architectural designers and educators alike still persist in their efforts to endorse a sense of fit between the traditional perspective drawing and the production of digital visualization. Whereas, as this paper proposes, there are absolutely core and fundamental problems with perceiving the digital image as being the same animal of representation to that of the hand drawn visual. Moreover, we would argue, the digital image is the absolute antithesis of the creative process as experienced in the keeping of a sketchbook.

The contemporary architecture studio – whether educational or practice based – is littered with the paraphernalia associated with the production of digital visualizations. Today, such spaces are rarely furnished with rows of drawing boards and drafting stools, rather they are superseded by the disembodied computer screen, giving the impression of being more call centre than design studio. Moreover, the contemporary perception of architectural design practice is that it is chiefly concerned with the production of images (virtual simulations of final built forms) rather than the production of representations that require interpretation by the client, and further translation on behalf of the designer, in order to be fully realized as buildings (Temple, 2007).

Frascari famously highlights these issues in his concerns regarding architectural image making and the legitimacy such lends to the construction the built artefact. Historically, the drawn image of a proposed building has featured degrees of separation with its built derivative, leaving scope for imaginative interplay to occur between its visual representations, the designer, the client, and the final iteration of the drawn as a physical artefact. Moreover, Frascari argues that the utilisation of architectural image making as a vehicle of the architects authority and legitimacy concerning precise similarity between the virtual architectural artefact and its actual built form has driven an impenetrable divide between architectural documents and their authors. In addition, he argues that

> *"A drafters contract based on this process of legitimisation obliges the architects to produce drawings that should not nurture any imagination. The outcome is that the reading of drawings has become an unimaginative routine; what was once a pleasant walk in the intangible vagueness of the realm of discernment and construing of factures is now a sterile exercise of the realm of contingency."* (Frascari, 2011).

This increasingly popular perception of the architectural designer as being primarily an image-maker in the production of buildings is not restricted exclusively to those outside of the immediate discursive field of the architectural profession. Designer as image-maker, rather than maker or builder, is gaining acceptance, or increasing levels of acquiescence, with architects and architectural academics alike. By endorsing the production of such images, architectural designers and educators often unwittingly contribute to the prioritization of the scripted digital visualization over the incomplete, unscripted, sketch-based representation. However, such is the ubiquitous nature of digital technology, that by seeking a compromise between traditional modes of representation and the digital visualization of architecture (or, conversely, by denying it altogether as a valued form of architectural representation) characterises much of the discourse concerned with the production of digital images within architectural design practice and education.

In effect, the representation of a building design through a measured perspective has always operated as a simulation of reality, as all optical media functions in a similar vein, producing comparable ocular tricks and effects in the way that they emulate the human experience of sight, depth and spatiality. However, the drawn perspective, by merit of its unfinished status, exercises considerable restraint in its efforts to become a full virtual simulation of any future actualization in built form. The same cannot be afforded to the advanced optics of 3D software and graphics programs, where the hyper-real simulation of the actual leaves no room for interpretation or imagination. In many respects, such simulations become objects of desire in themselves, a folly of the perspective representation, giving rise to a fantasy of the actual building that, once the actual building is experienced, leads to a sense of disappointment in the actual. The real becomes rather a let down when compared to the promises enshrined in its virtual simulation.

Frascari (2011) highlights these concerns also, attacking the pseudo legitimacy afforded to photorealistic representation (whether mechanical or digital) as generating a *"…trivially unimaginative and visually impaired view of the constructed world"* and he goes on to align such representations of architecture as being *"…equivalent to those dreadful children's colouring books…"* that *"…brings about a feeling of having imagined an image, when it is has been merely a following of guidelines. With use of drafting machines [electronic or non electronic], imagination is useless, only neatness is required"* (Frascari 2011).

Julia Wood, professor of communication studies, describes communication as the systemic process through which individuals interact with symbols to create meaning (Muehlhoff, 2010). Having established that this paper is contextualized by, and concerned with, issues surrounding discourses in relation to architectural representation, it can be inferred that visual communication within the field of architecture is culturally generated through the practices and production of discipline specific artefacts such as architectural graphics. Stuart Hall anchors communication and meaning within the visual domain by stating that:

> *"Culture, it is argued, is not so much a set of things... as a process, a set of practices. Primarily, culture is concerned with the production of meanings, the 'giving and*

taking of meaning' between members of a society or group..." (Rose, 2001).

Arguably, this is the process by which representation functions through the exchange of buildable information between the producer-sender and the receiver charged with interpreting meaning from the artefact through a system of signification. Digital visualization, however, imparts non-decodable information from itself to receiver in a swift one-way transaction eliminating the opportunity for two-way exchange. The scripted nature of the digital image, and its inherent propensity for communication the completed artefact, negates the opportunity for exploration. Indeed, the closer the digital visualization becomes to a 'photorealistic' image of the building as will be, the less likely the opportunity for change, evolution, and development can be realized. For such to happen, the digital image has to unpicked, demanding a reverse motion through the design process. The sketchbook, by comparison, encourages the exploration and evolution of a building towards its presentation as a proposal rather than finished artefact. Whilst sketchbooks and the act of sketching offers up freedom of creative endeavour, the digital image overwhelms such opportunities, evoking a tyranny of scripted control over creative exploration, it dictates the completion of the design journey. The journey effectively ends before the first steps are taken.

There are, of course, many stages of the design process that lie in between to the diametrically opposed architectural representations of sketch and digital visual and, moreover, stages that capitalize on the various merits common to both representational methodologies. Designers may well print out digital images, trace over them by hand, then transfer their attentions to further sketchbook-based exploration. This mixed approach to the production of architectural representation goes someway into claiming back the fixed, scripted nature of the digital image; it redeems and reclaims the digital image, allowing it to become transient and open to change once more.

Frascari (2011) notably extols the use of the 'hybrid' image in the production of architectural drawings, making similar claims to the redemptive power of chimeric images forged from analogue and digital systems of representation. More significantly, he claims that the utilization of hybridised imagery (being that of collaged elements of sketching, found photographic material and digital produced photorealistic representations) reinvests the ontological into the architectural image. A quality he regards as having been lost "*... because of the present instrumental understanding of drawings which is firmly rooted in the erroneous notion that photographic representations must be the only ones able to sanction plausibility.*" (Frascari, 2011).

However, this redemption of the digital image through mixed praxis is not in question here. Rather, we are concerned with the exclusive representation of the built artefact through photorealistic digital representation. The use of hand drawn techniques within systems of digital manipulation inherently breathe life into the fixed *tabula rasa* of the photorealist digital representation. Arguably, if the two approaches are mixed, the digital image is no longer digital in the true sense of the word, but rather more fully virtual and actual in the Deleuzian sense. The integration of sketching and the digital representation produces a digital chimera that becomes open to change and interpretation via the action of osmosis through a scanner; in effect at least, the digital image becomes healthily polluted by an ontological infection afford by the sketch.

Baudrillard considers the loss of meaning through the proliferation of information and the simultaneous reduction of communication claiming that artefacts, specifically images,

no longer possess signification and therefore make reference only to other images in a conflicting relationship between production, artefact, and meaning or reality (1972; 1981; 1987; 2004).

Freedom of design communication and its increasing reliance on digital technologies are the paradox of postmodern culture. Devices and applications associated with contemporary architectural digital imaging are designed and manufactured to integrate and increase communication but, in fact, lead to isolation, segregation, and detachment from the process of architectural production and realization. Baudrillard maintains that communication technologies are designed to "*fabricate non- communication.*" The very disciplines designed to illuminate the role of media technologies in the act of improving or facilitating better communication have merely aided the proliferation of a more closed, one way conversation concerning the evolution of the architectural artefact. (Smith, 2010).

From Baudrillard's point of view, the image is not solely bound to the hyper-real representation. That is to say, the hyper-real architectural image, or more specifically the digital visualization, does not and cannot represent reality or the real. Not only is the visualization autonomous, it also displays the characteristic inability to communicate and connect conceptual references. With indiscriminate use, the digitally mediated, scripted and complete visualization is often reduced to its iconic properties. This is not the case with the representation that is produced within a system of signification, that being synonymous with the architectural sketch, the unfinished and unscripted idea that is in a state of becoming. The visualization, however, is grounded in redundant self- referential formalism of the scripted image (Perez-Gomez and Pelletier, 1997). The digital visualization may be prolific as a result of the function of its mode of production; nonetheless, it is simultaneously hermetic and self-indulgent. It bombards the viewer with information yet communicates nothing. Technologies available in the digital studio are keen to serve as the catalyst of the phenomena, fast-tracking the trend without pause to consider the long-term effects on the profession, designer, student, or indeed, the contemporary built environment.

The purpose of this paper has been to extol the sketchbook and the process of sketching as (still) being a central activity in the evolution and communication of built artefacts amid the significant effect and impact of digital technologies on the same. Moreover, the paper argues that the architectural sketchbook opens up infinite virtual possibilities that are lost, ironically, when virtual digital technologies are the sole agency in the designing of built artefacts.

Perhaps it is of greatest importance to consider the status of communication of architectural information. If it is not, visual communication is bound to continue along the procession of simulacra towards a pre-scripted hyper-reality, at which point, the discipline of architecture itself will need to be re-evaluated.

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About the process of design

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PROLOGUE

Relatively little is written and less taught, in general terms, about the processes that might be used when working on an architectural design problem. This paper summarises some attempts to address that through a presentation (first given in 2007) to 3rd year and a workshop given to 5th year architectural students, to encourage them to more consciously structure and elaborate their design process.

Design is generally seen as a process of framing the problem, or of drawing up a brief, followed by making a proposition or speculative proposal followed in turn by analysis and evaluation of that proposal. Proposition can be facilitated by looking at precedents or by the use of concept, metaphor or abstraction. Analysis and evaluation can similarly be facilitated by developing an idea of the whole project and its values, and using this framework to assess the steps taken.

Design is clearly an unpredictable and uncertain process and can involve undertaking a continuing process of trial and error. The next step cannot usually be deduced, or induced, from the previous one. It can sometimes be seen as an abductive process of "inference to the best explanation". The American philosopher Charles Sanders Peirce (1868, 1878, 1883), though working in the field of the philosophy of knowledge generally rather than architecture, first introduced the term as "guessing". What is inferred is framed by both intrinsic and extrinsic values.

Karl Popper (1959, 1963, 1972/79, 1994), through his theory of Critical Rationalism rejected inference generally as offering any positivist sense of truth and instead offered the notion of greatest value for the least likely proposition that cannot yet be falsified. The three steps he outlined were: problem situation, tentative theories and error elimination. This model, again conceived in relation to philosophy of knowledge generally, was adopted by Michael Brawne (1992, 1995, 2003) for his elucidation of the architectural design process as: project definition, trial solutions and design development. Alexander Wright (2011) developed Brawne's version of the Popperian model as a *Critical Method* for design education and elaborated ways that trial solutions can be generated under the headings of typology, determinism and abstraction.

The text below is more idiosyncratic but complementary to Wright's *Critical Method* and considers in particular the initial framing of the problem (The Brief and Your Goals) the designer's method of working (Your Process) and offers some example exercises as alternative ways to generate trial solutions (Some Exercises).

ABOUT THE PROCESS OF DESIGN

"How will you go about finding that thing the nature of which is totally unknown to you?" (Plato Meno ca 387 BCE trans. in Solnit 2005)

To me this quote encapsulates the essence of the creative design problem. It is what makes being a designer so exciting: facing the unknown. The creative act requires us to move into the unknown.
But that does not mean we cannot manage the task. We can develop the brief, make explicit goals, choose a working method and use design exercises. A design process is not homogeneous. There are many facets to each architectural problem. It is not possible to address all aspects at once, so consider a few at a time. For example, architecture is partly comprised of how it acts in space: thresholds and boundaries, shared or social spaces (their scale, shelter, privacy and connectedness), about a reading of space, about a journey, about how it is used. It also is about how it is experienced by our senses, which is much more than physiology. It is about the memories, ideas and cultural baggage we bring when responding to materials, textures, smells, colours, heat and cold, sounds and atmospheres. It extends to our awareness of craft, detail and aesthetic composition.

The design process is not usually linearly additive. When we look at the whole task in hand we can choose one particular problem as an intermediate target and work with it. On the way we will make discoveries and create possible solutions. Further along we can choose another aspect and set a new problem to work with. As we progress we will gain both a wider understanding of the issues and constraints involved and begin to see a range of possible threads or solutions to pursue and develop.

Many students avoid starting multiple strands as they are afraid of the perceived difficulty of reconciling them later. The job of clarifying and developing different ideas is usually more difficult than the task of integrating them. Once the ideas are made explicit it seems the subconscious can begin to process them and the pieces can more easily fall into place, cross-fertilize or be allowed to die away as being less appropriate.

So in summary the design process is made up of different types of activity; it can be enriched by setting oneself particular design exercises which also serve to create more manageable and less scary pieces of work that can, as a result, be more enjoyable. In many weak schemes it is clear the student started with an end product in mind and then worked backwards to fill in the gaps. Fear or a weak design process may both be contributing causes. It is surely more interesting and rewarding to work in a more open-ended way and to use the process of design as an exploration of possibilities and ideas. These notes are some of my suggestions for how to structure that exploration and develop one's design process.

1. THE BRIEF

Consider different aspects of the design brief given to you and consider filling in gaps or amplifying what is given. These aspects might come under the following headings.

Aesthetics
Consider what the building should look like, what it might feel like, the visual and sensual culture of the object. Consider what qualities are appropriate rather than necessarily give definite answers. Examples are, aspect: open or closed; material choices: contextual or acontextual (i.e. like or not like its setting); form: orthogonal, collaged, extruded or organic; complexity: simple or developed; surface: true to material or patterned or coloured.

Sustainability
Consider ecology, technology, economic viability and the material choices that might be appropriate. Particular ecological concerns are: climate change (especially CO2 and methane emission, primarily from producing electricity and heat), pollution (especially persistent organic pollutants (POPS) from building materials like plasticised PVC, leaching via sewage and rivers into the sea, disrupting the reproduction of marine life), resource depletion and maintaining biodiversity (such as specifying timber certified by the Forest Stewardship Council from sustainably managed forests).

Social
Consider how the building will act, how it can be used and the possibilities for the empowerment, or otherwise, of its users including also the quality of public realm and how the building relates to or transforms public space. So much of our city space gives priority to vehicles over people to the detriment of the social life of the street; look at examples using shared space. Many specialised buildings have uses delimited by time. What other lives could the building have 'out of hours'.

2. YOUR GOALS

What do you want to achieve? Set some specific goals that come from your own agenda. These can come under the headings of aesthetics, sustainability and social or be framed in any way you choose.

Examples:

> *"I want to work with a more complex and responsive geometry. For the last three years I have always done boxes and I want try something different, to move away from that now"* - Chris Brown.

Chris built an experimental series of models casting plaster into a cube filled with balloons. These became concept models for his hotel with vaulted womblike rooms.

> *"I don't know what the material of my building is going to be but it I want it to relate to my chosen brief for an arts and craft sales gallery and workshop. I want it to be hand crafted and jewel like"* - Siba Adom.

Siba's façade became a series of iridescent jewel like panels. Siba now runs a jewellery and accessory business in Accra.

> *"What uses could a community centre have and how could I use the concept of weaving strands together to make one"* - Louise Thompson.

Louise's concept model showed weaving as a way of closing to form a roof or solid façade and unwoven strands as a way of making an open façade or gestural entrance.

> *"What would make good contemporary high density housing and how can I use the concept of a hedge between the city and the green belt to make it"* - Isabella Percy.

Order and chaos struggle for a harmonious balance, to make a porous and habitable structure on the southern edge of Melksham.

3. YOUR PROCESS

How will you work? What is your way of managing your design process?

3.1 Choices
Design is all about making choices. That does not mean the design process has to be entirely rational. You can equally respond to instinctive suggestions but try to raise your awareness of where the impulses come from, what is behind them. Making these explicit can help you evaluate them.

3.2 Work
Work, especially drawing by hand, to your limit of that moment. Sit under a tree (or any other quiet space away from distractions) and draw by hand until you are 'empty'; until you feel you have drawn out anything that is sitting unexplored in your mind. Once one thing is committed to paper it often allows other ideas to float to the surface. Sleep on it overnight and see what has changed, shifted, moved on, refocused, emerged the next day when you sit down to the same task again.

3.3 Medium
Change medium. Once you have exhausted one medium, for example hand-sketching, switch to another medium, such as modelling, and choose a material to work with: clay, plasticine, card, balsa, plaster. This will change what you can explore and what you can resolve. As Marshal McLuhan (1964) said "the medium is the message". Each medium creates its own environment, which is favourable to some messages whilst being less responsive to others.

3.4 Inner Voice
The inner design voice can be very quiet and small. You need to consciously give weight to your inner voice, trust your judgement and, if you later think you have made a mistake, learn from it.

Often in tutorials a student will say "that's what I meant" or "that's what I thought" but hadn't yet found the resolve to commit to that idea on their own. Take courage. Peter Smithson famously encouraged his students to try things and added that for him many of the things he tried did not work out.

3.5 Dialogue
Work through dialogue with another. It is not essential but it will make things easier. It is much harder to get stuck this way.

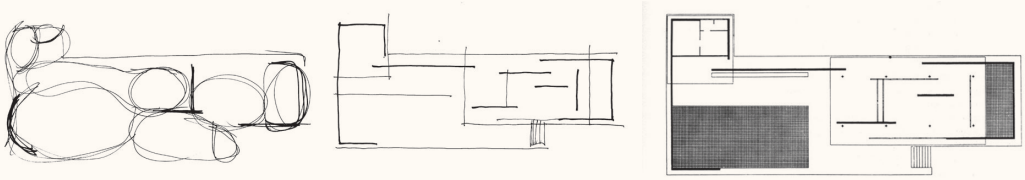
"Long conversations
Beside blooming irises
Joys of life on the road" Haiku by Matsuo Basho

4. SOME EXERCISES (TO GENERATE TRIAL SOLUTIONS)
Develop your design process by creating specific studies or mini design tasks. Think of them as being like 'five finger exercises' for the piano. They can be a way to get started when it is not clear to you where to start from. The blank white page can be an inhibitor to creative thinking. It is also important to allow yourself to explore options speculatively without thinking you are committed to them. You can change your mind. Going somewhere you later judge to be wrong and looking back can tell you about what you consider appropriate.

Exercise 1: Favourite Object
Pick a favourite object, for example one you carry with you, or choose a significant found object.
Consider why it is a favourite or significant object, its qualities. How might your building do something similar?



▲ **Figure 1** Exercise 2, Part 1



▲ **Figure 2** Exercise 2, Part 2

A butterfly knife that combines opposites: hard, functional, threatening but also ornate, filigree, pretty; also: what is concealed and what is revealed. *Georgina Weston.*

From the latter theme Georgina went on to create a group of houses, each partly buried and partly cantilevered from the sloping site, emphasising respectively privacy and display, the introvert and the extrovert.

A mobile phone: black, smooth, rectilinear, the size and shape of its components like a fractal with the parts a smaller copy of the whole and vice versa. *Ellie Redmill.*

This lead to a modular building where the form of each part related to the whole while also dramatizing natural light through exchangeable elements in black and white.

A twig: how it joins, the form at joints and changes in direction. *Julia Wildfeuer.*

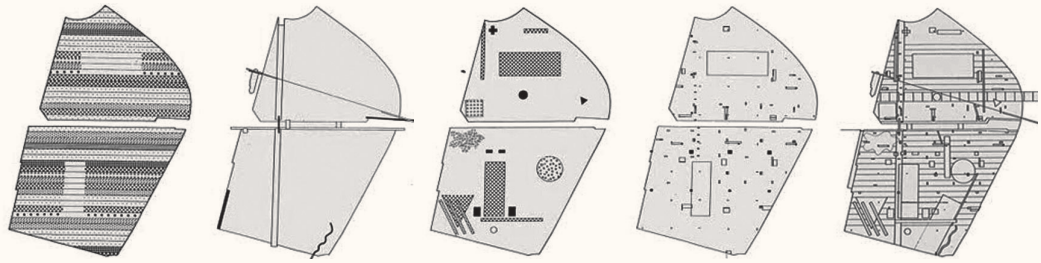
Julia's design for a very small building ended up with partitions inflected by the presence of their junctions with other walls, in a way that revealed their presence, somewhat in the manner of soap bubble models or the plans of Hans Scharoun.

Exercise 2: From Free to Orthogonal Space

Part 1: sketch imagined spaces and relationships as freely and loosely as you can in a cloud or bubble like way. Draw again and again in this way, trying different starting points or relationships. Coalesce the parts into a more definite arrangement or pattern.

Part 2: from the emerging pattern and relationships develop rules or straight guiding lines and gradually coalesce or convert further into a more orthogonal form. Strive to distil, to edit down to the main moves only. How few moves or gestures do you need to achieve a plan that works?

The example drawn above is obviously a cheat as, to the best of my knowledge, Mies van der Rohe did not work this way. The amazing thing for me about the Barcelona Pavilion is its implied choreography. The well timed dance one is guided or led along by successive prompts: the stairs, shelter, the view of the hidden courtyard, the statue of Alba, the long view to the end and finally, when there is nowhere further to go, resting on the bench facing the water.



▲ Figure 3 Exercise 3

Exercise 3: Memory Scale Collage
This is a way of abstracting the design task as one of scale and grain.

Part 1: list relevant reference spaces or objects you know. Paste the plans over your site.

Part 2: from the reference objects determine the grain(s) or scale(s) relevant to your brief.

Abstract them as a grid that is spaced apart by the relevant distance(s). Draw in response to the emerging grain: things existing (kept) and proposed (new). Also look at what follows the grain, what transgresses (is larger or differently proportioned), what sits well below (more compact spaces, points or nodes). Theses scale exceptions can now be seen and manipulated in the foreground in contrast to what is typical or normal.

Rem Koolhaas and Elia Zenghelis (OMA) working on the competition for the Parc de la Villette, Paris in 1982 decided they needed to discover the scale of the park. Initially they pasted buildings and then squares over the park. Then, realising that a park is not a building and a square is more readily defined by its edge conditions, they decided to find a relevant social dimension. They decided that you could walk past a friend having a picnic without greeting them if you were 25 metres away and used this social scale to cut the park into 44 strips. Now they knew how big the park was.

Exercise 4: Wallpaper Map
Choose a range of ready-made patterns or wallpapers that you judge can relate to your concept. Sketch or list different ways of interpreting a chosen few of these patterns. For example: as solids and voids, as contours, as areas of different activity, as private or public space etc.

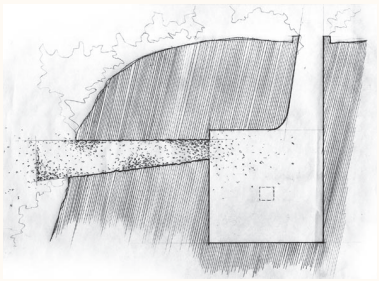
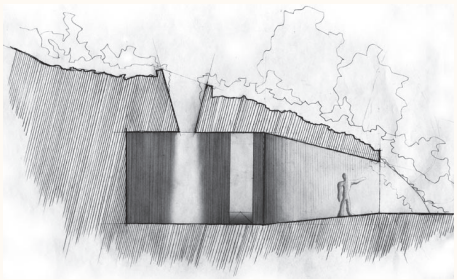
Phoebe Braidwood used this exercise (figure 4) to begin her design for a Cider Park on Weston Island, Bath in 2006, mapping and then modelling different strategies from found patterns.

Exercise 5: Name
Whatever idea or aspect of your project you want to explore: give it a name. Then diagram that name in as many ways as come to mind immediately. Once you have diagrammed all the possibilities that come easily to mind, choose another name and draw the diagram(s) for this new name.

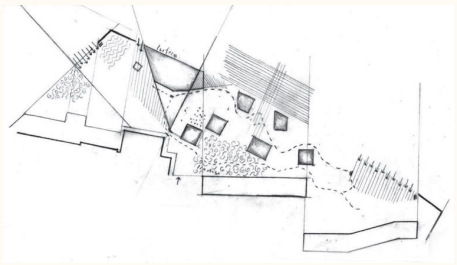
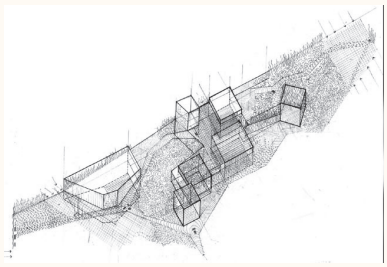
Exercise 6: Muff on a Huff Puff
A game which is a sort of architectural version of 'picture consequences' which one Danish family I know calls 'Muff on a Huff Puff'. It exploits the hive-mind to develop ideas. A list of players is drawn up with the accumulated creation going off on a journey round a circle of people. An alternate version has the pieces returning to you at each stage, so it is more like a dialogue without words.



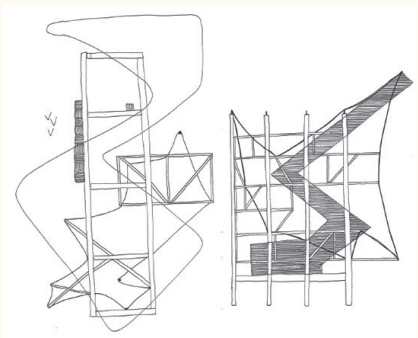
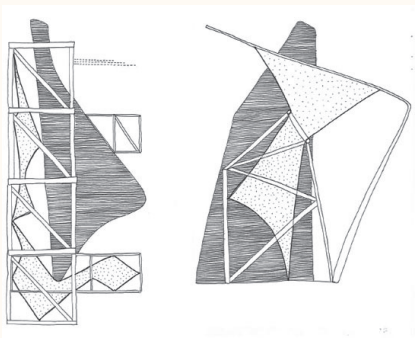

▲ Figure 4

▲ Figure 5 Lee Holcombe: Tomb sketch plan & section

▲ Figure 6 Charlotte Walker: Pavilions in a Patterned Park

▲ Figure 7 Jimmy Williams: Folly

Ideally each stage would take place on a subsequent day so one could sleep on it overnight. Each stage should be limited in drawing or modelling time to less than an hour, preferably 30 to 40 minutes. Aiming to be generous with thinking time, even if thinking takes place in the background, and economical with production time.

Pick a concept you wish to use in your building and draw an image or conceptual diagram. Give it a name of one or two words and pass it on. You receive an image or diagram with its

name and use this as a brief to draw or sketch an architectural idea or device that develops an aspect of the building and pass it on. You receive a drawing of an architectural idea or device and in response develop this into a hand drawn plan and section to scale and pass this on. You receive a plan and section drawn to scale and in response make a quick study model. You receive a model. Describe a construction detail of the modelled building in less than 50 words, like a detail brief, and pass this on. You receive a description of a detail and you make a sketch drawing, to a scale, of this detail and pass it on. Pin up the results one above the other. Thus each column starts with a conceptual image at the top and ends with its related construction detail. There can be a significant element of Chinese whispers with some unexpected interpretations along the way, but also some serendipity (happy accidents) or enlightening proposals.

EPILOGUE

The notes above deal primarily with the first two stages of the design process: project definition and trial solutions. Critical analysis and evaluation have not been discussed. I am aware that though some students find generating trial solutions difficult there are others who generate abundant material but seem to find bringing this to a conclusion challenging. They need to develop a corresponding level of critical or analytic ability. Often this will come with greater experience. Sometimes it is just a matter of developing their confidence in their own abilities.

Consider also that not everything has to be designed. In developing the brief for an ideal school, for an internal design challenge at Feilden Clegg Bradley Studios, I interviewed people about their memories of their own time at school. The most potent places were not the programmatic spaces, classrooms or halls, but the left-over spaces, the less defined spaces, adopted or adapted by them, alone or as a group, for their own purposes. So in our brief we called for the inclusion of 'Ambiguous Space', space to play or dream in. We are creative and curious apes. We engage with our environment in diverse ways. Try to capture the spirit of what is possible.

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Education for uncertainty

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INTRODUCTION

At the time when the RIBA is rewriting its validation criteria and we are in the process of setting up a new school of architecture our focus is on the development of a new framework for architectural education that puts professionalism, collaboration, research, industry and employability first. Our curriculum has to have currency to deliver knowledge with relevance in the culture and context of making buildings today – subjects such as energy literacy, low energy design, from concept to post-occupancy and understanding the basic principles of sustainable design. It also needs to deliver critical research skills. The dialogue with practice needs to be fluid; we need to engage in dialogue, to understand the possibilities for us all to learn and engage with Architecture - the academic discipline and profession as it evolves in the 21st century. A school of architecture can situate between the academic and the pragmatic, the imagined and the real. The profession is an interdependent entity. A new education model needs to be inclusive, encourage participation from education and practice to create a platform for open and equal discussion and to learn from each other and respect different positions and perspectives. What is the difference between being a practitioner and an educator? When are we in designing mode, researching mode, learning mode or teaching mode? We are all part of a system whether we are students, architects in practice, architects in education, researchers or interested participants in the discipline. We are all contributors to the evolution of our field. Our interest is not in delivering a "fantasised and idealised notion of architectural practice" (Sarfatti Larson, 1993, p. 10), instead we want to help students develop the skills, knowledge and ethical compass to make what they will of its constantly shifting potential.

"Perhaps the most important thing that we can teach students is how to respond to uncertainty and change, how to themselves become resilient" (Nowotny, 2015, p. vii). The focus of this paper is on developing a professional architectural education for uncertainty which embraces "the beautiful risk of education" (Biesta, 2014). We look back to 1960s when "Interdependence and Uncertainty (Tavistock Institute, 1966) was firmly on the agenda and architecture and the social sciences achieved a marriage of convenience that dwindled to almost nothing with the demolition of public sector 'salaried architects' in the UK (Morris and Mogey, 1965). Both architecture and the social sciences have, however, moved on since this time and we argue that the time is ripe for new, more nuanced interdisciplinary work drawing on the subtleties of new methodologies and methods.

We begin with an examination of one key precedent for such an education, before moving on to a discussion of the skills, knowledge needed for the exercising of professional judgement and the learning environment we think

necessary to become resilient professionals sharing risk in a responsible and critical way with society. If risk is suppressed in one place it inevitably emerges somewhere else, hence a profound need for professional and ethical judgment. We argue that education for uncertainty is also education for diversity as it has much to do with sharing contextualizing knowledge while acknowledging and bringing forth inequalities of risk.

1. AN EXPERIMENT IN PROFESSIONAL EDUCATION FOR UNCERTAINTY

The architecture profession in its official guise began in the early nineteenth century as a reaction to the inadequacies of the pupillage system (Mace, 1986, p. xvii). "The history of architectural education in Britain can therefore be seen as a search for an alternative to pupillage motivated by a negative perception rather than a clear ideal of something better" (Powers, 2015). In the 1970s it was recognized that, "lacking a research tradition of its own" architecture had an over reliance on traditions from other disciplines (Broadbent et al., 1970) and further, that "the design, or action disciplines tend to remain intellectually weak" and "subject to every wind that blows in the academic world" (Hillier and Leaman, 1976). As professional schools were assimilated within universities they lost "commitment to applied work" even though they were set up to link practice with research (Boyer, 1997). Remedial action was, and still is needed.

An early example of "education for change" is provided by the first paper in the short-lived journal Architectural Research and Education, founded in 1970. "Diploma Project 1968-69", its generic name designed to suggest the open nature of its brief, is an account of a studio designed to promote "professional effectiveness"; "to encourage education for change" ; "to improve skills in advanced architectural design"; "to develop effective attitudes to the professional role and to prepare for team work in professional practice" (Abercrombie et al., 1970). The evaluation of the project, a published pedagogical research piece was structured under these headings. Its first author – the 31 students and staff were the project team - was Minnie Louise Johnson Abercrombie, then leader of the Architectural Education Research Unit (AERU) at the Bartlett; a psychologist by training. Their concern, 'education for uncertainty', is our concern, leading us to speculate on the best way to translate this into a 21st century context.

The project, based on a series of earlier experiments, offered a carefully choreographed educational experience lasting an entire year. It is worth noting, since we are now at a time when UK education is in danger of bifurcating between research and teaching (BIS, 2015), that it was partially funded by the Leverhulme Trust and the Social Research Council. The project shows the influence of Richard Llewelyn-Davies who was Professor at the Bartlett from 1960-1969. Llewelyn-Davies was a key figure in the development of the 1958 Oxford Conference and instrumental in mapping out a research vision for the RIBA at that time (Llewelyn-Davies and Cowan, 1964). The "intention" of the project was to give students responsibility for their evolving education "by involving them in planning the course, choosing their design projects and assessing their work" (Abercrombie et al., 1970). The studio teachers were "participants" in this collective process. The "core activity" of the unit was conceived as a sequence of design projects of increasing complexity. Following a short introductory exercise, designed as an ice breaker, that would raise a series of issues about the "current professional scene", the group was given a "closed" task, an architectural competition for 24 flats for old people in Byfleet, Surrey which led into broader discussions about "social and ethical" problems of design for ageing. Moving on to the next problem North Kensington, then a "twilight" area of London, was chosen as a site as it meant that the students could work with a variety of agencies interested in its development. This area became the locus for an exploration of issues of "social and architectural concern"

individually and in groups in the period between Christmas and Easter. The last term, from Easter to the summer break, was then devoted to a synthesis of studies by the whole class, which took the form of an "integrated proposal within the specified urban area". This process was accompanied by introduction to a variety of current case studies intended as "a vehicle for understanding the application of technology, economics, contract procedure etc. to design". "Free group discussions" based on a lecture or readings happened on a weekly basis, often straying from their intended course.

Evaluation of the project was based on staff observations, student log books and comments made in the "free group discussions". A 1964 paper by Newton Watson shows that the Bartlett had been pioneering new forms of assessment for some time. Having dispensed with the 'jury', Watson and his team wanted to recast end of session assessment as "a teaching medium". It was to take the form of a "discussion" accompanied by a "studio work record", explicitly not an assessment, with comments under the headings: "communication"; "analysis of the problem"; "structure"; "materials"; "functional planning"; "services" and "inventiveness" (Watson, 1964).

The results of the AERU unit were perceived as patchy – but the team are to be commended for their degree of self-critique and willingness to admit to failure, enabling us to then learn from their mistakes. As is so often the case today, staff reported that students often experienced difficulties in making design proposals after doing extensive amounts of "social" background research (Abercrombie et al., 1970) accompanied by "frustration" and a loss of "confidence". The students, apart from one exceptional group, started working from home, failed to attend reviews, became more and more siloed and generally there was "a great reluctance to work as a community on mutual assessment". The highly engaged group however devised an engaging, choreographed celebration of their project:

> *". . .one member of this group contributed proposals for a mews housing scheme, the spatial organization of which fulfilled his wishes for "participant democracy", by which the occupants could choose their own combination of spaces. Another member concentrated almost exclusively in provoking radical political ideas in the audience. The excessive length of the presentation (four hours with a short interval) inhibited immediate feedback, but the demonstration of skill, energy and enthusiasm made an impact which has subsequently been favourably commented on."*

In general, "the designs were not remarkable for their originality". Some students reported "a newly acquired confidence as self-learners and critical thinkers whilst others lamented their "turmoil, distress and uncertainty". Abercrombie et al do not report on whether they found that this turmoil presaged intellectual breakthrough or despondence, but clearly this is an uncomfortable and delicate moment in the educational process if students are to become self reliant. It also has a poor fit to our current climate in which the student is a "customer" and league tables of student satisfaction are paramount.

Clearly the overall culture of the school and the university is one which had already acclimatized Bartlett students to a rigid structure, with success measured in the attainment of good grades.

Nowadays we are very familiar, certainly at MArch level, with offering an open brief in which students choose both site and purpose – this does not seem to have been the problem for the AERU project. Reading between the lines it seems that the main issue

was the self organization, self-assessment and team-working for which the students, who came from a diverse range of educational backgrounds, were deeply unprepared. At the heart of this was their difficulty with justifying informed professional judgments both individually and collaboratively to guide their actions going forward. Despite their desire to provide a loose and challenging framework that would allow students to innovate in safe circumstances, the team were hindered by both their framework for assessment and the need to fulfil professional validation criteria, a problem that that AERU tried to address by appointing a team of external examiners who reviewed the students work on an ongoing basis. Significantly they reviewed the process not the product (Abercrombie et al., 1970).

The RIBA criteria, currently up for review, have changed very little over the last fifty years. Now with the RIBA Review of Education we have a real chance to make them better. The advent of digital technology maes the development of an ongoing reflective portfolio in which students choose and chart their own way through their learning an easy option, in a climate in which architecture has become so complex that they cannot learn everything. The concept of the "reflective practitioner" as developed by Donald Schon is an important set of attitudes and learning approaches to develop in architecture students, as something that will stay with them throughout their professional career (Schon, 1984).

In trying to create an education that embraced uncertainty, the AERU team were taking a great risk, the important thing being the sharing of that risk with the students. "Classrooms that embody education as a practice of freedom cannot be made entirely safe. These learning environments are unavoidably risky in terms of the intellectual regions they engage, the emotional experiences they engender, the verbal exchanges they facilitate, and the actions they endorse" (Glass, 2004).

Whether students want or are ready to accept that risk is another matter, particularly since risk is highly culturally specific (Hood et al., 2001).

2. PROFESSIONALISM

David McClean notes that a central problem of architectural education as it is framed at the moment, is that it makes students dependent on their institutions and on their teachers. These dependencies on tutors are constructed or reinforced by a lack of clarity of learning intention, confusion over the purpose and role of projects in relation to learning outcomes, the nature and quality of feedback, and in terms of what is assessed and valued. Diversity in learning style and intelligences exists within student cohorts. For a pedagogy to be inclusive, this diversity must be understood and explicitly accommodated in the learning process. Inclusivity is fundamental to engendering a sense of belonging in the student, as is the acknowledgement of their personal opinions, views, and experiences. The habituation of reference to others, of formation of judgments that assimilate personal opinion with external views, and information gleaned from multiple sources, is key to independent learning, this process cumulatively allowing the student to develop a sense of independence over time (McClean, 2009). The mode of engagement is arguably more important than content.

The paradigm shift away from teaching to learning identified by McClean has parallels in the evolving professionalism debate. The word 'profession' has etymological origins in the Latin word 'profiteri' which means to declare openly. To be a professional is to profess to having a level judgment above and beyond that commonly available in our population. For us the ability to make these judgments resides in research skills, the rigorous use of knowledge and the critical application of ethics (Kaye, 1960), categories that give

structure to this section. As knowledge has been democratized, the professions have come under attack (Eraut, 1994), in particular for a lack of ethical compass (McNeill, 2006). Nowotny suggests that experts need to make explicit the way in which they deal with uncertainty, in this way sharing an understanding of its nuances and responsibilities with society (Nowotny, 2015). In the case of architects this would mean admitting, discussing, sharing and learning from failure, involving society in the creation of a more solid body of knowledge on which to base decision making. It is the ethical duty of architects to put the interests of society, not individual clients, first (Green, 2011).

The amount of time needed to become a professional is debatable (Sarfatti Larson, 1977). Arguably, architectural education is too long (Pringle and Porter, 2015), yet at the same time you never stop learning to be an architect. Education is there to encourage good habits of life long learning and self development both in yourself and in others, not to impart a quickly dated body of knowledge. These attitudes and values around learning and professionalism start in the school of architecture.

Geoffrey Broadbent and his fellow editors at the Journal of Research and Education made a plea, again equally as relevant now as it was then:

> *"The RIBA must explicitly allow the schools to diversify their criteria of excellence for the award of degrees, so that students who specialize in understanding design problems can be regarded as equal in all respects to those who specialize in their solution. Both types are appearing in the schools; both will be needed as practice uses more information originating in research; above all, both will be needed if the growth of architectural research is to lead to a better environment. It goes without saying that it should be no more difficult for students who take this route to qualify a full members of the RIBA"* (Broadbent et al., 1970).

Broadbent and his colleagues here recognize that some students might choose to examine the processes through which architecture comes into being rather than immerse themselves in that process to produce a finished product, the design or building. The profession needs people who both go through the process and those who examine that process. This is an extremely important point that many of us have hit upon more or less unconsciously in the process of teaching and which we will address explicitly through our curriculum.

A. SKILLS

"Within this context one of the central predicaments facing the education of today's architects is that of defining the designer's expertise in relation to an industry in revolution" (Sheil, 2015). The skills of architects are not widely understood or recognized, but we want to make them explicit so they can be shared by non-architects and architects in formation. The creation of new knowledge is described as having four phases: "socialization", "externalization", "combination" and "internalization" (Lu and Sexton, 2009; Nonaka and Takeuchi, 1995). Essentially, this a cyclical journey in which tacit knowledge is converted into new explicit knowledge and then back again at the levels of both individuals and groups. We are fully aware of architectural culture's refusal to be pinned down or made explicit – but, we argue, there is a profound need to attempt to set out our stall if only to allow others to engage with it.

Although rarely recognised, the primary skill set of architects, we argue, is research. Research is "defined as a process of investigation leading to new insights effectively shared" (HEFCE, 2011). It is a globally respected language that cuts across cultural

divides. Much of what happens in practice involves investigation, but a major barrier to the advancement of the profession is dissemination (Samuel et al., 2013) – we rarely learn from our mistakes. Our vision of architectural education embodies a feedback loop of investigation, reflection, shared critique and improvement, a process not dissimilar to that undertaken by, in our view, enlightened practices that are fully engaged with building performance evaluation, not just in terms of energy but also in terms of social and cultural value.

Kyna Leski observes that the stages of creativity are essentially the same, irrespective of whether the creativity is artistic, scientific, technical or business (Leski, 2015). The first stage in a design project is "The collection and ordering of information", which always "presupposes a theoretical framework of reference" (Echenique, 1970, p. 25). Architectural models, whether built in cardboard, portrayed on a wall at a studio review or parametric, are representations of "theories" if not methodologies (Echenique, 1970, p. 30) and it is time to make this explicit (Dye and Samuel, 2015).

Research and representation go hand in hand. Whilst writing might be the traditional tool of many researchers for the exploration of ideas, drawing, modelling, mapping, filming and designing are the tools of architects. We believe that "tools", a word acceptable in architecture culture, are actually "research methods" by another name. In our first year students will be sent out to examine the city seen through a range of tools, which will, in later years develop into a "tool box" or "mixed methods approach", hopefully connected through triangulation. These are key research skills and need to be seen as such as they are ripe with potential for interdisciplinary exploitation.

Our curriculum will build on the definition of "Architect Types and Skillsets" developed through extensive consultation by the Arts and Humanities Research Council-funded 'Cultural Value of Architecture' project (Samuel et al., 2014). The project set out three overlapping typologies of architectural practice, each working with a different value system: cultural value, social value and commercial value. The different architects working in each of these value systems apply very different research methodologies to what they do. The social architect, concerned with creating social value is very often engaged in participatory methods. The commercial architect, concerned with maximising financial gain, is likely to prioritise economic methods. This taxonomy of knowledge economies within the field of architecture provides a structure for research training, tested and refined with a large group of practitioners, students and the public. We recognise the dangers of being reductive, exclusive and over rigid when trying to trying to be transparent, inclusive and explicit. The only way through this is through constant renegotiation.

B. KNOWLEDGE

"Somehow we have to produce embedded knowledge: i.e. insights that are there for excavating later, when the context is right but not until then" (Strathern, 2000, p. 189). If students are effective researchers they have the ability to acquire knowledge as necessary, however there is a basic level of subject-specific knowledge important for the practice of architecture. We have subdivided this into three categories: knowledge for making – focussing on product and traditionally the priority of many architectural schools; knowledge for collaboration, and lastly practice economics. Different schools place emphasis on different types of knowledge, for our school as much emphasis will be placed on collaboration and business as on the processes of design.

"Schools have infected a generation with an anti-business mindset". (Pringle and Porter,

2015). Students usually address practice at the very end of their training. In our case critical reflection on business will start at the very beginning. Practice economics encompasses a knowledge of existing and past practice procedure and the economies of the profession, monetary and non-monetary. The aim here would be to arm students with the economic and critical savvy to fight the cause of their field, something that is notably lacking in current cohorts (Imrie and Street, 2011).

Knowledge for collaboration includes digital tools for knowledge sharing such as BIM, manufacturing, the structure and methods of the construction industry, the wider knowledge economy and policy, including intellectual property. It focuses on supply chains, the meaning of globalisation and its impact on our environment and on ways for architects to become active in engaging with these debates. A key element of professional knowledge are regulatory frameworks which traditionally take a back seat in architectural education as they are thought to limit creativity. However, they should instead "be understood not as external to creative processes and practices, but as integral to them" (Imrie and Street, 2011). Codes and laws originate from a desire to promote public wellbeing and reduce risk within civil society. Participation in debate on the creation of codes is simultaneously a rarely acknowledged form of co-design and an expression of the professions contingency (Imrie and Street, 2011).

Knowledge for making of course includes tectonics – making with thought, inclusive design and space planning and place making. These will be taught and described as much as possible as explicit skills, not just as a vague subset of what happens in studio. Comfort, light, acoustics and energy, must of course be addressed, but in an intelligent way that addresses the complexities of human behaviour. More work needs do be done into the vital task of setting out the fundamentals of architecture in order to open it out to non-architects. Pedagogues such as Lorraine Farrelly and Simon Unwin who have set out to try to describe the basic elements of the discipline are not just producing text books, they are trying to give order to a field in desperate need of clarity (Farrelly, 2007; Unwin, 2014).

A further aspect of training students for an uncertain future is transferable skills. Schools need to promote a professional discourse that creates a balance between subject specific skills and more transferable professional skills in the explicit understanding that some students will stay in the profession and some will make the positive decision to go. The idea that "the major part of your education is always going to be the design of buildings" (Marjanovic, 2003) is severely dated. Students are well known for their dissatisfaction with programmes of architecture and whilst it may be the noisy and jobless minority who complain, it is unacceptable that any students should remain unemployed after such a long and expensive training (RIBA, 2015). Rather than giving sighing acceptance to RIBA statistics that only one in fifteen students who begin their studies at a UK school actually qualify as architects we should be making sure that there are more jobs for them within architecture if they want them by raising the impact of the field as a whole. If they do choose to leave the field it must be recognized that they are not "drop outs" but actually perform a very useful function in disseminating the use of architectural skills in the wider world (Sheil, 2015). We have an ethical duty to furnish students with the best possible chances of success in their own terms. The expectation of high workload, unsociable working hours and unreasonable work expectations start in the school of architecture and fuels the inward looking nature of the field.

C. ETHICS

To behave ethically is to acknowledge the rights and experience of others perhaps less

powerful than oneself, it is also a key element of being a 'professional', in other words weighing up risk. Criticism of architects' ethics thus touches on a sensitive issue for a profession that is always looking nervously at its historically accumulated privileges. (McNeill, 2006b). Miles observes "architecture is an agent of the consumer society: it appears to act on that society's behalf in reinforcing the orthodoxy of the market" (Miles, 2010). Judith Blau notes a bifurcation in the intention of architects who on the one hand are committed to doing good in the world and on the other, to following business (Blau, 1987). We believe in the possibility of practices combining business with ethics by accessing new research-related funding streams and by widening the menu of services that they offer to clients. An example in the UK is Architype architects who have been recipients of UK research council funding to assist their ongoing commitment to building performance evaluation and soft landings, helping users to use their buildings well, which in turn gives them a market edge in their field.

Students will be encouraged to take a holistic and critical stance to the subject and to recognise very often that practice is about the strategic movement of risk based on research. The global space within which architects operate often defy "regulatory frameworks of nation state" and inhabit an obscure world of global ethics (McNeill, 2005), one which can only be navigated by those who know how to access knowledge with ethical sensitivity. There are also important aspects of professional and social responsibility that schools of architecture have a responsibility to encourage within the student body. Our students need to understand and participate in the social issues in and around architecture. We want them to be actively involved as citizens in the debate around key issues such as: housing, public space and social concerns around environment energy use and accessibility.

In schools of architecture across the UK, ethics approval is increasingly a compulsory aspect of any project involving research though coverage is patchy. They are frequently allied to risk assessments, originally set up to protect workers and therefore key to responsible working. At the University of Reading, students must fill in an ethics application whether they will be working with people or not. A light touch version of which will extend to all studio projects, not as a paper exercise but as a fundamental acknowledgment of duty to others. Given that professional institutions such as the Institute of Civil Engineers have put in place an ethics tool to guide their members through this area, sensitive both morally and legally (ICE, 2015), it can only be a matter of time before architects too follow suit.

3. LEARNING ENVIRONMENT

Context is increasingly recognised as central to learning (Elton and Johnston, 2002). "Real learning takes place between students and out in the world" (Powers, 2015), hence the profound need for any architecture school to be permeable, to practice, to the wider university, to the wider built environment industry and to society. Building on the endeavours of Reading 2050 we want to create a school of architecture as an "Urban Room", as referred to in the Farrell report as a vital accessible space for debate and discussion around architecture and the public realm. Simultaneously a research laboratory on the role of architects in the co-creation of places, and a place for students to experiment in engagement with civil society.

The Urban Room will focus on collaborative processes and strategic planning, rather than built outcomes, the domain of many of the project offices that are based in several UK schools. Such project offices have traditionally been linked to the development of Live Projects in their particular schools, sometimes because of the complex issues of professional indemnity. They take different forms and can offer academics and students

opportunities to be involved in real or Live Projects working with a real client on a real problem. This approach to architectural education is another example of simulating real practice problems in the student learning experience. Whether such offices, sometimes fuelled with 'free' manpower from students, have a competitive advantage over local self-funded practices is a moot point.

We seek to make Live Projects in synergy with practices, building on a model currently in development in the MArch at Northumbria University, in which students add value by bringing additional research capability to a practice project and its processes. "Live projects are, if pedagogically understood and appropriately managed, a natural setting for a situated, critical and inclusive education" (Morrow and Brown, 2012). They require brave tutors who can support students through uncertainty and the considerable demands of real clients in real situations. Live projects can be assessed, as they are at Sheffield University, by the client, by the students and by the tutors; each form of assessment brings into relief the different value systems at work, a critical understanding of which is vital to operation as a professional (Butterworth and Care, 2014).

The students in the AERU experiment took responsibility for a portion of their own self-assessment. It must be possible to develop a self-audit system that ensures that all students take responsibility for picking up the necessary skills along the way. Currently students fill in a PEDR log of their developing experiences. A new form of validation is needed that allows for the custom-build of learning in each individual student potentially through the use of digital mapping and which makes the full range of architectural expertise clear as a road map of potential.

It is widely acknowledged that architecture students must learn to work collaboratively with one another, just as the industry itself needs to become more permeable. Parnell notes; "the development of empathy and cooperation among students of architecture is identified as most lacking in the traditional model of their education" (Parnell, 2003). Wherever possible students will work collaboratively and we will work on current best practice to develop appropriate assessment tools (Butterworth, 2014). Tutorials in small groups are nearly always better, they encourage the development of critical skills, collaboration, shared responsibility and shared learning. They also protect the student from the one to one contact which can for some people and some cultures be very uncomfortable.

"One of the mistaken arguments for the retention of the crit is that it prepares for the real world – but at what cost? Answer: the development of alien vocabularies (spoken and drawn) understood only by architects, arrogance (attack being seen as the best form of defense in a crit), are the common traits, among others, which are established in schools of architecture and which then contribute to the formation of the character of the architect." (Till, 2009) We argue that crits are based on a very outdated vision of the 'real world' – aggressive confrontation is no longer seen as good management and serves to perpetuate excluding and destructive leadership models - and should be reframed, in the manner of Nowotny, as collaborative research. The format of the review should be established and actively engaged with, by the students as part of their training in co-production and in the facilitation of events, a very key aspect of the architect's role.

As the Bartlett exercise showed, university structures have traditionally worked against experimental pedagogists, but things are rapidly changing as innovation incubators are starting up across the world. The 'Sliperiet' at Umeå University in Sweden is a beautiful example. Combining "maker spaces and labs" with "work space for the creative industries"

it offers a common platform for researchers, students, businesses and public stakeholders (http://www.sliperiet.umu.se/en).

Researchers in the Sliperiet have recently been successful in bidding for major funding to develop a digitally printed timber house. Such an enterprise starts to model the real potential of academic/industry connection to which we aspire.

Working as an individual on the studio project encourages individualistic and unrealistic expectations of life in practice. The building as a project is a collective endeavour, it brings together a range of contributors in a team, from the design team, engineers, surveyors, to the client project managers, and the contractor. Collaboration between architects and the public is important and needs to be part of an education model, but collaboration between the built environment disciplines is also vital. This was an important observation of the recent Farrell Review of Architecture and the Built Environment (Farrell, 2014) and it is an ambition of the new school of architecture at the University of Reading, that the courses will connect to the built environment disciplines to create shared curricula around design and aspects of building implementation.

Education systems in Universities can be very deterministic and create barriers to develop truly integrative and collaborative approaches to learning, compounded through the logistics of budgetary planning. The idea of an education model that offers students possibilities of interdisciplinary learning connects to the idea that there can be instances in the academic context where we prepare students for their practice experience. A collective approach to the design project is one area that we can develop an understanding of team dynamics and participation.

As Abercrombie et al made clear, there is more to architectural education than working towards assessments. Rather than 'overteaching' we want to provide targeted teaching that leaves time free for reflection and opportunities for students to develop into active citizens. Care will be taken with the student experience, developing their confidence to work with potential clients as well as real life skills around communication and team experience. Not all education experience needs to be assessed, nor should students expect it to be.

CONCLUSION

Our new school at the University of Reading is responding to a series of issues that relate to architecture as a profession that is intrinsically linked to the construction industry and economy. It is located alongside a School of Construction Management and Engineering, educating the Quantity Surveyors and Construction Managers of the future. If we are to start new cultures of problem solving, collaborative thinking and working in schools of architecture (Farrell, 2014; Morrell, 2015), we need new frameworks for teaching and a shared language of research. The new School can offer a place where research is at the centre of the student experience, not peripheral to it, and where practitioners can develop a dialogue with the school around their own research agendas and potentials

Skills, knowledge and ethics, the fundamentals of professional judgment, then become a cohesive framework for the delivery of learning outcomes and self-assessment, rather than a deterministic set of RIBA Validation criteria currently in use in many schools. The framework should be reference point for a well-balanced curriculum, setting the scene for learning for uncertainty, not a schedule of what is to be learnt. Like the old adage often used in studio, that constrained sites offer a better foothold for creativity, it is our thesis that carefully considered constraints, constraints that address learning from past

experiments in education, both of our own and others, and are designed to help students address their 'Fear of freedom' (Freire, 1981) perhaps paradoxically, offer a degree of empowerment.

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Negative capability in the design studio

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"We are searching for some kind of harmony between two intangibles: a form which we have not yet designed and a context which we cannot properly describe."
Christopher Alexander (1964)

INTRODUCTION

Most artists and designers will admit that some of their greatest innovations and achievements are the result of an accident. This fortuitous sort of accident however, typically happens only after an extensive period of trial and error. A seasoned designer knows that a certain amount of frustration and chaos must be endured in this process before such luck can be gainfully procured, but for students who are new to the design process, these states of confusion and unknowing can be unnerving if not intolerable.

Accidents are unintentional by nature; they happen unexpectedly, outside one's sense of control. The ability to perceive, think and function beyond a fixed capacity (or control) is also known as negative capability. The poet John Keats first used this term when trying to describe a person's openness or receptiveness to a reality that extends beyond the confines of his or her knowledge. Since then, the term has been appropriated by philosophers and other theorists who seek alternatives to the ongoing dialectic between structure and agency.

The concept of negative capability has a direct relationship to what design researchers Meinel and Leifer (2015, p. 4) refer to as *The Ambiguity Rule*, which states: *"Innovation demands experimentation at the limits of our knowledge, at the limits of our ability to control event, and with the freedom to see things differently."* As design educators, we can provide a structure or platform for students to experiment on their own, but how can we create a studio environment that encourages risk-taking, allows for error and teaches students to acknowledge and tolerate states of ambiguity; how can we teach them to hone their skills in negative capability?

FAIL BETTER (Beckett, 1984)

Every year incoming university students show up to class ready to succeed, ready to follow the well worn paths to knowledge and ready to achieve, but rarely are they ready to fail. In fact, the fear of failure can be so paralyzing that it can keep some students from making a dedicated attempt. In some ways this is no surprise, students are rarely shown examples of failures by well-known artists and designers don't often disclose their foibles. Resistance

to failure is a natural component of healthy behavior, but in its extreme condition it keeps students from learning what is perhaps the most valuable of all lessons – **resilience**. And for the creative disciplines, which value divergent thinking, a certain amount of risk-taking is an essential part of the practice.

Setting a classroom environment that is both rigorous on the one hand and permissive on the other is not an easy task for instructors. Permission must be granted to make mistakes while maintaining the expectation for hard work, quality work and critical analysis. Initial discussions around these subjects can help set the appropriate tone, one that normalizes accidents, mistakes and failure while it calls for diligence, insight and courage.

In 1973 artist Agnes Martin spoke to students at University of Pennsylvania about the importance of failure:

> *"I will speak later about successful works of art, but here I want to speak of failures. Failures that should be discarded and completely cut off. I have come especially to talk to those among you who recognize all of their failures and feel inadequate and defeated, to those who feel insufficient¬– short of what is expected or needed. I would like somehow to explain that these feelings are the natural state of mind of the artist, that a sense of disappointment and defeat is the essential state of mind for creative work."* (Martin, 1993, pp.68-69).

She goes on to talk about the feelings of joy that come from an awareness of perfection in the mind– feelings that are connected to our experience of happiness and inspiration. But, she says, *"we must surrender the idea that this perfection that we see in the mind or before our eyes is obtainable."* In truth, the more we are aware of perfection, the more we realize how unattainable it is. That's why design is so difficult– one is constantly working through disappointments and failure to the point of defeat. *"But still one wakes up in the morning and there is inspiration and one goes on"*, Martin assures us. As one accepts failure, there must still be a determination to continue.

Reading and discussing these ideas in class can help set a tone for hard work and experimental trial and error. It sets an expectation not only for failure and defeat, but also resilience and tenacity. And beginning designers need to be prepared for failure if they want to achieve success later on. This paper outlines three strategies for teaching risk-adverse students in order to help them understand and endure the nature of ambiguity in the design process. The first two assignments, which were developed for first-year foundation level students, emphasize improvisation while they investigate unfamiliar modes of perception. The diversity of outcomes from these activities confirms the substance of individuality and can help teachers determine the best way to accommodate different learning styles. The last example (Leap Across Gaps) is a semester long project designed for second-year architectural design students and focuses on representational translations in space.

I. Draw with Closed Eyes

First year design classes typically offer highly structured assignments, many of which are meant to breakdown students' preconceived notions of perception and representation. The emphasis in these assignments is on investigation and exploration rather than instruction. In other words, a limitation is prescribed, one that is often perceived as insurmountable, and the main goal is to initiate a process of discovery and invention. Blind contour drawing– or "pure contour drawing" as it was first popularized by Betty Edwards (Edwards)– is a method that prohibits the artist from looking at the paper that they are drawing on.



▲ **Figure 1** Drawing with closed eyes

Numerous variations of this assignment exist. The two outlined here focus on selective observation and touch. Both assignments are self-portraits, the first asks students to look in a mirror and draw what they see without looking at the paper. Students must keep their eyes on the mirror and move their pencils continually on the page for 20 minutes. Some students use a draped piece of fabric or paper to help eliminate the temptation to look. Predictably, 20 minutes feels longer than expected, so students are encouraged to draw slowly and deliberately, taking their time to discover new and unexpected features. While the students are drawing, its important to emphasize that for this particular exercise, **observation is more important than representation**.

With pencil and paper ready, the second assignment asks students to close their eyes entirely and draw their face by touch only, so that one hand is drawing while the other hand is feeling the shapes, features and textures of the face. Once again they are asked to do this for up to 20 minutes, taking their time to feel not only the haptic features of their face but the tactile movement of their drawing utensil and paper.

The initial frustration of not seeing their drawing in progress, usually subsides as students begin to concentrate on the task at hand. Once a student starts to loose self-consciousness and surrender to the process, some remarkably original and creative results can occur. Below are a few examples of blind drawings that illustrate the openness of forms and variation of marks that typically result from this assignment. Students are quite amused when they first see their blind drawings, surprised at the unexpected results. But there is also a dissociative pleasure that can occur– the realization that something quite out of the ordinary, and beyond expectation can be created when one is willing to let go of intensions and become immersed in a process with careful attention.

After pinning the work up for review, instructors can recognize the individual styles for learning and expression. The perfectionist will typically use smaller, lightweight lines, with an approach that is dominated by hesitation, risk aversion, neatness and calculated precision. The expressionist will employ larger heavily weighted lines and marks that have a wide range of diversity. Their approach is more spontaneous, bold and muscular. Both styles have something positive to offer, and both have something to glean from the other. Understanding these differences can help instructors tailor their feedback to the needs of the student.
Students may not see the value in these awkward blind drawings at first, so it is important



▲ **Figure 2** Examples of configurations made with a kit-of-parts

to point them out. Identify the difference between open and closed forms, for instance, and variations in line quality and fluidity. Draw attention to the expressive moments that can happen unwittingly and remind students that some of our greatest discoveries and inventions are the result of an accident.

II. Play with Objects

According to the architect Yona Friedman (Obrist, 2007), "*Intelligence starts with improvisation.*" It is this act of uncertainty that prompts the vigilant search through complicated arrangements and situations. Getting students to improvise in beginning design classes can be challenging, especially with young adults who harbor self-conscious inhibitions. Exercises that take the form of a game break down inhibitions while they facilitate engagement and collaboration. In this way games are useful in foundation classes.

In this assignment students are asked to revisit the classic childhood pastime– playing with blocks. At the beginning of the semester, students are asked to fill a shoebox with regular and irregular wooden blocks, panels, rods, and found objects. It is important that the materials in the box are modular and reconfigurable. Other than that the only rule is that some of the blocks be the same size and all the materials fit together neatly in the box. The course it is developed for, *Introduction to Architecture Design and Graphics*, teaches students principal architectural drawing techniques and creation in space. This eclectic kit-of-parts is used throughout the duration of the course to teach the students about composition, representation, drawing systems and design thinking.

Using this kit-of-parts, collaborative warm-up exercises are structured to initiate



▲ **Figure 3** Detail of student handshake series

communication and exchange between the students. The task is straightforward: on a 18x24" sheet of paper, create a sculptural composition with your kit that explores the elements of composition (solid-void relationships, repetition, balance, tension, focal point). Once this is constructed, students swap places with one another to respond, revise and rearrange their peer's piece. This continues until each student moves at least five times, providing multiple opportunities for improvisational revisions.

The act of playing is an essentially pleasant, engaging experience, but it can also be precarious and full of risk. For small children play comes naturally and usually involves the body and the manipulation of objects in space. The risks on a playground are mostly physical and emotional. As one matures, language and other complex instruments enter the playground and the risks become more social and psychological– there's the risk of being misunderstood, the humiliation of defeat, or the embarrassment of undue exposure. But when one is subsumed in the act of playing, no matter what the age, inhibitions tend to fall away as a sense of freedom, spontaneity, and possibility unfold. At least this is what one hopes for. Returning to a childhood pastime with the inquiring mind of an academic can help students rediscover the moments of creativity and invention they enjoyed as children, giving them access to their inherent capacities as adults.

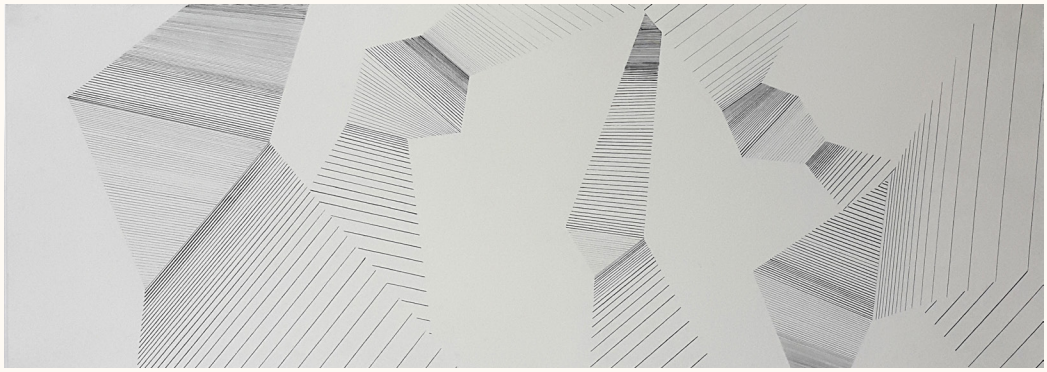
III. Leap Across Gaps

Second-year university students begin to develop visual communication skills and more confidence. But the design studio continues to be full of risk and uncertainty, as it should be. This next semester-long project, first developed by Sigrid Miller Pollin in 2005, begins with a handshake and ends with a building design. For most students, this is the first class in which they learn how to translate art and forms into architecture and buildings. The semester is organized into five projects that are sequential and conceptually linked. At each juncture, students must leap across a gap of **not-knowing**.

1. THE HANDSHAKE

After researching the photography sequences of Eadweard Muybridge, students are asked to choose a partner and choreograph a handshake that they must then document with a series of photographs. With this everyday symbolic gesture, students pay attention to the way social interaction occurs as movement through space. After the sequence is composed (some of which are quite fancy), teams partner with other teams to share and document the handshake sequences they've created. Once the series is printed and hung, students present their series along with an articulated term that describes their r**elational concept**, such as interlocking, intertwining, compression, extension, joining, etc. These concept terms have great importance because they anchor the student's investigations throughout the semester.

2. THE DYNAMIC DRAWING



▲ **Figure 4** Dynamic Drawing, by student, Benny Yeo

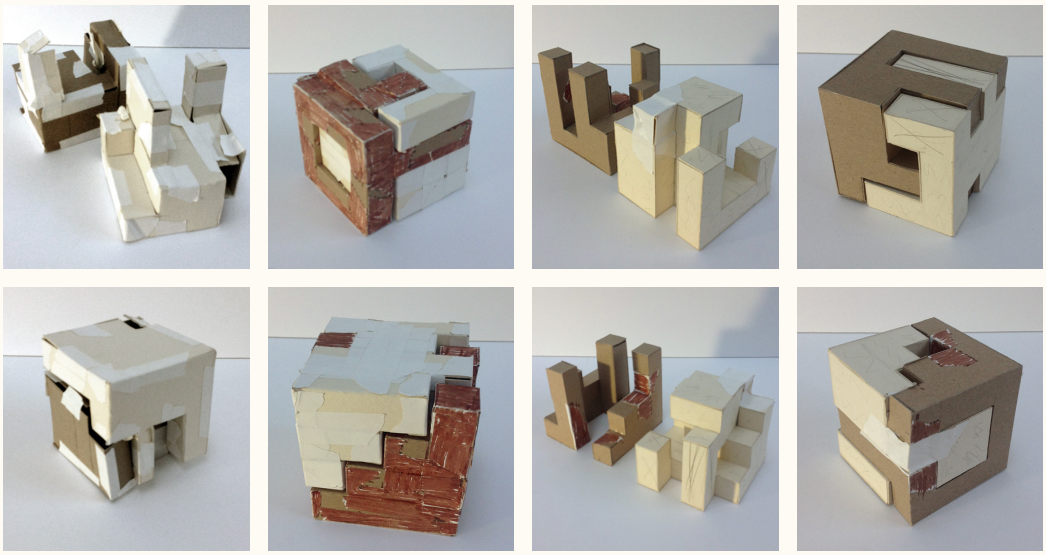
In the next part of the project, students are asked to work individually to translate the handshake series into an abstract *Dynamic Drawing*. Here they are introduced to the first leap– how to translate familiar objects moving through space into an abstract drawing that communicates their conceptual term. The important part of this exercise is to encourage students to think abstractly about form– to extract a geometrical form out of a representational image. For reference, they are shown examples of the early 20th century cubist artists– like Braque, Picasso and Gris¬– who were fascinated with the possibilities that exist between time, space and the 2-dimensional image.

3. THE DUALITY CUBE

The next leap is a big one. The students– having distilled time, movement and space in to a 2-dimensional abstract drawing– must translate (or interpret) their drawings and concepts into a 4x4x4" orthographic cube using two different materials. The two materials must be formed into two masses that can come apart and fit together– much like the original handshake. This cube explores the formal relationships between two common building materials– concrete and wood.

To begin this leap, students are asked to make 3D sketches. The guidelines for this step are explicit: "*the two materials should be 1/16", 1/8" or 3/16"* thick board materials (chipboard, cardboard, butter board). Although one material may dominate the model, the maximum difference should not be more than 60/40. All forms should be orthographic. Two voids (or more) must be incorporated into the cube. If possible, these voids should play a role in the overall meaning/ideas you are exploring on this project. One void should engage an outside plane and the other void should be inside your form (buried or hidden). They may be connected or autonomous, similar-sized or different. The voids should not be smaller than 1". Create at least 2 study models. These study models should be made quickly. They may be held together with white glue or tape (Miller Pollin, 2005).

The objective for these study models is to quickly discover potential configurations. There are many entry points for this translation. For instance, students can photocopy their *Dynamic Drawing*, cut it into 6" strips and begin to wrap it around a cube to see what ideas emerge. Or they can return to the photo series of the handshake to look for ideas about creating a joint relationship between differing materials. In all cases the concept idea that came from the photos and drawings (i.e. intertwining) are meant to guide the process.
Although the guidelines for this assignment are very prescribed– with specific materials,



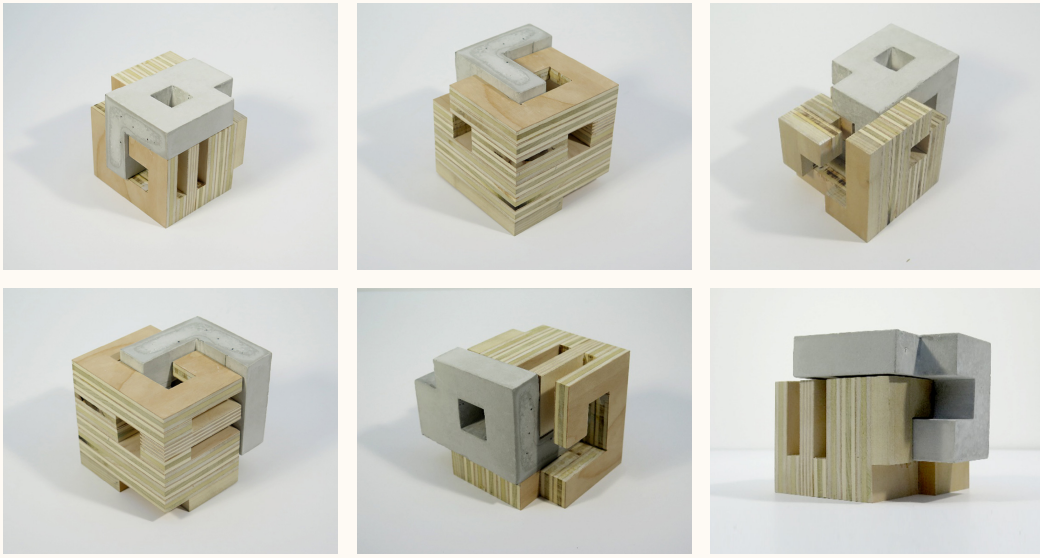
▲ **Figure 5** Duality Cube: showing progress of 3 sketch models from left to right. By student, Coleman Barnes

dimensions, and requirements– many students still find this step difficult and confusing. Invariably there are those who want to know the correct way to do it. But as a problem with multiple (even infinite) solutions, and there is no one correct way, and each person will resolve it differently. Here the students must teach themselves how to do it through trial and error. They must wander intuitively from a place of not knowing to finding a form which can then be considered, rejected, revised or further developed. This place of not knowing is what the poet, John Keats (1877) refers to as "*Negative Capability, that is, when a man is capable of being in uncertainties, mysteries, doubts, without any irritable reaching after fact and reason.*" It is this receptive and searching state of mind that leads to innovation and discovery beyond one's knowledge or perceived capacity.

As students find their way through this step, it is important for them to receive feedback and guidance not only from the instructor, but also from their classmates. Students learn the most from seeing the various ways their classmates tackle the problem. The early, rough unresolved sketches have as much to reveal about process as the more polished models. Here students experience first hand that good designs can emerge from not-so-good designs, and great designs can come out of those that are mediocre. This is an important point to emphasize because many students get frustrated if their models are not working well. Some feel exasperated over having to make and re-make models and drawings. They feel they have already made a decent sketch and that it is enough. What they need to understand is that great designers revise their ideas and models over and over and over again. It is through this revision process that one begins understand why certain designs work or don't work. This is a kind of knowing that can't be learned any other way; it cannot be taught, described or formulated– it must be experienced and weighed by each individual maker.

4. ROCKITE AND WOOD

Before the students move on to the concrete/wood edition of their cube, they are shown exemplary projects from previous years and asked to rethink their models. More advanced students who have completed this course are invited to come back and share their



▲ **Figure 6** Finished concrete and wood cube, by student, Brian Turner

knowledge from past experience. This includes giving a demonstration of mold-making for the concrete (Rockite) and some tips on crafting the wood to fit into the concrete. In the end, students who have taken the opportunity to revise their ideas in the previous step, typically make projects that are more interesting, complex and well thought out.

5. THE PROGRAM

The final leap integrates and transforms the cube into an architectural model and design. Here students are given a detailed program and asked to translate their cube into a design for an artist's studio and gallery. As they continue to explore the interplay of dualities—two forms, solid-void, two materials, two qualities— they learn to link concept, form, program and material. Once again students are given explicit guidelines for the assignment and once again they begin the process with sketches and study models. The cube acts as a foundation for their designs as they translate the material and spatial configuration to accommodate the program. Students are allowed to take liberties in the translation of the cube to a habitable space, but the overall composition of the design must be consistent with a single configuration of their cube's into two parts. For their final evaluations students must present a ¼" scale model of their design along with plans, elevations, sections, interior views, light studies, and a concept statement.

Students begin this task by exploring the various interconnected configurations for the two parts of their cube. The goal for this project is to find an appropriate spatial configuration for the program that best expresses their **relational concept** (i.e. intertwining). The designs they come up with are meant to build on the insights of earlier projects while they explore the qualities of material and light. It is a rigorous and demanding task to finish all the requirements in the allotted time. Students learn how to think spatially as they translate their designs between two and three-dimensional representation.

At crunch-time, students feel pressure and stress that they won't be able to complete the requirements on time. Some express over-whelming feelings of frustration, confusion and



▲ **Figure 7** Finished model for final presentation, with light studies. By student, Benny Yeo

dismay– at which point they should be reminded that perfection is not expected, that perfection is unattainable, and that they should improvise to the best of their ability. In this way they can receive useful and timely feedback that will help their projects progress.

For the final reviews, students present their sequential explorations from the entire semester, including process sketches and models. The projects vary in comprehensive quality. Often there is a wide range in quality within one student's presentation. A project with an outstanding model, for instance, may present weaker drawings, while one with exemplary drawings may have a less developed model, but a wonderfully articulated concept statement. Because the task is so demanding for the allotted time (about one month), students must decide how and where to focus their energy. What is most important is that they can see for themselves how design can begin with something as simple and ordinary as a handshake and end with a design for a habitable building; how forms and concepts can be extracted from one thing and transformed into another. They also recognize the ability of a building design to extend and express relational concepts like intertwining, compression, or joining.

CONCLUSION

The assignments outlined above are presented for educators who are interested in creating a studio environment that values inquiry over knowledge. Like many studio assignments, they have evolved as they're passed down from one teacher to the next. By nature, they are meant to be adopted, shared, revised or reworked. As the editors of **Paper Monument** point out:

> *"There can be legendary assignments, attributed to legendary teachers, but few people would consider it improper to re-use them. Just like the jokes that assignments sometimes resemble, a lot depends on the telling. Likewise, if assignments are like prescriptions or recipes, it's crucial to know what the ailment is or who is coming for dinner."* (Petrovich and White, 2012).

Draw with Closed Eyes; *Play with Objects*; *Leap Across Gaps* – these are all calls for action

that involve risk- the risk of loosing control, the risk of judgment, the risk of making mistakes, of rejection, of failure or absurdity. As such, these calls for action are good prescriptions for risk-adverse students. Being a perfectionist certainly has its advantages, especially in the final stages of design, but in the beginning stages, the expectations a perfectionist harbors can hinder the creative process.

The first exercise forces students to let go of perfection, to close their eyes to what they know they can do and pay attention to alternative modes of perception– like touch, movement and spatial flow– revealing how innovative and original creations can result from unintentional actions. The second revisits a playful childhood pastime, reminding them of their innate creative abilities. This cultivates a climate of experimentation and collaboration in the classroom. The third example benefits more experienced students, challenging them to leap across the interstitial gaps of knowledge and instruction. It promotes trial and error, which is the fundamental method of solving problems through repeated, varied and failed attempts.

One should not expect to play beautiful music the first time an instrument is picked up. Likewise, students should know they are not expected to create a masterpiece, at least not in the beginning. And they should be open to accidental discoveries along the way. Together these projects help teach students the benefits of negative capability in studio environments. They show that control, assessment and judgment need to be suspended in the early stages of design for divergent thinking to manifest. Most importantly, they can help students understand and accept that uncertainty and failure in the design process is not only inevitable, but one that is integral to creative practice.

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Goodbye Mister Bond: 007's critical advocacy for feminism & modernism

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INTRODUCTION

It's not just villains that are fond of saying, "*goodbye mister Bond*". Any viewer mindful of prejudice is likely to have wished that he - or rather his casually misogynistic attitudes to women – could get killed off on occasion, too. And yet, could James Bond be considered to be both a feminist and modernist advocate? If not, then why would the author - an architect and a feminist - find the way in which both women and modernist buildings are represented in all 24 Bond films politically affirming and even professionally inspiring - as opposed to simply sexist or oppressive (Funnell, 2011)? In the spirit of *auto-ethnographic curiosity* (Chang, 2008), this paper considers whether the way in which Bond films represent both women and modernist architecture amounts to negative stereotyping, or if they offer instead a critique of their mutually problematised status within society.

RISKY WOMEN

Whilst author Ian Fleming's James Bond character has long been vilified as a sexist, the cinematic franchise continues smash box office records (Ashton, 2015). But what is it about the Bond franchise that women find appealing?. More recent iterations have seen the Bond character manifest "*endearing cracks*" and "*weaknesses*" (Cox, 2015), not unlike a concrete edifice, gently degrading. Previously it has been argued that the Bond series strategically incorporates second-wave feminist discourses, not as a means to alter Bond's attitude to women, but rather, to alter the attitudes of the women around him to Bond (Chapman, 2000). However, this analysis fails to take into account the possibility that women might not be tuning in because they're interested in Bond, but because they're interested in Bond 'girls' (or rather women) instead. Because whilst the immutably *misogynist* Bond sets an unachievable, hyper-masculine and even *misandrous* ideal for most men, female audiences are, in contrast, offered a far greater confection of complex and brilliant female characters to identify with. Overall in fact, Bond women are portrayed as unrelentingly brilliant: displaying substantial skills in hand-to-hand combat (*From Russia With Love*, 1963), poly-linguistics & HMRC treasury duties (Eva Green speaks three languages; French, English and Swedish), nuclear-physics (such as 'Dr Christmas Jones' in *The World is not Enough*, 1999), geo-political expertise, as well as demonstrating a tenacious ability to survive a perilous existence through timely shifts in allegiance to the winning team. So what is it about them that prove to be so compelling? And from the auto-ethnographic perspective of an architect and feminist, so professionally affirming? If the latter is true, what are the origins of these parallels exactly?

"YOU ALWAYS WERE A CUNNING LINGUIST, JAMES" (TOMORROW NEVER DIES, 1997)

For many commentators, the names of some of the Bond Women such as Pussy Galore, Xenia Onatopp, Honey Rider, Octopussy, Plenty-O-Toole & Holly Goodhead, are viewed as demeaning to women due to their sexual overtones (Angelsey, 2012). However, a study into the etymological, lexical and phonological associations of Bond women's names reveals their purpose to allude to more complex plot narratives (Vikstrand, 2006) or each character's multiple and often contrasting identities. To perceive them as purely "*disposable pleasures rather than meaningful pursuits*", as Bond woman Vesper Lynd points out in Casino Royale (2006), is to underestimate them, with typically fatal consequences - three quarters of the 44 women Bond has slept with have tried to kill him – regardless of whether they were coitally claimed by him or not (Stokes, 2008). Subsequently, one might assume that Ian Fleming's decision to name Bond after, "*the simplest, dullest, plainest-sounding name*" he could find (Sterling & Morecambe, 2003) was partly motivated by a desire to create a blank screen onto which the complex lives of the female characters could be more effectively projected. This advances Kingsley Amis's view - captured in his 1965 book entitled, *The Bond Dossier* (Amis, 1965) – that Bond has no inner life in Fleming's novels, so any opinions we give to him are our own projections. In either scenario, Bond's 'blankness' resembles the 'blank canvas' or tabula rasa associated with the large slab of white-rendered walls favoured by early modernist architects.

EXPENDABLE WOMEN, INCREMENTAL CHANGE

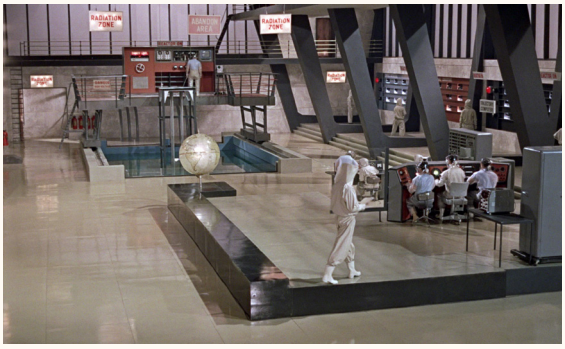
Of course, not all Bond Women are given explicitly sexualised names. *Thunderball*'s (1965) Dominetta Vitali - described by Fleming as, "*an independent, a girl of authority and character*" (Fleming, 1961) – takes her name from the term 'dominus ' meaning lord & master' (Vikstrand, 2006). And whilst Fleming always described 'M' as a male character in his books, the directors took the canonically questionable decision to make 'M' a female in *Goldeneye* (1995) until *Quantum of Solace* (2008), a decision assumed to reflect the appointment of the real-life head of MI5 – Stella Rimington, (West, 2010). Revealingly however, 'M' was in fact Fleming's nickname for his own mother (Sterling & Morecambe (2003), which perhaps explains why 'M' is the only character to whom James Bond is ever accountable. Indeed, Judy Dench's portrayal of 'M' was described as that of a, 'tough yet occasionally tender' boss (Child, 2012) – and even a working mother. And yet, Dench's 'M' has been viewed as a departure from the usual ageist stereotypes, which portray older women as, "*sick, sexless, uninvolved and alone,*" (Payne & Wittington, 1976). In killing off 'M' in *Quantum of Solace* - the ultimate act of Oedipal matricide – Bond is finally cut loose from the apron springs and literally turns feral - working outside of MI6. Perhaps this accounts for why he hooks up with an 'older' Bond woman, Lucia Sciarra, in the subsequent film (Spectre, 2015), as if as a gesture of maternal longing. In this, the most recent Bond film, representations of women have generally been reported as having improved (Lee, 2015). For example, the afore mentioned Lucia Sciarra is a Mafiosa queen unafraid of leading a large team of men; Miss Moneypenny has graduated from a secretarial wife to counsel and capable agent in her own right (*Skyfall*, 2012); psychologist Dr Madeleine Swann only adheres to the Bond-smitten stereotype when he subjects her to a co-dependent relationship – by bringing harm into her life and then protecting her from it; and the mysterious Mexican 'Estrella', while limited to being Bond's plus-one during the Day of the Dead party, avoids the tradition of being killed off when someone more intriguing comes along. But is this true progress? Not really. Bond has always dated brilliant women who consistently and repeatedly, "*put Bond in his place*" (McGowan, 2010) despite their apparent – or possibly intentional – disposability (Over the course of the 23 James Bond films, Bond has sex with 55 women. Seventeen of the 55 end up dead).



▲ **Figure 1** Elrod House, by architect John Lautner (1968) featuring in Diamonds are Forever (1971)



▲ **Figure 2** Barbican, Chamberlain, Powell & Bon



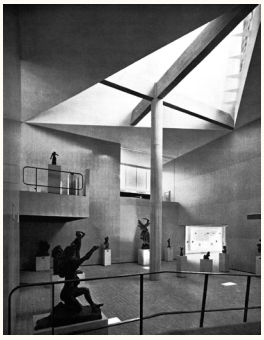
▲ **Figure 3** Dr No's Command Centre (1962)



▲ **Figure 4** Albert Kahn's Ford Centre



▲ **Figure 5** Osato's office in You Only Live Twice (1967)



▲ **Figure 6** Corbusier's National Museum of Western Art in Tokyo

Indeed, whilst the women are becoming more certain of themselves, Bond's attitude to women seems generally unchanged. The message to women is clear. Progress is being made, but it is incremental. However, if misrepresenting women "*once is happenstance. Twice is coincidence. Three times is enemy action*", then perhaps we should take author Ian Fleming at his word (Fleming, 1959) and examine the matter further.

RISKY MODERNISM

It is not just women who struggle to survive an encounter with Bond. Many modern buildings



▲ **Figure 7** Goldfingers 'rumpus' room



▲ **Figure 8** Frank Lloyd Wright Rosenbaum House



▲ **Figure 9** Hugo Drax's lair in Moonraker (1979)



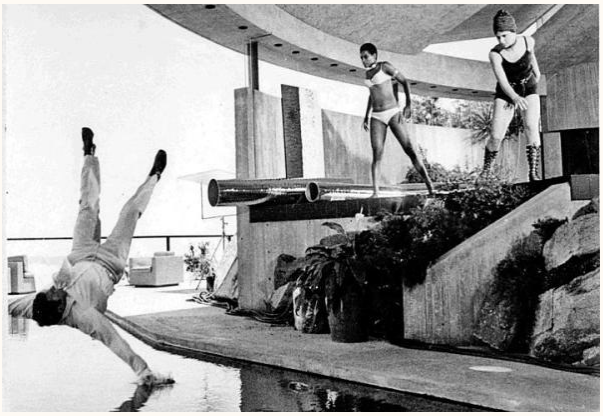
▲ **Figure 10** Wright's Ennis House

suffer similarly too. In fact, the aspirations of most Bond villains - to improve humanity by inserting a rational, orderly utopia of their own design, (Rose, 2008) favouring a palette of concrete, steel and grand-scale fenestrations – are profoundly similar to those of many modernist architects. For example, Le Corbusier's stated intention, *"to create architecture... to create order,"*(Le Corbusier, 1931), is echoed by Bond villain Elliot Carvers ambition to, 'launch a new world order' in *Tomorrow Never Dies* (1997). Indeed, Bond villains, *"neither express their roots in history nor attract the viewer with the splendour of intricate facades,"* (Greinacher, 2012) preferring the, *"somewhat frightening sign of progress driven by technological and scientific advances,"* embodied in the international style (Rosa, 2000). The majority of Bond films depict the villain's lair in either appropriate key modernist buildings – such as architect Lautner's Elrod House in *Diamonds Are Forever* (1971) [Fig 1] or the MI6 mole in *Quantum of Solace* (2008), who lives in London's Barbican centre (Rose, 2008) [Fig 2], or resort to conspicuously derivative film sets. Examples of the latter include *Dr No*'s command centre [Fig 3], resembling Albert Kahn's designs for industry (Greinacher, 2012) [Fig 4]; Osato's spacious office [Fig 5] in *You Only Live Twice* (1967) and Corbusier's National Museum of Western Art in Tokyo [Fig 6], Japan; *Goldfinger*'s rumpus room's [Fig 7] similarity to Frank Lloyd Wright Rosenbaum House [Fig 8] and Hugo Drax's behind-the-waterfall lair in *Moonraker* [Fig 9], whose Mayan-patterned relief panels resemble those of Wright's Ennis House (Rose, 2008) [Fig 10].

However, it isn't only modernist buildings that are appropriated by and associated with villainous activities. That one of Bond's most troubling villains was named after Erno Goldfinger was no coincidence. It was widely known that Fleming held 'scathing views' against modernism and was renowned for generally naming villains after living people (not just architects) with whom he'd developed a negative association (Rose, 2008).



▲ **Figure 11** James Bond's regency style, mid-Georgian-esque apartment in Dr No



▲ **Figure 12** Bond is removed from Elrod House by Bambi & Thumper



▲ **Figure 13** Iec Trevelyan (Janus) dies by his own satellite in Goldeneye (1995)



▲ **Figure 14** Blofields Lounge with Piranha pool in You Only Live Twice (1967)

Interestingly, some of Goldfinger's rare post-war private houses shared the same fate as the modern architecture depicted in the Bond films, and one of the most significant of his private residences was demolished to make way for a bungalow (Fisher, 1998, cited in Greinacher, 2012). In much the same way that the plainness of Bond's name acts as an unremarkable blank canvas upon which the more complex female characters concerns are projected, Fleming similarly chose to situate Bond in 'unremarkable' accommodation, featuring "*combinations of French Empire, English mid-Georgian, but very few Regency touches*" (Snadon, 2012) [Fig 11]. This creative disregard for Bond's interiors stands in stark opposition to the, "*detailed and prominently featured*" architectural interiors of his villains (Greinacher, 2012). What Bond (or his interiors) seem to stand for are out-dated, traditional values, which one could easily align with his similarly out-dated attitudes to women. But are these really Bond's values? After all, he seldom spends time at home and instead endlessly covets the modern lifestyles and locations of his catalogue of nemeses. Perhaps his desire to destroy them is more about his out-of-control and consistently thwarted longing to possess them, rather than his disdain. Arguably, this principle could easily be applied to the women in his life.

A WOMAN'S PLACE IS IN THE VILLAINOUS DOMESTIC INTERIOR

Bond villain domains form a backdrop against which many common domestic anxieties are explored, particularly in relation to women's confinement within the home. For example, the villain's lair is typically isolated, thereby forcing intimacy between the villain and his mercurial and often reluctant girlfriends - invariably requiring Bond to engage in acts of rescue. As Dr No put it, "*together, that is sovereignty. The world is too public. And how*

do I possess that power? Through privacy" (Fleming, 2002). The desire to simultaneously achieve "togetherness" and "privacy" is of course a conundrum faced by most nuclear families and spawned the drive towards suburban isolation – against which teenagers, seemingly much like Bond – have attempted to rebel. The conflict between longing for both "*togetherness*" and "*privacy*" is what Richard Sennett discusses in *The Brutality of Modern Families* (Sennett, 1970), arguing that the emphasis on privacy underpinning the nuclear family impacts negatively upon the "*civilising possibilities that a metropolis uniquely offers [that] are disappearing*" (Sennett, 1970). Arguably, both togetherness and privacy are more likely to be achieved, for better or for worse, within a high-density modernist housing block, than in a remote suburban retreat (Lawson, 2009).

According to Udo Greinacher, Bond villains' homes are "*designed to dominate from within*" (Greinacher, 2012): from the "female territory" of the interior (Havenhand, 2004). In much the same way that feminist writers have described women's domestic status as housewives (Franck & Paxson, 1989; Gordon, 1996; Floyd, 1999) as "*guardians of aesthetic values*" (McLaren, 2015), Bond villain interiors are often protected by women, as most strikingly exemplified by the expulsion of Bond by Bambi and Thumper in Diamonds are Forever (1971) [Fig 12]. In addition to the conceptual conflation of women's bodies and interiors (Gordon, 1996), the psycho-sexual symbolism of Bond's unwelcome 'invasion' into the (male) villains metaphorical interior feature in queer theory analyses of the Bond Genre (Stegall and Edwards, 2009; Miller, 2001) extending his modernist longings towards contemporary definitions of metro-sexuality.

DIEGETIC DOMESTIC TECHNOLOGIES & OIKOPHOBIA

Bond villains' interiors seem generally inclined towards the fetishisation of technology. Indeed, the "technological advances and functional designs" (Greinacher, 2012) depicted in these interiors, appear to perpetuate the myth that technological progress produces household appliances that sufficiently liberate women from their domestic duties and enable them to enter the workplace (Lupton, 1993). But do they? When Bond villains' 'domestic appliances' turn hostile and are even used against the villains themselves, female viewers are invited to indulge their oikophobic (an aversion to home surroundings) anxieties. For example, the villain Renard is killed by his own Plutonium reactor in *The World Is Not Enough* (1999); Alec Trevelyan breaks his back on his own satellite dish and is then crushed to death by a falling antenna in *Goldeneye* (1995) [Fig 13]; and Dr No, who boils to death in his own cooling vat (1962), tacitly conveying that any attempts to subvert modernism's pure aesthetics with contaminating technologies comes at a deadly cost. In light of this, Ozenfant and Le Corbusier's description of modernism as being, "*the vacuum cleaning period of architecture*" seems to take on new and even acerbic meaning (Jencks, 2002). Similarly, when villains attempt to subvert modernism's constrained palette by inserting 'natural' elements into the minimalist interiors, decorative aquariums transmogrify into shark tanks (*The Spy Who Loved Me*, 1977; *Thunderball*, 1965)and Piranha pools (*You Only Live Twice*, 1967) [Fig 14], and the architecture become retaliatory. Subsequently, from an architectural history perspective, one could construe this as a resistance not only to subverted aesthetics but also to High-Tech architecture, which emerged from Modernism in the late 1960s.

For the average woman viewer with domestic duties, however, these technology-infused interiors play out the dichotomy between technological terrorisation versus domestic drudgery - but from a safe distance. And whilst the majority of futuristic films fulfil their role in pre-conditioning audiences towards accepting advanced technological devices in outer space, Bond films focus on technologies that impact on the interior through diegetic

prototypes: visions of the future that help suspend our disbelief about change (Sterling, 2013). Subsequently, Bond films depict satellite TVs not dissimilar to today's entertainment centres, comprehensive surveillance years in advance of domestic intercoms and baby monitors, and even introduce nuclear energy into the home, decades ahead of microwaves. It is intriguing that whilst Bond can handle any array of portable, non-domestic devices, from flying-shooting-submersible sports cars to mid-range missile fountain pens, the villains' technologies prove more deadly than his own, and are frequently used by Bond against the villain. This message – pervasive in many forms of media from TV commercials and beyond - merely serves to affirm the domestic norm: that women assume primary responsibility for domestic life, rather than risk sharing them with their incompetent and even dangerous-to-domestically-equip male partners (Lupton, 1993).

PARALLELS WITH PRACTICE

As the evidence so far suggests, both the tacit feminist narratives and inverted modernist advocacy may account for why a feminist and an architect might be drawn to an otherwise overtly misogynist film franchise. But as many commentators have identified, these stereotypes still seem out-dated. What is it therefore that feels pertinent and even applicable the circumstances of a woman in architectural practice today? Could direct comparisons be made between the status of women in architecture and Bond women? Or perhaps more poignantly, could we better understand something of the current professional conditions of architectural practice, via a thorough scrutiny of the troubling appeal of James Bond? Let's look at the points of likely comparison. Firstly, statistics from the UK Fees Bureau (2016) show only 22% of the profession is female, and twice as many women architects are unemployed compared to men. In effect, both Bond women and women architects form a marginal interest in proportion to the considered importance of the activities of men. Secondly, in much the same way that Bond usually gets through several women in one film, women architects are more likely to take on part-time roles due to parenting career breaks and are further disadvantaged by doing this against the back drop of a long working hours practice culture (Mark, 2015). In terms of pay differentials, the average male architect earns 18 per cent more than the average female (Fees Bureau, 2016) even though they possess the same skills. As examined previously, many Bond women display capabilities equal to Bond, but arguably these skills – diplomacy, advanced accountancy, bad client/boss/contractor management expertise to name a few – seem far more pertinent to the practice of architecture - or espionage - than those of bombastic Bond. Indeed, Bond's contradictions around the need to be both a 'predator' and a 'gentleman' [Arp & Decker, 2006; Taliaferro & Le Gall, 2006) are not dissimilar to the need for architects to resolve both their commercial interests with their ethical ones.

And much like Bond's 'disposable' women, more female than male architects were made redundant during the last recession (Hopkirk, 2012) in addition to those who simply leave the profession after a few years in practice of their own volition (Duncan, 2013) - most often citing endemic sexism and concerns over childcare than any lack of interest in the work.

Seemingly, the women who succeed in Bond films have learned to adopt a status of sexual 'ambiguity' as means to survive (Ladenson, 2001), in much the same way a female architect might feel the need to conceal or play down her familial or maternal status or responsibilities. Although Dench's M reveals she's a working mother, the maternal status of the women Bond sleeps with remain concealed. Indeed, despite all the unprotected sex Bond has, it seems remarkable that he produces only one son – with Kissy Suzuki – a detail in Fleming's novel *You Only Live Twice* (1964), one that, unsurprisingly didn't

make it into the film version in 1967. In general, the fade-to-black cinematic convention supposedly alludes to the possibility of sexual intimacy, and is sometimes used in Bond films as a means to moderate the many sex scenes. But as any 'working-mother' architect will tell you, 'fade to black' doesn't imply you're sleeping with the boss, it simply means that you're too exhausted to contemplate nocturnal adult interactions in the bandwidth between finishing at work and waking up before the children, in order to prep for an early site meeting. Overall, the parallels between architects in practice and women in Bond films share two core principles; that underrepresentation perpetuates disadvantage and that very little seems to ever change.

CONCLUSION

So do Bond movies really rail against modernism & women as previously assumed? For some proponents of the Bond genre, Bond's attitudes merely reflect – rather than direct - public perception of both women and modernist buildings. However, as this analysis has illustrated, by attempting to make an enemy of both architecture and women, a political and even aesthetic empathy can be discerned. In other words, Bond's routine annihilation of both women and modern architecture be understood less as a grudge against modern architecture and instead - an extreme yet galvanising form of critical '*consciensization*' (Friere, 1968) that, "liberates human beings from the circumstances that enslave them" (Horkheimer 1982). In effect, by aligning the plight of modernist buildings to that of Bond women, it could instead be construed that Bond films offer a tacit advocacy of the position of both within society. Where the real critique is focussed it seems, is upon Bond's 'traditional' values and aesthetic origins. Furthermore, in asking, "*why does saving the world necessitate the demolition of meticulously designed hideouts that display amenities & technology not available to most of us?*" (Greinacher, 2012), leaving the viewer to wonder whether this is a petition against affluence and not just aesthetics. Subsequently, the flooding, setting alight and exploding of modern buildings can instead be construed as an act against socio-economic exclusion, rather than an act against architecture. Indeed, the "*endearingly cracked*" (Cox, 2015) character of James Bond cannot be fixed by women anymore than the problem of women in architecture become fixed by women-appeasing male architects. Perhaps - as Bond's name implies, these cracks can only be 'bonded' together by the man himself.

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Tactics developed in times of economic crisis applied in design studios

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ABSTRACT

Crisis: Turning point in a disease (for better or worse) - Hippocrates

Previous economic growth and the relatively low number of practicing professionals in Portugal allowed architects such as Álvaro Siza (2012) to work mainly through commissions made by government entities. According to Costa (2013), the international recognition of these architects led to an influx of students into architecture schools. Recent research (Caldeira, Santos and Ravara, 2013) shows that an excessive number of recently graduated architects together with the decline in the construction industry gave rise to high unemployment rates among Portuguese architects.

Some of them, consciously or not, went looking for work in the fringes of the discipline. They are characterised by a multitude of attitudes working on transdisciplinary projects. They do not have any commissions, they re-invent sustainable models leading to self-built, ephemeral constructions, minimal interventions without design, self project financing or fund raising. They are networked, grouping and ungrouping quickly not only locally but worldwide. Architect designed political interventions appear on the streets. Some embrace social causes and others design only digital projects.

If the architecture of the preceding generation was intended to last one hundred years or forever, now it is designed to last one week or never to be built allowing an increased design freedom. The building materials of the preceding generation were limited to stone, concrete, glass and wood. Now the range has been extended to plastic, earth, wax, mirrors, paper, live animals, ready-made and pixels. They ask themselves frequently what can we do with €500? Or what can we build in one week? They re-invent the meaning of the word architecture. Baptista (2010) suggests that this happens not because they don't want to do the previous architecture, but because this is the only architecture they can do.

The architect's practice and education needs to change not only to suit challenging economic times but due to restrictions of our finite world: super populated, connected, fully explored and with increasing levels of consumption. Students sometimes have expectations to design through massive amounts of material and human labour. This is an issue which will become increasingly difficult to do.

Learning with the Portuguese example we are applying their tactics in Design Studios in Austria and Australia, countries not hit by monetary constraints. Instead of asking students to draw proposals on paper or models, we ask them to actually build something with a low budget in a short time. Not models but 1/1 finished products that, due to their resource scarcity, will achieve maximum impact on their audience. The evanescent character of these proposals allows great freedom in students' designs.

We ask students:
- What can you build with 100€?
- If you do it in a group will it be better?
- What materials can you cut, sew, weld, assemble?
- What can you build in one week?
- Is it Architecture?

With this hands-on approach, students understand quickly that their actions (sketches/ideas/proposals) have consequences (finished project/created atmosphere/audience perception), understanding the vertical connection between representation and a built project.

CONTEXT

Portugal had a construction boom that reached its peak in 2001 and has been declining ever since according to Gil and Ministro (2012). The country is currently in debt, with high levels of unemployment and an absence of resources. Cunha (2012) suggests that the word *austeridade* - austerity for the Portuguese – is equal to a rise in living costs that has consequences such as disease, malnutrition, low self-esteem and depression. Rights considered acquired are reduced - health, education, social benefits, unemployment benefits. Freedom of expression is further decreased in the media. Journalists are dismissed at Público (newspaper) and Lusa (news agency). Diário de Notícias, Jornal de Notícias and TSF are bought by the people they once criticised and who are connected to Angolan power. There is popular dissatisfaction and a widening in the gap between poor and rich.

Architects of the preceding generation (born in the 40s, 50s and 60s) were centred in the single author model with enduring offices and fixed jobs. They produced projects in their most classical sense: Utilitas, Venustas, Firmitas. Luís Tavares Pereira and Pedro Gadanho curated the 2004 Portuguese Official Representation at the Architecture Biennial of Venice: Metaflux - Two Generations in Recent Portuguese Architecture. Gadanho (2004) has categorised two generations of architects as X and Y with subtle differences:

> *"At first sight, it may seem surprising that questions of identity are raised regarding Portuguese architecture. In terms of global cartography, it not only belongs to the centre, but is also easily identifiable, specifically through some of its leading figures and major trends. As one of its truly exceptional figures has become part of the world star system, Portuguese architecture has guaranteed a wide recognition. Equally, as its nature was fleetingly legitimised by a critical discourse that came from the centre, it guaranteed an apparently secure identity niche."*

Luís Tavares Pereira and Pedro Gadanho where quite aware of the subtle differences between the X generation - Eduardo Souto de Moura, João Luis Carrilho da Graça, etc. - and the Y generation – Guedes + de Campos, Serôdio, Furtado e Associados, João Mendes Ribeiro, Promontório Arquitectos, Inês Lobo, as* atelier de santos, Bernardo Rodrigues, Nuno Brandão Costa, S'A Arquitectos. However, work methodologies of both

generations were the same and an outside observer could not read or understand other more understated differences.

Baptista (2007) started publishing Cadernos Geração Z in the architecture magazine Arq/a. Baptista attributed eight pages to each studio, which then had the freedom to publish whatever it wanted. Invited studios of the so-called Generation Z were: MOOV, Arquitectos Anónimos, Kaputt!, AUZprojekt, Embaixada, Extrastudio, Plano b, Red, FOR A, blaanc, André Campos + Joana Mendes, Extrastudio, Atelier Data, Ateliermob, dass and On-Office.

Baptista (2009) then pinpointed affirmative visible differences between this and previous generations:

> *"In general terms, the idea of generational change in Portuguese architecture manifests itself essentially through a progressive distancing of the younger generation in relation to the ideological conception and aesthetic that has characterized Portuguese contemporary architecture. In this sense, seeking to mark the shattering and dissipation of identities that support the specificity of Portuguese architecture. Essentially, this generational distinction aims to capture the change in attitude of younger architects, for whom earlier disciplinary dichotomies, to a large extent, no longer make sense or are operative. In fact, national vs. international, local vs. global, public vs. private, ethics vs. aesthetics, program vs. form, abstract vs. figurative are, for these emerging practices, no longer considered opposing or exclusive realities. For this reason, they assume above all, a more contaminant and hybrid positioning, adopting the most effective and resourceful creative strategies, taking into consideration the response to a specific situation. In fact, we cannot speak merely of programmatic, formal or aesthetic issues, but mostly about* ***new approaches and working methods****. This is clearly reflected in the changes in the ways of structuring studios, almost all of them adopt the form of a collective as well as the development of collaborations that cross multiple interests and disciplines from design to urban planning, through the human sciences and technological research."*

Baptista (2008): "Recent events led the new generation of Portuguese architects - published as Geração Z (Generation Z) - to develop work methodologies distinct from the previous generation." It is exactly these different work methodologies that have been implemented in student design studios in Austria and Australia.

If the most obvious characteristic of the Geração Z studios is its diversity, what they have in common according to Gadanho (2010) is:

- Market: lack of commissions, having to work with low budgets, no fixed definitive employment.
- Mobility: They have experienced a no-borders Europe, Erasmus programs and low cost flights.
- Networks: Internet has allowed new partnerships with distant partners, access to international competitions, etc.
- Communication: New computer based representation skills.
- Pop: As in popular. Representative mechanisms to be considered by non-architects. Starting with Photoshop and doing away with the contamination of buildings. Instead of a coherent language it is varied from project to project.
- Nature: the goal is no longer a permanent building. Ephemeral actions and

performance-based projects are valid.
- Attitude: Architecture studios don't have personal names anymore. They are acronyms or provocations hiding authorships. Architecture is no longer done by an author. It is a social act with multiple interactions.
- Conscience: A new attitude implies a new conscience. Social conscience, Political conscience.

TACTICS

We have looked into the work done by these Portuguese studios and organised their work methodologies into tactics possible to be applied in design studios:

1. Positive Attitude
Example: MOOV was a small studio of three members. Their motto was "Say yes to everything". No matter what your clients ask you to do - small renovations, factory buildings or a city - they just said yes to everything. The reason was tied to the very low ratio of client meetings and actual project conclusions. MOOV soon understood that they didn't want to be the "delaying factor" in negotiations. Because of this, they simply said yes to everything. Only when the time was right and negotiations advanced, would they explain their conditions to customers. These conditions could range from payments to design ethics.

Relevance in student design studios: A positive attitude allows students to aim for ambitious tasks that they wouldn't normally engage with. Protected by an academic environment, it is acceptable and desired that they aim high, sometimes achieving outstanding results and sometimes failing completely. Both situations are accepted equally. Failure is not only accepted but also encouraged. Furthermore, students are asked to define failure themselves, instead of letting other people decide for them. Once students lose the fear of failing they are ready to fully develop their capacities.

2. Collective Authorship
Example: Kaputt! Arquitectura was a collective experience. A studio with an open-ended number of members. Depending on the conditions of the projects or members available, the number of members varied from three to sixteen. All members had the same relevance independent of their age or experience and all decisions were made in a group. Needless to say that they were all paid the same - when there was money. All ideas were collective: the sooner they forgot who initially had an idea, the sooner they could appropriate it, distort it, bend it, make it better and pass it to someone else. In the end, no one could trace back how an idea had materialised. It became collective.

Relevance in student design studios: Methods for improved group work dynamics.

3. Into the Streets
Example: Frequently, instead of waiting for clients, these studios went full on with a hands-on approach that normally implied an intervention in an urban setting sometimes in the realms of street artists such as graffiti artists, street poster designers and performance artists.

Relevance in student design studios: Students are able to test their designs in a real life environment, having instantaneous user feedback from finished projects instead of speculating about projects that are only drawn on paper or screens.



▲ **Figure 1** *Máscara de Iniciação*, Authors: Kaputt! Arquitectura - Sérgio Antunes, Irene Bonacchi, Ana Brütt, Sofia Reis Couto, Rita Ferreira, Kirill de Lancastre Jedenov, Filipe Moreira, Manuel Ribeiro, Luca Martinucci, Budget: 50€ cardboard, glue, paint, Material: Cardboard, Photo: Kaputt! Arquitectura, Lisbon, Portugal, 2007



▲ **Figure 2** *Instrument for an altered spatial reality*, Authors: Andrea dal Negro, Simon Vettori, Master students - Studio 1 Institut für Gestaltung, Innsbrück Universität, Studio Coordinator: Kirill de Lancastre Jedenov. Budget: 20€ paid for materials and laser cutter at university workshop, Material: Wood based material, mirrors, Photo: A. dal Negro, S. Vettori, Innsbruck, Austria, 2012

4. Maximum Expression with Minimum Resources

Example: In 2007 Kaputt! Architecture was invited to produce four pages to be published in a magazine. Unusually the magazine offered €500 for the task. The following questions arose in the course of Kaputt! group meetings: Instead of publishing already existing material, would it be possible to do architecture with this budget? Not representations of a possible architecture but a physical object that could be called architecture? Inspired by an Enric Miralles photograph where he is looking through a model, they started the project *Máscara de Iniciação* (Figure. 1) where the user wears architecture. The goal of the project wasn't to impact external observers but to design how the user perceives the space around them. This instrument is not only a filter between the user and the space around them, but it also contains in itself internal spatial qualities. A micro architecture. Máscara de Iniciação is affirmatively asymmetric, not only its design but the experiences it provides. If with the left eye one can perceive the external world through an architectural composition, with the right eye one can perceive an interior space filled with natural sunlight that shifts as the wearer moves. The project was implemented in a short period of time with a limited budget. Once ready it was taken to the streets to be tested in an urban environment. The authors wore the instrument on the streets until security members asked them to stop, claiming "possible public disturbance" even if they couldn't explain exactly what this disturbance was. Authors described the project intention as: "To understand in a more direct way how can Architecture design have a strong impact on our reading of the environment. To operate directly on the sensorial capacities of the individual."

Applied in student design studios: The project was directly replicated at Innsbrück Universität, Austria in 2012. It was requested that the students design not a model but a finished product. A one-week project to "Design and build an instrument that alters the

perceived reality", "Wearable at human scale" and to "take it into the city". Students Andrea dal Negro and Simon Vettori studied African masks and noted that their strong presence is due to their rigid symmetry, un-proportionated dimensions and the fact that some parts of the body such as eyes and ears are not in their usual places. They chose to create a mask as symmetrical as possible on the exterior, but in a way that the user would experience an asymmetrical perception of the space around them (Figure. 2). To obtain this they quickly produced a cardboard prototype with multiple successions of asymmetrical mirrors in its interior. These mirrors not only altered the user's vision but also altered the three-dimensionality of exterior objects. Inspired by filming processes from Alexander Sokurov's (1999) *Mother and Son*, objects could become slightly flatter or completely flatter depending if they were seen through one or two mirrors. Sokurov used to film through successions of mirrors to obtain images unrealistically flattened. In the project's next phase students used the laser cutter to obtain better finishes at scale 1/1.

In 2015 150 second year students from The University of Western Australia undertook a similar project. As second year students they had more time to design and produce the project: 5 weeks.

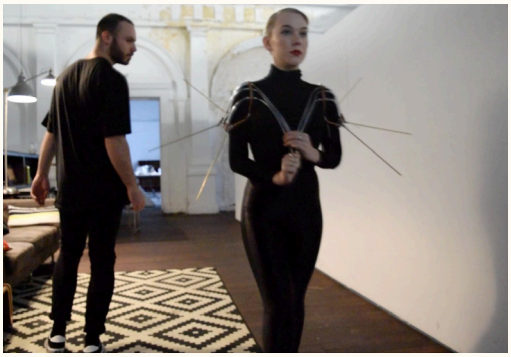
Jedenov (2015) wrote on the students' brief: "To design and build an instrument - wearable design of scale 1/1 that significantly alters how we perceive the space around us. The design will interact with the user and somehow with possible viewers. Students will be invited to test the instrument in the city centre and document it in one short film. Again it is anticipated that students develop an idea as a group and further pursue it through a complete design cycle - from idea to finished product.

There will be:
- NO scale models
- NO regulations to be taken into account
- NO technical drawings

It is expected:
- Spatial creation
- Ideas
- Finished products of their real scale."

With the same brief but different studio coordinators (Robert Cameron, Nicoletta Pizzuti, Devon Ward, Monia Allegre, Emily Van Eyck, Brad Ladyman, Catherine Lindsay), there was a variety results as some were interested in spatial qualities, others in mechanics and others in electronics.

A few example of student projects were:
- Floating helium supported video camera that allows user to view himself in plan
- Movement restriction and posture change instrument
- Condensation chamber
- Multiple vision
- Inflatable instrument activated by walking
- Arm extensors
- Ultra sound sensors full suit
- Electronic gloves that translate touch into sound
- Suits with destabilising integrated fluids
- Machine for private group conversations in public spaces



▲ **Figure 3** *Yielding & Intimidation*, Authors: Carrick Elliott, 2nd year student - Integrated Design, Making, University of Western Australia, Studio Coordinator: Catherine Lindsay, Unit Coordinator: Kirill de Lancastre Jedenov, Budget: 80$AU, Material: nylon, polyester, brass, Photo: Carrick Elliot, Perth, Australia, 2015



▲ **Figure 4** *Homeobox*, Authors: Arquitectos Anónimos: Filipe Afonso and Vasco Magalhães + Hugo Reis

Budget: 500€ for cable ties. Boxes were free, Material: polyethylene boxes and cable ties, Photo: Alberto Plácido, Escola do Porto, Portugal, 2010

- Movement activated instruments
- Solar power activated instruments
- Atmospheric altering instruments
- Air quality prostheses

As an example: *Yielding & Intimidation* from Carrick Elliott: "The concept consisted of designing a method to make surrounding parties yield to the user. The design was centred around agonistic behaviour as seen in nature - similar to that of the frill-necked lizard"

To achieve this Elliot opted to work with nylon lines threaded into bendable polyester tubes and a brass extension. When the user feels threatened, he/she can activate a mechanism for the wearable instrument to look dangerous and occupy more space creating an invisible protective barrier. It was also required that students record a one-minute video where they tested the wearable instrument in an urban environment.

5. Readapted Materials

"The present takes up all our time - Why do you want to know about our future?" Vasco Magalhães, Arquitectos Anónimos

Example: Parametric architecture tendentiously generates complex forms that are difficult to be built. Arquitectos Anónimos with the project *Homeobox* (Figure 4) were using parametric processes to work with a single module (beer box) and a single connector (cable tie) in order to create a complex geometry that would also be easy to build. The beer boxes were reused and re-purposed: They were no longer for carrying bottles but became structural. Openings ceased to be a place to fit hands but became a place to attach cable ties. According to Filipe and Vasco Magalhães:

> *"The Growth of the homeobox population was subject to specific restrictions: 1. Adaptability to the morphology and dimensions of Siza's cube 2. Structural strength 3. Accessibility 4. A universe of generative propagation 5. Variation in growth, the script behaviour "swarm" gave a set of attractors and repressors bound to the geometry of Siza's cube."*

Through the design of their own scripts, Arquitectos Anónimos left the computers to generate multiple design solutions and then chose one. They can be compared to a DJ who does not make music but rather chooses and edits. What interests us in this project is not so much the use of scripts but the reuse and re-purpose of simple everyday materials that make complex geometries, however easy to build.

Applied in student design studios: Concepts of Ephemeral, self-built, recycled and readapted existing materials were applied in the unit Integrated Design Making at the University of Western Australia. The unit's brief, Jedenov (2014) was an adaptation from Kaputt!'s (2009) *Diagrama Aranha* (Spider Diagram) and it is clear that its objective is the immediate realisation of possible architecture:

> *"The Integrated Design Studio will not be restricted by the conditions normally implied in Architecture. Architecture is a heavy discipline. It will prevail for a long time. One should carefully consider how its constant visible presence and eventual large volume will impact its surroundings in the long term. How it will age, how its environment will age. It is of slow execution, expensive because it needs the earth´s limited resources and usually has a large number of people involved in its construction. It is also responsible for changes in the quality of living, for better or worse. When designing architecture there are multiple variables to take into account: PROGRAM - Typology, Area/Proportions/Sizes, Functionality/Organisation, PLACE - Legislation, History, Local economy, Flora, Fauna, Materials, Geography, Social, Religion, Culture, Politics, Environment, Light, Climate, Topography, CLIENT - Ideas and preconceptions, Determination, Age, Bank account. Integrated Design Studio will not carry this weight. Our studio will look into exercises from the fringes of the discipline creating situations that can be built in the studio. Finished products of their real scale."*

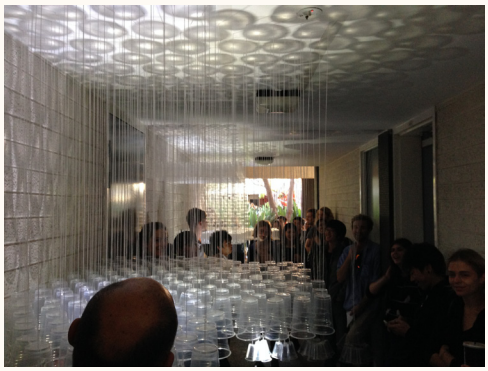
> *"Instead of asking students to design buildings in stone, concrete, glass and wood that are never going to be built, we have recreated in class exercises where students were asked to actually build something in one week with a very low budget. We require them to not to design something, but to actually build it, not to do models but 1:1 finished products. To design something that would amplify or alter the spatial characteristics of a place and to build it, understanding what was or was not achieved."*

As a first example, *Canyon* in which one of the group's students worked in a liquor store. The group went looking for alcohol consumption statistics for the city of Perth. They found how much the city consumed per week and translated this number to its equivalence of liquor cardboard boxes. With this number they collected all the necessary cardboard boxes: 850kg of them. They also developed a unique folding method on which the coloured part of the cardboard is predominant on one side. This is their module. They separated the cardboard boxes by colours and carefully layered them in a way reminiscent of geological processes. Slight variations of positions enabled them to create benches and resting surfaces. Once the project was concluded one could visualize instantly the amount of liquor consumed by the city in one week:

> *"We focused upon how the Antelope Canyon in Arizona fitted the atmosphere we wanted to evoke within the space. We became focused upon replicating the same horizontal strata and weathering pattern, similar to the canyon, which could invite perceptions of time/erosion and energy into the space. Being a massive structure, we decided to focus on easily attainable and recyclable material. The softness and*



▲ **Figure 5** *Canyon* Authors: Kim Mudie, Jaimie Hilton, Ryan Williams and Carter Wight, 2nd year students - Integrated Design, Making, University of Western Australia, Studio and Unit Coordinator: Kirill de Lancastre Jedenov, Budget: 80$AU, Material: 850kg of cardboard boxes recycled from liquor stores, Photo: Cale Black, Perth, Australia, 2014



▲ **Figure 6** *System* Authors: Jin Yong, Zaina Yousef, Ian Cox, 2nd year students - Integrated Design, Making, University of Western Australia, Studio and Unit Coordinator: Kirill de Lancastre Jedenov, Budget: 80$AU, Material: Plastic cups, string , Photo: Kirill de Lancastre Jedenov, Perth, Australia, 2014

> *grooves of the layering of boxes allow areas to function as seats and provide a tactile surface for the design."*

As a second example, a group of students recycled and readapted plastic cups. Each module consists of a plastic cup and a string. These modules were arranged in a way that created a variety of topographies. Through trial and error students were able to find the exact string that allows each module to move without getting tangled. Through small air movements the cups balance and shift creating mutable topographies and kinetic reflections:

> *"The corridor or perhaps the tunnel, captures and directs the movement of air in effect altering the cup's position in space and time. The action of walking through or past the cups also achieves reference to Brownian motion, the action of moving particles in a state of collision, which can be noted under a microscope. The sound of cups colliding adds to this effect. The experience of sound, light and movement, and the positioning of each unit, all of which construct the corridor simulates an immersion of limitless scale, which ties into our system."*

6. Political Conscience

Examples: The studio 18:25 produced the image *Prudência em São Bento* where an apparently vacant Portuguese parliament is being taken over by nature. No explanation is indicated by the authors about what is happening to the parliament, leaving the viewer to speculate on it. Is democracy over? Has power shifted to Brussels?

Kaputt! Arquitectura in their entry for the competition, House of Arts and Culture, in Beirut, Lebanon made a strong political statement: *"How does one design a building that has a high chance of being bombed? What should such a House of Arts and Culture represent? To answer these questions, we agreed to pull back from any warlike imagery, which had been previously (often excellently so) represented by local architects, and chose to go the opposite route. Instead of making a resistant, defence structure, we design an extremely delicate yet organic structure. Like the Lebanese cedar tree, which is renowned for its ability to resist and revive, the structure we created is peaceful and open. It says "please*



Figure 7 *Prudência em São Bento* Authors: Luca Martinucci and Filipe Alves, Lisbon, 2012

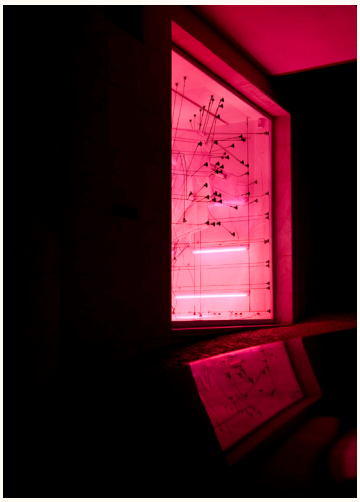


Figure 8 *Data Places* Author: Tobias Beale, 2015

do not bomb!" And this simple gesture, we believe, could constitute a small step towards peace. Architecture for peace."

Applied in student design studios: Following these examples, Tobias Beale (2015) an honours Independent Design student from the University of Western Australia proposes a data centre in the Western Sahara a traditionally nomadically occupied country divided by a berm that runs for 2700km know as the "Berlin Wall of the Western Sahara". By placing this infrastructure/building exactly above the berm, the building/infrastructure is itself a political act:

> *"The resources offered by the data centre installation attracts an increasingly stable population on either side of the berm. Goods and services start to be exchanged between locals and the data centre employees and some exchange of goods between people dwelling on separate sides of the berm. This is easier through the intermediary of the non-place of the data centre building. The non-space of the berm is further compressed. Growing dependence on the infrastructure by the*



▲ **Figure 9** *Cortiço em Palma* Authors: Kaputt! Arquitectura - Sérgio Antunes, Irene Bonacchi, Ana Brütt, Sofia Reis Couto, Rita Ferreira, Kirill de Lancastre Jedenov, Filipe Moreira, Manuel Ribeiro, Luca Martinucci, Budget: 500€, Material: One single polycarbonate board, fluorescent lights and filters, rope and rubber suckers. Photo: Maria Timóteo, Lisboa, Portugal, 2006



▲ **Figure 10** *Flock of Swallows* Authors: Kirill de Lancastre Jedenov and Filipe Alves, Material: 600 handmade Bordalo Pinheiro Swallows, Photo: Kirill de Lancastre Jedenov, Cascais, Portugal, 2012

people living on either side of the facility, ensures that a high level of security is maintained."

"Data hardware will inevitably be eclipsed in the form envisaged in this project, the ITPAC. Global networks are also in constant flux. At the end of the lease agreement, if not already eclipsed, the data infrastructure will likely be removed leaving a figured landscape and a well-established connection between the disputed territories. The non-place has been redefined as a place of interaction and exchange."

7. Acceptance to Work with Available Materials

Examples: In the year 2000 Kaputt! arquitectura was invited to design the show window for the art gallery Carlos Castanheira with a reduced budget of €500. They took an interest in plastic polycarbonate plates and went to purchase a few of them. As each one cost €350 they decided to do the project with a single plastic polycarbonate plate that would be folded and cut without any leftovers. Through the structural lines of the plate they ran a nylon string. This string was fixed with screws to the wall and connected to the glass of the window shop with suction cups. Once in place the piece was floating in the air (Fig. 9) and fluorescent light bulbs with a simple pink theatre filter lit up:

"The design of the pangolin's exoskeleton permits the animal to elegantly roll itself up. This exoskeleton however, is nonetheless a rigid, resilient and protective material. The Cortiço em Palma proposal is nothing more than a folded exoskeleton. It is the absence of the body that gives it strength. The exoskeleton's transparency gives insight to the void left by the absent form. As the shape of the missing body is unknown, a strangeness is generated by the observer who views only a translucent exoskeleton floating in an empty space."



▲ **Figure 11** *Flow* Authors: Studio 1 Institut fur Gestaltung, Innsbrück Universitat: Beatrix Nock, Esther Hollwarth, Tobias Niggl and Viktoria Gruber, Budget: 125€, Material: Lights, wire and tape, Photo: Kirill de Lancastre Jedenov, Innsbruck, Austria, 2012

Kirill de Lancastre Jedenov and Filipe Alves were invited in 2012 to intervene in the Pousada de Cascais. First they visited the space and the following day had a meeting with the owner. The space, designed by Gonçalo Byrne, had a rigid symmetry with a very pronounced height. In order to break the room's rigid symmetry Jedenov and Alves considered a tridimensional installation that would reflect the dynamism of a flock of swallows in flight at the exact moment it turns. When they met the owner they were amazed to learn that the hotel would open in one week. While they were still contemplating on what to do, the owner informed them that they wouldn't have time to create their proposal and suggested that with one single phone call he could get as many Bordalo Pinheiro swallows as he wanted. Not fond of how the idea was becoming figurative Jedenov and Alves asked for a number of Bordalo Pinheiro swallows that they considered to be impossible to obtain as they are hand made: 600. With one phone call the owner managed to order 600 Bordalo Pinheiro swallows to be delivered in three days. With this in mind the project was designed because this was the material they had as they would never be able to find another material with such short notice. They designed a flow for the 600 swallows that would pass from one wall to another, then to the ceiling and through the skylight breaking the rigid symmetry of the room. The result is not what Jedenov and Alves wanted, it is the possible result that was well accepted by the owner and hotel clients.

Applied in student design studios: When this project was shown at Innsbrück Universitat, a group of students - that had one week to do a project - decided immediately to do the original three-dimensional proposal for the Pousada de Cascais. They imagined it made of light and went looking for available materials. In the university storeroom, they found 27 fluorescent lamps of different sizes. It was immediately decided that this would be the possible project with the available material (Fig. 11). Their description: "Rules for fishes: follow the fish in front of you. Maintain the speed of the fish next to you. With the rules out of the analysis, we started to do the flow."

CONCLUSION

The world is rapidly shifting. It has always shifted and humans adapt to these shifts. Rapid is the novelty. As soon as we adapt to a different state the world has already moved to another

leaving us completely unprepared again. The heavy and slow discipline of Architecture has difficulty keeping up with the changes of the last decades. Architects act on issues of territory, scale, culture, politics and technology. While architects design buildings the same way as in the last century, cities are created according to the range capability of Wi-Fi networks, one country intercepts and analyses all communications made by another country and unmanned drones cross deserts in search of their victims. If this happens today, what will take place in the near future? In a finite world, fully explored, architects and designers cannot continue to work with the classical methodologies of the tabula rasa or rehabilitation of the pre-existing as it once was. It is important that students understand that there are other available fields for them to operate. Other tactics used by emerging Portuguese architects such as International Adaptable Networks, Social Conscience and a long term sustainable approach are now being applied in design studios at the University of Western Australia by Lara Camilla Pinho from blaanc borderless architecture with great success.

There is a clear connection between the number of architecture studios and the quality of architecture projects in a city/country. Places like Europe and Japan that are usually well known for high architecture standards have many architecture studios of all sizes. Places with lower architecture standards usually have less variety of practices that lead to less competition. Large architecture studios usually dominate the market. In high-density cities such as Hong Kong it is virtually impossible for an independent young architect to have a building commissioned. If they are lucky they might do interiors for a portion of one floor of a skyscraper. In Australia major commercial businesses design vast parts of the suburbs - with little or no intervention from an architect. Big architecture companies get most of the remaining commissions. Learning with the tactics developed in times of economic crisis we can empower students to be more independent through self-build and building 1/1 finished products. We can also teach them to work with what is available. This in itself could lead to a more sustainable model where materials travel less reducing the ecological footprint. Our aim is to empower students, for them to start planning to have their own studios, no matter what size they are. If we are in a position to increase the number and variety of architecture studios in Australia and Hong Kong, we are most likely also increasing the architectural quality of these places.

In the near future we will continue to test these tactics in design studios. We are also planning an Australian participation for the Lisbon Architecture Trienale 2016, where we will teach Australian students from UWA the tactics developed by Portuguese architects and they are going to apply this tactics while they operate directly in Portugal – our strategy unexpectedly went full circle. We will explore these tactics further and we will also be looking closely at the work produced in other countries affected by the European crisis.

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Liquid states and concrete uncertainties

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ABSTRACT

Through the lens of a specific material, the paper advocates a risk-based methodology in design-research, teaching and practice. In search of alternative to the more immediate design protocols and diagrammatic thinking pressuring architectural education today, new ways of making are sought.

Concrete as process rather than concrete simply as a material sets an empirical endeavor in prototyping, where risk is averted by an urgency to gradually anticipate a high plausibility for failure. From active experimentation with the material (liquid to solid formations) and its properties (pressure and leakages), the curious mind is provoked cautiously to failure and is left no choice but to reinstate a 'No Safety Factor' approach, if creativity is to be prolonged once more. Incremental trial and errors experiments in formwork design, closely engaged with a short-lived liquid mass in space stretch at most a design process opportune to physical discoveries yet prone to uncertainties; a potent diversion to resist any predicable formations. The current (formwork) findings from a live design-research project, titled 'New Orders (NO), in search of a new point-block diagram for Hong Kong ', manifest some of the claims raised above and further speculate from various case studies in studio teaching and practice.

NO projects a series of alternative structures for housing through a prototyping process. Nine proto-structures are developed through the conception and realization of columns cast in concrete. The series explores specific structural articulations at 1:1 scale which are further architecturally tested as speculative towers for urban living at 1:100 scale.

At 1:1 scale, new techniques of formwork design, which employ a range of materials (hard and soft) are put forward in an effort to anticipate more responsiveness to the concrete properties and to strive for more fluidity, lacking between tectonic elements currently. The point of departure for this project is the ubiquitous and rudimentary column-slab system, still dictating its way at most building scales.

By revisiting the work of the early 'structural rationalists' (E. Torroja, F. Candela, P.L. Nervi, H. Isler, R. Maillard, E. Dieste, et al.), NO considers the transformation of structural languages to revive an architecture for vertical living (point-block).



▲ **Figure 1** Medusa formwork and cast prototype in a precast factory in Dong Guan, China

While these structural mavericks took reinforced concrete to the limit of what the new material could do both structurally and spatially, their pioneering work responded, for the most part, to lower building scales and to singular programs (i.e. civic, cultural, religious); all but housing. NO revives the dialogue in the context of high-density Asian living. The dialogue is being pursued with new formwork techniques that break the homogenizing influence of concrete. The overarching design-research proposition is to reassert structural design, construction procedures and material properties as the main driver for novel spatial organizations in a way that helps break from the monotony of current systems. In support of risk-taking, NO argues for design anticipation through non-linear ways of making; more specifically by concocting temporary apparatuses or *falsework* (in the case of concrete formwork) that refrain and swerve the Maker away from that first impulsive sketch.

INTRODUCTION

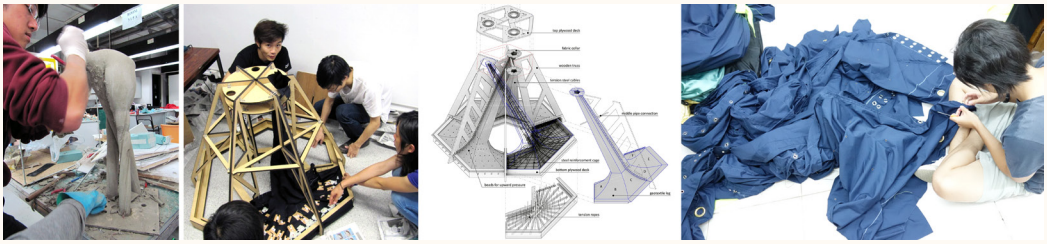
> '*I am worried by what is done with new materials, or rather what is not done… Because it can flow, it seemed to me that concrete should give rise to very different articulations, more closely related to the requirements of living volumes.*' (Huber, 1971)

A material of choice in research-based experimentation has been concrete. As much prominence in (digital) fabrication has been placed on surface definition machined from sheet materials and on standardized building components, the virtues of working with volumetric materials has largely declined (Clifford, 2014). Instead, in actively engaging with liquid concrete, not only an urgency to confront live forces (such as mass and pressure) is accrued, but volumetric thinking is able once more to influence the design trajectory of a project. New forms of architecture may emerge again from the resurgence of prototyping with volumetric materials, as with reinforced concrete, a continuous medium still carrying much untapped potential.

In this regards, concrete as process rather than concrete simply as material, switches the focus instantly on the preemptive; that is the conductive uncertainty necessary to comprise all which comes before any solid formation. The insistence on designing procedures of making, and more specifically on conceiving temporary formworks or *falseworks* congruous with the liquid material, serves therefore as the protagonist for this essay.

FALSEWORKS: MEDUSA

A first experiment on fluidity revisits a historically pertinent column to slab archetype also known as umbrella structure or mushroom column (as found in the work of Nervi, Candela, Wright, Artigas, et al.). While performing from vertical to horizontal, the full scale prototype *Medusa* explores alternative materials for formwork design that are more responsive and adaptive to the casting process. Aiming at greater continuity between column and



▲ Figure 2 Medusa; empirical design process with students at incrementing scales (1to10, 1to4 and 1to1)

slab, the prototype comprises of three interlocking legs demarcating a central aperture through which light diffuses internally. The overall formwork system is made of tailored geotextile legs stretched onto a timber framework. It is cast upside down to make full use of live gravitational forces and once cured, flipped back to its intended position. Locally, a constellation of cables and beads placed in tension redirects the flow, pressure and volumetric distribution of the liquid mass against the responsive formwork. The various types and magnitudes of forces exerted onto the formwork are left impressed on the surface of the concrete, amplifying the distinctive fluid property of the material. Yet, their final surface registrations are curiously read as if counter reacting to what the laws of gravity would normally dictate.

By being cast upside down, the experience of the final built prototype constantly fluctuates from solid to liquid state and demonstrates an ambiguous resistance to its otherwise affirmed belonging. The resulting effect could only be achieved by placing much attention on the conception of the formwork and on the subsequent procedure of construction rather than on the final form.

Furthermore, this research in fabrication was incrementally conceived collectively with students through teaching and the full scale prototype realized with the collaboration and support of an industry partner.

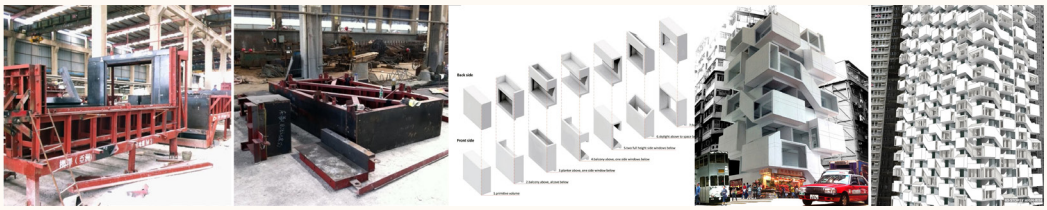
The main intention of the project is to bridge academia and practice, design and construction by *meeting half-way*.

That is, with students we took residency in a mass-production precast plant in Dong Guan, China and reciprocally engaged with fabricators, engineers, precast experts, tailors, steel workers, carpenters, riggers, welders, concreters and others. The realization of the project would have not been possible without mutual knowledge exchanges on site. A key pedagogical aim is to expose students to full-scale construction and to actively learn from different building trades and techniques. By being strategically located next to the Pearl River Delta (formerly known as the factory of the world), research-based practice in Hong Kong presents unique opportunities of collaborations at the onset of any design projects, with large-scale manufacturers and technologically advanced factories.

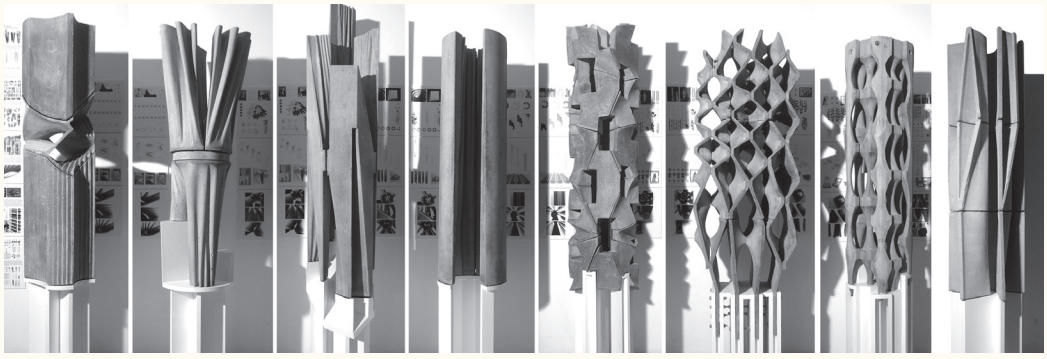
HOUSE ME TENDER

The previous experience in learning how a large precast plant operates daily provided the inside knowledge for a live Research & Development project named *House me Tender.*

The proposal exploits Hong Kong's precast tradition in housing by envisaging customized modular plug-in possibilities. Reconfiguration of formwork parts from existing chain



▲ **Figure 3** *House me Tender*; steel formwork, catalogue of precast variant, 9-storey and 40-storey prototypes



▲ **Figure 4** *New Orders*; concrete prototypes of column 1 to 8

of productions presents future residents with catalogues of precast variants. Based on needs and desires, they are able to choose independently the extent of their living spaces straight from the factory. Consequently, the implementation of mass customization through formwork procedure makes the overall identity of a residential complex singular yet heterogeneous. The ultimate social ambition for the project is to reassert the individual as the main protagonist for the making of their own living environment.

Mass customization is not a new concept and can be found in many other fields such as in product design or in the automobile industry, but as of today it rarely occurs in built architecture, especially in housing. The concept of producing variations from a type is often paired with the advancement of digital fabrication and therefore directly dependent on software communicating with machines (Smith, 2010). Because architecture relies more and more on industrialized parts to construct buildings, this new paradigm for housing seems much overdue.

Through revisiting current formwork methods, a set of possible varied outputs from a precast type could be made largely available. Steel formworks based on existing technologies are cyclically being assembled, disassembled and reassembled on the production line daily. Reconfiguring them with supplementary interchangeable parts would not necessarily compromise the efficiency of production, but will further enlarge the pool of dissimilar precast outcomes. To seek to implement mass customization in precast housing puts forward greater flexibility and adaptability over time in accommodating various types of living units for various social needs. It would also further challenge the supported tendency to segregate housing types for specific social groups (i.e. low cost vs. high end).

NEW ORDERS

The live project proposes new diagrams for point-block towers in Hong Kong. Nine concrete columns are developed through a prototyping process in formwork design at 1:1 scale.

The design-research reasserts structural design and construction procedures as the main driver for new housing speculations at 1:100 scale in an effort to break away from the uniformity of current post-slab systems. From design analysis, New Orders considers the transformation of structural languages of the work of early 'structural rationalists' in order to revive an architecture for vertical living.

While these structural mavericks took reinforced concrete to the limit of what the new material could do both structurally and spatially, their pioneering work responded, for the most part, to lower building scales and to singular programs (i.e. civic, cultural, religious); all but housing.

The research aims to develop new structural articulations for high-rises that are more agile in negotiating the transition from one kind of program to another within a complex. For some time now, the post-slab system has been less in service of the architect than of the developer and contractor, seeking less construction time and larger sale margins. Hong Kong's built environment exemplifies that assertion where all living cells within a building entity have each been normalized to great heights. This neutralization in housing is facilitated by a rudimentary and fast cast-in-situ concrete frame onto which standardized precast facades and curtain walls are clipped.

Housing complexes in this context have become condensed agglomerates of sealed units around a single core, pruned for individual living. The collective qualities that once distinguished the early experiments of the Housing Authority in Hong Kong (i.e. Wah Fu and Lai Tak estates) have slowly been stripped off from buildings and at best flattened to quasi-public podia (Ottevaere, 2014). The podium-tower model, Hong Kong's dominant duo-functional typology (commercial/residential), suggests little possibility for community living, caused by a relentless repetition of the same living cells. Indeed, integrated public spaces (i.e. courtyards, elevated streets as extensions of living spaces), outdoor living at the unit scale, shared functions, amenity spaces, public grounds and urban connectors, all of which stimulate social interaction in housing, are nowadays scarce encounters in residential projects in Hong Kong.

New Orders seeks to provide prospective residents with a range of living units types and with gradients of communal spaces that reconcile (semi-) outdoor living issues in a sub-tropical climate.

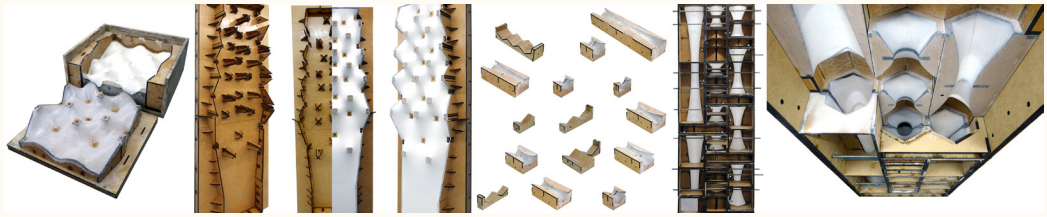
Most of the architectural investigations are being pursued through material testing and formwork prototyping. They concentrate on the physical descriptions of negative volumes for concrete casting. Some of the methods and findings are presented below:

A recurring and improved technique from the making of some of the columns involves the 3D interpolation of 2D geometries through *material computation*.

Global geometries are first partially translated in an assembly of various 2D edge profiles. A sheet of geotextile is then stretched onto a timber skeleton (made of planar elements) to complete the remaining 3D geometry. The method employs a simple means to fabricate complex geometries and is found more effective in deriving an optimized volume description than existing cumbersome processes concerned with the making of rigid and lost formwork (plaster copy or CNC milled positives). Once properly secured onto the timber framework, the fabric is then hardened with epoxy coating, giving it enough resistance to be cast.



▲ **Figures 5 & 6** Column 2 positive formwork, Column 4 test formwork and final solution



▲ **Figures 7 & 8** Column 6 high and low points formwork, Column 7 fluting parts and final formwork assembly

More specifically, column 2 experiments with a corrugated wall as a delineator of space. The study of Eladio Dieste's vertical ruled surfaces initiated this set of experiments. His use of conoids to amplify the surface of a wall (Ochsendorf, 2004) does not only augment the structural resistance of the overhanging arms but also demarcate the spatial and living organization of the column.

Column 4 speculates on courtyard and intra mural living by reevaluating the internal thickness change of a hollow column. Two fractal lines located at bottom and top profile are delimited from the feedback of solar analysis. The articulation of the lines corresponds to the level of solar radiation it receives. Where exposed to more heat, the lines recede inside the wall thickness to generate shade, while in areas with minimum sun exposure the lines protrude outside of the wall. The fabric technique then takes charge of efficiently materializing a series of varied channels between the two 2D profiles.

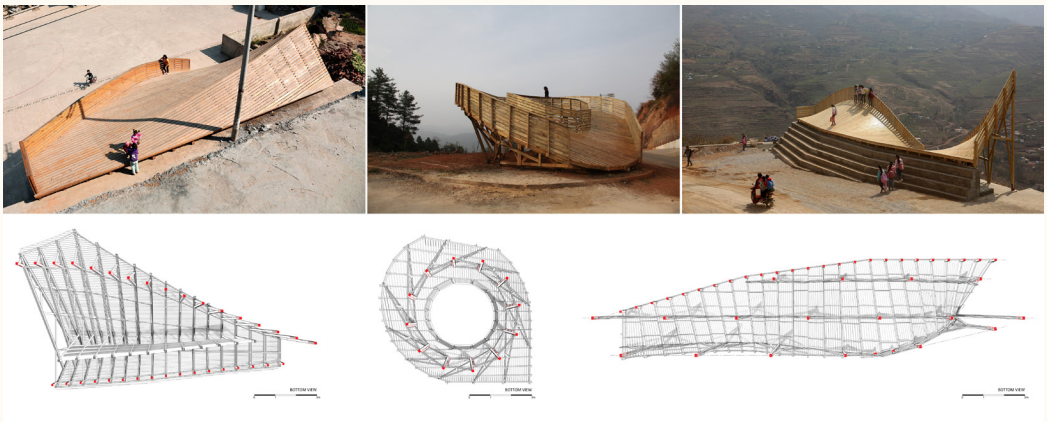
The research in column 6 begins with how to interconnect a set of sheer walls into a cohesive structure while concurrently formulating an integrated organization of mixed living spaces.

The prototyping exercise exploits the simplicity of Frei Otto's high and low points tensile membranes, transposed here vertically. The three-dimensional surface derived from the points-set is again achieved with geotextile pressed onto a constellation of physical vectors and bounded by edge profiles. This set of protuberances not only provides greater lateral resistance to the wall structure but also directs the principal organization of the living units for the project. Each unit is laid out following two main directions, one frontal, receptive to light, and the other transversal to increase natural ventilation across the connecting walls.

The exploration for column 7 starts with Robert Maillart beamless mushroom slab structure. His elimination of beams allowed the slab and columns to perform as a monolith and continuous connection (Mivelaz, 2008). Maillart's columns not only flare upwards to distribute the ceiling loads on larger areas but also downwards to reduce pressure on soil foundation.



▲ **Figures 9, 10, 11** Column 1 formwork rubber parts, Column 2 fabric and rubber test, Column 5 reconfigurable



▲ **Figures 12, 13, 14** The Pinch (left column), The Sweep (centre column), The Warp (right column)

Column 7 takes the doubly-flared primitive and vertically repeats it to create a compound of tall and slender elements of various periodicities and of ranging density and porosity in section. The primary aim is to reorganize a multi-storey high-rise into partial aggregations of horizontal instants, unevenly distributed across the height of a column. The formwork method for this prototype is modular. The negative balusters are comprised of rigid parts for the slabs and soft ones for the vase-shaped elements. The vase-like modules are also made with fabric stretched on planar profiles.

The idea of modularity is tested further in column 5 with the introduction of methods for mass-production and formwork reusability for repetitive casting. In making use of quasi-periodic geometry (disclosing long range vs. close range symmetry), the column employs a minimum types of concrete elements to form a field of maximum diversity.

From adjacency analyses, assembly rules are determined by sorting which edge of a tile can combine with which edges of other tiles (Ottevaere, 2009). Six formworks only are needed to create a diverse field of 41 repeated elements. They are devised as 8-part moulds in the production of the 3-dimensional modules. The CNC parts of the EPS mould are made independent to ease the (re)assembly and dismantling of the formwork at each pouring cycle.

In some instances, undercuts found in the global geometry of some of the columns poses a main challenge in the execution of formworks. Such is the case in the stacking of Hypars (double curved ruled geometry) describing the central public voids of column1. The fabrication accounts for the issue of formwork decentering found in thin shell structures with the introduction of an intermediary step in the making procedure. Rubber plugs contribute to the hybrid formwork with their ductile property to prevent any concentration

of stresses on the concrete shells during the demoulding process.

Overall, the fabric technique, incrementally developed throughout some of this prototyping exercise is not dissimilar to an effective method invented by Philippe De L'Orme, now called stereotomy. This art of stone carving made efficient use of projective geometry by translating spatially complex solids into two-dimensional templates to guide the stonecutter in the carving of a block (Evans, 1995). The method employed here also rationalizes complex solid geometries into frameworks of simple 2D profiles from which a softer material (geotextile) optimally computes the overall three-dimensional negative space for volume casting.

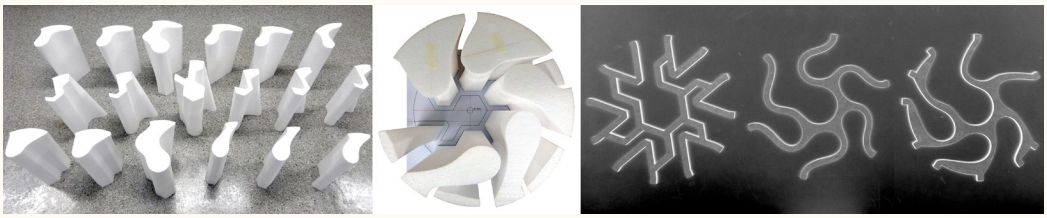
LINE ON FIRE

This last section on *falsework* puts forward new topologies generated from the description of a line moving in space. The investigation begins with the realization of three timber structures (*Pinch*, *Sweep and Warp*), focusing on timber formwork research. Learning from the work of Felix Candela on Hyperbolic Paraboloid surfaces for thin concrete shell construction (Garlock, 2008), the structures retrace how ruled geometries (generalized by a sequence of rotating lines) directly regulate procedures of formwork construction, made of straight timber elements. Sequences of changing wooden trusses capture the movement of a line to support ruled decks performing as active grounds. In doing so, the trusses are organized transversally for the *Pinch*, radially and tangentially for the *Sweep* and longitudinally for the *Warp*.

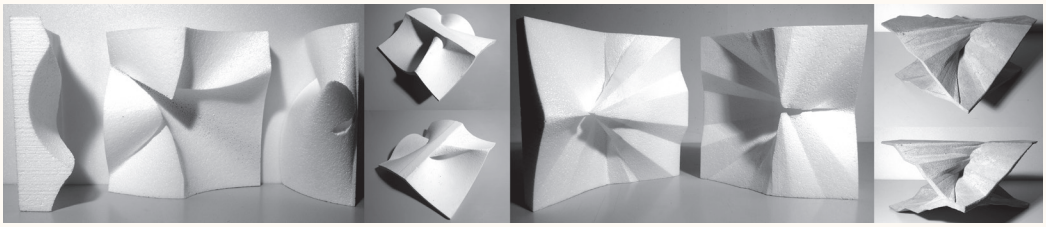
The results are three small-scale social programs: a library, a play area and a roadside marketplace. Located in remote mountainous landscapes (Yunnan, China), each project was designed with a strategy of maximizing the use and experience of the landscape. They were each built with students and with the help of a local timber workshop, developing construction methods for adapting highly articulated geometries to simple traditional techniques. Situated at the intersection of teaching and research, experimentation and on-site construction, complex geometry and local craftsmanship, these design-build projects embolden students with full-scale construction exposure in difficult sites through experiential learning.

Further speculations on the line as vehicle to describe volumes of revolution are considered in the prototyping of column 8 and 9. A 5-axis custom-made automated hot wire is utilized as the main research tool. By inputting specific protocols for synchronized motions (4 translations and 1 rotation), new topologies emerge defined by movement and time. These are further employed to section EPS foam blocks into part-moulds for thin shell concrete casting.

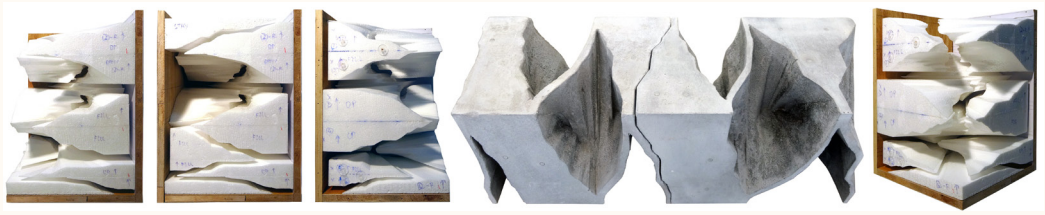
Column 8 begins with the study of Pier Luigi Nervi's columns of varying sections found in many of his built work. Due to its plastic properties, reinforced concrete permitted Nervi to transform a column's profile from top to bottom in order to respond to different structural demands. Informed by 'objective static and construction consideration', the transition from changing sections is negotiated by straight lines connecting points on the contours of each section (Nervi, 1965). The lines are then directly translated into planks for the making of the formwork. Column 8 appropriates this geometrical procedure in vertical deformation. First, various 2D sections are identified within the shaft of the column. Then, the hot wire cutter takes care of deriving the resulting ruled geometry linking the different sections. Taxonomies of EPS-plugs subsequently make up for the negative volumes in between which the concrete is then poured.



▲ **Figure 15** Formwork strategy for column 8



▲ **Figure 16** Initial formwork investigations for column 9



▲ **Figure 17** Column 9 formwork production and partial concrete cast

Column 9 expands on the procedure horizontally. In addition to movement, a time factor is introduced. New slab topologies arise from incremental protocols on a moving line in space. Although the project is still in production, early findings present unique slab topologies, whose forms would be difficult to preconceive through other means of digital fabrication. Being described by successions of straight lines, these intricate slabs retain an efficient and a direct link to timber formwork and full-scale construction. The EPS mould-making method also resonates with the parallel made earlier on stereotomy, although this time by operating internally in the slicing of a block.

CONCLUSION

The paper attempts to demonstrate a productive approach in conceiving architecture through education and practice by means of actively designing construction procedures, informed by material properties and principles of structures. By pursuing risk-based methodologies towards (empirical) prototyping, the design process is more anticipatory of what something might become under gravity laws, rather than being preoccupied with the material translation of a formal input.

The scalability of the presented concrete techniques at full building scales, remains an issue to be addressed in future projects. Although many of the discovered principles are sound structurally, their implementation at larger building scales would be a matter of revising first the robustness of some of formwork procedures.

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A certain degree of uncertainty: embracing risk in the thesis project via the 'creative survey'

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UNCERTAINTY AND THE THESIS PROJECT

In our desire and responsibility as educators to equip our students with useful skills for their future careers in practice, we spell out very carefully the challenges that lie ahead. The effects of climate change, scarcity of resources, the marginalisation of the profession, the weight of personal debt, all stack up to present an extremely uncertain future for students graduating now, and it looks like these challenges are only set to increase in the future.

Sometimes I wonder whether this detailed explanation of how difficult their careers in architecture are going to be can be counterproductive. There is perhaps a fine line between readying students for the fight ahead and scaring them into immobility. I also can't help but reflect that highlighting to students the skills required for future challenges, only serves to highlight the inadequacy of many conventional methods of architectural education. This paper explores one pedagogical tactic that goes some way in empowering students to cope with and embrace uncertainty, both in the design process and in their future practice.

Over the last 14 years I have taught 180 fifth and sixth year MArch students in design studio. Between 2013 and 2015 I ran Sheffield School of Architecture's MArch course, with oversight of 225 students across the two years. I therefore have a very good understanding of trends, shifts and developments in student design projects over time and across many levels of expertise. Having also reviewed at other schools of architecture across the UK, tracked RIBA student awards, and visited many end of year exhibitions, I believe that I have a good sense of the work produced at MArch level nationally. I suggest that over the last decade, at MArch level, student design ambition and willingness to experiment and take risks has decreased. I see this evidence of playing it safe both in the outcomes and processes of design and most of all in the final year, in the thesis project. The irony is that in their final year, when, more than ever before, students should have the skills to embrace risk, they are often developing thesis projects that merely replicate existing models and do not prepare them for the challenges ahead. This paper explores the role of uncertainty in the thesis project with the aim to discover whether consciously embracing uncertainty can bring benefits both to the quality of the design research produced and also to our students' future careers.

The method of the creative survey attempts to reinforce and valorise the "divergent" or "exploratory" phase of design research, as identified by

Plowright (2014), where a project is defined, shaped and developed through creative critical enquiry and testing. This is a resistant approach to the growing emphasis I see upon the "convergent" or "evaluative" phase of design research where value is placed upon the measuring, sorting and analysis of information. I suggest that an over-emphasis upon the convergent phase of design research can too often result in reductive thesis projects of limited scope framed by pre-existing models and that are instrumentalist rather than speculative in their attitude towards problem-solving.

UNCERTAINTY AND THE CREATIVE SURVEY

Over the past 10 years I have developed a pedagogical tool in my design studio, the creative survey. In this paper I suggest that this method can help students cope with, and indeed, welcome uncertainty into the design process and I reflect upon the problems, opportunities and consequences associated with this. Referring to interviews with past and present MArch students from my studio I will describe how this way of working has affected their attitude towards uncertainty within their education and within their ongoing careers in practice.

I will describe how, in its development, the creative survey has expanded from a single exercise at the beginning of the design process to become the crystallisation of a broader critical methodology for the production of a thesis project that we believe has wider implications on architectural practice. In the writing of this paper I have found the work of Helga Nowotny around uncertainty in science and social science, culminating in her book *The Cunning of Uncertainty* (Nowotny, 2016), to be very useful and much of this paper's enquiry is developed through the lens of her theories on the subject.

INTRODUCING THE CREATIVE SURVEY

Frustrated with the limitations of existing site survey practice and the abstraction enforced by conventional modes of survey documentation, I have identified and further developed non-conventional survey techniques that engage with site differently. In my teaching I call these techniques creative surveys and since 2005 have been implementing, researching and developing the creative survey through my practice and teaching in collaboration with my students.

The conventional site survey is limited by its tendency to locate the architect-surveyor in the role of expert, observing the site as an abstract field of operation, a delimited, static and a mostly physical entity. If the conception of site were to shift closer to the reality of a changing place, conditioned through the complex intersection of multiple factors (Kahn, 2011), then the role and actions of the surveyor should change also. If the site is to be seen as a "*relational construct that acquires meaning and value through situational interaction and exchange*" (Burns and Kahn, 2005) then to appreciate this the architect surveyor should play the role of "*an active agent of interpretation*" (Pearson and Shanks, 2001), closing the gap between surveyor and site. If we take the constructivist attitude that "*a site exists out there in the world but acquires design meaning only through its apprehension, intellectually and experientially*" (Burns and Kahn, 2005) then this active interpretation on site by the surveyor becomes fundamental in the construction of the meaning of site. The potential is there then to multiply surveyors and therefore construct multiple meanings of the one site, an opportunity to remove the survey from the province of the expert and place it into the field of collaborative enquiry.

In response to these desires for thick descriptions of site, the aim of the creative survey,



▲ **Figure 1** Claudia Amico Tudela dancing in Accrington Market Square, credit Carolyn Butterworth



▲ **Figure 2** The Gutter Fisherman, credit Kirsten Aitken

therefore, is to construct architectural knowledge, individually and collectively, of the past(s), present(s) and future(s) of site, through situated propositional performative actions. Inspired by the interdisciplinary enactments of *Theatre/archaeology* (Pearson and Shanks, 2001) they form relationships between the architect, site and local people by producing incorporations of site that combine

> " *juxtapositions and interpenetrations of the historical and the contemporary, the political and the poetic, the factual and the fictional, the discursive and the sensual...their parts do not necessarily cohere. They will require work but they leave space for the imagination of the reader. The interpretive instinct of the visitor is not denied: meaning is not monopolised.*" (Pearson and Shanks, 2001).

In the past, students have danced in town squares, fished into forgotten rivers, searched the city for free power, built dens and staged a crime scene and in their partiality, temporality and contingency, all these creative surveys were inherently uncertain.

INTRODUCING UNCERTAINTY

Nowotny identifies the lure of uncertainty, coupled with our curiosity, as the driving force of creative human endeavour (Nowotny, 2016). Uncertainty is not only present in everyday life but also is "*embodied and enacted in notions of the future or in the domain of knowledge production*" (Nowotny, 2016). It is impossible then, to escape uncertainty in any form of propositional design practice, especially one with a social aspect, such as architecture. However, our "*craving for certainty*", Nowotny suggests (2014), masks both the presence of uncertainty and the opportunities it offers within "*the open horizon of human betterment*". She identifies the desire for predictable and certain outcomes as an increasing tendency in science and in social sciences where there are "*expectations to provide knowledge which is deemed adequate to mitigate specified social problems and come up with solutions to what is to be done about them*". I would suggest that this is also a growing tendency in architecture and agree with designer Bruce Mau when he says, "*We won't solve the problem just by developing the solution*" (Hyde, 2012). Mau calls for a more open, inter-disciplinary and optimistic attitude to the future where creative

approaches are developed that are "*compelling and exciting*" and that "touch you in some way emotionally" (Hyde, 2012). This paper proposes that by engaging with uncertainty in the creative process, for example through means of the creative survey, students can discover new emotional connections between themselves and the work they do. This leads to a greater sense of personal satisfaction and achievement, but also, in the process, collaborating and communicating more successfully with others and producing work that recognises the value of serendipity, long established as a form of cunning in science's creative process as "*the unexpected finding of something one was not looking for yet whose significance one recognizes*" (Nowotny, 2016)

I suggest that students should be encouraged and helped to recognise and work with uncertainty for two reasons. First, actively working with uncertainty develops skills that are incredibly useful in their future practice, namely "*adaptation, anticipation, preparedness and even innovation*" (Nowotny, 2016). Secondly, picking up that last skill of innovation, students who embrace uncertainty in their own work can produce design research that surprises them and their peers by being far more creative and complex than they ever imagined they could produce. This learning of how to both cope with and profit from uncertainty can be an exhilarating experience for students. Realisation of the "*cunning of uncertainty*", equips students with "*a complex but very coherent body of mental attitudes and intellectual behaviour which combines flair, wisdom, forethought, subtlety of mind, deception, resourcefulness, vigilance, opportunism*" (Nowotny, 2016)

INTRODUCING THE INTERVIEWEES

This paper explores the relationship between the creative survey and the cunning of uncertainty through interviews with five past and present students from my design studio. All of them were, or are final year students and had been introduced to the creative survey early on in their thesis design process. Two of them have only recently, within the previous month, carried out their first creative surveys on site and are in the process of developing their thesis project, the others had completed their thesis projects, graduating between 2012 and 2015, and so were able to reflect upon their thesis project from the context of their current practice. The students interviewed via email were Kirti Durelle (KD) graduated 2012 and Timothy Waddell (TW) graduated 2013. The students interviewed and recorded in person were Matthew Pearson (MP) graduated 2015, and current Y6 MArch students Jennifer Clemence (JC) and Jonathan Day (JD). The students were chosen because, in the case of the graduates, the creative survey had become an intrinsic and continuing methodology that had fundamentally affected the development and outcomes of their thesis projects. The current students were interviewed because of the curiosity and openness with which they had just recently approached the creative survey method. The intention was to interview students who had quite clearly benefited from the creative survey technique, beyond its capacity to act merely as an alternate survey method.

THE TENSION BETWEEN RISK-TAKING AND PLAYING IT SAFE

The interviewees recognised the craving for certainty that Nowotny describes, and identified it in many arenas that had directly impacted both upon their academic work and their perception of their future in architecture. These arenas included the risk-averse construction industry, the challenges of climate change and, closer to home, the need for employment and the desire to do well in their studies. One described how, before he started his final year, he had already identified, by looking at past projects that had done well, "*copyable ways of working, that ticked all the boxes*" (MP, 2016) and had felt pressure to follow this more predictable route to success. However, all the students also recognised

the valuable opportunity that the academic environment offered to experiment and take risks, an opportunity not so clearly present in the world of practice. They felt the tension between these two sets of desires, to experiment and to play it safe, quite acutely, *"if you focus on the market you miss the opportunity in your thesis project to experiment when you won't have that opportunity again in practice"* (JC, 2016) and *"many people play it safe and produce similar programmes and similar architectural outputs but it's important to experiment and Uni is the best opportunity"* (JD, 2016). It was interesting to hear how the students also believed that the structure of the year made it difficult to experiment despite encouragement from course leaders and studio tutors to take risks with their work, *"you feel the pressure in 6th year to find the project quickly so you can hit the deadlines through the year"* (JC, 2016), *"I felt the pressure of time and wanted to make sure I hit deadlines"* (MP, 2016).

FEAR, DOUBT AND MESSINESS

I introduce the creative survey as a studio methodology in the first week of the studio and invite the students to work performatively on site within the first 2-3 weeks. Most students are expecting this because the studio has built a reputation for its creative survey work and deep immersion on site (the studio name is now *Studio in Residence* to reflect its close relationship to sites). However, no matter how much theory I introduce with the creative survey and how much evidence I show of impact on past projects, I find initially that most students perceive it merely as a quick and easy technique to reveal more information about the site. In fact one said very candidly *"I didn't think the creative survey had any merit at the time - I just wanted to get my head down and do my project"* (MP, 2016). It is only in the action of the creative survey, in the enactment of what Judith Butler would call *"a doing"* (Carlson, 2004) that the full potential of the creative survey emerges through their own direct experience; *"The creative survey approach embraced the process of site discovery as a design tool, rather than a preliminary fact-finding exercise meant to inform the design process later on."* (KD, 2016).

When asked how they felt when doing the creative surveys, all the students spoke of how daunting it was to be so present and active on site and how far out of their comfort zone this made them feel. It felt *"like I was breaking the law!"* (MP, 2016) and *"It was kind of terrifying actually; equally exciting and stressful; it certainly filled me with doubt."* (KD, 2016). Although they initially felt rather nervous they quickly learned how to engage people on site in conversation, *"the first day was daunting, you feel pretty self-conscious, but you learn pretty quickly how to approach people and then become more confident"* (JC, 2016) and ended up enjoying themselves *"the whole experience was fun, that's the best way to describe it"* (MP, 2016). They all recognised the uncertainty that the creative survey introduced into the early stages of their projects, which at first was rather unsettling, *"I felt a little bit lost"* (JD, 2016), *"[I was] unsure as to how these actions may translate into an architectural thesis"* (TW, 2016).

All of the students reflected particularly upon the uncertainty that their encounters with other people on site brought to their design research, recognising in the process *"in the real world, things can become messy very quickly"* (Nowotny, 2016). Jenny sought the active input of homeless people she had met on site and gave them disposable cameras to document their day - a rather chaotic process with unpredictable outcomes. The photos and insights she got back, however, were *"very revealing and rather emotional"* and she was surprised by the unexpected creativity demonstrated in some of the images, leading her to reflect on how the creative survey *"gets rid of preconceived ideas of people"* (JC, 2016).

Some of the students recognised the effect the creative surveys had on their own understanding of knowledge; how it is made, by whom and how - *"the point is you are doing something you're not an expert in for a change - that way you are taught by locals and find out how the site works from their point of view"* (JD, 2016).

The participatory nature of Tim's creative survey led him to evolve a thesis project that he defined as *"a relational construct"*, both in its design process and outcomes.

> ***"As the design progressed I gradually became more comfortable with exploring the site with others, and developing a co-authored proposal. The sense of uncertainty that initially filled me with fear became sought after to aid project progression."*** (TW, 2016).

This resulted in one of the bravest thesis projects I have been lucky enough to tutor - a speculative proposal that presented an ambitious formal design as the fluid product of a creative participatory process while still capturing all its inherent complexity, contradiction and compromise.

> *"Without creative surveys this thesis would not exist. They were the locus towards a dynamic, incremental, and living architectural process. Creative surveys provided clarity on how and where I work most effectively. I now understand that, as an architect/designer, I work best in complex and uncertain environments, where projects are developed in collaboration with local residents groups through consensus."* (TW, 2016).

These moments of learning how to work with people in co-created situations, co-producing knowledge, gives students direct experience of how they might approach, what Nowotny identifies as "the next big challenge for science", equally a challenge in architecture - ***"how to bring society in...and let it take part, not only as consumers or presumed beneficiaries, but as producers of knowledge in the process of research itself" (Nowotny, 2016).***

Performativity, Complexity and Uncertainty

Working creatively and performatively with site throws up lots of information in the moment that needs to be captured and reflected upon. A performative action is simultaneously active and reflexive, it is doing the thing itself while thinking about doing the thing itself, involving the sense of an audience even if that audience is the self. This immediately introduces Richard Bauman's "consciousness of doubleness" (Carlson, 2004), requiring students to meet the complexity of these situations head-on and navigate their way through the shifting territory of subjective and objective knowledge.

> ***"I inevitably had to relinquish control to the reality of the site – the weather, the other people who were there, the fact that perhaps my plan was not so good after all… But that was ultimately the whole point of the exercise, the tension, the confrontation between what was planned and what actually happened. I mean, this is architecture practice in a nutshell." (KD, 2016).***

Nowotny (2014) identifies a ***"rise of complexity in today's world"*** asking ***"how can we cope with complexity?".*** She suggests that the commonplace application of statistical and digital modelling in science reduces complexity and denies the role that uncertainty can play in the creative process of knowledge production. ***"Science thrives on the cusp of uncertainty"*** and it is only in learning to navigate the non-linear dynamics of complex open and evolving systems (Nowotny, 2014) that future researchers (and I would add to

this, designers) can explore ***"novel ways of seeing, intervening in and interpreting the world and pushing the boundaries of what is known further into the territory of the unknown" (Nowotny, 2016).***

CERTAINTY AND UNCERTAINTY

This desire to recognise and embrace uncertainty within the thesis project is not a call for unlimited freedom and wild speculation, rather a reminder that good design and research is

"simultaneously constructed from real phenomena and invented... In other words, both design and research are well-fabricated hybrids. Composed of both objective truths and personal fictions" (Salomon, 2011). ***The production of a thesis requires a rigorous systematic framework within which the opportunities brought by uncertainty can flourish, "Play needs firm limits, then free movement within these limits. Without firm limits there is no play"*** (Koolhaas and Mau, 1995).

The interviewees recognised the importance of a balance being struck between logic and intuition throughout the production of their thesis projects, ***"it's also important to do the general desktop research once themes have emerged from creative survey" (JD, 2016).*** Once achieved, this balance lent a sense of security and freedom to push boundaries in their work, for example Matt embraced uncertainty within his project but always within a framework of certainty. He was very diligent in producing clear detailed information on context, site as existing, supporting data and research etc., to form a firm foundation for more open explorations, providing a framework that provided security for him (and his tutor!) in order to make space for experimentation elsewhere, ***"I found that if I modelled the context in a detailed way, then that allowed [me] to take bigger risks and do more provocative things with the site "*** (MP, 2016).

Writing on how opportunities for risk-taking and innovation can be cultivated with the research design studio, David Salomon (2011) calls for the development of "experimental cultures" in architectural education, within and beyond the thesis project, through the integration of

> ***"...both rational and irrational inquiry. This new culture, logically and intuitively, collectively and individually, would use its skills to alternatively generate and evaluate new experiences, knowledge, and things directly from the material world around it."***

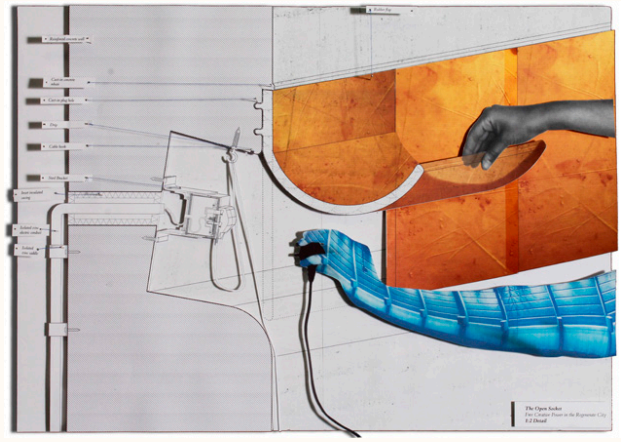
This ***"recursive process",*** as he calls it, echoes the relationship between rational ***"day science"*** and intuitive ***"night science"*** recognised by biologist François Jacob (1987, cited in Nowotny, 2016,) and student Tim Waddell's ***"reflexive, co-creative approach"*** to his design research development (2016).

CREATIVE SURVEY AS DESIGN RESEARCH METHODOLOGY

The students who benefited most from the creative survey were the ones who came to understand its potential as a design research methodology rather than it being merely an alternate method to reveal site information. Kirti Durelle structured his thesis project around self-organised sequential creative surveys on multiple sites and went so far as to say that "the creative surveys became the thesis project" forming



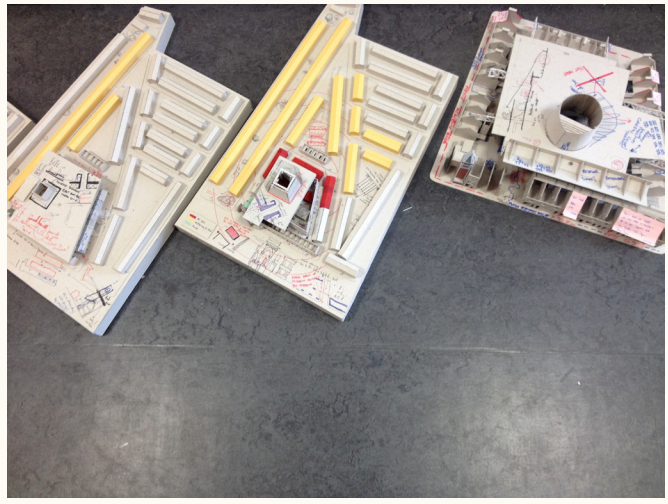
▲ **Figure 3** Group Performance, credit Kirti Durelle



▲ **Figure 4** Free Power Socket Detail, credit Kirti Durelle



▲ **Figure 5** A Community Survey, credit Timothy Waddell



▲ **Figure 6** Participatory Design Models, credit Timothy Waddell

> *"a dialectical relationship where site and ideas would influence and reshape each other...understanding that the research never really ends: the finished building is part of it and it too remains open-ended to an extent."*(KD: 2016)

Tim Waddell reflects on how his learning through adopting creative surveys as a design research methodology affected his understanding of the relationship between the production of architecture and role of the architect:

> ***"Through the adaptation of accretive surveys within the design process, I began to view architectural production; and architecture, as a 'work in progress', with the architect assuming varying roles throughout the design process; observer, reporter, community member, enabler, provocateur, 'architect', ambassador, user, and so on. These roles, acted out in real time and with real people, allowed me to engage with a complex web of social, political, and cultural contexts traditionally ignored in student projects. By engaging with these complexities, I enacted a live***

working methodology, and acquired a range of reflexive design skills that are still proving invaluable." (TW, 2016).

CASE STUDY: THE CLAMPS

To bring this section to a close it may be useful to quickly sketch the trajectory of one student's thesis project, from initial creative survey to final proposal, in order to try and demonstrate some of the themes that have emerged in this section.

Last year, at the start of term, I asked my students to construct, in groups, survey apparatus to install on site in Sheffield. One group devised a series of 'clamps', a family of bespoke machined fittings to be installed around elements in the site including handrails, railings, grilles, columns and benches. Matt Pearson (2016), as quoted earlier in this paper, didn't expect to get much from this exercise but, despite this, took it seriously, if only to get some nice images for his portfolio. He certainly wasn't expecting how the creative survey would disrupt his carefully prepared strategies for the year - it "*massively opened up the project*" and introduced uncertainty right into the heart of the thesis. On a simple level he surprised himself by enjoying and learning from the creative interplay between the group and also found the information that came back about site to be much more useful and interesting than he expected "*loads of conversations, a more rounded idea of what's happening [on site] right now*". Once installed, the clamps became triggers for events and taking time to install and operate the clamps meant the group were on site for many days. This afforded them the chance to create a thick description of site, capturing individual and collective readings, some generated themselves, some drawn from others, all hovering somewhere between fact and fiction.

For Matt this creative survey developed an unexpected and powerful bond between himself and the site. This was the "*first time I had ever made things at 1:1*" and "*it was the first thing [of mine] that has ever got built and put in the built environment*". This initial pride in construction was tested very quickly as the clamps were left on site and disappeared through vandalism, demolition, destruction and decay. This was a very successful creative survey with the group able to interpret the work in many ways that led to a full range of diverse projects. The clamps affected Matt's thesis project at many levels - directly informing the production, form and programme of his thesis. Before the creative survey he had every intention of designing a manufacturing plant, after the creative survey his thesis, *The Heart of the Machine*, became an explicit process of design research, continuing to use creative surveys on site to explore the interdisciplinary production of architecture through the integration of art and engineering. He also enjoyed the year a lot more than he expected because the process of design research prompted by the creative survey "*allowed me to sink my teeth into something which I didn't know the answer to*" and the realisation that "*to do really well I needed to not know the answer*". He now believes that without the early injection of uncertainty that the creative survey gave him he would have followed the predictable model he had identified for success, probably have done well, but would have been bored in the process. He was able to trace a direct lineage from the clamps to the "*the best part of the design at the end, the most interesting parts of the drawings*" and felt that "*the most provocative parts of the project came from this early work*".

Matt is now running his own practice and still using the creative survey techniques he learned during his thesis year to embrace uncertainty. He reflects that his thesis taught him the benefits of not always being in control, "*to let things go*" and that "*when I was the most uncertain about things I was most creative*" (MP, 2016).



▲ **Figure 7** Installing the Clamps, credit William Monaghan



▲ **Figure 8** Matt Hugging Column, credit William Monaghan



▲ **Figure 9** The Heart of the Machine, credit Matthew Pearson

MEETING THE FUTURE WITH A CERTAIN DEGREE OF UNCERTAINTY

The pressure on the thesis project is enormous

> *"Somehow, it must reconcile personal exploration with pedagogical agendas, combine the specific requirements of a project with a more general quest for knowledge, and fulfil the desire for invention with the need for professional competency—all the while advancing disciplinary knowledge."* (Salomon, 2011).

The pressures facing future architects are even more daunting. In his book Future Practice (2012), in the face of the crisis looming over architecture, Rory Hyde interviews many practitioners, innovators and designers to gain insight into the future roles of the architect. These include *"fundamental interpreter[s] of an extraordinarily dynamic reality"*, *"facilitators of change among large groups of people"*, *"urban activist"*, *"community enabler"* and *"civic entrepreneur"* - a dazzling array of possibilities for graduates, but

all these roles are still very much evolving, with no tried and tested models for success to follow anymore.

Embracing the creative possibilities of uncertainty is no magic bullet that will enable students to shape, define and fulfil these roles. However, having spoken to students and recent graduates, I believe that the cultivation of a positive attitude towards uncertainty can certainly help them meet the future with optimism and resourcefulness, "*you are drawn by curiosity, you have a sense of direction, but you do not know the outcome*" (Nowotny, 2014).

It's perhaps illuminating that none of the graduates I interviewed have gone into full-time employment in conventional practice. Two of them are combining practice with on-going post-graduate studies and one has set up his own practice in temporary event architecture. Along with the current students interviewed, they were all doubtful of the opportunities available in conventional practice for experimentation and embracing uncertainty "*uncertainty is rarely formally acknowledged in practice (although it certainly exists) – because architecture tends to portray itself as capable of ironing out the unknown*" (KD,2016).

In conclusion, this paper attempts to show how the creative survey can help to embed "*a certain degree of uncertainty*" (JD, 2016) into the design research process, thus building a strong emotional and intellectual relationship between the designer and their work that is robust enough to cope with complexity and thrive on collaboration with others.

> "*Uncertainty is always there. [The creative survey] helped me start accepting plurality. This is a learning curve that did not stop with university, I still experience it today and it is quite liberating as a designer to embrace it rather than ignore it. [It's] about accepting to give up a little control, to let the world interfere or contest whatever it is you decide to put out there. It is humbling really, and I find it is a really important part of being a designer.*" (KD, 2016).

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Waddell, T. (TW). Interviewed via email by: C. Butterworth, 13th January 2016

curiosity
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Keynote

Etienne Wenger

Participation and professional education in the 21st century

I will introduce a branch of social learning theory in which learning is viewed, not merely as the acquisition of information and skills, but primarily as our changing ability to participate in the world. This entails not only a change in a person's knowledge, but a transformation of their identity. Relevant participation happens at two levels. First it happens in communities of practice where we develop specific forms of competence. Second it happens in relation to broader landscapes of practice. This includes many communities and practices in which we cannot claim membership or competence, but about which we can claim some degree of knowledgeability that informs our participation.

'In the complex world of the 21st century, the interplay of these two forms of participation becomes central to professionalism'

In the complex world of the 21st century, the interplay of these two forms of participation becomes central to professionalism. For a traditional school, the danger of ignoring participation is to view competence as a degree and knowledgeability as information. For forward-looking professional educators, social learning theory suggests approaches that go beyond degrees and information to focus on the formation of a robust professional identity.

ion

Take the red pill: a journey into the rabbit hole of teaching informed research

Dr Charlie Smith
Liverpool John Moores University, UK

ABSTRACT

In one of the more well-known scenes in the film *The Matrix* the character Neo has to make a decision. He takes either a blue pill to return to the relative security of what he knows, or he takes a red pill to go on a journey into the depths of the unknown.

Griffiths (2004) identifies four models of research-teaching dialogue: research-led, research-orientated, research-informed and research-based. This paper focuses on the latter, and argues that this approach is most aligned with the creative and divergent processes of design studio learning. In a discussion that links the themes of participation and production, studio teaching and its associated creative processes are explored as the generator of research. Arguably the term research-informed teaching implies that research leads teaching, and therefore the approach described in this paper is made distinct by subverting the traditional term in favour of teaching informed research.

Central to the teaching-informed research approach are studio projects. They are the essential substance of the research methodology, and become the research data for analysis. This paper makes reference to two projects by the author that have adopted the teaching-informed research method in the design studio – one undergraduate and one postgraduate – which have led to award-winning and international publications. Discussions about methodology and outcomes identify some significant principles to consider – and lessons learnt – when designing teaching-informed research projects, which are evaluated in depth. For example, a common thread linking both projects was constructing a brief for the students to explore contemporary issues in building-types that are currently facing contentious challenges. Also, in a divergent process – which lies at the essence of the design project – outcomes are unknowable, and the researcher must embrace and account for the fact that the project trajectories are unpredictable and unexpected. The morality of students conducting research for academics is also discussed; it is argued that the pedagogic integrity of each student's project is of primary significance, but that the value of the research outcomes often lies in comparative analysis of the collective body of work produced in the studio.

This paper will demonstrate that when structured in an appropriate way, such a journey into an unknown rabbit warren of unanticipated twists and

turns, which is an inherent characteristic of this approach to the relationship between teaching and research, can result in rich outcomes. It also argues it is an approach most suited to the creative environment of the design studio.

INTRODUCTION

There is a complex, and often uneasy relationship between teaching and research in higher education. This is frequently expressed as a tension between where academics' priorities should lie. For example, there is evidence to suggest that national research audits can isolate research from teaching (Jenkins et al. 2003), at both institutional and individual levels (DBI&S, 2015). It has also been argued that there is no simple functional relationship between quality of research and quality of teaching at a programme level, where teaching and research are often organised separately with limited thought given to how they might be linked (Jenkins, 2004).

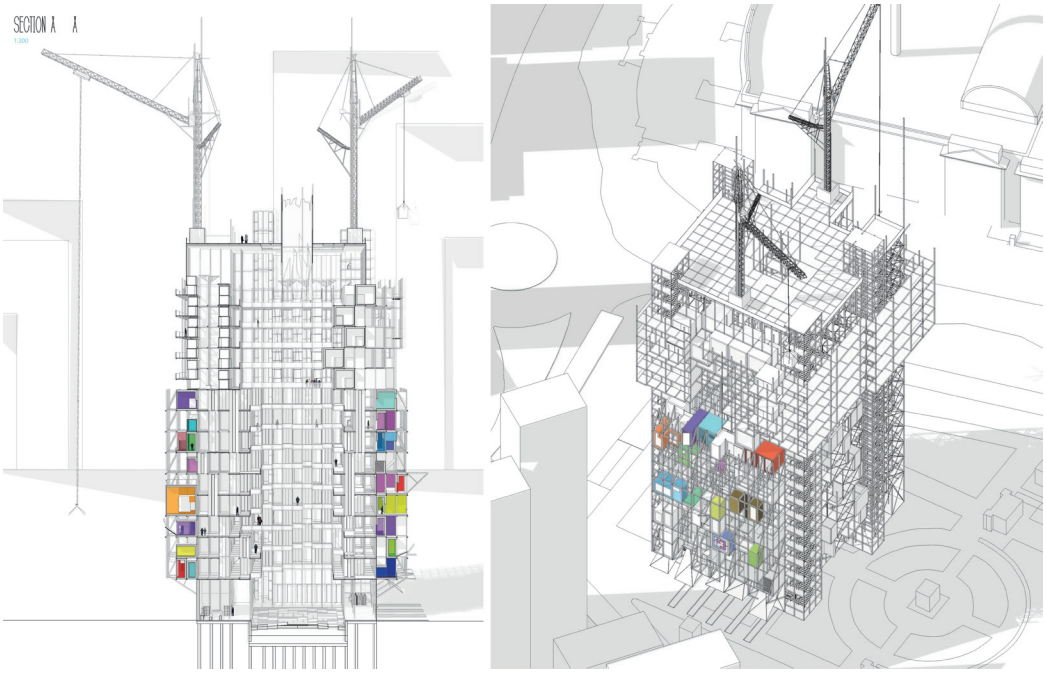
What are the ways to unite teaching and research in Architecture programmes? The general view of the relationship between research and teaching is that the latter benefits through curriculum content being informed by research – even if it is conducted independently of the teaching – thus ensuring that content is progressive. Whilst this position is not necessarily being questioned here, Griffiths (2004) argues that research and teaching can relate to one another in a variety of ways – often influenced by the discipline context and field of inquiry – and the above scenario covers but one.

Architecture programmes, and indeed other creative disciplines, have been far from exemplary at exploring relationships between research and teaching, and identifying ways in which they can create a symbiotic dialogue. This is both rather ironic and a tragic loss. Research and innovation are fundamental parts of studio design processes, but opportunities are being missed to capture these and formalise them as research outputs, which can be presented at conferences, published and returned to the Research Excellence Framework (REF). Furthermore, publications about project work produced in studios often focus on the projects themselves, as opposed to deeper meanings signified by the work in wider contexts of challenging research problems. This paper evaluates two case studies that demonstrate potential ways to integrate design studio teaching into research projects as a central part of the methodology, leading to publishable outputs beyond the field of architectural education.

Much has been written about the relationship – the nexus, as it is often called – between teaching and research in higher education (Brew and Boud, 1995; Hattie and Marsh, 1996; Robertson and Bond, 2001; Hattie and Marsh, 2004; Jenkins et al., 2003; Jenkins, 2004). There are conflicting views on whether the relationship has a positive, neutral or detrimental impact on the quality of students' learning experience. This paper posits a radical idea: whilst some argue that staff research is an irrelevance or even an obstacle to improving teaching quality, can teaching and research be conjoined in ways that enrich the learning experience?

DEFINING TEACHING INFORMED RESEARCH (TIR)

Griffiths (2004) has identified four models of research-teaching dialogue: research-led, research-orientated, research-informed and research-based. This paper focuses on research-based teaching which is defined as being, "designed around inquiry-based activities, rather than on the acquisition of subject content" and where, "the scope for two-way interactions between research and teaching is deliberately exploited" (ibid., p.722).



▲ **Figure 1** Section and axonometric. The changing permeability of this dynamic structure expresses increasing accessibility to the books within, which in turn is representative of the evolving democracy of knowledge. By Sarah Aziz

The argument being put forward here is that this approach is the one most aligned with the creative and divergent processes of the design studio.

Arguably the term research-informed teaching (RIT) implies that research comes before teaching, so as to inform content and ensure the curriculum is at the forefront of knowledge – a popular perception of the research-teaching nexus. However, in the methods described below it is studio teaching and the design processes associated with it that lead the research, and which dictate the paths that it follows. Therefore the approach is made distinct by subverting the traditional term in favour of teaching-informed research (TIR).

Central to TIR in Architecture are studio projects. Every year in every programme a wealth of creative and inspiring project work is produced. Often these projects challenge and explore contemporary problems and issues, and propose a diverse range of innovative solutions. However more often than not, after the End of Year Show these projects are catalogued and archived, and become nothing more.

In TIR these design projects provide material for research. Whilst the students will conduct their own investigations as an integral part of their conceptual thinking and design development, this is independent of the TIR processes that follow the projects' completion. They provide the medium for analysis and evaluation against wider concepts and issues, and it is here that the main TIR processes lie. Put another way, the students' projects are the research data. The following two case studies describe experiences of the approach, and are followed by discussion around the outcomes and lessons learnt about adopting this method of uniting teaching with research.

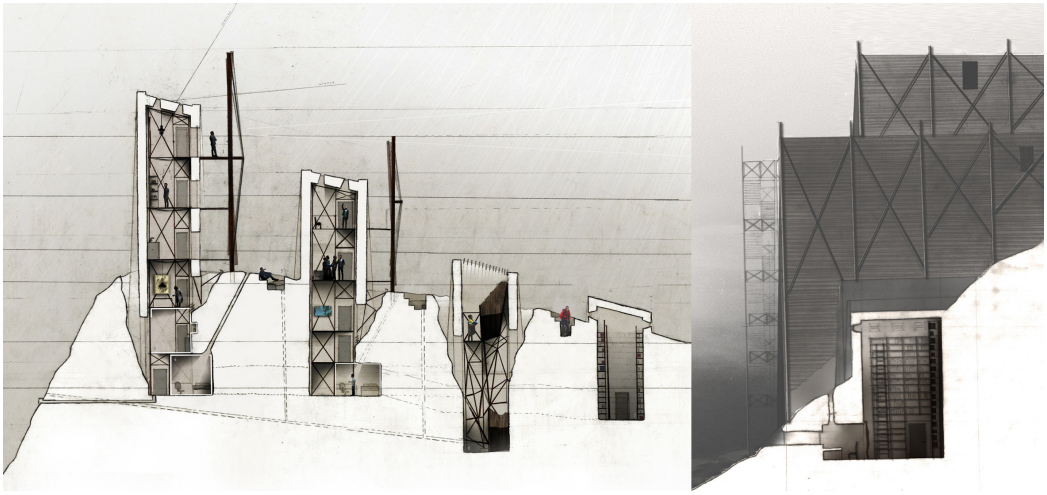
CASE STUDY ONE – THE BOOK REPOSITORY PROJECT

In November 2013 a project was devised for NQF Level Six Architecture students to design a Book Repository. The brief was for the final project of an undergraduate course at a United Kingdom university – a 20-week design module. It was one of five different projects offered to the cohort of 52 students, and they were asked to choose which project they wished to work on, subject to an appropriate balance of numbers within each tutorial group. Following a democratic selection and allocation process the Book Repository project group was composed of 11 students.

An aim of the project was for creative designers who have grown up on this side of the digital revolution to explore the role of books, and of the buildings in which they are housed. The term library was deliberately avoided to encourage students to approach the project without prejudice to a particular tradition or typology. They were asked to consider: the nature of the book as an individual object, the book as a collection, the relationship between the reader and their book, and the nature of research (or searching). A site was suggested, although a number of students identified their own site during the course of the design process.

Following their completion it was clear that a number of the projects addressed a variety of issues facing contemporary library design and the role of library buildings in society. For example, despite being designed by so-called digital natives, physical books were highly significant in every project; recent research in the US (Gregory and Cox, 2015) has shown a significant – and unexpected – preference in students for books over digital media for the majority of different reading needs. However whilst real books were always present, in the majority of the students' projects they were an expression of a larger concept as much as for reading – such as their cultural symbolism, for example. In fact spatial explorations around the activity of reading were notably limited. Several projects explored the wider and more complex roles libraries play as an important civic space and place of social interchange within the public realm. As such, these projects reflected somewhat surprising research which revealed that the majority of library visitors do not go there to borrow or return books (Aabo and Audunson, 2012). It has been argued that libraries are undergoing a renaissance (Hvenegaard Rasmussen and Jochumsen, 2009) as this traditional building type is re-invented for contemporary and future cultural exchange, and it is this re-imagination that the students' projects explored in depth.

During the summer, after the projects were completed, a research paper was written about the changing roles of physical books and library spaces, discussing their place in the civic realm in the context of increasing digitisation and cultural diversity (Smith, 2014). The discourse was structured around the students' projects as the central narrative thread, with issues they illustrated referenced to existing research on contemporary library design identified by the literature review. A key aspect of the overall body of work the students produced was its sheer diversity; the projects ranged from a place for storytelling to a place for writing, a third place, a meteorological observatory, a book museum and an archive. Such a multiplicity of responses highlights an intrinsic quality of the TIR approach. As a divergent process, design projects evolve in a wide variety of trajectories. For the researcher – like Neo taking the red pill in *The Matrix* – what lies ahead is unknowable. However, this turned out to be a very positive quality, as the paper was able to illustrate a variety of different key themes and issues. Had all the projects been very similar, that discussion would have been much less rich. This demonstrates how the inherently divergent nature of studio design projects is a strength in the TIR method.



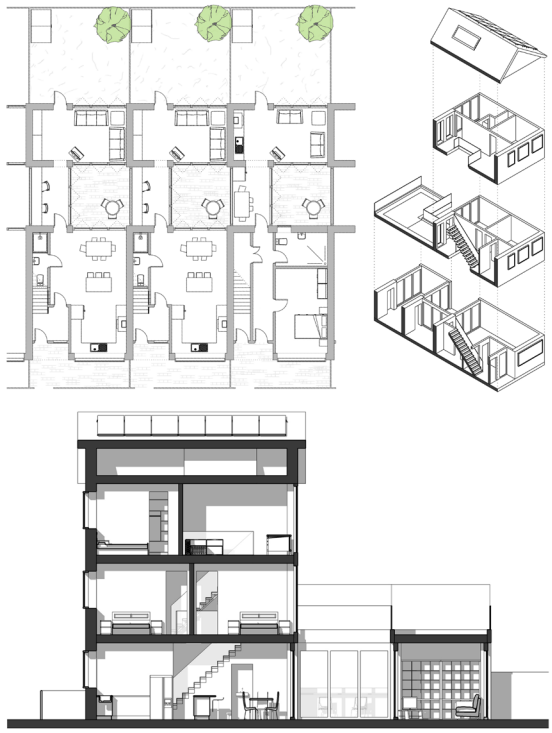
▲ **Figure 2** These sections through the meteorological observatory and archive show how the protective walls of the building are embedded into the mountain landscape – the smallest of which is the archive itself. By Alex Bodman.

An interesting aspect of the paper was that the tutor had no ambition to create a research output when setting the brief. That idea came after the project submissions when, reflecting back on the body of work that had been created by the students, its pertinence to contemporary issues in library design became clear to the tutor. As Schön (1983) highlights, design is not simply a matter of solving problems but also of finding out what the problems actually are. As opposed to submitting the paper to a journal about architectural education, it was submitted to *New Library World* – an established practitioner journal specialising on the changing role of the library and the impact external factors have on its future role and development. It went on to win Outstanding Paper in the 2015 Emerald Literati Awards, and led to the author being invited to write a book chapter on the future of libraries in the digital era, which also utilised student projects in the narrative (Smith, 2016). This clearly demonstrates the esteem which research based around students' project work can achieve.

CASE STUDY TWO – THE TERRACED HOUSING PROJECT

New housing design faces a raft of challenges, at the forefront of which is a triumvirate of interrelated needs: to make dwellings more spacious, more affordable and less damaging to the environment. Each of these is important in their own right, but are they reconcilable? Conventional thinking suggests larger dwellings cost more, as does increasing their environmental sustainability, so consequently they become less affordable.

In March 2015 Architecture students studying the NQF Level 7-1 MArch programme at the same university were set a project to design housing for sites in Liverpool. The module lasted for six weeks during the second semester. Students were asked to select one of three typical UK housing types – an urban block, terraced, or detached/semi-detached – again subject to an appropriate balance of numbers within each tutorial group. Following another democratic allocation process the Terraced Housing project group was composed of 14 students. They were given a site in the Georgian quarter of Liverpool, not far from the city centre, and were challenged to explore the potential of the terrace typology for housing suited to contemporary forms of living, and which examined the interrelated priorities of space, affordability and environmental sustainability.



▲ Figure 3 Plan, isometric and section. In addition to providing different configurations of the internal layout this project also provided the option of additional space for extended family members to live with a degree of independence or a home office. By Omar Shariff.

In the summer following submission of the projects, when the pressures of teaching and assessment had subsided, a comparative analysis of the projects enabled common themes and design strategies to be identified. For example, rather than just considering space standards quantitatively, numerous students explored it as a qualitative concept, which led to thinking beyond conventional dwelling spaces and questioning what modern patterns of living actually demand.

Some commonalities emerged, such as providing dedicated spaces to enable adult offspring (unable to afford their own dwelling) or elderly relatives to live as part of an extended family. As such, the family unit became a plastic concept which the students perceived as flexing and changing significantly over time. Some students proposed multiple living rooms so that occupants could relax in different ways at the same time – suggesting the notion of the whole family gathering around one television is an outdated one. Other projects proposed dwellings incorporating sliding or folding screens so that rooms could be easily reconfigured throughout the day – subdivided when different activities had conflicting needs and then recombined to create an open plan. The RIBA (2011) have argued for more research into what constitutes adequate space to suit contemporary living patterns; taken collectively these projects make some suggestions toward that understanding. Lack of natural light is a significant cause of dissatisfaction with new housing in the UK (Ipsos MORI, 2013); a number of projects addressed this, and in some instances courtyards or skylights and light wells were included as well as large windows.

In the first instance the project work was presented by the tutor at an international conference on housing, which showed the students' work at a formative stage partway through the module. The author was invited to develop that initial paper into a book chapter, discussing the apparently conflicting issues of space, affordability and environmental sustainability in new housing in the UK, and arguing that by using advances in each separate area to mutual advantage it is possible to reconcile them (Smith, 2015). Whereas the Book Repository paper used the students' projects as the central thread of the narrative running throughout, here the projects were discussed in one section within the chapter, using them to illustrate potential solutions to the numerous challenges that currently face new-build housing across the UK, and highlight potential trends and new ideas.



▲ **Figure 4** Site plan, section and perspectives. This project proposes two different house shells containing a staircase, kitchen and bathroom. Beyond these, it is up to the end-user how space is tailored to the needs of its inhabitants. This concept was explored by applying three different scenarios to each of the shells and examining how those family types could appropriate the space. By Matthew Kerrod.

SOME LESSONS LEARNT ABOUT TIR

A fundamental quality common to the Book Repository and Terraced Housing projects was that as theoretical constructs the students were permitted a high degree of intellectual and creative freedom. Consequently their designs could push boundaries in exploring what libraries and housing could be. Doevendans et al. (2002) discuss three types of research: questioning-prescriptive, questioning-descriptive and research of the imagination; TIR clearly lies in the latter category. This is a highly positive quality to using studio design projects as research methodology – they can explore deeply hypothetical concepts.

Griffiths (2004) argues that research in applied fields – common to built environment subjects, including architecture – is about bringing new approaches to intractable problems and conflicts in the field, and not towards knowledge and understanding for their own sake. The implication of this for the TIR approach is that studio projects must align with such problems and conflicts. Another commonality between the Book Repository and Terraced Housing projects was a brief to explore issues in building types that are currently facing contentious challenges. Therefore, to adopt the TIR approach project briefs should not be esoteric or abstract, or generate self-fulfilling prophesies, but respond to – and be interrogated against – challenges in real-world scenarios. Writing briefs that align with contemporary problems and conflicts also strengthens the potential impact of the research, and creates wider scope for dissemination in discipline specific journals as well as those in the field of architectural design and education. Setting briefs that challenge real-world problems may be disconcerting for some teachers, as it might be thought that reality could inhibit creativity in the design process. This suggests that such projects are more suited to cohorts in higher levels, as they are better able to reconcile creative exploration within imposed parameters.

One of the key aspects that makes TIR distinct from other approaches to the research-teaching nexus is the sequencing of the project work within the research methodology. In TIR the projects take place immediately after the research question – the brief – is set. All other stages – including the literature review and analysis – follow because these are all directed by how the project work evolves, and where it leads to.

The case studies described above both followed similar sequences in terms of research process. Preliminary research was conducted to establish the context for the design brief – a standard part of setting any project. The brief was then issued to the students and the projects followed the normal journey of development for the duration of the module. Once submitted the overall body of project work was comparatively analysed to identify themes and trends. Next a literature review was conducted by the tutor to facilitate a deeper level of understanding of particularities raised by the projects. This review identified existing research about salient issues in the field of inquiry to contextualise the projects; in both case studies this covered critical issues in design, theory and policy pertaining to the building type specified by the brief.

The research output was then written using the projects to illustrate issues, drawing on the literature review to validate these. The Terrace Housing project differed slightly because the conference where the work was presented at a formative stage took place whilst the projects were running; therefore the tutor conducted the initial literature review in parallel with the projects, which had the benefit of informing the studio work as it progressed. The comparative analysis of the projects then took place following their submission, and a further literature review was undertaken before the chapter was completed.

Because the majority of the research processes in TIR usually take place after the students' project work is completed, a potential shortcoming is that the research cannot feed into – and therefore inform – those projects. It is often argued that the benefit of research-informed teaching lies in its enhancement of curriculum content, thereby deepening students' learning. However, if the project brief is refined in response to the TIR outcomes, then they become part of the foundations for subsequent cohorts to progress their projects from. This creates a developmental cycle to the TIR method in which each cohort can spring from the previous one. However, this does require continuity – as opposed to reinvention – of project briefs from year to year.

Although a number of students designing Terraced Housing explored increasing affordability through both advanced housing manufacture and reducing utility bills, a shortcoming was that there was no robust method for these strategies to be costed. This highlights the need for an appropriate evaluative framework through which to critically appraise the projects. In the case of the Book Repository this was achieved through the literature review, which followed completion of the projects when the idea for a paper first came about. Existing research on issues raised by the students' work was explored, and the validity of the projects in the context of those issues then established.

Questions may be raised over the ethics of students' work being used as part of tutors' research. Is it appropriate that projects produced by students are subsequently used as material for staff conference presentations and publications? The students' projects are being produced anyway, but what are the implications if they are then used as material for research?

When briefs are being written, it should go without saying that the primary objective is alignment with the module's Learning Outcomes and any validation Attributes or Criteria that are mapped to it. Then the pedagogic depth and creative potential of the brief should be established, ensuring that strong students will be sufficiently challenged whilst those less capable have sufficiently defined parameters to work within. The relationship to a particular tutor's research field should only then be drawn. Put simply, the learning experiences of the project precede any consideration of a research idea. Equally, the students' exploration and final resolution of their project must be the primary focus and outcome; should their work diverge from any preconceived research objective this must be embraced and encouraged. In fact – as demonstrated above – the more diverse the projects produced, the more expansive the comparative analysis in the context of problems and conflicts will be.

If there is no increased demand placed on students beyond completing project work in accordance with the requirements of the module, arguably they benefit from having their work included in research outputs. Whether an international conference presentation or peer-reviewed journal publication, these can be included on students' CVs, blogs and websites, thus providing means to promote their design work. By following these principles the TIR method will not fall foul of accusations of students doing a tutor's research for their behalf. Another risk may lie in a belief by students that they have been set a particular project to satisfy the idiosyncratic research interests of their tutor. However, if students select which project they design in a module – as in both the case studies discussed above – should any brief not appeal to them then they simply avoid proposing it as one of their preferred options.

It should also be self-evident that students' permission must be sought before publishing their work, and that they should be acknowledged in presentations and publications. Interestingly, the author has never been denied permission to use students' project work in a research publication, even by students who have graduated and therefore are not subject to any influence of the student-tutor power dynamic. In fact, some have commented on the interest they have in seeing the tutor's interpretation of their work when it is discussed in a wider context of the research question.

CONCLUSIONS

Every year in every Architecture programme a wealth of creative, innovative and inspiring project work is produced. Should more of this be captured in research outputs which extend beyond publications on architectural education? There is much debate over the relationship between teaching and research, and how they impact on each other; that relationship can be significantly affected by the pedagogic methods of a programme (Robertson and Bond, 2001). As Brew and Boud (1995) highlight, the nature and quality of the co-relationship between teaching and research will have significant impact on the degree of productive symbiosis. Arguably studio teaching – with inquiry-based learning and one-to-one tutorials – is highly suited to fostering close links between the two, and studio projects have much to contribute to discourse on a wide range of contemporary problems.

The experience taken from running the two TIR projects described above has highlighted some key issues to consider when adopting a similar approach. Firstly, project briefs should be set to explore contemporary problems and conflicts in building types, or the equivalent, which are currently facing contentious challenges. This creates a relevant field for the research to contribute to. Secondly, the majority of the literature review and all of

the analysis generally follows completion of the project work by the students, to explore in more depth particularities revealed by the work.

Finally, there needs to be an appropriate evaluative framework for the project work – the research data. For example, this could be comparative analysis, contextualised against issues relating to theory, design or policy in the field of inquiry as identified through the literature review. However, where that field extends beyond the tutor-researcher's expertise, such as detailed cost appraisals or the appropriation of new technologies, then collaborations may need to be sought in order to robustly appraise the project work.
Interestingly, in debate over the relationship between teaching and research there are very few arguments that teaching effectiveness makes for better research – a causal link is, almost without exception, sought the other way round (Brew and Boud, 1995; Hattie and Marsh, 1996). In sharp contrast the TIR approach, in which research emerges from the outcomes of teaching, creates a very persuasive case for placing excellence in studio teaching at the epicentre of creating good research. Furthermore, when a cyclical developmental process is created year on year, research findings and outputs from TIR can inform and enrich the learning of subsequent cohorts.

Like research, learning is also about formulating knowledge. In the approaches described in the case studies, research develops from the students' project work, which is the product of the design process. Although beyond the scope of this paper, there is a strong case to be made for research outputs arising from of the creative processes that students engage with during the development of their projects, which would equally fall under the conception proposed here of research being informed by teaching. Either way, when teaching leads research the path will be an unknown rabbit warren of unanticipated twists and turns. However, as an inherent characteristic of the TIR methodology this can result in rich outcomes that relate studio teaching to much wider contexts, and lead studio project work into diverse fields of research.

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#Mcgillarchitecture: design education in the age of instagram

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ABSTRACT

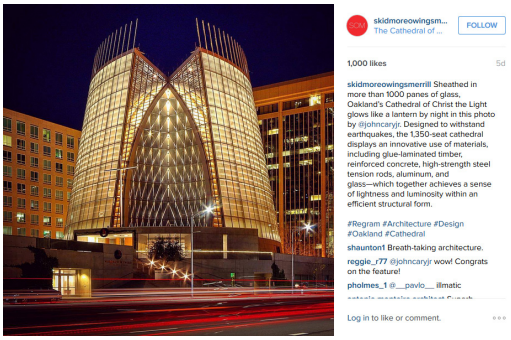
Instagram, the online mobile photo-sharing social networking service, appeals to architects and architecture schools because of its emphasis on high-impact visual images. Architects and students frequently post images of their work, from in-process drawings and models to full-scale buildings, providing unprecedented public access to the design process. From the perspective of an accredited architectural school, we argue that Instagram has rich potential to connect to other architecture schools, expose student work to a global audience, and reach out to donors in new ways. In general, we note Instagram's power to enhance the profile of the profession, nationally and internationally, through what we describe as the academic "selfie"—a mode of exposing architecture school culture via Instagram.

THE RISE OF INSTAGRAM

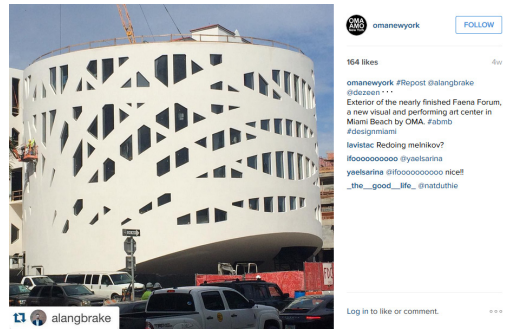
Instagram, the online mobile photo-sharing social networking service founded in 2010, has a particular appeal to architects and architecture schools because of its emphasis on high-impact visual images. Architects and students frequently post photographs of their work from in-process drawings and models to full-scale buildings, providing unprecedented public access to the design process (the estimated number of Instagram users is now 300 million, http://techcrunch.com/2014/12/10/not-a-fad/). For example, in its most predictable usage by architects, the Instagram account of high-profile firms like Skidmore Owings and Merrill (SOM) showcases their best projects in perfect lighting conditions or in use by happy clients. This image of the firm's Cathedral of Christ the Light in Oakland, California, for example, shows the church glowing "like a lantern". For those of us old enough to remember the power of magazines such as *Progressive Architecture*, these photos recall the marketing oomph of a good centerfold in that glossy and influential magazine. In this guise, Instagram is truly what one architectural critic has called "a more perfect version of everyday life." The non-architectural equivalents would be the gorgeous meal, the perfect outfit, the beautiful child, the flawless flower petal – Instagram is full of such idealized images.

According to SOM website, the firm has recently won a social media award from the New York chapter of the Society for Marketing Professional Services (SMPS-NY). The organization's 2015 Marketing Communications Awards program recognizes the firm's Instagram account, @skidmoreowingsmerrill, in its social media category.

OMA New York takes the opposite approach, posting less staged/contrived pics such as construction photos of its Faena Hotel at Miami Beach. These



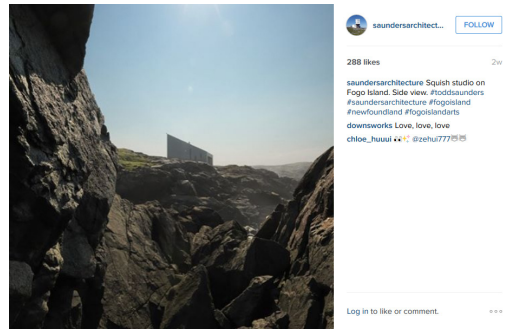
▲ **Figure 1** A snapshot of Skidmore Owings and Merrill's Instagram account



▲ **Figure 2** A snapshot from OMA's Instagram account



▲ **Figure 3** A snapshot of Herzog & De Meruron's Instagram account



▲ **Figure 4** A snapshot from Saunders Architecture Instagram account

are anything but idealized and are instead sloppy, messy, non-precious, etc. Such images show the making of architecture, rather than its final product. Both product- and process-oriented views, of course, are highly privileged (what we mean by this is that the real view is actually accessible to very few people).

The list of architecture firms on Instagram is quite long, including other high-profile firms like Herzog & De Meuron, NBBJ, Snøhetta, Olson Kundig, Shop Architects, and Zaha Hadid. Each of these firms engages Instagram as a strong, visually-based platform to showcase its finished work, office candids, and general inspiration. Instagram provides them with a virtual space to join in conversations with other professionals, and architecture lovers worldwide through bold visual messaging.

For those of you unfamiliar with Instagram, it is important to point out that Instagram images, which are the focus of every account, are accompanied by short captions and then followed by a long list of hashtags: key words connected by # symbols that allow viewers to search out particular interests. Social media specialists think of hashtags as an online filing system. Clicking on a hashtag on Instagram takes you to all the images that used that hashtag.

Obviously, hashtags allow for a wide exposure of images by reaching out to diverse users. They can be general like #architecture, #design, #visualization, #art, or more specific acting as a sort of trademark an account. Creating a new hashtag for a certain project, content, or account can offer audiences a way to broadcast the images relating to that

project, group, or account. Hashtags also encourage audience participation, thus serve to create a dialog about a given topic and are considered the main driver behind connecting users who might not be following the account. One of the interesting trends as well is "re-gram" or "re-post", where users can re-publish an image from an account they are following, and if their followers see it, they might end up following the account.

The interactive aspect of Instagram is that viewers can express approval of images by clicking on a tiny outlined heart below each image, which shows as a "like". Additionally, viewers subscribe and "follow" particular accounts, receiving instantaneous images on their smart phones and tablets. Some viewers write comments, which are most often in a casual, nearly spoken tone – and many are emotionally charged. Remarkably few are vulgar or offensive and there is no mechanism for "disliking" an image.

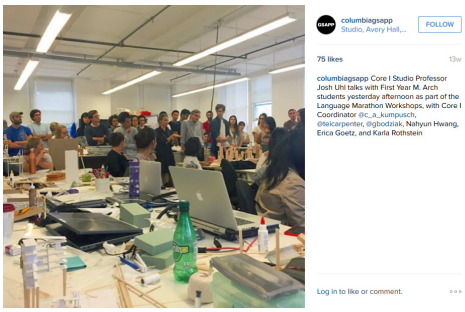
We illustrate with a typical example. In the case of Norway-based Todd Saunders' image of his studio on Fogo Island, 288 viewers liked the image and a viewer named "downsworks" added: "love, love, love". Saunders' hashtags, a modest list, include his own name, the name of his office, the place, and the client. Saunders has 10,000 Instagram followers. Similarly, the Mexico City-based architecture firm Rojkind Arquitectos has about 14,000 Instagram followers. The account also uses a short list of hashtags, sometimes only one or two, including the project name, or describing the action taking place in the picture (for example, staff members meeting or sketching). What is also interesting about this account is that it posts pictures of work by other architects, including a project by BIG, and a presentation by Sou Fujimoto at the World Architecture Festival in Singapore in 2015.

From the perspective of architectural education, the subject of our conference, Instagram is a growing and hugely useful database of student work and school information from around the world. On Instagram we see the studios and studio work of other schools and they see ours. This image posted by Columbia University (figure 5) for example, posted thirteen weeks previously, is typical, showing the Ivy League school's architecture studio: tables, laptops, glue, Perrier, coffee, half-completed models, lots of backs of students (a particularly irksome characteristic of architecture school photos). It is the educational equivalent to the OMA construction image, a spontaneous, backstage view of how architecture gets made.

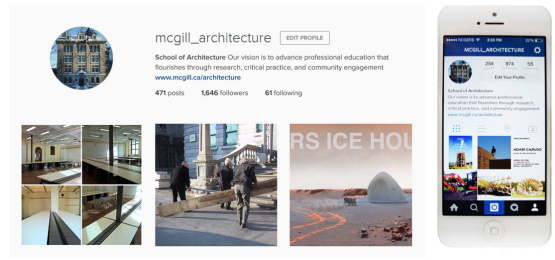
More than 60 school of architecture across North America run active Instagram accounts. The popularity Instagram is gaining among architecture schools raises questions about the benefits to architectural education of engaging in social media platforms. We believe that Instagram offers a mode of exposure that goes beyond conventional studio life, connecting with other schools, with architectural firms, and with university alumni (especially those who are potential donors).

@MCGILL_ARCHITECTURE

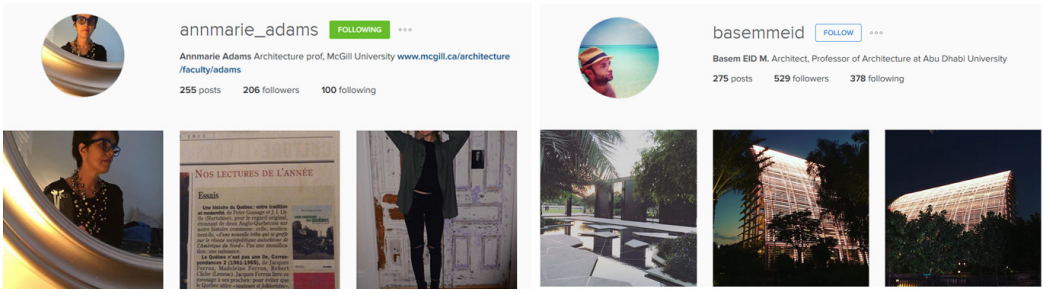
At McGill University's School of Architecture in Montreal, we have firsthand experience of Instagram. The two of us, Bassem Eid Mohamed (then a postdoc fellow and now an Assistant Professor in Abu Dhabi) and I (then the school director and now a happy sabbaticant) started a school account in November 2014: @mcgill_architecture. Basem, already familiar with Instagram, suggested that it would be good PR for the school; Annmarie was a complete novice. Our basic models were the popular accounts of two American schools: Columbia University (@columbiagsapp) in New York and Sci-Arc (@sciarcinside) in Los Angeles. The Bartlett also has a very active and interesting site, @bartlettarchucl, to which we have often looked for inspiration. It has nearly 5500 followers with only 258 posts.



▲ **Figure 5** A snapshot from Columbia GSAPP's Instagram account



▲ **Figure 6** mcgill_architecture page on Instagram



▲ **Figure 7** Personal accounts of Annmarie Adams and Basem Eid M. We both follow a number of students whose accounts then contribute to the school's feed.

To make a long story short, our site has grown quickly in the last fourteen months and we now have over 2100 followers (note: our school has 300 students). Our 540 or so postings have included student work, faculty publications, university events, student travel, convocation, and shots of daily life in the Macdonald-Harrington Building, the heritage structure we share with McGill's School of Urban Planning. We follow 15 other schools and about 45 other schools follow us. Note we do not follow any of our students' accounts (though Basem and Annmarie follow many students from our personal accounts, an interesting triangulation and rich source for ideas).

After about 6-8 months, our team grew to four members and we try to post images daily (or at least seven per week). Basem and Annmarie were joined by Howard Davies, a popular adjunct professor and Montreal architect with an extraordinarily close relationship with students; and more recently Manon Paquet, a Masters student. In general Annmarie and Manon post the images; Basem, now headquartered in Abu Dhabi, provides constant advice and often enriches our list of hashtags. Howard is our hunter/gatherer, always out getting us great images. Annmarie writes most captions and edits all of them for uniformity. Captions are in present tense and are careful to avoid any value judgments (ie, we never say "this excellent project", "this beautiful model"). We believe this broad representation and neutral positioning encourages students to send us their work, building an atmosphere of trust.

We tag each of our images to #mcgillarchitecture, a hashtag that acts as a trademark for all the content of our account. This hashtag is also used by many of the students to share their work with Instagram users via their personal accounts, and also global users who now search with this hashtag. We also use #mcgill and #mcgillu to reach out to the

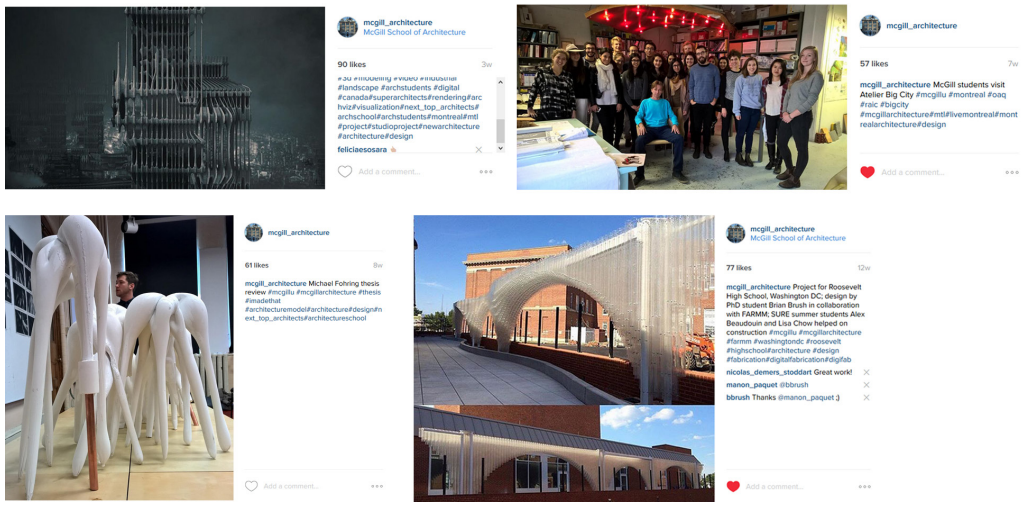


Figure 8 A snapshot from mcgill_architecture Instagram account illustrating four of our images

larger McGill community. We saw the power of hashtag outreach after only a couple of weeks running the account. Starting up mcgill_architecture in time for final studio reviews in November 2014 meant we had bountiful material to post immediately.

We tend to err on the side of caution in our choice of images. Typically, we try to select images that express a strong statement with regard to design, modelling, or the depiction of school facilities. We post representations of both traditional and digital media. We also post many images of events, studio reviews, and student gatherings, as a way of exposing the dynamic social climate in the school.

Through this collegial experience, we have come to appreciate two aspects of Instagram that show our work way beyond any website or school catalogue might do. Firstly, the power of non-conventional hashtags to connect our images to a huge audience searching for specific types of work. For example, including the hashtag #inflatables on our image of PhD student Susane Havelka's prototype dome for the Arctic meant that viewers looking for inflatable housing could find it. This, in fact, brought us more followers, showing the aspect of design/build practice within the school's programs.

And excitingly, our images are often reposted on sites with much higher numbers of followers, exposing our school and work to a whole new audience. This is extraordinary for students of architecture. We offer three examples in this regard. In December 2014, when we had just started the account, U3 student Alex Kobald's images of a 3D-printed model for a library project was reposted by @superarchitects, garnering over 3000 likes. On our site, however, the image had gotten only 40 likes. Kobald, now studying at MIT, remembers the moment: "I found out about it [the reposting by superarchitects] after landing in Vancouver airport for Christmas break and I received messages from five or six of my classmates with links to the page. It did lead to some messages from people asking how the model was made as well as some additional follow requests on Instagram and LinkedIn… it was pretty cool to be featured. It showed me a larger and highly public collection of student work than I was aware of" (personal email from Alex Kobald, 9 January 2016).

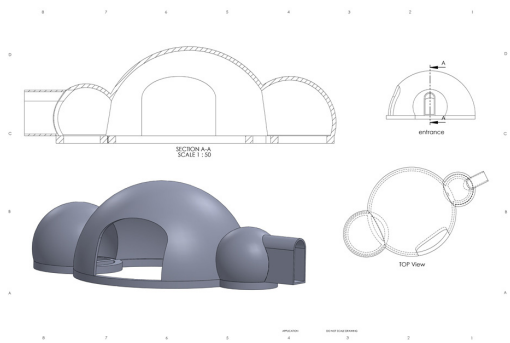


Figure 9 Monolithic Dome, Susane Havelka's PhD dissertation research



Figure 10 The image by Alex Kobald on our site, and on @superarchitects

This image specifically demonstrates many aspects of Instagram we described earlier. Given that it was the time of studio reviews for many architecture schools, the account @superarchitects initiated the hashtag #SAstudio to collect as much studio work to one link. So we used the hashtag as shown in the below image, in addition to our trademark hashtag. @superarchitects regrammed our image, which resulted in increasing our followers by over 50 users in a few hours.

In a similar fashion, on June 7, an image from professional Masters student Michael Fohring's thesis was reposted on @IMadeThat, a site developed specifically to showcase projects and to inspire architecture students from around the globe. The account was launched by the Association of Collegiate Schools of Architecture (ACSA) as part of an outreach communication campaign. IMadeThat's feed is built around reposting images already published by the architecture school accounts. In order to get connected, images have to be tagged #IMadeThat.

And even more recently, two McGill images were reposted on @next_top_architects: the model produced by the McGill team who participated in the Tonjing Construction Competition in China last summer and a rendering of b-shack, a community-based project produced by FARMM (a research lab in our school) constructed on the Macdonald [the agricultural] campus of McGill University, attracting 151 and 2,611 likes respectively, and dramatically boosting the number of followers to the school site. These three sites, @next_top_architects, @superarchitects and the above-mentioned @IMadeThat, we would suggest, are particularly powerful.

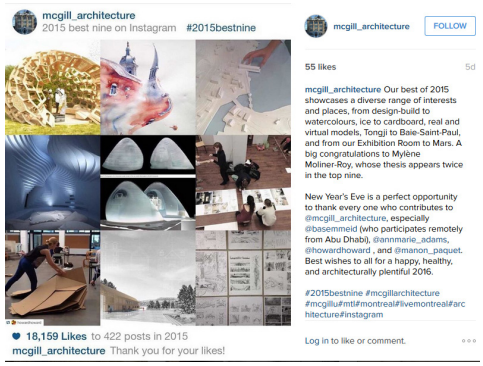


Figure 11 Our top nine images for the calendar year 2015



Figure 12 Snapshot from Bjarke Ingels' account on Instagram

We are constantly questioning the likes we get for images we post. We try to understand what is behind the number of likes an image would get over another one. This topic frequently generates e-discussion among the four of us who manage the account. This can be clearly demonstrated in the illustration below. Using a special website, we measured responses to our year of images. The resulting nine images demonstrated an unexpected variety. As you can see, the top nine are very different from each other: three renderings, two models, a watercolour painting, two shots of students, and a wall of traditional, hand-drawn work. They garnered between 90 and 165 likes.

With regards to a literature review on this subject, note that there is only one serious paper on Instagram: Alexandra Lange, a highly respected architectural critic based at Harvard University has written about the Instagram presence of starchitect Bjarke Ingels: *www.dezeen.com/2014/01/07/opinion-alexandra-lange-on-how-architects-should-use-social-media/*.

Ingels' Instagram account is quite different than most architects. Firstly, it has 119,000 followers. And he offers glimpses of his private life that no doubt add to his reputation as a man about town. As Lange points out in her list of images that characterize Ingels' account, "Selfie, LEGO selfie, girlfriend (I hope), Gaga, monograph, fog, fox socks. His Instagram has a lot to do with the architecture of self-promotion, but little to do with actual building." It is more like *People* magazine than *Progressive Architecture*, that is for sure. The point of her article, however, is to urge architects to use Instagram to write a draft of history, introducing viewers to what they are thinking, reading, seeing rather than letting others do it for them. In her delightfully frank writing style, Lange warns architects to "let the rest of us in, so it doesn't take bankruptcy, demolition or obituary to get people talking about architecture."

CONCLUSION

As we hope is evident, we are enthusiastic about the role Instagram can play in architectural education. To investigate such a notion, we are constantly monitoring other accounts. This surveillance pushes us to be more selective when posting our images. We have also noted an invisible spirit of competition among schools of architecture that can be read in the images and associated hashtags.

We have also reaped the benefits of connecting with potential donors through our site. In this regard, an aspect of the project which show's Instagram's potential to stand in as a

virtual "visit" to the school. As a result, McGill's advancement professionals have been huge supporters of our Instagram initiative. Charlotte Niedermann, Development Associate in the Faculty of Engineering, reports: "I use the School of Architecture Instagram account as an alumni engagement tool. The account is a great way to connect alumni to the School, especially those who live far away or aren't actively involved with the School. The alumni can see with their own eyes the calibre of our students and their work. The posts share the School's traditions as well as illustrate what has changed over the years. The account also communicates the impact of philanthropy at the School. It is an effective tool in the stewardship of our major donors and has the potential to inspire philanthropy in other alumni" (personal email from Charlotte Niedermann, 9 January 2016).

One issue we think merits further study is the relation between the number of likes an image gets and a project's real-life grade. Our preliminary observations on this are that the two measures, likes and grades, are not parallel (or are non-conforming). Not accounting for time of day and other important factors, for example, and focusing only a third-year library project in which many projects were posted (in three phases), we note that the project that received the most likes (as a final rendering), received the same grade as one that received far fewer likes. Similarly, and as a cross checking measure, we note that the project that was considered by the instructor to be the "most resolved" was ranked only third by Instagram followers. As our work continues, we will likely discover that the time of day, the context of posting (alone or in a series), and other "environmental" factors may have an influence on the people's choice. And we acknowledge that such factors might also affect good old-fashioned grading by professors.

As is well known, social media is hard to control. For instance, there is a popular trend in social media platforms and specifically on Instagram: "follow me and I follow back." This tit-for-tat is misguided. Also, some hashtags are only designed to attract attention. An example of this is #tagsforlikes. Several scam accounts have liked our images and have followed our account in order to boost their own followers.

Before too long and following this preliminary presentation, we hope to co-write a critical paper on the architectural discourse generated by the three Instagram sites (@superarchitects, @IMadeThat and @next_top_architects) and to do a systematic study of @IMadeThat, in order to understand which student work is chosen and why. What are the ethical and philosophical implications of these connections? Since the so-called digital revolution, for example, critics have noted that architectural production has been homogenized. Certainly in schools of architecture admissions committees commonly note that portfolios look more alike than ever before. An increase in team projects over the past ten years, too, has meant that students graduate with portfolios comprised of shared projects. What does this mean for the future of architecture?

Finally, we underline that based on our recent experience, Instagram has rich potential to improve the basic level of communication within schools. Students and profs alike have noted how much they enjoy knowing what their colleagues are doing in such a fun and easy way. We have thus learned a lot about ourselves through Instagram and our efforts to produce an academic "selfie." All of you are part of that power too. Look for images of our presentation today on mcgill_architecture soon.

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Towards a connected curriculum in architectural education: research-based education in practice

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ABSTRACT

This paper outlines a long-term flexible education strategy for integrating research and teaching at a research-intensive UK university. The "Connected Curriculum" is part of a recently launched twenty-year vision and a wholesale commitment to changing programmes of study. It will enable students to participate in research and enquiry throughout their education. In addition, it aims to allow students to make connections both vertically across a programme's year groups and horizontally across disciplinary divides, as well as beyond the university setting. The paper begins by outlining the Connected Curriculum, including its framework of six dimensions of connectivity. Then it moves to look specifically at research-based education in practice. In doing so it pulls together a number of relevant curricula examples from built environment disciplines and further afield, which have clear implications for architectural education. Through illustrating relevant international and interdisciplinary praxis, in the context of an internationally-recognised strategic approach, the aim of the paper is to inspire curricula enhancement relevant to diverse architecture programmes.

INTRODUCTION

Change is affecting higher education globally in a number of ways and universities must adopt flexible yet coherent strategies that prepare students with the skills needed for successful and thriving careers in an unpredictable future. A growing body of literature argues that one way this can be done is by enhancing synergies between teaching and research. Bringing students closer to research has a number of benefits relevant to students' current experiences and careers as graduates. These include motivating students through treating learning like research cited at the edge of knowledge discovered through collaborative and shared enquiry. University College London (UCL), a leading UK research-intensive university, has implemented a distinct research-based education strategy, known as "Connected Curriculum", which is increasingly drawing the attention of the international higher education community. This institution-wide approach focuses on making learning and assessment relevant to what students will do in their future careers and on facilitating opportunities for connections. Importantly, though, this strategy takes a non-prescriptive approach: it offers suggestions for research-based education in unique subject-based contexts. The focus of this paper, then, is to use the framework of the Connected Curriculum to inspire architecture educators to develop more enhanced research-based curricula.

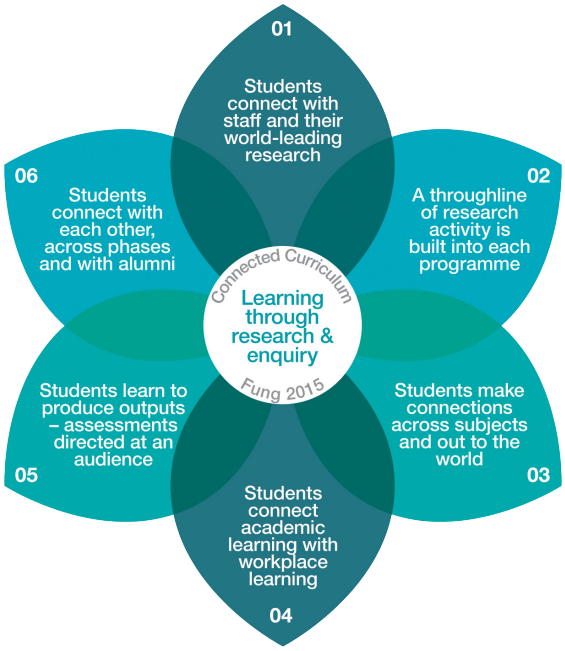
The discipline of architecture is ideally suited to lead the way in research-based education. In many ways learning and research already go hand in hand in architectural education. The design studio project is a strong example of collaborative and individual learning in a research setting. And through authentic assessment activities, students present to and engage the community beyond the university – specific points encouraged in the Connected Curriculum. Along with showcasing this and other strong examples already taking place, this paper also makes the case that there are ways in which architectural educators could enhance their own research-based offering. There is much to learn by looking beyond the limits of the discipline to strong curriculum design in other areas. It is argued that research-based education in architecture can contribute to and enhance an already established tradition of authentic learning in a community of practice.

The paper is conceptual in nature, however by way of secondary research it draws on an internationally-gathered collection of existing curricula enhancement case studies. It looks largely to the collection of case studies put together by of higher education consultants and developers Mick Healey and Alan Jenkins (2016), as well as from examples at UCL. The structure begins by both highlighting the value of research-based education as well as unpacking UCL's approach. Finally, using the flexible framework adopted by UCL, the last section zooms in to the practical level. It sets out a number of diverse curriculum enhancements that may inspire architecture programme leaders. While these are framed in the context of a UK institutional strategy, the examples are relevant beyond the local context and to other disciplines.

A RESEARCH-BASED EDUCATION STRATEGY: THE UCL CONNECTED CURRICULUM

UCL and other institutions are beginning to adopt research-based education strategies in response to a shifting higher education climate. Barnett suggests the role of the university is changing where it must increasingly prepare students with new ways of knowing, in order to thrive in an unknown future. He notes: "In an age of supercomplexity, a new epistemology for the university awaits, one that is open, bold, engaging, accessible, and conscious of its own insecurity. It is an epistemology for living amid uncertainty" (Barnett, 2000; see also Brew, 1999). Brew (2012) identifies other changes which are also affecting the way universities are operating, including the shift to massification (Elton, 1992; Westergaard, 1991) and time pressures on academics (Hattie and Marsh, 1996). A growing body of literature (Brew, 1999; Brew, 2012; Hattie and Marsh, 1996; Healey 2005) argues that bringing students closer to research, employing pedagogic approaches which engage learning as shared discovery or enquiry, will go a long way to improving contemporary education. Learning through research can deepen learning and understanding, especially when it enacts inquiry-based learning, and learning which closely parallels problems found in one's future career (Healey and Barnett, 2005; Healey and Roberts, 2004). The urge to bring teaching and research closer together is also driven by university managers to remove a long-standing binary which sees both areas as separate and unproductively disparate. This is evident with the ideas "teaching load" (what academics have to do) and research reward (what scholars are rewarded for doing) (see Fung and Gordon 2016). The challenge is for universities to reshape curricula so that staff and students can work together to treat learning as a journey; academics are further along the spectrum, and both staff and students develop through research and enquiry. Such an approach would reconceptualise higher education as "communities of practice" (Brew, 2012; Wenger, 1998).

The Connected Curriculum is UCL's institution-wide strategic approach to reinvigorate learning in this way. President and Provost Professor Michael Arthur remarks that "our



▲ **Figure 1** The Connected Curriculum Framework

top strategic priority for the next 20 years is to close the divide between teaching and research. We want to integrate research into every stage of…" education (Arthur, 2014). Recognising that the term "research" is discipline and subject specific, from the outset such a whole-institution approach encourages local and distinct adaptations. The Connected Curriculum framework (Fung, 2015a; Fung, 2015b; Fung, forthcoming a) was designed to operate as a flexible tool for programme leaders and others with a stake in education planning to think through the development of their offering (Figure 1). It also invites staff and students to "question critically the nature of evidence and knowledge production" in their own and in other subject fields (UCL, 2015d).

The core principle is that students learn through research and enquiry. Six dimensions of activity each branch out from this core, which invite teams to think about approaches to learning and opportunities for connecting learning beyond the classroom.

Dimension 1 encourages students to connect with staff and to learn about ongoing research. It hopes to both break down unproductive hierarchies between staff and students, with students able to ask questions, and to bring students closer to a part of university life that they traditionally never experience. Curiously the thing that drives institutional reputation is often removed from student experience. This is also about introducing students to many members of the research community of practice that they belong to.

Dimension 2 encourages a connected sequence of research activities throughout students' programmes. It is important for development and learner scaffolding (Rosenshine and Meister, 1992) that students have opportunities to learn through research and enquiry at every phase of their degree. While the "capstone" dissertation project is encouraged as a minimum, there should be structured opportunities to develop expertise in research throughout earlier years, both within the curriculum and through extra-curricular activities.

Dimension 3 recognises that research is inherently social, and in order to strengthen the community of practice opportunities need to be structured which encourage students to connect their learning across the subjects they are taking and with the wider world beyond. It would be unhelpful for students' future careers and lives if their education was not applicable to contexts beyond their immediate learning environment. Through this dimension students will have opportunities to connect with external organisations and communities.

Similar to dimension 3, students need opportunities to make connections between the research and learning they undertake on a course with what they will be doing in their future careers. Dimension 4 encourages students to connect academic learning with workplace learning, and in so doing will be able to develop a range of professional attributes and skills needed to succeed in modern work environments.

Dimension 5 focuses on assessments and invites programme teams to reconceptualise them as relevant and appropriate for the development of skills needed for students' future careers. Is an essay or unseen final exam actually the best form of assessment? Possibly in some cases, but ideally some assessments will engage an audience beyond the marker, giving students a voice beyond the immediate activity, including with the community, industry partners, or employers. Arguably students will also learn more useful transferrable digital skills, through, for example, producing a video or website. Motivation is a key factor in rethinking assessments as outputs, with many students excited about the possibilities.

Finally, dimension 6 encourages interpersonal connections. The ability to work with and connect with people from different disciplines, cultures, and backgrounds is an increasingly valuable skill in a globalised economy. Students need opportunities to connect with other students in upper and lower years, on other programmes, and with people beyond the university, including alumni. While these connections may need to happen naturally, structured opportunities within the curriculum will be needed in order to develop a thriving research community.

RESEARCH-BASED EDUCATION IN PRACTICE

The Connected Curriculum framework is sufficiently flexible yet thorough to inspire enhancement in architectural education (as well as all disciplines). The six dimensions discussed above are by no means new to pedagogic approaches that already exist. There is a strong tradition in architecture of students learning through research and enquiry. Importantly, Connected Curriculum aims to inspire further enhancement on the back of this firmly established approach to education, while encouraging authentic learning in a coherent community of practice.

If one thinks of architectural education, likely the image of design studio comes to mind; indeed, in many schools it dominates both staff and students' workload and energy. The studio, both timetabled learning hours and physical space, strongly fosters a research community. Students spend great lengths of time in the studio working on coursework, well beyond meeting with teachers about progress and feedback. For many students, desk space is also provided, which further adds to the sense of belonging. Students conduct practical research into the built environment, engaging websites, books, model making, computer drawing and experimentation. The dominance of the studio suggests that architecture students regularly engage in the core ideas of research-based education.

In line with the Connected Curriculum, studio learning can be linked to many of the framework's six dimensions; at UCL the goal is to enhance these dimensions where possible. Often course teachers establish a theme for the cohort's projects, which may be based on their own academic research; if so, students have the opportunity to learn through making connections with staff and their research (dimension 1). In that studio takes place at every step of the way, ideally building on the work of previous years, a throughline of research activity is firmly established (dimension 2). It is worth reminding students that studio is research and that it is a progressive journey of enquiry. In some cases, in line with dimension 3, studio is closely linked to work in other subjects, for instance architectural

history and theory or technology courses. Firmly situating and encouraging cross-subject connections reinforces the importance of learning in both subjects and allows students to develop through related yet distinct research projects. Aligning studio projects with other disciplines, for instance town planning, or engineering, further enhances connections relevant to students' current learning and essential skillset needed for future employment. Though setting research projects in studio that relate to what students will be doing in diverse careers (dimension 4), including but not only in architectural practices, students will gain practical job developmental skills which can be motivating and underscore the relevance of the learning exercise. The activity of inviting external critics to view coursework, where students present their projects to relevant interdisciplinary professionals (the "crit"), is a further strongpoint linked to dimension 4. Studio work often culminates in the production of outputs directed an an audience (dimension 5). As well as the interim and final crit presented to invited guests, it is increasingly popular for schools to showcase studio research in end-of-year exhibitions or shows (as illustrated in the now-lengthy UK summer architectural calendar). Finally, through the above noted studio pedagogic approaches, especially the end-of-year show, architecture students are able to make connections with each other, across phases and with alumni (dimension 6). Further opportunity to showcase studio work throughout the year and invite others to view work in progress would also encourage greater connections, leading to further motivation and a strengthened research community of practice. While studio is so firmly established, it and other architectural courses can be enhanced through looking to, and being inspired by, relevant international work on research-based education in practice. The following is just a small sample of the many ways research-based education could be adopted in practice.

DIMENSION 1: CONNECTIONS WITH STAFF AND THEIR RESEARCH

While the studio can bring students in contact with academic research, this is not a guarantee, and indeed it may be that the theme is driven simply by an interest in the area; further it may not introduce students to a wide range of the department's teaching staff. Structured opportunities for students to engage course leaders, and others in the department, are needed, which facilitate opportunities for diverse connections and introduce students to the strong research community they are part of. Some students do not realise academics even conduct research outside of their teaching commitments, others may feel that they are not allowed to even enquire about this. To overcome this unproductive binary between teaching and research at UCL there has been a history of creating induction-week activities which require students to enquire into staff research and report back on their findings. In the department of geography tutorial groups have been allocated a member of academic staff and each is then provided with three pieces of writing and a CV, and an interview is organised. Students then go off in small groups to read the material and devise interview questions to uncover the objectives of the interviewee's research. As well, students find out how the research relates to his or her earlier studies, and how it relates to current teaching, other interests and geography as a whole. Finally, students produce a short report on their findings (Dwyer, 2001; Healey and Jenkins, 2016 [all references are to case study numbers]).

Other areas of the university, such as the Faculty of Brain Sciences, have modified the approach. In this case students view polished, short videos of academics speaking about their research so that they can ask challenging questions about scholars' areas of expertise. Students are required to present on the findings (Fung, forthcoming b). The design of the activity means that students are able to develop a number of skills: teamwork skills; transferable skills such as project management and interviewing; and communication and presentations skills. Importantly, this exercise introduces students to the wider research

culture within the faculty (Standen, 2015). "Meet Your Researcher" (UCL, 2015e), as the idea is now known locally, which is adopted in various guises, is being encouraged in all departments; it would certainly suit architecture, where interesting yet diverse research is being conducted within one community.

The Science Faculty at McGill, Canada, has undertaken a similar but distinct sort of approach. Twice per academic year a handful of academic staff talk about their research in short casual presentations, and then students and staff have lunch together, informally discussing the research. This clearly works to break down unproductive binaries between staff and students, leading to the latter feeling comfortable enough to approach the former to ask questions.

Another way that students can make connections with staff and their research is by supporting the research itself. While research assistants are firmly established in some departments, designing an assessment activity could be a productive way to bring more students in contact with academics and their research. It is possible that students could even help with, for instance, data collection. This could have a number of ramifications for architecture, for example students could help gather GIS information and they could help conduct large-scale spatial studies through inputting data. One example from biology shows the scale and potential for motivating students. At the University of Sydney, Australia, a first year cohort of 1000 students carry out a small research project as part of a larger study of asthma across the metropolitan area. Students gather airborne fungal spores, in their backyards, over a ten-minute period. They learn how to identify the fungi and develop a distribution map of the spores. They then have the opportunity to discuss the cohort's findings with the scholar and international expert. The activity led to a better awareness of the research process and the course content (Healey and Jenkins, 2016; Taylor and Green, 2007).

DIMENSION 2: A THROUGHLINE OF RESEARCH ACTIVITY IS BUILT INTO THE PROGRAMME

As noted above, in order to strengthen a research community and remind students that they are contributing to a shared construction of knowledge, drawing attention to the throughline of research is essential. In some cases, it could mean renaming courses to make this explicit. In most cases holistically mapping a constantly evolving curriculum rarely happens, yet this may be a useful way in which to identify the demand for a research throughline.

At the University of Tasmania, Australia, a structured and logical progression of research learning takes place throughout the full three-year undergraduate programme. In the first year assessment activities allow students to engage with researcher positionality and institutional ethic applications. Students work with real research data in year two. In the final year dissertation research is supervised by academic staff and both work together to produce a research paper for an undergraduate journal (Healey and Jenkins, 2016). A teacher could run with this and set an assessment task to write an architecture journal article, in the style and requirements set by a publisher (see also UCL, 2015b). Or students could be assigned a project to investigate an architecture journal article and put questions to its author, engaging in possible dialogue with the scholar (Healey and Jenkins, 2016). While most architecture programmes are professionally accredited and rigid, a number of small interventions could be made to establish a throughline of research. Encouraging research community activities such as research seminars, departmental conferences, and student-led research journals and digital platforms for the dissemination of coursework would further reinforce the research community which students are a part of throughout

the duration of their studies. Moreover, these would not require major revisions to the programme structure.

DIMENSION 3: STUDENTS MAKE CONNECTIONS ACROSS SUBJECTS AND OUT TO THE WORLD

Through making practical connections between immediate learning and other courses and beyond, students will be better equipped to apply the skills of research and enquiry to global problems in the future. All first year engineering and computer science students on the Integrated Engineering Programme at UCL work on two five-week long research problems based on real challenges. This includes identifying the problem, designing the research project, and finding a solution. In that the problems are based on global challenges, such as sustainability and health, students work closely with teaching staff and external experts (Healey and Jenkins, 2016). These problem-based scenarios, situated in real global challenges, offer authentic learning similar to what graduates may do in their future careers.

Learning with objects is a closely related pedagogy also useful for encouraging students to make connections across their learning out to the world beyond (Chatterjee and Hannan, 2015). At the University of Strathclyde, UK, first year mechanical engineering students work closely with a car, disassembling it, and selecting a component for investigation. They research its functions, physics, design and manufacture, and produce a poster explaining their research (Healey and Jenkins, 2016). At UCL, similarly, second and third year architecture students recently visited the UCL archive collection. The studio group was investigating remoteness and were particularly interested in the story-telling abilities of artefacts. Students were able to view and handle a number of objects, including a rocket designed to be fired onto the Moon, a number of letters and photographs sent home from arctic explorers, and rocks from remote St Kilda, UK – the location of the group's upcoming site visit

Situating learning in the city or landscape is another key way students can make connections between course material and the world beyond in a research-based setting. Students in architecture, construction and project management and planning come together for a large first year course at UCL. "Making Cities" uses contemporary London as a research laboratory, with students required to investigate a component or area of the urban fabric through videography. Similarly, "Making History", also at UCL, encourages students to use the resources around them in the city – archives, documents, objects, collections, buildings, images, and soundscapes – to creatively investigate London's history (UCL, 2015a; Fung, forthcoming b).

DIMENSION 4: STUDENTS CONNECT ACADEMIC LEARNING WITH WORKPLACE LEARNING

Built environment disciplines tend to have close links with the community, which bolster connections between learning and work. Many engineering programmes are developed to work closely with firms who also help create assessment activities that respond to real community problems. Construction and project management programmes similarly work closely with industry and regularly schedule site visits. It is clear that employers benefit from educating the next generation of professionals: they want to be well-placed to hire new graduates. In architecture, students often see the link between studio work, or technology courses, with employment. It is clear to them that learning and assessment parallel tasks in work. However, the connections between other parts of their curriculum and workplace learning, such as architectural history and theory, may be less clear to students. The need

to reinforce the importance of foundational history goes without saying, but there may be other ways that help draw clear links with employment and which have the added benefit of increasing motivation. One is to encourage students to undertake historical projects that are needed or parallel the work of national historical societies for architecture. Could English Heritage, for instance, help identify essay topics or could historians from the organisation speak to architecture cohorts about their careers?

The Science Shop model has been well established in other countries and disciplines. It links up undergraduate students in need of a dissertation topic with civil organisations in need of research. It gives students an opportunity to lead their own research project, attempting to answer a real problem in the community. A key part of this is taking advantage of institutional support, public engagement teams and university volunteering departments, who are well-placed to understand the needs of the community and who are keen to encourage partnerships. Working on these real research problems gives students a way of applying their learning to what they may be doing in their careers, and supporting a charity with their expertise.

Like the Science Shop model, architecture students at The University of New South Wales, Australia, offer a relevant example of community engagement through research. Shaped by the needs of community partners, programme leaders set out a number of projects for students to work on solving in teams. After a research and design phase students then present their solutions back to the community (Healey and Jenkins, 2016). Students clearly see the relevance of their learning to what they may do in their careers; they understand the importance of research and enquiry and how it leads to design solutions.

DIMENSION 5: STUDENTS LEARN TO PRODUCE OUTPUTS – ASSESSMENTS DIRECTED AT AN AUDIENCE

Architecture education has many outward facing assessments; both the crit and the final year show (both discussed above) speak to the way in which assessments engage an audience beyond student and marker, producer and consumer. While many programmes have unseen final exams, in architecture this is usually not the case; summative marks tend to be awarded for final projects. Where architecture assessment activities could be revitalised is through exploring ways in which written assignments can serve a purpose beyond the immediate assessment activity and engage an audience beyond the marker. Little motivation can be found in writing an assignment solely for a marker, which then gets filed into an archive. One way students can engage an audience is through creating a Wikipedia page on a relevant previously-unreported component of architecture. Students could then follow it, and defend it through the review process. Another way is through drawing students' attention to research exhibition opportunities. The British Council for Undergraduate Research – paralleling similar national organisations in other countries – has been set up to give opportunities for students to showcase final-year research projects to a national community. A related Posters in Parliament event, allows a select number of students to present their research in a prestigious setting to Members of the UK Parliament. Even arranging a local undergraduate research conference (Healey and Jenkins, 2016) would allow students to think of their research as serving a purpose beyond the assessment activity. This would help strengthen a research community, and it would help students learn valuable presentation and research synthesising skills.

Fourth year anthropology students at McMaster University, Canada, work together to produce an edited book collection. The teacher sets the overall theme for the cohort, each student produces a chapter, and together they collectively learn about book proposals,

editing and production (Healey and Jenkins, 2016). The move to open-access and digital publishing may mean getting student work published could be even easier. To improve on this model, a course leader could assign the book topic in the first year, with three successive cohorts adding to the book. This would allow an internal selection process of the best chapters. A digital webspace or internal newspaper production, could allow full and more immediate publication.

Architecture students at UCL have a long history of producing assessments for an audience. In 2014 a group of second year students were given a brief to create an exhibition on a well-known and important architectural figure that once taught at the school, Reyner Banham. Throughout the term, students conducted research and designed a small exhibition which was mounted in the school's architectural library. Through uncovering local history, students were able to learn through research and enquiry and to produce an assessment activity that was outward facing and engaged a wide audience. Similarly, in 2015 a design studio group of students at UCL produced short films which were exhibited at one of London's Curzon Cinemas. The activity asked students to step out of the comfort of their familiar studio and to deploy their work in a public arena. In attendance were a number of invited guests, including filmmakers, artists, designers and architects, teachers, parents and friends. All guests were asked to both rank the films out of five stars and to offer a few words, which students were then able to put on their film posters. Students found the assessment activity quite entertaining and were proud to showcase their work to an audience.

DIMENSION 6: STUDENTS CONNECT WITH EACH OTHER, ACROSS PHASES AND WITH ALUMNI

The nature of the architectural crit, if it is open and welcoming of others, and the final year show, are two ways in which architecture students have opportunities to connect with each other. The challenge of connecting with alumni can be also overcome to some extent if architecture schools are active in encouraging graduates to return for these events. While there is likely room for improvement in many ways along these lines in architectural programmes, the "Making Cities" course at UCL, discussed above, which puts students in interdisciplinary teams is a structured example of encouraging students to connect across disciplines. In fact, understanding professional relationships in the built environment is one of its aims. As a first year first term course, students have the opportunity to understand how three professional disciplines contribute to the makeup of the built environment, and also to learn the challenges, rewards, and necessity of connecting across disciplinary boundaries (see also Edwards, Campkin and Arbaci, 2009).

Also at UCL, postgraduate students in the Development Planning Unit work closely with several sites in the global south. Each programme has a particular site and set of partners / community groups that they work with over three to five years. Students investigate the site, producing a policy brief detailing what could be done to ameliorate a problem. While the nature of the 12-month course, which includes just a short field trip to the site, is compressed, students connect with successive cohorts who in turn visit the site and monitor progress for continuity. What originally may have been a challenge, means that students are able to learn how to bring a project to a milestone in order to pass it on to others, while connecting with future generations that they do not even meet. This approach has also been taken in undergraduate courses in Science at UCL (Chang, 2007; Healey and Jenkins, 2016). Finding more innovative, structured, and serendipitous ways to allow students to connect with each other is an ongoing challenge.

CONCLUSION

This paper began by unpacking the UCL Connected Curriculum, an institutional response to research-based education, and its six dimensions of connectivity. It then went on to frame this in the context of tangible local, national and international curricula examples. In doing so it modestly aimed to inspire curricula enhancements in architecture and beyond. While architectural education has much to celebrate for its pedagogic innovation and its firmly established tradition of authentic learning in a community of practice, the principles of research-based education promises further enhancement. Designing architectural programmes that encourage curiosity, and that allow students to participate in research and enquiry in a community setting, will arguably enhance the student experience in a number of ways. Specifically, a Connected Curriculum in architectural education can: reduce unproductive hierarchies between student and teachers; foster a spirit of shared uncertainly in real problems; allow students to learn about and engage with a part of university esteem that often goes unnoticed; connect students across disciplines and years, as well as build links between students with alumni, employers and the community; and motivate students with assessments that both engage an external audience and are relevant to what one may do in an architectural career. Through realistic career-like problem-based learning, curricula should foster curiosity that speaks to the ways in which academic research is situated at the edge of knowledge. Through inculcating a spirit of community, establishing a department where students can engage in academic research, students will be able to participate in an authentic community of research practice. Finally, through valuable assessment activities, students will be able to contribute to the production of knowledge at their institution.

It is true that an institution-wide strategy of this size and duration may face its challenges and sceptics (UCL, 2015c), and that some students may be initially put off by its demands for collaboration and critical thinking, but as suggested above, the discipline of architectural education is already doing so much along these lines. Few will doubt that the Connected Curriculum's flexible dimensions of good research-based education will lead to a rewarding experience for all, and ultimately valued architectural graduates.

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Architecture and engineering: interdiscilplinary education

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ABSTRACT

The exact territory of architects and engineers has long been contested, ever since the separate professions emerged out of the industrial revolution. During that era the need for specialist exploration and regulation of the application of scientific knowledge, was fulfilled by the creation of the engineering profession. Engineers' certainty in describing their roles in designing our built-environment is founded on the seemingly unquestionable necessity of their involvement, to ensure safe and economic designs, through the application of evidence-based research methods. Their design methodology can be seen to be fulfilling their role and evaluating their contribution simultaneously. This contrasts against the intellectual interrogation of different design methods throughout the history of the architectural profession and the challenge faced in demonstrating the value of architectural design.

The expectation of the current architectural and engineering education systems might be that, through their accreditation by the respective professional bodies, they reflect and reinforce professional boundaries. However across all disciplines there is now an increasing requirement for different disciplines to work together on big challenges. Reflecting on such collaborations in all disciplines, recent published work questions whether interdisciplinary research bridges, dissolves or further deepens divisions. Using theories of interdisciplinary research and education this paper compares the accreditation criteria of both the architectural and engineering professional bodies and collates data on interdisciplinary programmes to analyse the division between the two education systems.

THE CASE FOR INTERDISCIPLINARITY

The word interdisciplinary has become a very commonly heard term across teaching, learning and research in Higher Education and it has acquired a multitude of definitions as well as its own research field. Proliferation of this term could perhaps be cynically attributed to the governmental identification of bridging disciplines as an attractive activity in education (The National Committee of Inquiry into Higher Education, 1997) and to maintaining cutting edge research in the UK (HM Treasury, 2004). Specific funding streams have been identified in UK Research Councils for interdisciplinary research with the latest thinking to have separate interdisciplinary review panels and even to directly allocate funds by top-slicing the UK Research Council budget (Nurse, 2015). However the pressing nature of present-day world challenges such as climate change, water shortage and food security genuinely seem to demand the bringing together of skills and knowledge from across established disciplines. As technical issues that are associated with

building design increase so too has the need to understand how they can be effectively applied to take account of human factors.

There have been many recent calls for both engineers and architects to develop a deeper understanding of each other's disciplines, such as in the report written for the Ove Arup Foundation on interdisciplinary education: "*With the future of construction activities heading towards total solutions and large and varied projects, the need for interdisciplinary skills is likely to increase. Universities and industry should not fear this change, The findings suggest interdisciplinarity can be a strength not a weakness in the education system*" (Gann and Salter, 1999). Gann and Salter (1999) are however careful to note that for engineering the inclusion of interdisciplinary skills in education should not be at the expense of high quality technical education.

Doug King's report *The Case for Centres of Excellence in Sustainable Building Design* (King, 2012), written for the Royal Academy of Engineering, sets out to quantify the number of interdisciplinary professionals required to implement government initiatives to tackle climate change. He uses this data to make the case for Centres that promote interdisciplinary education in the UK: "*The primary aim of the proposed centres of excellence is to enhance the education of building designers, within a multidisciplinary environment, so that they are equipped to deliver the low carbon buildings using the most economic and advantageous techniques.*" (King, 2012).

The report The Future for Architects (Building Futures, 2010), written with the support of the Royal Institute of British Architects (RIBA), records the recognition by students from both professions of the contribution that architects make to the design process but also the opinion of engineering students that architects may need more technical skills to compete in the construction industry: "*Both the engineering students and the architects agreed that the architecture profession brought a 'social science' aspect to the building process that engineers often lacked. However, the engineering students believed the engineers of the future would be leading the production of buildings, unless architects became more skilled in engineering.*" It is interesting that in the same report architecture students also felt restricted by the title **architect** and wished to have more diverse options on graduating (Building Futures, 2010).

Pathways and gateways: the structure and regulation of architectural education (The UK Architectural Education Review Group, 2013), a report sponsored by the Standing Conference of Heads of Schools of Architecture, recognised similar issues. It recognises an increase in the role of the engineer and interestingly that that is coupled with a move away from design-led practice: "*The last five years have seen the unprecedented growth of integrated consultancies whose appetite to swallow up smaller firms seems to know no bounds. These practices are spread globally and employ interdisciplinary staff. This type of practice marks a fundamental shift in the profession away from design-led practice towards a process-driven consultancy often led by engineers.*" (The UK Architectural Education Review Group, 2013). Addressing these concerns the Farrell report (Farrell, 2014), whose expert panel included architects and urban designers, suggests that a common foundation year for all students of the built environment is needed and the report supports the view expressed in *Pathways and gateways: the structure and regulation of architectural education* that more fluidity should be allowed between the study of all professions in the built-environment.

Two approaches to interdisciplinary education could be identified from these sources. The first aims to broaden architecture or engineering education whilst maintaining the core knowledge and skills needed for each profession and the second possibility is where a new profession is created by bringing together knowledge and skills from both the existing professions.

THE DISCIPLINES

In order to define the term "interdisciplinary", researchers have often found it to be necessary to define the term "discipline" first. A huge number of definitions are offered which can be broadly categorised as containing both or either of the following aspects (Barry et al., 2008; Klein, 1990; Nissani, 1997; Boisot, 1972):

1. An academic field of knowledge that has particular methods and common assumptions or axioms.
2. The social and cultural structures that represent and perpetuate the definition of a discipline such as the teaching and assessment of the discipline and the existence of representative University departments.

The evidence for the existence of social structures that define both architecture and engineering as disciplines is carefully set-out in *Architect and Engineer: A Study in Sibling Rivalry* (Saint, 2007). This book documents the professions' divergence from the role of the master builder, with engineering pursing the new possibilities that the application of scientific methods offered the industrial revolution. Saint (2007) also reflects on the setting up of distinct education systems and another key social construct, professional bodies, whose existence helps regulate, represent and support those joining the professions through offering chartership as well as contributing to the validation of education providers.

The Institution of Civil Engineers (ICE) was founded in 1818. It was the first professional body in the world that represented and brought together professional engineers (ICE, no date). Later on in the nineteenth century a number of other professional bodies emerged to represent the increasing engineering specialisms, including the Institution of Mechanical Engineering and the Institution of Electrical Engineering. In order to determine the requirements and standards to achieve chartership in any engineering specialism a body now known as the Engineering Council (EC) was created in 1964. The EC also works internationally to ensure the recognition of UK engineering chartership in the global market (Chapman and Levy, 2004).

In 1977 the Joint Board of Moderators (JBM) was set up as a validation body, by several professional bodies including The Institution of Civil Engineers and The Institution of Structural Engineers, to assess degree programmes to determine their achievement of EC standards (JBM, no date). There are other professional bodies that validate programmes according to the EC standards such as the Chartered Institution of Building Services Engineering (CIBSE).

The professional bodies associated with architecture are fewer. The Architects Registration Board (ARB) is essentially the equivalent of the EC since it establishes the professional standards required for chartership and ensures that they fulfil the European Commission's requirements. The RIBA was founded, much earlier than any of the engineering professional bodies, in 1837, and both represents the architectural profession and validates programmes to the ARB standards. The RIBA is therefore equivalent to CIBSE in the way CIBSE represents building services engineers and validates programmes to EC standards. However the RIBA

EU Directive 2005/36/EC and RIBA (2010) Criteria.		EC (2013) Requirements (references Table 2)	JBM (2009) Requirements	CIBSE (2015a) Requirements
GC1.1-3	**Ability to create architectural designs that satisfy both aesthetic and technical requirements.**	**GC1.**2-3 addressed in C1, C2, C7 and C8.	**GC1.**1-3 addressed in Annex B.	**GC1.**1-3 addressed in Appendix C.
GC2.1-3	**Adequate knowledge of the histories and theories of architecture and the related arts, technologies and human sciences.**	**GC2.**1-2 relates in part to A1.	**GC2.**1-3 addressed in Annex B.	**GC2.**1-3 addressed in Appendix C.
GC3.1-3	**Knowledge of the fine arts as an influence on the quality of architectural design.**		**GC3.**1-3 addressed in Annex B.	**GC3.**1-3 addressed in Appendix C.
GC4.1-3	**Adequate knowledge of urban design, planning and the skills involved in the planning process.**		**GC4.**3 addressed in Annex B.	Only **GC4.**3 addressed in Appendix C.
GC5.1-3	**Understanding of the relationship between people and buildings, and between buildings and their environment, and the need to relate buildings and the spaces between them to human needs and scale.**	**GC5.**1-2 addressed in C1 and C2.	**GC5.**1 addressed in Annex B. **GC5.**2&3 addressed in Annex C.	**GC5.**1 addressed in Appendix C. **GC5.**2&3 addressed in Annex D.
GC6. 1-3	**Understanding of the profession of architecture and the role of the architect in society, in particular in preparing briefs that take account of social factors.**	**GC6.**1-3 addressed in A3, A6, D1, D2 and E11.	**GC6.**1&3 only addressed in Annex B and F.	**GC6.**1&3 only addressed in Annex C and G.
GC7. 1-3	**Understanding of the methods of investigation and preparation of the brief for a design project.**		**GC7.**1-3 addressed in Annex B.	**GC7.**1-3 addressed in Appendix C.
GC8. 1-3	**Understanding of the structural design, constructional and engineering problems associated with building design.**		**GC8.**1-3 addressed in Annex B.	**GC8.**1-3 addressed in Appendix C.
GC9.1-3	**Adequate knowledge of physical problems and technologies and the function of buildings so as to provide them with internal conditions of comfort and protection against the climate.**		**GC9.**1-3 addressed in Annex C.	**GC9.1-3** addressed in Appendix D.
GC10.1-3	**The necessary design skills to meet building users' requirements within the constraints imposed by cost factors and building regulations.**	**GC10.**1-3 addressed in C1, C2, C5, D2 and D6	**GC10.**1&3 only addressed in Annex B.	**GC10.**1&3 only addressed in Appendix C.
GC11.1-3	**Adequate knowledge of the industries, organisations, regulations and procedures involved in translating design concepts into buildings and integrating plans into overall planning.**	**GC11.**1-2 addressed in A3, D3, D5, D6, E5, E6, E7, E9 and E11.	**GC7.**1 addressed in part in Annex D. **GC7.**2 addressed in part in Annex F.	**GC7.**1 addressed in Appendix E. **GC7.2** addressed in part in Appendix G.

Table 1: Mapping the EC (2013), JBM (2009) and CIBSE (2015a) requirements to the EU Directive 2005/36/EC (EC, 2005) and RIBA (2010) general criteria.

▲ Table 1

is the sole acting architectural validation body in the UK.

Through these structures industry should be able to work with academia in determining how and what emerging architects and engineers are taught and therefore form a feedback loop between what is taught in Universities and the current skills and knowledge required by each profession. The potential for the domain of a discipline to evolve is commented on by Squires (1992) who offers a definition of the term discipline which includes the need for disciplines to critically self-regulate through "reflexive analysis".

Addis (1990) collates the comments of prominent engineers, from Pier Nervi in 1951 to Peter Dunican in 1981, who consistently observed the gap between the theoretical knowledge taught and the practical understanding required by the industry. Addis (1990) comments that: "*The idea is thus encouraged that a structure has a single, unique model and, conversely, that a given model has a single and unique counterpart in the real world. Seldom is any mention made of the possibility of there being alternative models and that criteria are needed by which the alternatives can be judged and evaluated*".

It is clear that Addis is somewhat critical of academia as a preserver and generator of scientific theories and he observes a shortfall in critical reflection being exercised in understanding the assumptions and limits in the application of such scientific theories to the real world. This is reinforced by Addis' definition of the titles, engineering scientist and engineering designer (Addis, 1990). Such a dislocation between academia and

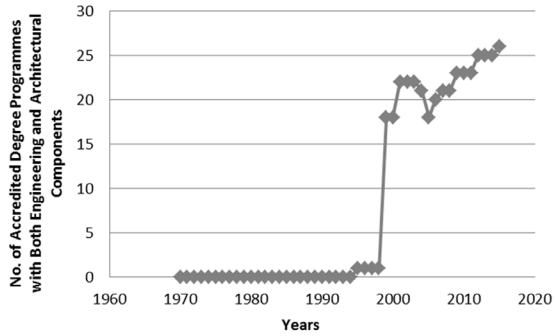


Figure 1: Total number of degree programmes that are accredited either by CIBSE (2015b) or JBM (2015) or both and which contain both engineering and architectural components.

▲ Figure 1

The Engineering Council's academic requirements for Integrated MEng Courses	
A.1-6 Science and mathematics	**1.** A comprehensive knowledge and understanding of scientific principles and methodology necessary to underpin their education in their engineering discipline, and an understanding and know-how of the scientific principles of related disciplines, to enable appreciation of the scientific and engineering context, and to support their understanding of relevant historical, current and future developments and technologies. **2.** Knowledge and understanding of mathematical and statistical methods necessary to underpin their education in the engineering discipline and to enable them to apply mathematical and statistical methods, tools and notation proficiently in the analysis and solution of engineering problems. **3.** Ability to apply and integrate knowledge and understanding of other engineering disciplines to support study of their own engineering discipline and the ability to evaluate them critically and to apply them effectively. **4.** Awareness of developing technologies related to own specialisation. **5.** A comprehensive knowledge and understanding of mathematical and computational models relevant to the engineering discipline, and an appreciation of their limitations. **6.** Understanding of concepts from a range of areas, including some outside engineering, and the ability to evaluate them critically and to apply them effectively in engineering projects.
B.1-6 Engineering analysis	**1.** Understanding of engineering principles and the ability to apply them to undertake critical analysis of key engineering processes. **2.** Ability to identify, classify and describe the performance of systems and components through the use of analytical methods and modelling techniques. **3.** Ability to apply quantitative and computational methods, using alternative approaches and understanding their limitations, in order to solve engineering problems and to implement appropriate action. **4.** Understanding of, and the ability to apply, an integrated or systems approach to solving complex engineering problems. **5.** Ability to use fundamental knowledge to investigate new and emerging technologies. **6.** Ability to extract and evaluate pertinent data and to apply engineering analysis techniques in the solution of unfamiliar problems.
C.1-8 Design	**1.** Understand and evaluate business, customer and user needs, including considerations such as the wider engineering context, public perception and aesthetics. **2.** Investigate and define the problem, identifying any constraints including environmental and sustainability limitations; ethical, health, safety, security and risk issues; intellectual property; codes of practice and standards. **3.** Work with information that may be incomplete or uncertain, quantify the effect of this on the design and, where appropriate, use theory or experimental research to mitigate deficiencies. **4.** Apply advanced problem-solving skills, technical knowledge and understanding to establish rigorous and creative solutions that are fit for purpose for all aspects of the problem including production, operation, maintenance and disposal. **5.** Plan and manage the design process, including cost drivers, and evaluate outcomes. **6.** Communicate their work to technical and non-technical audiences. **7.** Demonstrate wide knowledge and comprehensive understanding of design processes and methodologies and the ability to apply and adapt them in unfamiliar situations. **8.** Demonstrate the ability to generate an innovative design for products, systems, components or processes to fulfil new needs.
D. 1-7 Economic, legal, social, ethical and environmental context	**1.** Understanding of the need for a high level of professional and ethical conduct in engineering, a knowledge of professional codes of conduct and how ethical dilemmas can arise. **2.** Knowledge and understanding of the commercial, economic and social context of engineering processes. **3.** Knowledge and understanding of management techniques, including project and change management, that may be used to achieve engineering objectives, their limitations and how they may be applied appropriately. **4.** Understanding of the requirement for engineering activities to promote sustainable development and ability to apply quantitative techniques where appropriate. **5.** Awareness of relevant legal requirements governing engineering activities, including personnel, health & safety, contracts, intellectual property rights, product safety and liability issues, and an awareness that these may differ internationally. **6.** Knowledge and understanding of risk issues, including health & safety, environmental and commercial risk, risk assessment and risk management techniques and an ability to evaluate commercial risk **7.** Understanding of the key drivers for business success, including innovation, calculated commercial risks and customer satisfaction.
E. 1-11 Engineering practice	**1.** Understanding of contexts in which engineering knowledge can be applied (e.g. operations and management, application and development of technology, etc.). **2.** Knowledge of characteristics of particular equipment, processes, or products, with extensive knowledge and understanding of a wide range of engineering materials and components;. **3.** Ability to apply relevant practical and laboratory skills. **4.** Understanding of the use of technical literature and other information sources. **5.** Knowledge of relevant legal and contractual issues. **6.** Understanding of appropriate codes of practice and industry standards. **7.** Awareness of quality issues and their application to continuous improvement. **8.** Ability to work with technical uncertainty. **9.** A thorough understanding of current practice and its limitations, and some appreciation of likely new developments. **10.** Ability to apply engineering techniques taking account of a range of commercial and industrial constraints. **11.** Understanding of different roles within an engineering team and the ability to exercise initiative and personal responsibility, which may be as a team member or leader.
F. 1-4 Additional general skills	**1.** Apply their skills in problem solving, communication, working with others, information retrieval, and the effective use of general IT facilities. **2.** Plan self-learning and improve performance, as the foundation for lifelong learning/CPD. **3.** Monitor and adjust a personal programme of work on an on-going basis. **4.** Exercise initiative and personal responsibility, which may be as a team member or leader.

Table 2: The EC (2013) academic requirements for an integrated MEng Course.

▲ Table 2

the profession is not just observed in engineering but is also a source of concern for architecture, as discussed in detail in the RIBA's Skills Survey Report (2014a).

The eleven general criteria required by the European Commission to become a chartered architect are set out in the EU Directive 2005/36/EC (EC, 2005). Each of these general criteria are adopted and developed into 3 sub-criteria to form the RIBA (2010) criteria (see Table 1) which are required to be addressed at both Part 1 (undergraduate degree level) and Part 2 (masters level). The general criteria range from a historical knowledge of different subjects, to knowledge of the fine arts as well as technical principles. Many of the subjects addressed have their own claims to be a discipline.

Groat and Wang (2013), writing in the context of architectural research methodologies comment: "*Research into architectural realities is necessarily an interdisciplinary matter.*" and go on to outline the wide variety of methodologies available noting their origins in science, social science and humanities. The lack of an established subject specific methodology in the study of architecture facilitates a critical reflection on the choice of methodologies appropriated for a particular research question. However this mode of operating opens out architecture to criticism due to a lack of coherent evidence to support design decisions and fragmented research fields. These difficulties are acknowledged in the recent RIBA report *Delivering Construction 2025 RIBA Action Plan* (2014b) alongside a call for more collaboration between practice and academia to enable the lessons learnt to be built on and there to be a stronger culture of evidence-based practice. Squires (1942) comments on the difficulty of defining geography as a discipline which has certain resonances with architecture: "*… the breadth of the subject is enormous and the central core of theory holding it together is minimal*". This suggests that architecture as an education system as well as a profession might not fulfil all researchers' definitions of a discipline.

The Engineering Council (EC) criteria (EC, 2013) require a strong basis in science and mathematics (see Table 2 **A1-2** and **B1**). In this way a common language and methodology across all engineering programmes is assured and not just in those that are accredited by the JBM and CIBSE. This criterion is translated by CIBSE and the JBM into guidelines that ask for at least one third of the total curriculum to be spent on core technical subjects and that mathematics and its application is to be studied for at least 2 years of the degree programme. The EC criteria also ensures that the predominant design methodology is evidence based and quantitative (see Table 2 **B1-6**), so that every design calculation offers a quantification of the value of the engineers' contribution to the process.

Despite the traditional academic aspects of engineering exhibiting a strong link to scientific methodology through a core syllabus Squires (1992) in fact defines the separate subjects of architecture and engineering as potentially already interdisciplinary subjects themselves. This is supported by the attempt by Gann and Salter (1999) to quantify the *interdisciplinarity* in all built-environment programmes, including civil engineering and architecture, by analysing the programme components. The data collected perhaps surprisingly suggests that civil engineering programmes have the largest amount of interdisciplinary content. This is qualified by the comment that as architecture is itself interdisciplinary the analysis as to what is a different discipline to architecture could be misleading.

INTERDISCIPLINARY EDUCATION

Karlqvist (1999) literally defines the term *interdiscipline* as "*between disciplines*" and

	Interdisciplinary gaps	Modes of interdisciplinary research
1.	Doing the same thing in different ways.	Finding two things are different manifestations of the same underlying structure.
2.	Doing different things that can be combined.	Different scientific experts contribute to an overall or composite picture using their own theories and method.
3.	Doing different things that cannot be combined without an additional framework .	A new theoretical framework is required.
4.	Doing things differently.	Basic underlying assumptions and the paradigmatic bases for theories are different.
5.	Thinking differently.	Fundamental interpretative and conceptual differences.

Table 3: Interdisciplinary research (Karlqvist, 1999).

▲ Table 3

comments that it directly identifies a gap between disciplines that neither's methods can address in order to generate new knowledge. Karlqvist's identification of different types of gaps between disciplines are summarised in Table 3 and are linked to five possibilities for interdisciplinary research.

Given the desire in both professions for more interdisciplinary skills in graduates it is to be expected that the criteria required for degree programmes validated by engineering professional bodies will have some overlaps with the criteria required for validation by the RIBA. The extent of the overlap and the nature of the gaps between the subjects is much harder to define. Knowledge of fields such as building regulations, construction law as well as economics, health and safety and awareness of the roles of other construction professions could be seen as much needed common territory and are addressed in both criteria (see Table 1 **GC6**, **GC10** and **GC11**). Whether there are significant differences in the methods used to teaching these subjects it is not clear. Here perhaps the gap between the subjects could be described using Karlqvist's suggested assessment, as set out in Table 1, as being only mode 1 or, if the mode of teaching could be demonstrated to be similar, as having no gap at all.

Engineering education has traditionally required intense knowledge transfer to help students understand the mathematical models used to predict material, structural and environmental behaviour as set out in the JBM (2009) and CIBSE (2015a) accreditation criteria. The RIBA (2010) criteria in particular **GC8** and **GC9** (see Table 1) also require an understanding of structural, acoustic, lighting and thermal performance principles, although in the sub-criteria emphasis is also placed on understanding systems and strategies to integrate these principles in design. Based on the accreditation criteria it is relevantly easy to make the case that there is an overlap with respect to the technical principles taught but if the teaching methods used are inherently different, the actual learning outcomes might show a larger divide than the accreditation criteria suggest.

The criticisms of engineering education from Addis (1990) are not alone. Brohn and Cowan (1977), focusing on structural engineering education, note that: *"The qualitative analysis of structures is an important topic in a structural engineering curriculum. Neglect of this section of the syllabus will entail the production of graduates whose 'understanding' of structural behaviour is unacceptably weak, when assessed by standards which are generally accepted in the profession."* Brohn and Cowan (1977) also note that qualitative analysis is unlikely to be learnt through quantitative methods. Such critical appraisals have had an impact on the teaching of mathematics, refocusing the requirements to teach the subject to support engineering analysis rather than for the pure academic merit of studying it (Table 2 Criteria **A.1-2**). This shift is also reflected in the significant focus of the

Engineering Council (EC) criteria on design (Table 2 Criteria **C.1-6**) as well as traditional analysis. Johnson and May (2008) suggest the need for more case studies and application of structural analysis in conceptual designs in engineering design education. All these modes of teaching technology are familiar to architectural educators and increasingly address the approaches implied in the RIBA (2010) criteria.

In recent years the JBM and CIBSE have therefore recognised that an academic understanding alone isn't sufficient to make sure engineering graduates can apply, and apply creatively and critically, the principles they are studying. The accreditation guidelines for design projects were introduced in 2009 as **Appendix C** in the CIBSE (2015a) requirements and **Annex B** in the JBM (2009) requirements. They both state that *"In engineering a central activity is design, and the interpretation and execution of design"*. Design is recognised not as a linear process but as a highly iterative one. Engineering design projects that once were closed ended problems which could be solved using taught knowledge, are now required to be open ended problems, with complex contexts, where the brief can be questioned and where students are asked to use research skills to determine an appropriate way forward. The importance placed on the design studio as a key supportive environment by JBM and CIBSE is also a notable parallel with architectural design studios. The current EC (2013) criteria **A.1** and **Appendix C** in the CIBSE (2015a) requirements and **Annex B** in the JBM (2009) require an understanding of the history of technology, which goes some way to achieving the RIBA (2010) criteria **GC2**. From this evidence the methods used in teaching design in engineering programmes are being encouraged to move closer to those used in architectural programmes. Again referring to Karlqvist (1999) this might suggest a classification of a mode 1 interdisciplinary gap. However it would still be very difficult indeed to argue on the basis of accreditation criteria that in reality there was no distinction between the two educational approaches to design.

An alternative analysis of the criteria could be that, despite the overlaps in content and an increasing convergence of suggested teaching methodologies, there still remains fundamental conceptual differences between engineering and architectural education. This would suggest that, with a mode 4 or 5 interdisciplinary gap, as described by Karlqvist (1999) in the context of research, there are large barriers to producing truly interdisciplinary outputs. Such an analysis might resonate with a perceived *"rivalry"* (Saint, 2007) between the professions but it would be very concerning as it would have a fundamental implication for engineers and architects being able to work together in practice to generate cohesive designs. It would also suggest that much more work needs to be done on the nature and outcomes of interdisciplinary education to overcome such differences.

Quite how the RIBA (2010) criteria and requirements of the JBM (2009) and CIBSE (2015a) relate is of course is highly debatable and potentially controversial. The increasing agreement on the focus on design and integrated application of technical knowledge as well as professional knowledge and skills result in some very closely related, if not similar required, knowledge and skills sets as set out in Table 1. There is a surprising degree of overlap which could well get larger as the pressure for architects to have more technical skills (Building Futures, 2010) as well as develop evidence-based design methods increases (RIBA, 2014b).

If the suggestion that there is a fundamental conceptual difference between the subjects is discounted, such an overlap supports the assertion that perhaps both architecture and engineering degrees are already inherently interdisciplinary. It also suggests, that given the potential existing overlap, what might be termed interdisciplinary degree programmes,

that bring together components nominally identified as engineering and architectural, are increasingly possible without reducing the integrity of either subject and in doing so be able to be recognised by both the RIBA and the JBM or CIBSE.

There is however currently no agreement between professional bodies that an accredited engineering programme would be recognised as fulfilling any part of the RIBA (2010) criteria for chartership (and vice versa). There are however instances where components which form part of an accredited architecture programme are also taken by engineering students as part of an accredited engineering programme.

INTERDISCIPLINARY PROGRAMMES

There are currently 48 Universities which run RIBA accredited architecture programmes and there are 18 Universities who run one or more programmes that, according to their UCAS descriptions, offer a mixture of engineering and architectural components. The number of such programmes is steadily increasing over time (see Figure 1) according to the lists of accredited programmes held by CIBSE (2015b) and the JBM (2015).

These interdisciplinary programmes vary considerably in what they offer. The architectural components range from being 25% to 70% of the assessed programme content (depending on how the architectural content is defined). The architectural components selected can focus only on architectural design projects or focus only on topics such as humanities and technology lectures or a mixture of both. The logistics of teaching these components can be different, from being taught by a local architecture department alongside students studying an accredited architecture degree to being taught as components run solely for the interdisciplinary programme. This can involve being taught by tutors directly employed by engineering departments. The engineering components chosen can also vary their focus from building physics to structural and civil engineering, but are predominantly taught in engineering departments.

All these interdisciplinary programmes are either accredited by the JBM or CIBSE. The majority of these programmes are currently unrecognised and unregulated by the architectural professional bodies (ARB and the RIBA), except in three cases; the BEng in Architecture and Environmental Engineering at the University of the West of England (accredited by CIBSE and RIBA), the MEng in Structural Engineering and Architecture at the University of Sheffield (accredited by both the JBM and RIBA) and the MEng in Architecture and Environmental Design, University of Nottingham (accredited by CIBSE and RIBA) (RIBA, 2015).

It is difficult for students to move at any point from studying engineering to studying architecture and gain professional recognition. It is not as difficult in terms of professional recognition to move from studying architecture to engineering due to the ICE's Academic Assessment route which allows those holding qualifications unaccredited by the JBM or CIBSE to be assessed and where appropriate they are counted towards achieving engineering chartership.

It is currently extremely hard for interdisciplinary architecture and engineering programmes to gain and maintain architectural accreditation because:

1. The EU Directive 2005/36/EC (EC, 2005), enforced by ARB requires an accredited award to be principally in architecture. Principally is noted by the UK Architectural Education Review Group (2013) to be interpreted to mean 80% of its content. The

extent to which architecture may be defined as overlapping with other subjects may offer some room for interpretation.

2. The RIBA (2010) require *"50% of credits"* to be assessed via *"design studio projects"* at RIBA Part 1 (undergraduate degree) and Part 2 (masters) levels. For interdisciplinary programmes it is hard to achieve this requirement as well as achieving at both Part 1 and Part 2 levels all the specific RIBA validation criteria (which generally requires additional taught components to the design projects) and the requirements of JBM (2009) or CIBSE (2015a).
3. The RIBA's (2010) required sequential completion of RIBA Parts 1 and 2 to achieve chartered status.

It also seems impossible for graduates from programmes which are not recognised by the ARB and the RIBA to achieve chartered status. This was once possible via the ARB prescribed examinations route as exemplified by the University of Newcastle's Architectural Engineering MEng programme where students developed design portfolios and if they wished, they submitted them to the prescribed examination to be assessed for RIBA Part 1. This route seems to have disappeared with the ARB requirement for the prescribed exam seemingly requiring an academic qualification where architectural design projects form at least 50% of the assessed work.

The current architectural education system therefore cannot recognise potentially relevant knowledge and skills from nominally different subjects as easily as the engineering system seems to. Degree programmes that are nominally interdisciplinary are also being accredited and therefore defined, in the majority, by engineering bodies. This leaves engineering with significant control over the interdisciplinary domain between architecture and engineering, rather than it being an equal partnership.

CONCLUSIONS

Due to the increasing importance of developing interdisciplinary built-environment professionals there is a clear need for both architecture and engineering professional bodies to discuss and reflect on the apparent overlaps between the academic criteria required for chartership in either profession. It is clear that the engineering professional bodies do recognise the need for a more diverse set of professional skills than just mathematical and scientific knowledge and have adopted a much larger emphasis on design projects and professional skills, paving the way for them to lead construction projects. This, and the increase in the number of degrees that nominally offer components in both architecture and engineering, which are principally validated by engineering bodies, could be viewed as a threat to architecture both as a field of study and as a profession.

It is however very unlikely that, given the increasing complexity of designing our built-environment, the industry will return to having one profession that undertakes all design activities. There is a wealth of knowledge that architectural education has built up in supporting the development of highly creative designers, dealing with unquantifiable problems and critically selecting appropriate methodologies in research and design, which is greatly needed in industry. The architectural and engineering professional bodies need to work together in recognising the commonalties and specialisms of two education systems. They need to respect and use each other's expertise to support and regulate education standards to ensure production of the high quality interdisciplinary professionals the industry needs.

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A combined approach to engineering and architectural education

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ABSTRACT

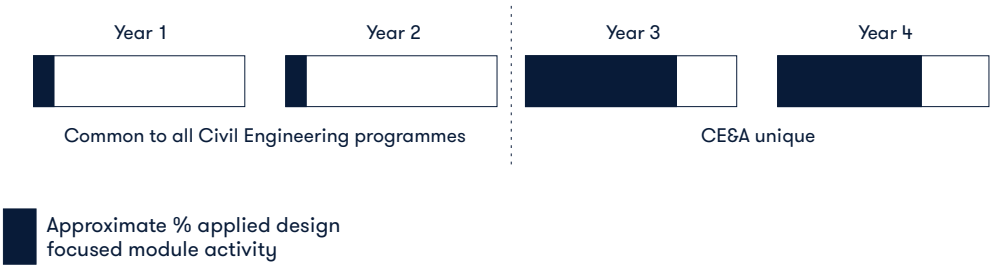
The majority of students starting an engineering degree in the UK have studied mathematics and one or more of the science subjects with their knowledge assessed through closed book examination. They have little or no experience in applying the subject material to a project brief and, it is this application, mixed with many other considerations, that translates the understanding of science into engineering. Engineering and architecture are both design disciplines so why do we teach them so differently?

Our four year integrated Masters programme in Civil Engineering and Architecture is aimed at those who wish to design structures; the core elements of the programme being Structure, Material and Place. This programme shares its first two years with our other civil engineering programmes. It was apparent that our design curriculum (across all civil engineering programmes) specified many of the expected key design skills but that it was not producing graduates who were agile design thinkers. During the last three academic years, strategic investments have been made to improve our design curriculum, encourage design thinking within our students (and staff) and to foster a greater design culture within the Faculty. This paper will describe the rationale for the development of the curriculum and some of the issues encountered in its implementation with reference to recent student outputs.

INTRODUCTION

The Faculty of Engineering and the Environment supports a wide range of engineering programmes offered at undergraduate level from civil, mechanical, aero and astronautics and ship science to acoustical, environmental science and audiology. Research is focussed on groups that comprise the sub-disciplines commonly associated with these programmes. The Faculty is recognised internationally for its research across all the subjects and, was assessed under General Engineering (Unit of Assessment 15) in the 2014 Research Evaluation Framework (REF). As a research intensive Faculty, all 193 eligible academic staff were submitted and results from the REF confirmed the Faculty's research as being the most powerful in General Engineering in the UK. Power is defined as the assessed quality and impact multiplied by the number of academic staff submitted. Additionally, the Faculty provided the most powerful submission to the REF from any single institution in the UK, in any engineering unit of assessment.

Many of the investments and curriculum developments described will not be viewed as innovative when compared to architectural or other design



▲ Figure 1 CE&A programme structure (Years 1 to 4)

focused educational programmes. However, a significant shift in emphasis in the mapping of primary educational objectives at undergraduate level towards integrated design and redirecting engineering laboratory areas away from research use only is highly significant, particularly in the context of the attitudes and behaviours associated with a research focussed community. The changes were necessary to meet the strategic goal of providing world class education in a research led environment in which new knowledge is being created. Careful planning and management of resources was needed to achieve this goal within existing and available infrastructure and resource restraints and they are now providing tangible improvements and outputs that are novel to civil engineering education.

This paper focuses primarily on the development of the MEng Civil Engineering and Architecture undergraduate degree, Faculty of Engineering and the Environment, University of Southampton, the specific investments made during the past three academic years and their relationship and influence on our core MEng Civil Engineering programme. These are described through the illustration of recent projects produced by students enrolled on the programme.

PROGRAMME CONTEXT AND STRUCTURE

In 2009-10, the University reorganised into a new Faculty structure with eight Faculties from the previous structure of three "super-Faculties" and twenty or so Schools. The new Faculty of Engineering and the Environment was formed around the core engineering programmes and Schools of Engineering Science: aero and astronautics, mechanical engineering, ship science, The Institute of Sound and Vibration Research and Civil Engineering and Environmental Science. For administrative purposes, the faculty is divided into four similarly sized academic units of Civil, Maritime and Environmental Engineering and Sciences, Engineering Sciences, Aeronautical Astronautical and Computational Engineering, and The Institute of Sound and Vibration Research.

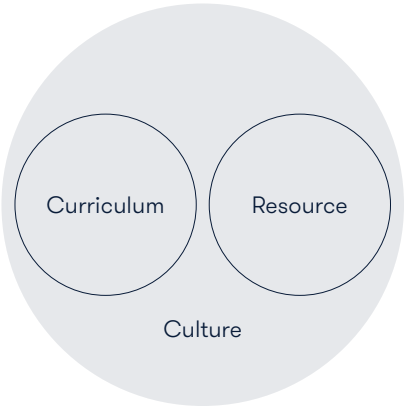
In 2012-13, taking advantage of the new Faculty structure and the synergies between disciplines that it opened up, the teaching of Year 1 was reorganised so as to create cross-Faculty modules delivered over the full academic year. Civil Engineering programmes participate in three of the new modules: FEEG1002 Mechanics, Structures and Materials, FEEG1003 Thermofluids and MATH1054 Mathematics for Engineers. The remainder of the Year 1 programme comprises an amended module CENV1023 Construction Design and Materials with a substantially increased materials science and design content, and a new module CENV1025 Civil and Environmental Engineering Fundamentals. The latter contains basic chemistry and geology for engineers, as before, but with the addition of computer programming, not previously covered in the first year.

Overall, the aim of these changes was to give students access to new skills in design and computing whilst not decreasing the content and intellectual challenge of their core engineering science activities. From 2012-13, requirements for progression were strengthened by making all modules in Year 1 Core subjects. Thus, the module pass mark of 40% must be achieved in all modules. (Previously this was only true for Mechanics, Structures, Geology for Engineers and Hydraulics modules). For all students entering the course from 2012-13 this limits the referrals that they may take on failure of a module to 30 credits in any one year (previously, there was no limit). The development of the Year 1 modules delivered across the full academic year removed the need for Semester 1 examinations and in their place an intensive two-week design workshop is undertaken that allows students to gain knowledge and skills in design by tackling a range of problems, culminating in a design project that runs through semester 2. Design communication through hand sketching, diagraming, technical drawing, modeling (physical and CAD) and prototyping is taught as an essential part of the design process as well as for final communication of output.

INCEPTION AND DEVELOPMENT OF THE CIVIL ENGINEERING AND ARCHITECTURE PROGRAMME

The Civil Engineering and Architecture programme was established in 2003 to be a headline programme within Civil Engineering and was targeted to attract high achieving students, particularly those who were design focused, or those who wished to have broad design skills. It was considered that the addition of architectural education content would broaden and enhance the core civil engineering education. There were initial discussions with Portsmouth University, School of Architecture to support the architectural aspects and their integration into the programme. This did not go forward, and a team of three/four visiting architects taught the architectural modules – no architects were permanent members of staff.

The programme is a four-year full time integrated Masters undergraduate Honours degree accredited by the Joint Board of Moderators (JBM). Students graduate with an MEng. This qualification offers the fastest recognised route to becoming a Chartered Engineer. Entry subjects are A-level Mathematics and an A-level in another science subject from Physics, Chemistry, Biology, Geography, Geology, Further Mathematics. The third A-level subject is flexible but it cannot be General Studies, Critical Thinking or Use of Mathematics. Current grade entry requirements are A*AA. Students typically have not previously carried out significant project based work. The programme was titled Civil Engineering with Architecture when first established. However, the programme evolved and was retitled Civil Engineering and Architecture with a substantial design component being common to the educational criteria specified by the JBM and ARB. During 2007 and 2011 a number of students successfully applied to the ARB for Part I accreditation through interview. As a result, in 2011 consideration was given to making an application to the ARB to formally accredit the programme. However, changes to the eligibility criteria resulted in applicants from the programme being barred from ARB Part 1 by interview because it could not be demonstrated that it had sufficient architectural education by virtue of its JBM accreditation. This resulted in a reflection on the future direction of the course. This coincided with the appointment of an architect as a full time Faculty member to oversee and strengthen design based education across the Faculty and estate and technical support investments to improve student design activities across the Faculty generally.



▲ **Figure 2** Investments in design

The three following key strategic decisions were made:

- The design curriculum within the Civil Engineering programme would be supported to the same extent as the Civil Engineering and Architecture (CE&A) programme – inheriting the momentum from the CE&A programme.
- The 'additional' CE&A modules within Years I and II would be removed so that the programmes had equal credit weighting – Years I and II would be the same for all Civil Engineering programmes.
- The CE&A programme would focus to a much greater extent on structural design.

THE BROADER FACULTY INVESTMENTS IN DESIGN

A number of strategic investments have been made by the Faculty to improve design teaching and reputation since 2011 to date and include:

- Appointment of new members of staff; Faculty Director of Design Education, Senior Experimental Officer (to lead on design for manufacture), Teaching Fellow to lead design development in mechanical sciences and three additional student facing technicians to run new studio/ workshops.
- Curriculum development with a significantly increased design and manufacture focus.
- The realisation of three 80 seat design studios and associated design workshops.
- Significant investment in an Engineering Design and Manufacture Centre (CNC machinery, additive manufacturing, laser and water cutters).
- The realisation of the Faculty Design Show (including establishing www.uosdesign.org, which acts as the Design Show catalogue and provides a future framework for communication student design activity) and the general increased focus/ communication of design activity across the Faculty.

Significant investments in resource and curriculum have realised tangible design impacts. However, the greatest impact has been the development of a design culture (Figure 2). Although much harder to define as it involves intangible elements such as pro-activeness, ambition, collective momentum and identity.

A decision was made to make all design activities project based. This addresses the key objective to strengthen the focus, structure and clarity of our design curriculum and to increase its meaning and rigour through the development of challenging outward looking project briefs that allow for unique solutions to be developed. These activities should encourage diversity and experimentation. A further critical development was to move assessment away from the individual numerical marking of multiple project components to the assessment of design as an integrated solution, fundamentally focused around core design attributes of innovation, process, communication and impact. The teaching impact objective provided a link to the REF Research Impact Statements.

To further support the design process, events such as interim project reviews using external practitioners, presentations and an end of year Faculty Design Show have all been implemented to fuel positive and competitive participation and increase our student's exposure to a wide range of audiences.

DESIGN MODULES

The following is a summary of the core design modules across the four years of the design curriculum:

Year 1
CENV1023 Construction, Design & Materials, provides a broad introduction to the 'design process'. A range of design skills including diagraming, hand sketching, modelling (physical and CAD) engineering drawing, manufacturing, as well as personal skills of observation, analysis, communication, and innovation are taught through their application within design and prototyping exercises. It is taught in parallel with adjacent introductory engineering science modules and specifically draws upon structural and material behaviours. Students are prepared for the *Constructionarium* (a residential field course www.constructionarium.co.uk) through completion of a series of tasks including construction method statements, temporary works design (formwork etc) and surveying and setting-out methods. The *Constructionarium* forms a core part of our civil engineering programme and an underpinning context to later modules on structural analysis and design, construction management and engineering economics.

Year 2
CENV2028 Design 2 provides students with the opportunity, working in groups between 4 and 5, to design a temporary structure for a site in the Southampton area. They are expected to utilise and further develop the skills and abilities introduced during Year 1. The module builds upon the critically reflective and competitive design environment initiated within Year 1 and offers the opportunity for a 'winning' design, as judged by a professional panel, to be developed further and built at full scale for the opening of the Faculty Design Show.

The completion of Part 2 marks the end of the common design threads that are shared across all civil engineering programmes. Part 3 and 4 of the Civil Engineering and Architecture programme is predominantly design project based (66%) delivered through both individual and group project work.

Year 3
CENV3062 Architecture 3 requires students to demonstrate a greater understanding of the design process, the application of relevant engineering skills and a maturity of judgment. Projects start at the conceptual stage but an emphasis is placed on detailed design,



▲ **Figure 3** Year 1 Prototype project installed on site



▲ **Figure 4** Year 1 Prototype project installed on site



▲ **Figure 5** Year 1 Prototype project. Full scale prototype installed on site



▲ **Figure 6** Year 1 Prototype project. Development models



▲ **Figure 7** Year 1 Prototype project. Student groups installing prototype structures for the Final Presentation



▲ **Figure 8** Year 1 Prototype project. Student groups presenting during the Final Presentation

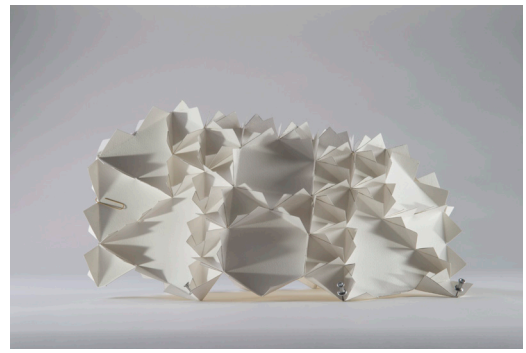
aimed at instilling the importance of refining initial design proposals and the application of specific engineering skills and analysis. CENV3062 Architecture 3 is a triple module (45 credits, rather than 15 credits) and therefore provides the required time for students to develop individual design directions and a resultant ownership of their work.

Year 4

CENV6159 Architectural Group Design Project is run over the first semester and requires students to develop and demonstrate a high degree of design ability within the context



▲ **Figure 9** Year 1 Prototype project. Full scale prototype installed on site



▲ **Figure 10** Year 2 Concept model; 'breathing' pavilion

of a brief with input from industry sponsors and/or university research. The combined experience and learning gained throughout the Year 1, 2 and 3 modules should be demonstrated. CENV6160 Architectural Engineering Project is a final semester individual design project providing students the opportunity to realise a design solution to a highly technical level that demonstrates the breadth and extent of their abilities.

The following project examples provide a selected overview of recent student project outputs that begin to demonstrate the impact of the recent investments in design.

This traversing structure (Figure 3) has been designed to span between a column and an adjacent wall. Intentionally sculptural in form, the structure uses the bending characteristics and the associated lateral forces generated by layered plywood struts to retain the structure between the existing built elements. Threaded steel bars connect the struts and allow for adjustment.

This lookout structure (Figure 4) was designed to sit on top of, and project from, the end of an existing brick wall. A sectional timber element made from Douglas Fir and perforated to reduce its weight, is held in place by a tensioned cord. The dimensions and geometry of the timber sections are informed by standard brick dimensions. A loose stack of engineering bricks counterbalances the cantilever of the timber through frictional forces greater than the tension forces in the cord and includes a factor of safety for the overall structural system.

This traversing structure (Figure 5) comprises three sections and has been designed to span between two handrails and to avoid obstructing the existing access route below. Two laminated flared MDF panels provide lateral stability, one rigidly connects to the handrail at a fixed angle, the other rests and pivots on the handrail requiring the central plywood section to bend under the weight of the panel; this results in the overall structural form.

These ascending structures (Figure 9) have been designed to slot into the vertical rebates in a wall and be capable of installation at differing heights. The structures act as levers to create friction forces between the structure and the internal sides of the wall rebates. Constructed from laminated laser cut MDF they are hollowed out internally and have concealed steel weights to create the required friction forces.

This structure (Figure 11 and 12) has been designed and built by a group of second year civil engineering students as part of their design curriculum. The project brief asked for the





▲ **Figure 11** Year 2 development models



▲ **Figure 12** Year 2 full size prototype construction

design of a unique temporary structure for a site adjacent to the medieval walls located towards the southern end of Southampton. The structure was to provide a focal point for visitors and act as a potential catalyst for cultural activities in the area. This structure fits around and masks the view of an unsightly existing footbridge whilst also acting as a celebratory gateway for pedestrians passing under and over the bridge.

The concept design considered a range of factors; the local site characteristics and its surrounding environment, the temporary nature of the structure, form, proportion and the user experience, differing material characteristics and construction process. The production of drawings and scale models and the use of calculation resolved the design through an iterative team working process. The detailed design was developed with support from a professional consultant team and further resolved the structural stability, member sizes, connection details and construction tolerances. The final structure was constructed with the assistance of a local contractor using locally sourced rough sawn Douglas Fir, proprietary galvanised fixings and an ultra-saturated water based red wood stain.



Figure 13 Year 3 CENV3062 Sectional development model

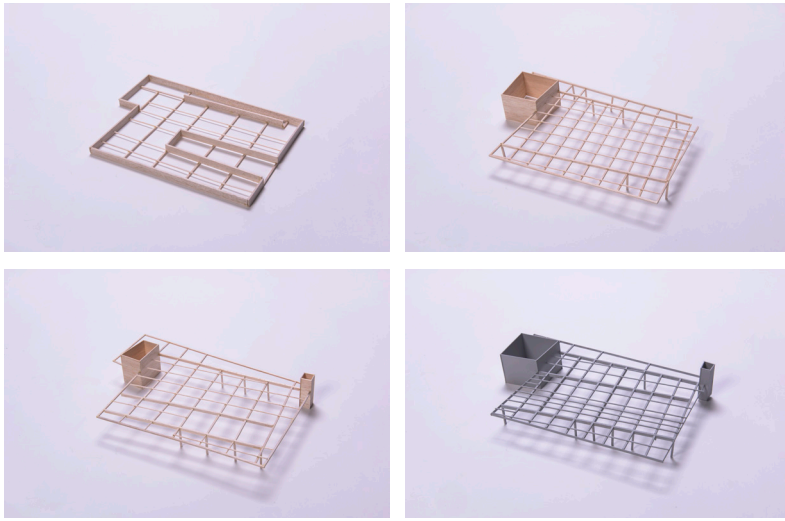


Figure 14 Year 3 CENV3062 development models showing primary steel frame

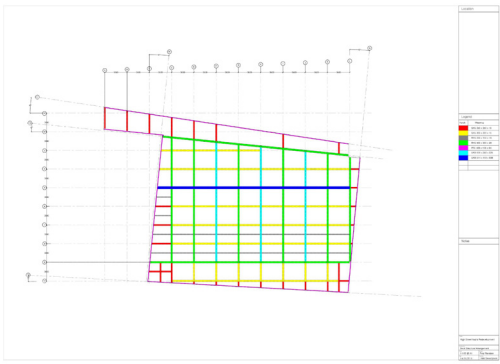
> *"Having the opportunity to work as a team and alongside professional consultants to develop our own unique design solution, and then to be involved in the full scale construction of our design has been a challenging and rewarding process. We are all very proud of our structure"*

Project student team: Aiden Brown; Part 2 MEng Civil Engineering and Architecture, Rosalynde Burchell, Sally Pickard, Jared Tiller; Part 2 MEng Civil Engineering.

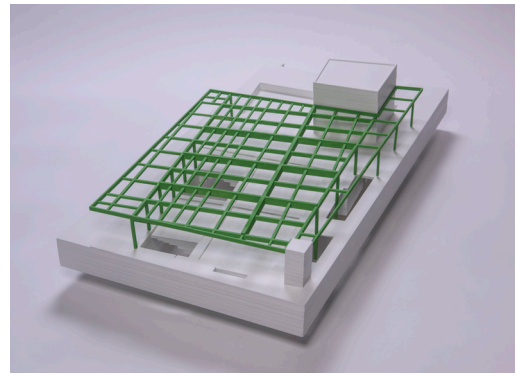
LOUVERED SHELL, HIGH STREET, SOUTHAMPTON

This project (Figure 13) proposes a cafe and restaurant unit to the south of the archaeological excavations, the utilisation of the existing vault and a wide span structure to protect the excavations from the effects of weathering. A louvered steel cladding unites the elements.

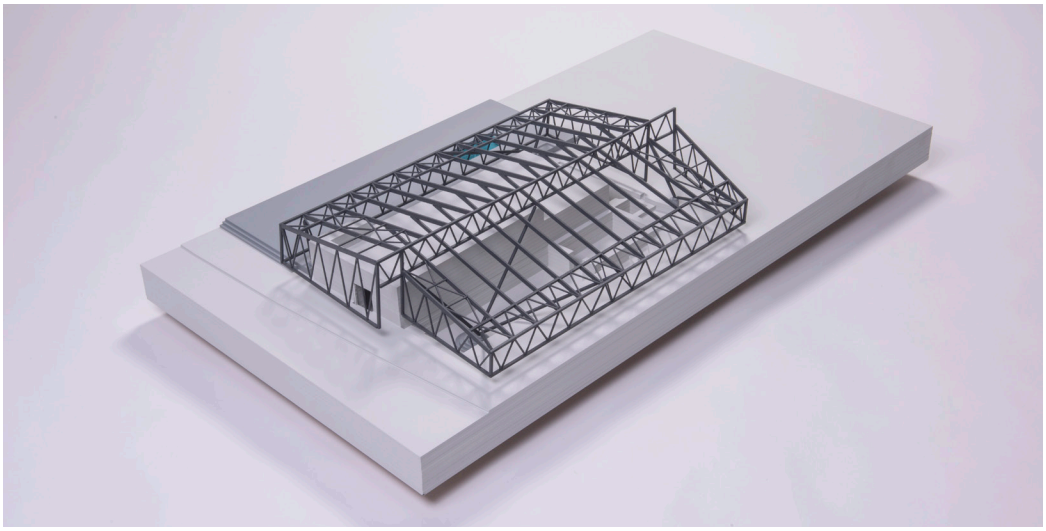
The area to the south of the vaults is excavated to create a submerged structural box housing a two storey cafe and restaurant. Double height volumes are used to create visual linkages between street and basements levels, utilise daylight and create unique and engaging spaces. Sheet piling is installed around the perimeter of the site with reinforced



▲ **Figure 15** Year 3 CENV3062 beam loading diagram



▲ **Figure 16** Year 3 CENV3062 Scale model showing site and primary structure (green) of proposed canopy



▲ **Figure 17** Year 4 CENV6160 Scale model showing the site and proposed structural frame and ground slab

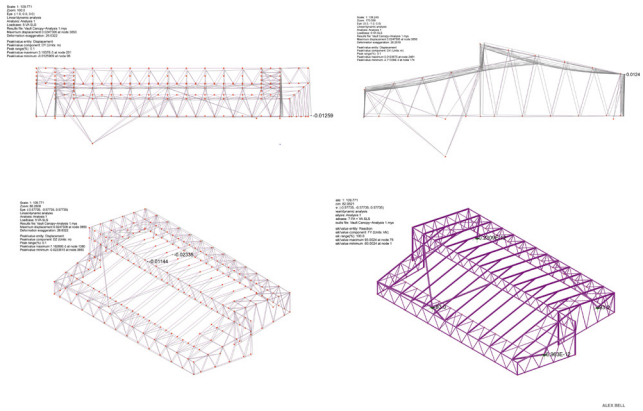
concrete walls cast in-situ to form the internal layout and provide stability for the roof and cladding structures.

Structural analysis carried out to ascertain the likely performance of the existing vault structure suggested that additional loading would be detrimental to its integrity. The proposed concrete slab above and pedestrian walkways are hung from the primary roof beams to avoid additional load being placed on the vault.

MULTI- LEVEL PLAZA HIGH STREET, SOUTHAMPTON

This project (Figure 14, 15 and 16) proposes the extension of the public realm to provide improved access to the basement level archaeological excavations/ vaults and to provide protection against the effects of weathering.

The area to the south of the vaults is excavated to create stepped access descending down to basement level, a plateau midway down breaks down the vertical travel distance



▲ **Figure 18** CENV6160 Structural analysis model using LUSAS

and provides an area for external seating in the summer; the steps are orientated south to also act as seating. Sheet piling forms the edge of the area to be excavated and extends around the existing excavations to stabilise the boundaries and reduce identified water ingress issues.

A steel framed canopy structure spans above the existing exposed archaeological excavations, its column loads transfer to the proposed retaining structure and the efficiency of the beam grid has been refined to reduce weight and aid construction. Access onto the southern section of the canopy extends the possibility for the public to experience of the site.

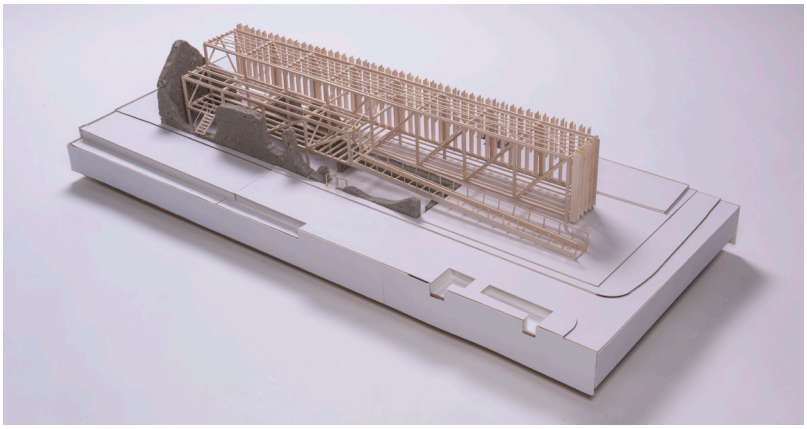
CANOPY, QUILTERS VAULT, HIGH STREET, SOUTHAMPTON

This proposed structural design (Figure 17 and 18) results from the consideration of the building's street context (scale, proportion and massing), programmatic requirements (access, circulation and function), site characteristics, structural and material performance, and the construction process.

A steel framed canopy primarily designed to enclose the existing medieval structures and shelter them from the effects of weathering. The structure also aims to increase public interest and cultural focus towards these important archaeological structures within the city wide context.

The external shell of the building staggers in plan and steps in height to establish an exterior mass suitable to its streetscape and to create inspiring volumes internally. These formal shifts provide locations for an entrance and exit and allow for significant glazed openings that maximise the use of natural light. The pitched roof effectively drains rainwater and further breaks down the mass of the building.

The complexity of the site ground model dominated the location and development of the inclined struts that provide vertical support to the roof structure and provide overall lateral stability. Trusses and bracing elements support spans, provide stiffness and characterise the appearance of the canopy structure. Piles, ground beams, thrust blocks and spanning slabs are used to provide stable foundations that avoid placing load on the existing structures during the lifetime of the building.



▲ **Figure 19** CENV6160 Scale model showing the site and the proposed structural framework

The building is clad with horizontal louvers that allow air to freely flow through and for the support structure to be seen as integral to the appearance of the building. The facades are further animated when illuminated at night time. The elevations are hung and stop short the surrounding street surface to emphasise the insertion of a modern structure and the retention of the historic fabric.

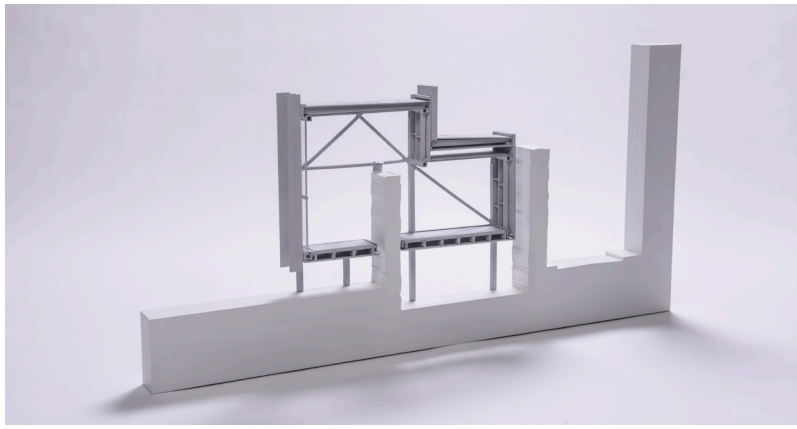
CANUTE'S PALACE RESTAURANT, CANUTE'S PALACE, PORTERS LANE, SOUTHAMPTON

A steel framed and timber clad building designed to partially sit within the footprint of Canute's Palace (Figure 19 and 20).

An evaluation of the site suggested that building solely within the footprint of the existing building would not support an economically sustainable restaurant and it was not possible to extend using the existing site levels. The floor level of the proposed building is raised (to retain public access to the archaeological remains) and ramped access utilises the existing masonry shell as the main entrance and to locate the kitchens and associated services. The dining area sits adjacent to the northern elevation of the existing structure and faces Town Quay Park. This arrangement results in the north wall of Canute's Palace being encompassed within the proposed building, acting as a visual break between the front and back-of-house and emphasising the relationship between new and old.

The proposed building extends east towards High Street to achieve a street frontage, maximise park views towards the north, and form a visual boundary along the southern park boundary. A braced steel frame supports this long, relatively narrow form, a column grid and its cross bracing is left visible and proportioned to realise an efficient structure, span underground archaeology and coordinate with functional requirements. The structure is *portilised* below its ground floor to avoid visually detracting from the view of the enclosed historic wall and removable screw pile foundations transmit the load to more competent strata and avoid placing load on archaeological features.

This project has been developed and communicated using a range of design methods; sketching, technical drawing (Autodesk AutoCad), three dimensional computer modelling (Autodesk Revit), physical model making, hand calculation and computational analysis (LUSAS) to provide a fully resolved structural solution.



▲ **Figure 20** CENV6160 Sectional model

CONCLUSION

It is important to recognise that the investments described within this paper are recent (within the last three academic years) and only represent the start of a much wider strategic plan to improve the design abilities of our engineering graduates. As such, the conclusions and reflections are made against limited data. However, it is possible to identify positive emerging trends.

- Students are becoming increasingly independent and proactive in finding solutions. They develop new knowledge and draw linkages between the content of all their taught modules within the context of addressing their design briefs. Craft, skill and judgement of the students is now more significant.
- It is apparent that students now have a greater ability to critically discuss their work. There has been a shift from a predominantly defensive stance when confronted by critical review towards more productive engagement that assesses the advantages and disadvantages of their proposed design solutions.
- Design has moved away from a final proposal to illustrate the aesthetics of an idea towards an understanding that design requires an iterative, critically reflective process and the delivery of a suite of high quality information from which others can understand the proposal.
- The importance of students feeling integral to a programme with a clear identity is becoming more apparent. The increased design opportunities offered within all civil engineering programmes offer 'ownership' of unique designed outputs.
- To support the uplift in design ambition, the development of appropriate work space and provision of dedicated technical support has required extensive re-purposing of estate. This was initially met with resistance amongst the academic community but which is now seen as essential to the broader development of integrating design across all undergraduate programmes. Transformative events such as the inaugural Faculty Design Show have been essential in demonstrating to the broader academic community the benefits and uplift in educational attainment made possible by these changes.

Nurturing the citizen designer: Re-defining participatory frameworks for professional re-alignments

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ABSTRACT

There are two clear conditions, amongst a host of others, affecting the prevailing state of architecture in the Indian context. At one end is the growing skew of professional attention around metropolitan and larger urban domains while at the other, is the disciplinary fixation in architectural schools on the glamour of the iconic as against the needs of the everyday. While architectural practice in India so far has offered negligible service to the vast majority of non-urban settings, in many ways, architectural design education programs too have remained disconnected with current flows of society and time. Let alone performing leadership and critical roles for practice, architectural education has struggled to address changing conditions of societal and physical settings.

Today, our increasing global connectedness is seen to effect widespread aspiration-driven demands on the professional expertise of architecture and related disciplines. In the race towards accomplishing our global dreams, the alienation of architectural practice, research and academia from existential social realities seem vividly deeper. While 'stakeholder engagement' has been a parallel mantra to all mega-development initiatives, the reality of participation increasingly revolves around professional super-specialists from all over the world.

Beyond the hype of neo-liberal opportunism and political rhetoric, could there be a re-alignment of our profession and academia towards addressing social realities and emerging contextual complexities through a re-defined framework of participatory engagement and co-creation of built environments? Specific to our conditions of professional (and academic) skew, this question formed the basis for a sustained inquiry towards re-visiting prevailing processes of academic exploration and practice. Using the rich experience of a prolonged community based engagement in remote tribal regions over two decades, this paper explores the dynamics of architectural contribution within the comparatively less discussed space of institutional practice as the intersection of practice, pedagogy and research… towards an alternative, immersive and grounded approach of nurturing citizen designers as custodians for a more collaborative, sustainable path for future change.

INTRODUCTION

India's requirements of shelter, infrastructure, work, business, recreation are multi-dimensional and diverse. Both, in terms of distribution and adequacy of

service, our prevailing professional reach is but a fraction of what our nation asks for. In this situation, product driven solutions attempted through conventional modes of architectural production as an outcome of practice-based engagements and correspondingly nurtured as pedagogic directions in architectural schools can but only address a very limited proportion of the built environment demand spectrum across the country. The productive capacity of an average firm and associated expertise networks that we have been so far familiar with using conventional mode of production through a linear progression of individual projects from conceptualization to realization cannot match the exponential demands of the building sector. Moreover, such production trajectories in the private sector have focused primarily on the relatively affluent minority in metropolitan cities whose financial prowess has attracted and shaped the overall profile and delivery mechanisms of our professional service.

Given the prevailing shortfall of practicing architects for the present magnitude of our urban population and even with the most optimistic speculation of hyperactive growth in the number of architectural schools and serving professionals, a healthy ratio of architects to population served in this country is almost unimaginable. Additionally, three and a half decades from now, around 2050, our country would be only halfway towards an urban society. Recent trends suggest that the convenient assumption of rural architecture primarily comprising of "self-build" units and hence offering negligible roles for the professional architect is dated and evasive of the realities of today. To the contrary, the pace of change in rural areas, especially in architectural shifts from the local vernacular to the aspired urban is significant across the breadth of the country (Dasgupta, 2008). If demands from this sector of our population are accounted and added to projected urban demands, we have at our hand a bewildering scenario of professional need that is not only beyond immediate comprehension, but also well beyond any possibility of coverage within a plausible time frame of the future. It is evident that a fresh trajectory of professional engagement as well as academic focus, in consonance with the unique and complex societal conditions of our part of the world, is necessary.

This new trajectory (in addition to, and not in substitution of, the prevailing range of diverse engagement paths followed by the profession) needs to address not only the seemingly incomprehensible dimension of quantum but more so, to the parallel and much neglected questions of equity, affordability, identity and sustainability that plague our academic and professional output. Since our Independence in 1947, the twin modes of architectural practice and education have concurrently progressed over the years through periodic waves of creative alignments – first with the Modern Movement and (simultaneously with) Revivalist surges in our search for a national identity of a free nation, then with our experiments with Neo-vernacular and Critical Regionalism, thereafter through sporadic forays with post-industrial Post-modernism and De-construction, finally embracing the world of neo-liberal, techno-service-systems based, globally universal architecture. While the bulk of architectural production revolved around these formal movements of architectural explorations, there have been scattered, albeit concerted efforts in alternative terrains of engagement especially for the less catered majority of non-urban and marginalized population of the nation. Thus at one end, the iconic figures of Le Corbusier, Louis Kahn and their progeny of Modern Masters paved the way for the Indian entry into the world of contemporary **designer** architecture……at the other, somewhat quieter practices of Laurie Baker and bottom-up initiatives like Development Alternatives, Costford, Barefoot College, Hunnarshala, Lok Jumbish and DPEP programs along with a handful of others have been striving to find relevant answers to ever-growing questions of architectural production and meaningful delivery of expert services. All along, the world of practice has progressively

remained the dominant leader in shaping the disciplinary discourse with academic programs submissively following the lead and responding with corresponding directions of applied knowledge necessary for such a practice-driven environment. Neither practice nor academia have nurtured a sustained platform for focused exchange on critical discourses related to either, the provision of professional architectural service or, disciplinary queries pertaining to academic inquiry raised in each passing time. It is in this vacuum of collective interaction that the **business as usual** mode of architectural involvement drifted through the dominant, perceived demands of the profession from the visible, resourceful, urban sector, both through state-driven agendas as well as private enterprise. In connection with his recently curated exhaustive work on the State of Architecture in India, Rahul Mehrotra, noted educator, practicing architect and urban designer says:

> *"The world changed drastically and rapidly in the 1990s – and we could not as an architectural profession keep pace with it – unable to understand what had hit us. Rather than developing newer languages and idioms, and tools to assess and read the new architectural turns, we often resorted to a denial of the shape of things, to a rhetoric of rejection, and misplaced nostalgia. Politics has become ever more complex, and architects from once being agents of social and aesthetic revolutions, now maintain a technocratic attitude, where you fine-tune your skills, but avoid addressing the very environment (social and cultural) that you ironically depend on for your daily bread and butter!"*

Academic curricula and more so, design pedagogy, have had dormant, satiated existences for quite some time consistently focusing on the extra-ordinary and iconic rather than on everyday realities (Dasgupta, 2012c). Rarely has there been a decisive urge to question our academic path and rather than allowing for the development of significant, differentiated trajectories of inquiry and exploration in consonance with our societal diversities, the super-imposition of a standardized, national agenda for architectural education through a mandated, central body has further frozen the possibility of architectural experimentation, critical debate and creative departures from the common denominator of prescriptive knowledge frameworks. Another noted architect and thinker in the profession, Prem Chandravarkar comments, "*In India architectural education tends to be highly vocational so the architectural profession by and large is not trained to think in theoretical or philosophical terms, and that's the other thing we sorely need to be - to talk about architecture in general terms.*" (Ramachandran, 2015).

Exercises in design studios are conceived as **projects** with clear beginnings and definitive/expected ends. Here, design explorations around each problem must be taken through a creative journey of conceptualization, development, resolution and representation. Open, **wicked** exercises are seldom imagined as possible avenues of experimental interrogation and design creation. One of the first departures that the new trajectory envisages is the formulation of an **open program** rather than a **closed project**. This shift ensures possibilities of adaptive re-orientation and flexible task articulation with respect to the unfolding dynamics of a transforming setting within which project-based explorations may be situated. The second departure that this trajectory suggests, lie in the sustained engagement of the creative team with a given contextual setting over an undefined, prolonged period of time. This by itself stands apart from time-bound, semester problems of academic design studio exercises or project deadlines associated with client based professional service. The possibility of an extended time frame allows for the development of multi-dimensional strategies for modulated engagement in response to the diverse sets of developmental processes that are simultaneously in play for transitional situations

within strongly differentiated social conditions such as ours. As is evident, such an extended duration of architectural engagement does not ensure either consistency of human resource within the creative team, nor does it allow formal parameters of academic progression and/or conventionally drawn project related Terms of Reference. What it does permit however, is a variable set of experienced and fresh minds, joining hands for the time they can be together contributing to the program in response to, or in association with the issues of developmental need perceived during their period of engagement and in alignment with stated visions and objectives of the program. Students, researchers, faculty, designers, domain experts join in, move on and re-join as and when intent, opportunity and occasion allow while the program continues to engage with the changing scenario of the setting in which it is located. The third departure is in the creation of a process-driven collective enterprise against a product-oriented design engagement. The central aspect of this shift is in the positioning of the designer as a **participant-actor** of the community with whom the design program progresses. It is in the belief that co-development of future conditions of building and living as a collective human endeavor as against the delivery of a specialized service or product is where the foundation of a grounded, intimate and collaborative process of creation gets embedded. This process embraces multiple levels of demands and aspirations as well as examines the methodological dimensions of the production of built environment that are both internal to the community as well as that harnessed from the world around. Within the larger sets of transformative forces in operation, this process-centric approach to the building of architectural knowledge (rather than the architectural unit) as relevant for the community's future trajectories of change, underlines the most important shift in this alternative path of architectural engagement.

EXPERIMENT

Over the last two decades, across the wide expanse of the Himalayan belt in northern India, the transformation of erstwhile vernacular built environments has been a growing phenomenon. The implications of such a pattern of change specific to this region is significant, given the fragile conditions of the eco-system on one hand and the prevailing trajectories of development trends in these areas, on the other. Vernacular construction with its pragmatic approach, locally oriented systems, embedded symbolism and inherent constraints, generates a distinctive built environment reflective of regional and local identity. But the growing aspiration for **urban** buildings, difficulty in procuring traditional materials and rising labor costs for vernacular construction, accompanied by demands of new building types, increased road connectivity, readily available, cheap, urban materials among other factors, have prompted an increasing pace of transition towards modern construction. The loss of the vernacular built quality is therefore in essence the redundancy of the systems that had led to its production. Transformations in the economic and cultural environment that had promoted these systems would inevitably lead to creation of a new order. The issue of deliberation is about the nature of the emerging order and its impact on the larger level. .

This paper highlights the discourse of change in vernacular architecture of the western Himalayas and connected methods/processes of constructional technologies tracked over a period of fifteen years through empirical studies and long term evaluation. The arena of such explorations is concentrated on three remote tribal settlements located within two districts of the state of Himachal Pradesh. Specifically, this part dwells in the first instance, upon the parameters governing the above mentioned directions of change leading to the gradual erosion of prevailing vernacular processes that constituted and typified settlement patterns and further goes on to discuss possibilities of multi-level, inter-disciplinary, collaborative prospects through a mechanism of sustained institutional engagement at



▲ **Figure 1** Example of vernacular construction techniques as against new trends in the study area

varying levels of decision making towards a sustainable future ahead.
Out of the three case villages, Bharmour in district Chamba has emerged from an erstwhile pastoral, nomadic pattern of life to an important religious destination, growing rapidly to engulf other surrounding hamlets towards the formation of a rudimentary urban center (Sarkar, 2008) The other two settlements, Kalpa and Sangla form a twin cluster of complimentary villages in the district of Kinnaur with unique cultural and social characteristics within spectacular scenic settings. All three settlements, positioned above 2300m from mean sea level are qualified also by a local economy with a high degree of horticulture base as well as a rapidly growing rural tourism sector. While Kalpa-Sangla attracts both national and international tourists who visit these locations as getaways or adventure tourism spots, Bharmour caters to an increasing population of domestic, religious tourists and pilgrims. All three villages reveal evolved processes of the vernacular and strong forces of change affecting them today. The following part describes the experimental engagement that has incrementally taken shape with glimpses of field observations and connected findings on salient issues along with essential features of a possible way forward through multi-level dialogue, strategy formulations and design guidance for future directions of change.

PHASES OF ENGAGEMENT

The Himalayan Action Research Program (HARP) had its genesis in a faculty-led research initiative, called the Related Studies Program located within the TVB School of Habitat Studies in Delhi. With an initial academic objective of developing an empirical, archival data base on indigenous architectural response to diverse climatic zones in this country and confronting the vexed question of an architect's role beyond the city, the program sustained its research initiative through a decade long engagement in the mentioned

study areas. Over 180 students and three faculty members with architecture, landscape and construction specializations apart from resource experts from the fields of economics, architectural conservation, urban design, building services, energy sciences and environmental planning converged at various points of time to actively engage with the selected tribal villages. Three distinct phases of engagement have been summarized below:

Phase-I involved fieldwork in all three villages, which initially comprised of extensive on-site documentation and survey of physical characteristics of the place through a series of mapping tasks across various scales of representation (Dasgupta, 2011a). The physical survey was accompanied by related studies of livelihood, life-style and occupancy patterns for a deeper exploration of tribal communities in harsh mountainous terrains. An analytical understanding of the physical characteristics of these settlements in relationship to the characteristics of the locale as well as socio-economic and cultural profiles was generated for each of the study cases as a precursor to further discussion and subsequent engagement. This period of survey, study and analysis stretched over a period of 2-4 years for each settlement.

Phase-II of the program involved a dialogue with the state government through the Secretariat and specifically with the Departments of Urban Development, Environment, Tourism and Tribal Welfare. Such a dialogue involved the exchange of inner perceptions of the state with the HARP design and research team on critical issues and findings of the survey and initiated study. The documentation of physical resources and their present status for each settlement served the foundation for debates across discussion meetings. The Chief Secretary of the Government of Himachal Pradesh called for successive meetings attended by Secretaries of individual departments including the Public Works Department; Environment & Forests; Finance; Tribal Welfare; Language, Art & Culture, Transportation and Tourism as well as, through live video conferencing with district administration, block/ *panchayat* level officers and representatives of local communities as respondents to a series of presentations made by the research-design group. One of the clear outcomes of the discussion was the perceived lack of creative and technical inputs that was imperative for directing growth and transformation of the villages through a well coordinated policy and connected action programs. The felt need of a prolonged community-driven engagement with the processes of change in selected areas and multi-tiered involvement of diverse expert domains was articulated as a vital aspect of the possible path ahead. At this stage, it is important to note that this mountainous state of Himachal Pradesh is still 95% rural and has had limited policy thrust towards planning and design strategies for rural transformations. The meetings at the Secretariat resulted in a formal MoU and Agreement between the Government of Himachal Pradesh and the School of Planning and Architecture, Delhi to conduct an applied research program using a modest grant for the selected three tribal villages towards formulation of guidelines for development and recommendations for further action.

Phase-III of the Himalayan Action Research Program included re-visits to each of the three case villages and re-engaging with the local community at varying levels of dialogue with a focused agenda of exploring possibilities of contribution to sustainable development and change. Recognizing the fast pace of transformations that all three village cases had undergone during the intermittent years after the conclusion of the basic surveys in Phase-I, the study team, along with district officials and village representatives embarked upon a bottom-up, reality driven, collective agenda for directed change. Fresh assessment studies were conducted including re-surveys of physical characteristics (built form, movement system, functional distribution, construction strategies, etc.) as an extension of the earlier

study as well as sample surveys of community responses towards a diverse range of issues and potentials that could be identified from within (Dasgupta, 2011a). Using the example of the twin settlement group of Kalpa-Sangla in district Kinnaur, a brief discussion of the salient factors and expressions of built form transformations is presented below:

TOURISM INDUCED CHANGE

Today's Kalpa-Sangla offers a picture of a rapidly emerging sporadic assembly of **urban** building types dotting its once pristine natural setting (Figure 2). The spurt of domestic and foreign tourism that this region is attracting has been one of the principal factors contributing to the fast changing scenario of a transformed aesthetic and built environment of this place. The advent of tourism has ushered in the production of new building types like multi-storied building stack amidst precious orchard areas, linear blocks along movement paths, clustered grouping and enclosed spaces in flatter areas, etc. These forms have emerged in the settlement fabric as trend-setting demonstrations influencing possible directions for other enterprises to follow.

TECHNOLOGY INDUCED CHANGE

A paradigm shift in the availability and use of locally procured building materials and technology towards modern urban materials and systems is generating a sweeping transformation of built characteristics (Figures 3, 4, 5) in Kalpa-Sangla and the state in general (Dasgupta, 2011a). The gradual erosion of climate sensitive past techniques of timber and stone-based construction, specific to this region including some invaluable practices of earthquake resistant construction systems are evident. This is giving way to energy intensive, conventional urban technologies using brick and cement masonry in reinforced cement concrete (RCC) framed structures and roofing systems. Most of the new buildings in the settlement (about 86%) are constructed using RCC along with brick and cement, due to its low maintenance, speed of construction and growing availability of materials and skill. Additionally, skilled artisans in RCC construction activity from the states of Bihar and Uttar Pradesh are entering the construction sector with rising demand for such modern techniques, steadily pushing local artisans gifted with the knowledge of the vernacular to the margins.

ASPIRATION INDUCED CHANGE

Relative affluence brought about with increased revenues from horticulture and monetary gains due to land based compensation for upcoming Hydro-electric power projects in the region have started nurturing new life-styles and alternative avenues of engagement with corresponding expressions across different social segments of Kalpa–Sangla, especially among the youth. Proliferation of personal motorized means of transport, mobile connectivity and satellite (dish) TV amongst a host of other contemporary technologies is ushering in an unexpected direction of socio-cultural and material changes throughout this settlement. Increased connectivity and economic prosperity have altered the way of living, particularly with strong influences from the urban world as reflected through built expressions and interior spaces (Figure 6).

COLLABORATIVE STRATEGIES

Reflecting on the findings and observations of the assessment study on the prevailing trends of change from each of the settlement cases, a summary of directions of such change becomes the starting point of discussing ongoing and future partnerships between external expertise and resident communities. The following table captures the generic levels of change (Figures 3, 4, 5) in the domain of the built environment, as observed across



▲ **Figure 2** Emerging Trends across functional building types

	PAST		PRESENT
From	Use of local materials and construction technologies in self-build units evolved over time	To	Urban (imported) materials with corresponding technologies and human resource
From	Highly evolved vernacular solutions to earthquake and other constraints of location	To	Ad hoc applications of engineering thumb rules for general construction decisions and critical structural requirements
From	Passive methods of climate response through design-construction techniques	To	Active methods of climate response with increased reliance on consumer durables
From	Indigenous spaces and built volumes corresponding to traditional living patterns and life cycle	To	New building types and spatial volumes in response to imbibed or
From	Rich craft heritage and accessory production from within the community	To	aspiring life-styles corresponding to acquired urban values.
From	Contextually rooted expression and aesthetic vocabulary		Steady erosion of craft-based applications giving way to use of manufactured products
			Borrowed imagery and hybrid building characteristics

all three settlements at different scales of correspondence:
The set of transformation trends (above) suggests at one level an increasingly unsustainable trajectory of building in these regions, while offering the potential for design and technological interface appropriate for such locations. In the ensuing future ahead, the settlements of Kalpa and Sangla are envisioned to embark upon a model developmental path that proposes a balanced growth of new activities without endangering ecological processes that nurture this region, while upholding cultural identity and vernacular

S.No.	Criteria / Types	Speed of Constrcution	Cost	Maintenance	Local Availability of Material	Local Availability of Skilled Labour	Effectiveness Against Rainfall	Effectiveness Against Extreme Temperature	Earthquake Resistance	Eco-sensitivity	Recyclability	Flexibility	Durability	Aesthetic Quality
1	Kath-Kona													
2	Alternate courses of brick masonry and timber tie beams													
3	Dhajji Wall													
4	Dry stone masonry													
5	Random rubble masonry in mud mortar													
6	Dressed stone masonry in mud mortar													
7	Dressed stone masonry in cement mortar													
8	Wooden panels on timber structure													
9	Brick masonry with cement plaster													
10	Concrete blocks with cement plaster													


Kath-Kona


Dhajji Wall


Dressed stone masonry


Brick masonry


Concrete blocks

▲ **Figure 3** Analysis of existing Walling Systems prevalent in the case villages

S.No.	Criteria / Types	Speed of Constrcution	Cost	Maintenance	Local Availability of Material	Local Availability of Skilled Labour	Effectiveness Against Rainfall	Effectiveness Against Extreme Temperature	Earthquake Resistance	Eco-sensitivity	Recyclability	Flexibility	Durability	Aesthetic Quality
1	Flat Mud Roof (with plastic sheets)													
2	Sloping Slate Roof with Timber Understructure													
3	Sloping Wooden Roof with Timber Understructure													
4	R.C.C. Flat Roof													
5	Sloping CGI Sheet Roof with Timber Understructure													
6	Sloping CIG Sheet Roof with Steel Understructure													
7	Sloping Recycled Tin Sheet with Timber Understructure													


Flat Mud Roof (with plastic sheets)


Sloping Slate Roof with Timber Understructure

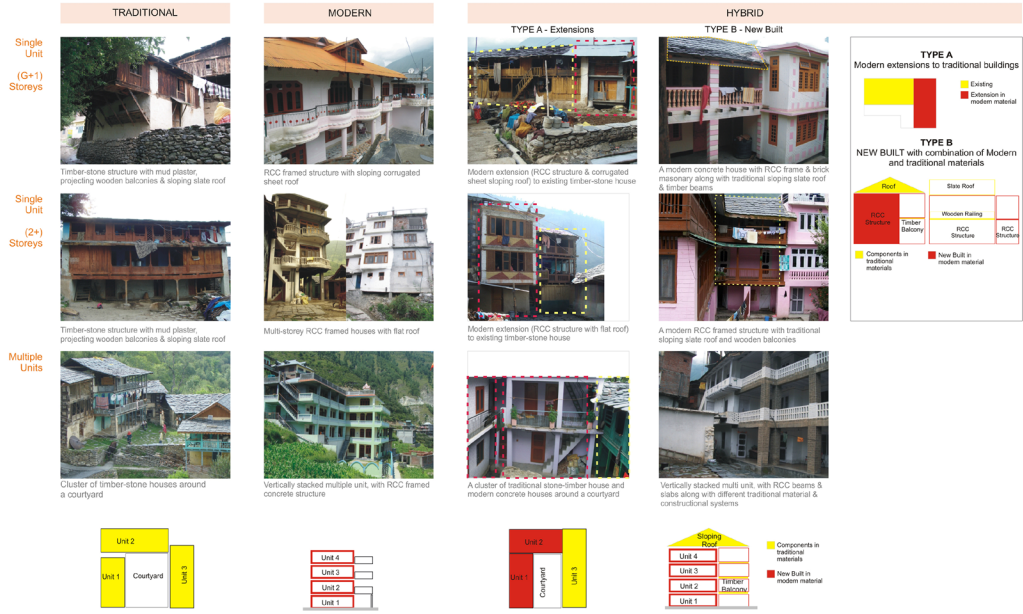

Sloping Recycled Tin Sheet


Sloping CIG Sheet Roof


R.C.C Flat Roof

▲ **Figure 4** Analysis of existing Roofing Systems prevalent in the case villages

expression. Such an effort has been initiated through combined explorations of possible prospects in community meetings. Individual members as well as groups of the local community are engaged with the HARP team to discuss, conceptualize and propose projects at varying scales in different parts of the settlement. Strategic inputs by way of design guidelines for future development (formulated specifically for each settlement) has been created as an outcome of the assessment studies as well as community based meetings on directions for the future (Dasgupta, 2012a). These guidelines, compiled in the



▲ **Figure 5** Unit-level Adaptation of Building Systems



▲ **Figure 6** Emerging Characteristics of External Built Expression

form of reports (Figure 7), specific to different parts and aspects of each settlement have been submitted to the Town and Country Planning Department, Government of Himachal Pradesh for deliberation and action by the State (Dasgupta, 2012b).

A comprehensive list of possible projects spanning across individual buildings to social and physical infrastructure for prioritized implementation with respect to community

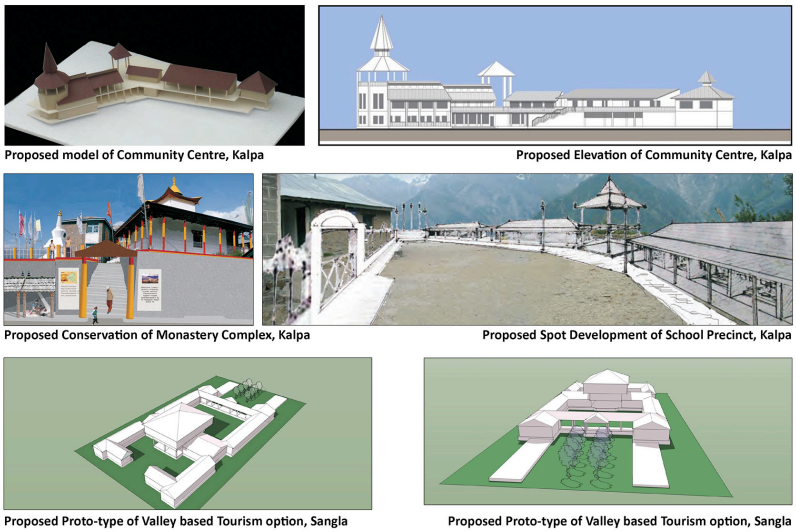


▲ **Figure 7** Assessment Studies and Design Guideline Reports submitted to the State Government



▲ **Figure 8** Community interaction and co-development of ideas

needs and funding possibilities have been collectively identified. Individual entrepreneurs with business proposals for new tourism options, domestic residents with ideas of house modifications as also temple trust desiring spot improvements and such others form the diverse group of stake holders from within the settlement and beyond (Figure 8). Over the last few years the HARP team has been engaged in the design of a variety of building and

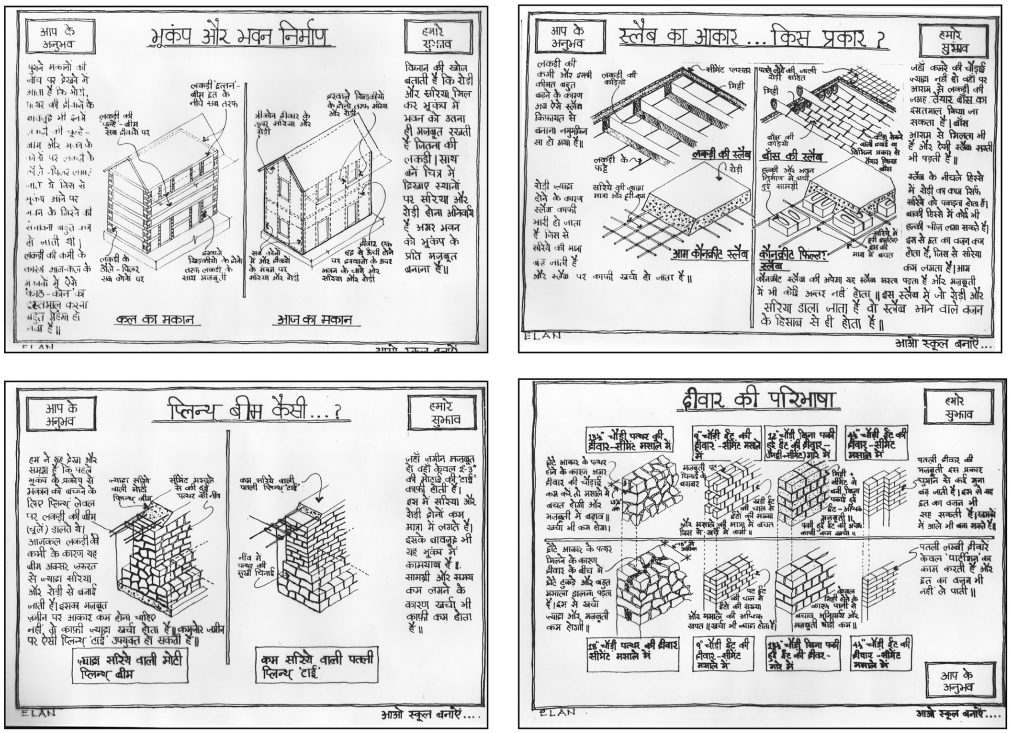


▲ **Figure 9** Samples of Project Initiatives at Various Scales Through Community Engagement

area development projects across a range of contextual conditions as potential examples of representative solutions (Figure 9). These projects cover a wide range of requirements from individual residences, guest houses and tourist lodges to village schools, community facilities, spot development, area upgradation, etc. Importantly, the range of design solutions explored by the HARP team along with the community contributes to the overall production of architectural knowledge in addressing new demands like that of rural tourism, recycling and retro-fitting, energy optimization and the like. Also the implementation program presents an option of developing projects under various modes of partnership, such as state and community, NGO and state, citizen and NGO, among others. This multi-level partnership expands funding and implementation alternatives too, since a number of the proposed mission projects could be funded through central or state level schemes from various departments/ministries as also by local groups or individuals as the case may be. The list of projects formulated with the community has been forwarded to the state government for consideration (Dasgupta, 2012b) and a few have found initiation too. Simultaneously, a determined agenda of awareness and exposure to realities of the built and natural environment prevailing in the settlements today along with their connected implications is being put in place through a system of newsletters, manuals and maps in local language, for all members of the community.

Earlier, a state wide endeavor towards universal primary education across 25 villages in four districts of the state gave the opportunity of realizing innovative primary school designs constructed through a partnership between the State Education Department, Village Education Committees, International Funding Agencies and Consultants under the District Primary Education Program (DPEP). Through community based participatory mechanisms at every stage, this project allowed for experiments in vernacular adaptations, exploration of intermediate construction technologies (Figure 12) and cost effective strategies to deliver site specific building solutions in individual village sites (Dasgupta, 2008).

The pressing needs of the community and the settlement as visible from the conducted studies require a cross disciplinary engagement with the community at every level of



▲ Figure 10 Extracts of Construction Manuals prepared for co-producing village schools

decision making. An extension cell of the research-design group is being setup in each of the three villages to enable a multi-disciplinary set of expertise be available for the diverse needs and requirements identified through previous studies. The cell has three clear mandates with respect to its performance within the settlement and resident community – knowledge production, capacity strengthening and outreach. It is seen already that the present community base is a highly evolved repository of traditional knowledge related to responses of built form within natural settings. However, present day demands and technological changes have not found sufficient place in the evolution of the above knowledge base. At the other end, the department of Town and Country Planning and the state Public Works Department have been yet unable to mobilize adequate in-house technical resource especially in hill-area planning and design. At both these levels the cell can play a pro-active role through training programs and workshops on live demonstration projects for enhancement of collective capacity of the resident community as well as state planning agencies. Scientific methods and technical know-how available in the world at large is to be harnessed through appropriate networking mechanisms and strategic outreach initiatives by the cell and contextually reapplied in the settlement fabric. Through time, the extension cell is seen to co-develop necessary inputs and innovative solutions to the emerging problems and issues that each settlement could specifically need to confront.

REFLECTIONS

Our engagement with the three tribal villages of Himachal Pradesh over the last two decades has now revealed an array of potentials and challenges for addressing the existing conditions of change in these areas. Possibilities of co-development of technologies through a combined technical interface is of considerable potential especially since the

inherent levels of indigenous knowledge systems and collective wisdom is still visible within the physical and social fabrics of these settlements. Beginning with the *"kathkona"* system of time-tested earthquake resistant techniques or innovative *"dhajji"* walling systems to advanced levels of stone masonry and carpentry skills as also climate responsive solutions through design layout and building skin details, the avenues of co-development of reliable, relevant and innovative technological outputs for a sustainable path ahead is of immediate consequence and application. Although local knowledge base and collective wisdom for each of the identified components of the vernacular is immense, applied technologies of today are neither derivative of local conditions nor are they selected with the refined judgment of past choices. It is at this juncture that the collaborative platform of the Himalayan Action Research Program with its extension cells in the field seeks to continue its contribution through a well-articulated, meaningful and responsive agenda of engagement. From scientific survey and documentation methods using GIS and other applications, solar passive techniques of energy optimizations, computer aided tools of climate simulations and technology options, composite walling, roofing, flooring and ceiling systems to policy directives on sustainable planning and waste management, eco-tourism, home-stays and craft based home industries, the spectrum of collective, participatory co-sharing of knowledge and application systems is, at once vast as is imperative. The introductory partnership for technical exchange created at the level of the state between the Government of Himachal Pradesh, School of Planning and Architecture, New Delhi, professional practices and resource experts is a unique, initial venture which is imagined to grow to a more comprehensive, wholesome and vibrant collective of interactive domains of diverse stakeholders for this task.

The challenges emerging from such experience of sustained engagement with communities under transition become important for consideration to the way ahead. These challenges occur at three broad levels. At the village level, aspiration-led demands and prevailing commercial forces significantly add to the pressure of rapid pace of change. The trends of upward economic mobility of a significant cross-section of resident inhabitants have given rise to a variety of internal demands catalyzing a chain of transformations with preference to urban products and life-styles. Non-availability of local material choices has further fuelled this trend corresponding to altered life styles. In addition, the lack of personal time for individual attention to building as a self–help personalized craft has given rise to outsourcing of building activity to contractors and masons not necessarily from the region. At the state level, such an endeavor faces significant challenges firstly, with respect to the dearth of exposure to the range of design and technological applications available for specific situations faced by hill settlements. Secondly, this lack of exposure is sometimes aggravated with an indifferent skepticism from some of the policy and decision makers to the efficacy of application of borrowed/alternative possibilities to problem resolutions. In addition, lack of consistency amongst government departments to sustain a long term explorative path of creative engagement is one of the strongest challenges still being faced by committed consultants of this state and across the country. Finally, the short tenure of Heads of Departments and members of the Secretariat who are vulnerable to be transferred out of their present positions before the end of any determined project becomes an extended area of concern for such kinds of experimental endeavor requiring prolonged support and patronage.

At the level of the research-design group, the difficulty of continued intensity of field involvement and necessary presence at site, especially for such remote Himalayan regions, becomes one of the primary challenges facing such an exercise. This results in a somewhat fragmented or sporadic nature of expert engagement in rural domains where consistent

inputs are all the more imperative. The lack of an evolved institutional and financial mechanism to support cross disciplinary partnership and co-development of technologies is finally one of the more crucial challenges to the development of appropriate design and production tools for the changing rural sector and connected environments.

CONCLUSION

Notwithstanding the above mentioned challenges in negotiating prevailing winds of change in these remote Himalayan regions, the larger cause of sustainable development and connected explorations towards the same needs to be the driving force for any such endeavor. The participatory framework outlined in the above experiment moves beyond the customary **stake-holder engagement** that most state driven missions for development have mandatorily requisitioned. The need for an evolving, sustained program of participatory engagement at varying levels of dialogue and partnership is imperative for a socially driven agenda of developmental change. In the case of this program, the creative design and research team has been oscillating between the community and the state allowing for a mediatory, facilitating role to be nurtured through a steady building up of a mutually inclusive relationship across both community and state actors. For the community, at the threshold of taking new decisions related to their aspirations and choices of shaping their built environment, the idea of a technical group discussing and associating themselves through knowledge exchange and co-design of their present and future habitat needs, holds relief and promise specially when the possibility of such an interface is seldom attainable in these remote regions. Through sharing of problems and prospects confronted by the community as well as through formal and informal exchanges related to the same, a mutualism of collective enterprise and contribution is built. Community expectations from the HARP team and the program has traversed through looking for specific design and construction advice to their new problems of tourism building types, structural inputs especially for RCC construction, building facades, retrofitting wet spaces and toilets and internal spatial modifications of houses to tourist home-stays. But more importantly, successive interactions have started orienting the collective architectural discourse towards issues apart from solutions, applied knowledge apart from new information, methods apart from products. The dialogue around architectural production commensurate with local needs and larger concerns, rather than the material production of architecture alone is a strong facet of the program taking shape gradually.

The intersection of practice-research-pedagogy that this experiment pursues suggests a move away from the existing, water-tight, knowledge sector domains that we are familiar with. To begin with, the understanding of developmental processes in our societies is by itself a critical pre-requisite, challenging in the process, some of the conventional modes of interpreting or, even by-passing our societal realities. Field based empirical research leading to greater unearthing of prevailing processes of architectural production feeds into the development of a pedagogic and disciplinary approach of addressing issues inherent therein. Far from the design studio, the student (as also the researcher/practitioner/teacher) **grows** with the program as it unfolds its layered characteristics of developmental change. While the formal curriculum trains them to address varying complexities of individual design tasks delineated by the studio tutor, the student here becomes the initiator of design dialogue related to necessary architectural production. His ways of **seeing** the issues of built environment through direct contact and connected interactions with the community allows him to construct a role for himself and delineate his contribution for the community and its future. He becomes the **citizen designer**.

If community capacities are to be strengthened in the shaping of their own habitats,

citizen designers need to play a pivotal role in spearheading such a task. Academic institutions correspondingly therefore need to undertake the responsibility of nurturing such groups of designers who would become instrumental agents of collective, creative action in each community where they find themselves in. Such a movement, where co-creation of human habitation for the future is galvanized through collective enterprise using proactive contributions of the citizen designer needs to spring from the academic world of architecture which, through its central agency of knowledge creation, capacity enhancement, outreach, networking and applied experimentation becomes the ideal venue for this alternative trajectory to unfold and consolidate. Beyond formal firm-based practice domains, the possibility of a new form of 'institutional practice' revolving around a collaborative framework of varied domain expertise creatively harnessed through the efforts of citizen designers engaged with co-production of design knowledge in association with the community, offers a fresh way of serving future demands of our unique built environments. Seen from the perspective of the professional world of applied knowledge, this kind of practice that lies at the intersection of research, pedagogy and professional service becomes a relatively new, but much required realignment of disciplinary engagement that connects more substantively and meaningfully to the real dimensions of our kind of society.

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Human computer interaction systems and educational strategies to support design participation

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ABSTRACT

This paper brings together some key issues: How can a computationally-based architectural design application be developed to facilitate design participation, specifically using techniques of human-computer interaction? What is the role of professional architects as facilitators of participation and how can they be educated for this role? What are the implications of design participation as an expression of a wider social and political process of 'democratisation'?

The term 'democratisation' usually refers to the widening of the franchise for active participation in political decision-making compared to decision-making dominated by established elites. Recently the term 'democratisation' has also been applied to the widening of access to personal opportunities and to technologies, the latter often in the form of computer based consumer products or services. The impact of such 'democratisation of technology' may also have wider social and political significance.

Therefore, what better use for the 'democratisation of technology' than the 'democratisation of architecture'?

Design participation starts with two ideas: First, that the most important aspect of any building is the satisfaction of the people who use that building. Second, if architecture has to balance technical, functional, economic, social and cultural concerns then the people who use the building are best place to determine this balance.

Previously, end-user participation in architectural design may have been considered to be rather 'idealistic', because of the lack of tools and methodology to make this a practical reality. The premise of the research presented here is that computational techniques, specifically innovative approaches to human-computer interaction can be used to develop special architectural design tools which can be effectively used by non-professional building users to create viable architecture.

Within the overall theme of design participation there is a very important educational sub- theme. Essentially, the participatory design software must not only provide an opportunity for the building users to express their own design intent, the software must, in 'very short order', educate the participants how to make design decisions. Specifically, how to make suitable trade-offs

between design and performance variables. Therefore, there is an important educational challenge within the design of a participatory software: in that the participants should be guided to understand design and the consequences of their design decisions.

This paper will describe both the exploratory research involved in the development of a participatory design application and the evaluation of the software on the basis of the user trails with participants. The paper will also describe the methodology used to compare the participants' designs with professional designs for buildings of the same type. The paper will conclude by presenting a new curriculum for architectural education based on the principles of user-centred design in which the architect's focus shifts from the expression of their own ideas to being the facilitator of the participants' ideas.

INTRODUCTION

In 1971 the Design Research Society, under the leadership of Nigel Cross, organised a conference called *Design Participation* which brought together leading policy experts, design theorists and software developers (Cross, 1972).

At this conference the idea of using the emerging technologies of computer-aided design (CAD) for design participation was discussed and further pursued by Nigel Cross and Tom Maver in an article published in the *Architects' Journal* (Cross and Maver, 1973). This idea was further supported by John Lansdown, who was the chair of the civil engineering subcommittee of the UK Science Research Council. As a result of these discussions a research project into *Computer Aids for Design Participation* was started at the ABACUS research unit at the University of Strathclyde in 1975. The objectives of this research were three-fold: first, to develop a suitable CAD system for use by lay participants; second, to test the usability of this system with participants and third, to objectively evaluate the quality of the designs produced by the participants in comparison to the design of professional architects for equivalent buildings.

This project represented a unique empirical study in the field of Design Research. However, we should remember that this work used what by today's standards would be considered as incredibly primitive interactive computing systems and before computing became a ubiquitous 'user experience'. For the participants this was most probably their first experience of computing, let alone interactive computing.

HISTORICAL CONTEXT

The 1971 Design Research Society's conference on Design Participation reflected a growing interest during the preceding decade in a number of key precursors to design participation. Within this period, the year 1964 emerges as a pivotal moment with the publication of four seminal texts.

First, the publication of *Architecture without Architects* by Bernard Rudofsky (Rudofsky, 1964), which explored the history of vernacular architecture. Rudofsky suggested that convenient, adaptable and in many cases highly aesthetic buildings and urban forms could emerge from an untutored vernacular design process.

Second, in the 1960s, there were a number of significant architectural practitioners and theoreticians who articulated what they considered to be the practical, social and political imperatives for community architecture. This included John Turner, working in Peru between 1957- 1965 (Turner, 1972). The advocates of community architecture recognised that

architecture intersects with social policy and therefore inevitably with ideology. However, they rejected conventional highly interventionist urban (re)development and associated community disruption. Instead community architects emphasised local activism, focussing on incremental improvement, building on existing community organisations and vernacular architectural traditions via self-help initiatives. These ideas were often characterised as being counter culture, non-conformist and represented a dimension of idealism and social action which was completely orthogonal to the prevailing architectural and political ideologies.

Third, in *Notes on the Synthesis of Form*, Christopher Alexander (Alexander, 1964) made the distinction between 'unselfconscious' and 'self-conscious' designing. We don't know if Alexander, Rudofsky and Turner were aware of each other's work. It certainly appears that Alexander supported the contention of Rudofsky who associated unselfconscious design with societies that design and build their own buildings, which are often transient or are frequently re-built. Alexander suggested that because the builder is the building user, the resulting architecture is 'unselfconsciously' adapted and 'fits' the needs of the user. On the other hand, he associated self-conscious design with the establishment of a distinct specialist profession of architects, who develop their own system of ideas, discourse and criticism. For Alexander, architecture became the self-conscious expression of the architect. He suggested that these academic and professional preoccupation are overlaid on and potentially mask the needs of the building users.

Fourth, in *Plug-in City* Peter Cook and the Archigram group (Cook, 1964) explored the idea of a technological urban service and support structure for flexible housing units which could be reconfigured to adapt to the changing, even transient needs of the occupants. The implication was that the occupants would be able to design, customise and reconfigure their individual units, within the defined constraints of the technological support system so that the overall architectural effect would be the aggregation of the occupants' designs. While *Plug-in City* represents a delightfully playful combination of science fiction, architectural fantasy and cartoon-like illustration, it effectively questioned how new construction technologies combined with new architectural thinking might transform the social, technical and professional status quo.

Fifth, in 1972 John Habraken published *Supports: an Alternative to Mass Housing* (Habraken, 1972) in which he advocated building public housing structures with continuous internal spans so that the internal spatial arrangement of the housing units could be customised to suit the needs of the individual occupants and potentially could be reconfigured for subsequent occupants. In the UK, architects at the Greater London Council (GLC) used the ideas of Habraken in the PSSHAK project (Rabeneck, 1975). PSSHAK stood for 'Primary Support Structures and Housing Assembly Kits'. This was used by the GLC in the design of public housing at Stamford Hill, Hackney and at Adelaide Road, Camden.

PSSHAK "was a system of prefabrication devised by Nick Wilkinson and Nabeel Hamdi, based on the writings of the Dutch architect Nicholas Habraken and designed for mass housing". PSSHAK "also aimed to demonstrate the feasibility and benefits of participatory design methods in the public sector, the designer acting as a 'skilled enabler' instead of the 'expert architect', approaches that Hamdi and Wilkinson have pursued ever since." (Rabeneck, 1975)

Sixth, during the 1970s and 80s the 'self-build' movement developed in the UK, in part by leading architectural pioneers such as Walter Segal. As Colin Ward has suggested, Walter

Segal's ideas challenged…..

"the assumption of both regulatory authorities and providers of finance, that a house should be a fully-finished product right from the start, rather than a simple basic structure that grows over time as needs grow and as labour and income can be spared. Segal's achievement was to devise a way of simplifying the process of building so that it could be undertaken by anyone, cheaply and quickly. He insisted that his was an approach, not a system, and he made no claims for originality or patents." (Ward)

The historical context and pre-cursor research all contribute to the arguments for Design Participation. The key issue is 'user satisfaction' or conversely the issue of 'user dissatisfaction'. We can further decompose this as:

- For most people, the building is not an end in itself, but is an intermediate object which indirectly may be satisfying because it enables activities which are the primary focus.
- The lack of user control over the immediate built environment creates a sense of powerlessness (hence user dissatisfaction).

In summary, it is generally recognised that the value of design participation comes from the process of participation (the sense of involvement and control) and from intangible aspects of the building rather than from measurable attributes of the physical building (Broome, 2005, quoting Turner, 1991 and Ward, 1985).

DESIGN CRITERIA FOR A SOFTWARE SYSTEM FOR DESIGN PARTICIPATION

The primary objective of the 'Computer aids for Design Participation' project was to create a computer system to support practical participation. Rather than focusing exclusively on these practical considerations, it was decided to implement this objective within the broader goal of creating a computer-based research tool which could be used to explore how participants design. What was being researched was more than a participant simply drawing or modelling of a building. It was a process of decision making and trade-offs in a highly complex multi-variate solution space. This combined both visual building geometry and other representations of requirements and building performance. Therefore a key element in the participatory design system was how to present information that could support decision making and trade-offs.

A key feature of the Habraken/Supports research and the Segal/self-build projects, was that they both offered the participants the opportunity to explore what might be called 'design freedom' but these systems also communicated the limits or constraints to that freedom. Therefore, it was concluded that it was also essential that a computer based participatory design tool should present similar design freedoms and also communicated the limits to this freedom so that the participants would be able to express their ideas, but not in an unrealistic way. There was a general feeling that the participants were vulnerable to having their designs dismissed (by professional architects) for lacking feasibility. Therefore the researchers felt that there was a need for the design system to support the participants in developing realistic and feasible designs.

The design of the participatory tools brought together existing research interests in performance-based architectural computing and human computer interaction, namely:

From the architectural computing perspective:

- The advantage of a computer graphic representation of a building is that it provides facilities for the user to create drawings and models which require less manual drafting skills and can be easily edited to create pristine alternative designs. This enables designers [both professional and lay participants] to experiment with different layout configurations and to explore trade-offs and the consequences of different design decisions. There are many additional benefits by representing a design in a computational form as it provides a direct link to performance analysis software.
- In the design of functional buildings such as hospitals and schools there may be complex space allocation rules or circulation requirements. Certainly for professional architects [and also by implication for lay participants] there is a need for 'decision support' tools to help the designers make these trade-offs and decisions. Often this involves dynamically re-computing space related measures as the consequences of design decisions.
- As a by-product of the computer graphics system used, both existing professional designs and the participants' designs could be represented with the same stylised graphics. This removed visual cues from the professional designs which might otherwise have indicated their professional origin and authorship. This allowed the professional designs and the participants' designs to be compared completely 'blind'.

From the human computer interaction perspective:

- A computer graphics representation of architecture is an important 'transitional' representation between 'man and machine'. It is 'human-readable' in that it can be viewed and edited as graphics by the designer [professional or lay participant] and it is 'machine-readable' in that it can be interrogated by other analysis and simulation software.
- A computer based interaction system can provide an adaptive learning environment, where the participants can develop their skills completely at their own pace, not forced as might be the case with a conventional tutor-student learning situation.
- Simple design rules can be encoded into the system in the form of a computerised expert tutor. The participants can be given optional advice about the viability of their design without any inter-personal pressure, which might be the case with the presence of professional expert.
- The participants' design activity can be instrumented for subsequent playback and analysis. This enables the participants' complete design process and all the intermediate steps in this process to be reviewed by the research team.

THE PARTIAL DESIGN RESEARCH APPLICATION

The resulting development of the 'PARTIAL' design research application represented the convergence of on-going research at ABACUS into the development and deployment of professionally-oriented CAD and architectural decision support systems and contemporary research in human-computer interaction to create task-oriented adaptive learning environments (Aish, 1977).

PARTIAL stood for **PART**icipation **I**n **A**rchitectural **L**ayout. PARTIAL assumed that there would be two different kinds of user: first, a researcher (or participatory architect) would define the participatory design task and who would review and interpret the results of

the participants' design and second, a number of participants who would create the designs. To support this research workflow, PARTIAL was in fact developed as a suite of three programs.

PARTIAL 1: this program was used by the researcher to define the design problem, including the space budget (or architectural program) and any fixed building geometry, for example if the design task was a conversion or extension to an existing building. The researcher could also select the different performance measures that would be displayed to the participants, including the visual characteristics of the performance display, its datum and scale. In addition, the researcher could select which tutorial and advice options would be available to the participants.

PARTIAL 2: this program was used by the participants within the context established by the researcher using PARTIAL 1. The design activity of the participants, how the architectural layout was developed and revised was recorded in a transaction or history file.

PARTIAL 3: this program was used by the researcher to analyse the transaction file, including the ability to display the state of the participant's design at any moment in the design history.

CHOICE OF BUILDING TYPE AND PARTICIPANT

One of the critical decisions in this research project was the choice of building for the participants to design and therefore the choice of participants. Many previous examples of design participation had focussed on housing. In this project we wanted to move away from domestic buildings and the associated issues of subjectivity and apply design participation to a functional building where there was a professional relationship between the participant and the building owner or institution. At the time of this research and in the immediate context (the city of Glasgow) there was an ongoing local government program to build nursery schools. It was decided to use nursery schools as the building type and nursery school teachers as the design participants. The ensuing participatory design sessions harnessed the very immediate and practical concerns of the teachers about the design of new schools which they might have to teach in. Also the researchers had access to a set of architect-designed schools to act as a reference for the participants' designs.

In practical terms, the design of nursery school had to fulfil complex space allocation rules or 'space budget'. Within the 'space budget' there were a defined number of rooms of different types. Both individual rooms of a particular type and the total area of all rooms of a particular type had to be within a defined minimum and maximum area . It was anticipated that as the participant was designing the school, it would be important to continuously re-compute the remaining space 'budget' yet to be allocated. This was not a task that the participant could be expected to complete using paper and pencil calculations. The participant's space allocation task could be more effectively support by a computer-based recalculation method operating continuously in the background.

The average of the performance measure of the set of professionally design nursery schools was also used as the 'datum' for the performance display of the participants' design (figure 4).

THE DESIGN PROCESS

The initial training was in the form of a tutorial where the researcher explained to the participants the key aspects of the program including drawing, the decision support tools,

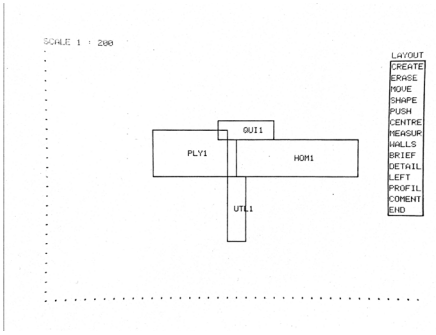


Figure 1 The participant's initial design sketch

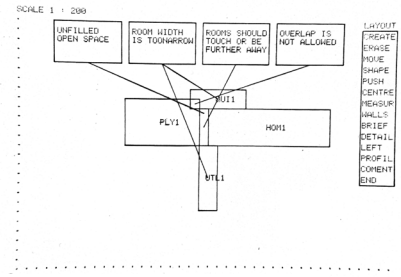
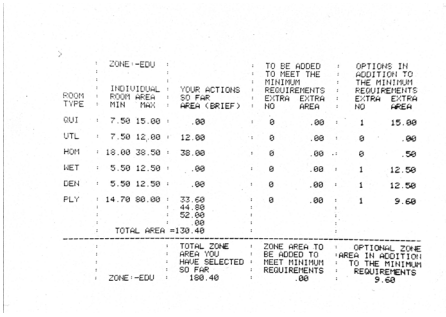


Figure 2 Advising on possible layout issues



ROOM TYPE	ZONE :-EDU : INDIVIDUAL ROOM AREA MIN	MAX	YOUR ACTIONS SO FAR AREA (BRIEF)	TO BE ADDED TO MEET THE MINIMUM REQUIREMENTS EXTRA NO	EXTRA AREA	OPTIONS IN ADDITION TO THE MINIMUM REQUIREMENTS EXTRA NO	EXTRA AREA
OUI	7.50	15.00	.00	0	.00	1	15.00
UTL	7.50	12.00	12.00	0	.00	0	.00
HOM	18.00	38.50	38.00	0	.00	0	.50
WET	5.50	12.50	.00	0	.00	1	12.50
DEN	5.50	12.50	.00	0	.00	1	12.50
PLY	14.70	80.00	33.60	0	.00	1	9.60
			44.80				
			52.00				
			.00				
	TOTAL AREA =130.40						

ZONE :-EDU	TOTAL ZONE AREA YOU HAVE SELECTED SO FAR	ZONE AREA TO BE ADDED TO MEET MINIMUM REQUIREMENTS	OPTIONAL ZONE AREA IN ADDITION TO THE MINIMUM REQUIREMENTS
	180.40	.00	9.60

Figure 3 Checking the space allocation

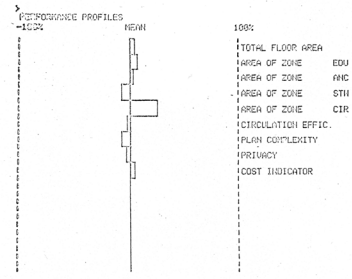


Figure 4 Displaying comparative performance

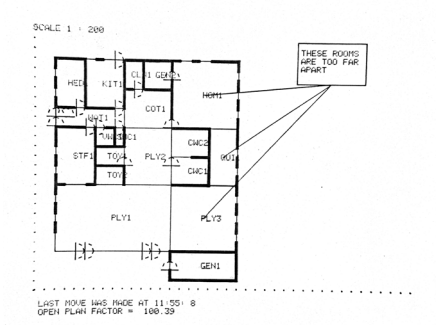


Figure 5 Space allocation during the design process

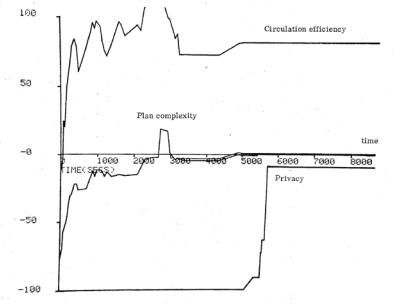


Figure 6 Changes in layout performance

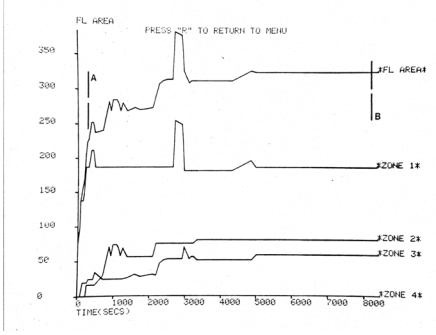


Figure 7 The participant's design at time **A**

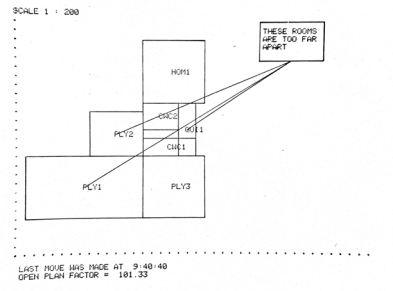


Figure 8 The participant's design at time **B**

and the evaluative tools. Typically the research would explain, “this is how you draw a room” (figure 1), “this is how you check that rooms you have drawn forms an appropriate room layout” (figure 2), “this is how you check that your design is within the space requirement” (figure 3), “this is how you compare the performance of your designed with other existing nursery school designs” (figure 4).

One participant interrupted this explanation, turned to the researcher and said, “You can go away now. I am going to design my nursery school”.

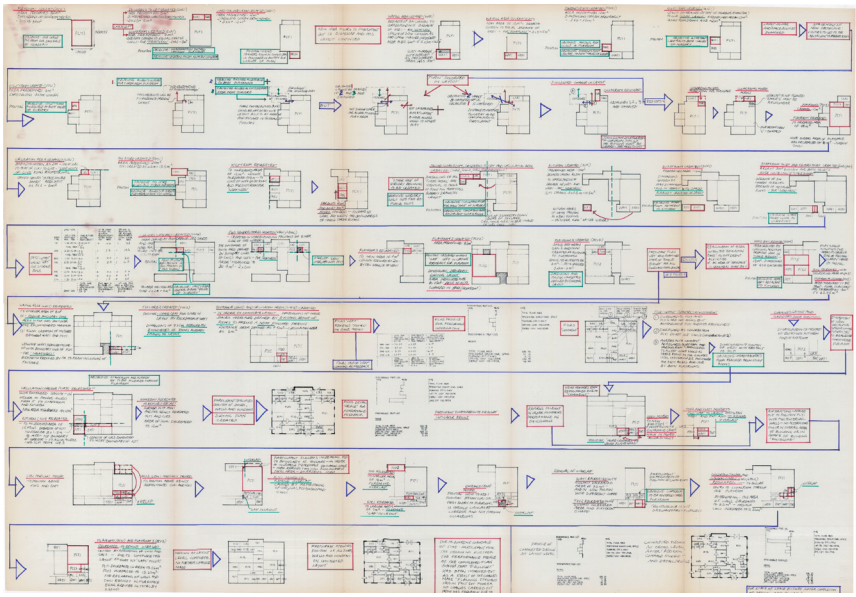
Using PARTIAL 3, the researcher was able to replay the history of the participant’s design process. Figures 5 and 6 show different aspects of the design history as the participant’s layout of the school evolved. The initial part of the design process appears to involve the build-up of room areas while the subsequent part of the process appears to be focussed on changing the design to improve layout performance. The researcher could select different points on the time (x) axis in the design history graphs and recover the participant’s design at these time points. For example in figure 5, the researcher has selected times **A** and **B** and the corresponding participant’s designs are displayed in figures 7 and 8.

CASE STUDIES

A number of case studies were carried out using PARTIAL with Nursery School teachers as the design participants (Aish, 1979), (Watts and Smith, 1979) and (Smith and Watts, 1979), including:

- Asking participants to rank existing professionally designed nursery schools
- Asking the participants to design their own nursery schools including some very detailed recordings of the design protocol used (figure 9). These studies demonstrated the number of different design requirements and issues that the participant was concerned with and was able to manipulate and combine into a single coherent design solution.
- A second ranking exercises where the participants were asked to rank all the participants’ design including their own. It was not surprising that each participant ranked their own design first.
- A group design sessions where a number of participants combined their individual designs into a common solution.
- A third ranking exercise after the group design session. In this third ranking task, the group design was also included in the set to be ranked together with all the individual designs.

Interestingly on the re-test, it was the group design which was consistently ranked first. “In fact in most cases, the individual considers the eventual group design to be more acceptable than their own original. This would suggest that cooperative involvement produces a more satisfactory outcome to the participant”. (Watts and Smith 1979) Watts and Smith addressed the question of how to objectively evaluate the participants’ design. They selected six designs developed during the previous participation sessions and six professional designs. The professional designs were redrawn using PARTIAL so that all the designs were presented in the same stylised graphics used for the participants’ designs. The two groups of designs were randomly merged into a common set, thus creating a completely ‘blind’ ranking task. The use of the same stylised graphics meant that there were no visual cues which could be used to distinguish the professionals’ and participants’ designs.



▲ **Figure 9** A detailed recording of the design protocol used by one of the participants (Watts and Smith, 1979).

A group of professional architects, not involved with the design projects, were asked to rank these designs in order of preference and similarly a group of nursery school teachers, not involved in the participatory design project, were also asked to rank the designs. The 'non-involved' architects equally ranked the architect-designed schools and the participant-designed schools. Effectively this meant that a group of independent professional architects could not distinguish the architect designed schools from participant designed schools. The 'non-involved' nursery school teachers consistently ranked the participant-designed schools above the architect-designed schools.

"It would appear that the participants were able to produce layout designs which were as acceptable to ['non-involved'] architects as those produced by architects using a comparable brief, and more acceptable to fellow ['non-involved'] school teachers than those produced by architects" (Watts and Smith, 1979).

CONCLUSIONS FROM THE PARTIAL RESEARCH

The PARTIAL project at ABACUS combined some highly original developments in end-user interactive computing with the formal testing of the effectiveness of these tools in architectural design. One of the key aspects of the PARTIAL system was the 'instrumentation' of the participants' design process. There are many further aspects of design participation that could have been explored with this system but time and resources did not allow. For example, the potential exists to analyse the participants design strategies, how different aspects of the design layout were developed or abandoned. Then there were the group design sessions, where it would have been fascinating to monitor the negotiations between the participants and to track how different aspects of the various participants' design were selected, combined or transformed into the group design.

OTHER RELATED RESEARCH

There are other related research areas, although a more detailed description and discussion is outside the scope of this paper.

RESEARCH INTO 3D TANGIBLE USER INTERFACE FOR DESIGN PARTICIPATION

During the participation research there were concerns that computer graphics may not be an ideal interface for lay designers and that a 3D Tangible User Interface (TUI) might offer a more direct way for the participants to create and review their work. A TUI could be a form of Lego which the participants directly modelled. A TUI is also 'machine readable', thereby providing input into a computational design system. In the late 1970s and early 1980s the development of 3D TUIs was pursued independently by a number of researchers. This research and its application to the Segal self-build system was reviewed in the 'Architects' Journal' (Evans, 1985). It was concluded that this type of interface may offer some advantages up to a certain level of complexity, after which its utility diminishes. The coarse 'granularity' and other positional and angular limitations essentially interferes with the architectural expression and fidelity of the user's design and significantly restricts expected 'design freedoms'. While it may be easy to initially construct a model with this type of 'block modelling', reconfiguring the physical model soon becomes significantly more arduous. The advantage of tangibility is outweighed by the loss of fidelity. Similar criticisms have been applied to other architectural applications of Lego, for example by Changizi (2012).

MASS CUSTOMISATION

Commercially available mass-customisation is usually restricted to the customer's choice of colour and finishes and does not allow for any change in configuration. This type of mass customisation does not appear to be relevant since it fails to address the issue of the participants' control over 'configuration' which is generally recognised to be the key 'design freedom' in participatory architecture. There are examples of mass customisation of furniture using consumer-driven parametric variation of a standard prototype. It is difficult to see how this would scale to architecture. Different approaches to mass customisation at both the product and the architectural scales are discussed by Kolarevic (2015).

DESIGN PARTICIPATION BY SELECTING FROM PRE-COMPUTED OPTIMAL DESIGNS

Doe and Aitchison (2015) researched consumer choice in housing where the client can select from a set of precomputed *pareto* optimal house designs. All designs are equally energy-efficient but have different configurations and achieve their efficiency is different ways. While this is an interesting experiment, the participants are not in control of the configuration. For example, we might hypothesise that a participant might prefer their own configuration even if it might be marginally less efficient than the set of precomputed designs on offer. However, this research did not support this approach.

Therefore there is little opportunity for the participant to explore 'design freedom' or for the participant to learn about trade-offs between configuration and building performance.

GAMIFICATION OF DESIGN

'Block'hood' is a design game developed by Sanchez (2015). It is recognised that games can sometimes provide a better understanding of certain systems and processes than other more conventional forms of presentations or explanations. However, games often present a limited, risk-free, sanitised view of reality. While games have the potential to provide training for some real world activities, the challenge is how to help the 'gamer' make the transitions to 'real-life'; specifically does the 'gamified design environment' present realistic design freedoms and constraints. Could a design created in such an environment actually be constructed? 'Gaming' may be satisfying. The concern is that it can become an end in itself and a substitute for reality.

EDUCATIONAL IMPLICATIONS

Participation is not just a question of a professional architect 'consulting' the future building users, selecting which of the participants' ideas to include and then assuming responsibility for the design. Participation means that the potential building users are the creative drivers of the design process, with... "the designer acting as 'skilled enabler' instead of the 'expert architect", as Hamdi and Wilkinson suggested (Rabeneck, 1975).

So what is the role of a participatory architect? Let us compare this role to that of an architectural educator. An architectural educator is usually an accomplished practitioner in their own right who additionally uses their creative skills to help their students to develop their own creativity.

Similarly a participatory architect should also be an accomplished architect in their own right who uses their creative skills to help participants to design buildings which are their expression.

Participation requires some re-focussing both educationally and professionally. The architect role changes from being the designer of the individual building to a broader more strategic role, that of being the 'systems architect' of the whole participatory process. Indeed, there are some really interesting 'system design' challenges for the architect. For example, one challenge might be creating a robot-assisted self-build system, using reconfigurable components, which could be potentially used for retrofitting existing buildings. Another software and usability challenge might be to create the next generation of computational participatory design tools, potentially using 'augmented reality' and simulation-based design. This 'systems design' role is no less creative than conventional architecture, but designing the tools and processes that encourage other peoples' creativity may require additional technical insights and skills.

CONSUMER SYSTEMS ARCHITECTURE

There are new opportunities: Architecture has the potential to be a critical part of a 'consumer electronics - digital media – built environment' spectrum of customisable 'user experience'. Design participation has the potential to be applied to all levels of this spectrum.

To this end it is proposed that the ideas pioneered in past 'Design Participation' research and community architecture should be consolidated and updated into a new course on 'Consumer Systems Architecture'. This course would address the question: what are the concepts, methods and skills that a participatory architect will need to be equipped with to serve and to prosper in the 21st century?

It should be stressed from the outset that the proposed course would be completely complementary to existing architectural education. It would build on established traditions of developing the students' ability for original and critical design thinking. Building on this foundation, the course would be extended in two complementary directions: first, it would have a strong social dimension, implied by 'user centric' and 'community centric' design and second, it would have a strong technical dimension, focussing on a broader range of electronics systems and computational and interactive technologies.

The title "Consumer Systems Architecture" combines:

- *Consumer*: because the course is completely consumer and community oriented

- *Systems*: because the course focuses the student on the 'systems design' issues involved in the participatory design of different types of buildings rather than on the student's own design of a particular building.
- *Architecture*: because the course unifies the concepts and practice of 'systems architecture' with 'building architecture'.

Building on existing architectural education (with its focus on context, form, function and making) this curriculum and the related design projects might include:

- *Computer Science*: Computation underpins all aspects of algorithmic design, embedded and real-time systems and human computer interaction. The emphasis of this module is to help the student progress from 'exploratory' programming to a more sustainable form of software engineering based on computer science concepts and software design methods. Just as with drawings, models and essays, architectural principles of structure and legibility should be applied to all aspects of the students' work including programming. Related design project: Write a program for someone else (not the student) to use and then evaluate its usability.
- *Human Computer interaction*: Principles of HCI and User experience (UX) design: The emphasis of this module is to help the student understand the different capacities of humans and machines and how these can be combined to create an effective man and machine system. Related design project: using software tools (such as 'Processing') to create a simulated user interface, for example to control an environment and validate the interface design by testing it with a panel of lay consumers.
- *Systems Integration*: Study the role of different engineering systems in buildings and how these can be integrated, including the role of multi-functional components that perform key roles in unifying different building subsystems. Related design project: design a multi-functional component and demonstrate its role within a building configuration.
- *Design Optimisation*: Understand how to create and navigate a design 'solution space' and how to create a fitness function. Related design project: use design computation tools to build and explore a solution space. Test the use of the design space solution explorer with professional architects and lay building users.
- *Consumer research*: Understand consumer demographics and how to find or create a market niche. Related design project: research the market for a new architectural user experience, architectural product, or service, including holding 'focus groups' to gather ideas and validate design assumptions.
- *Community and consumer engagement*: Understand different models of social engagement in design, including: mass customisation, design participation, team decision-making, direct democracy. Related design project: select a building type and a group of participants and conduct a 'design participation' project, including the selection of design rules and performance measures to be used. Compare the participants' designs with professionally designed buildings of the same type.
- *Research Methods*: Architecture integrates ideas across the whole spectrum of the sciences, social sciences, humanities and the arts. This integration often blurs the distinction between the essential and the expressive, between performance and persuasion. A student architect needs to be a passionate creator but also a dispassionate and rigorous evaluator of architecture, particularly of their own work. An architectural education should help the student prepare for the integrator and the evaluator roles. It should help the student to understand the different types of theories and research methods in the sciences, social sciences, humanities and the arts and given them the opportunity to practically apply the different research methodologies.

A 'Consumer Systems Architecture' course would be an example of research-based architectural education which harnesses the students' design creativity, but also gives the students practical experience of using empirical research methodologies to validated design ideas by consumers. In this way we can educate a new generation of architects who are technically and creatively equipped to drive the 'democratisation of technology' and thus the 'democratisation of architecture'.

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[Note: The ABACUS occasional papers referenced here are currently being digitised and are expected to be available on CUMINCAD http://cumincad.scix.net/cgi-bin/works/Home in the near future]

Digital tools beyond aesthetics: mass creativity and the enablement of emergence

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INTRODUCTION

Digital design tools are now undergoing a transition of application scope, expanding beyond their initial technical domains and leveraging the flexibility of the digital medium - in which they exist - to its fullest extent.

Digital means of communication are enabling the self-organisation of new cultures as well as decision-making structures revolving around the possibilities inherent to the digital realm. Design tools are slowly catching up - to a certain extent – by building upon the flexibility of parametric design in order to improve the communication channels of the design process, thus signalling the achievement of a certain "digital maturity" of the architectural design community. Unfortunately, the current state of collaborative design software is catering exclusively to the needs of the technical stakeholders involved in the design and building process, namely architects, engineers and builders. In our contemporary world, where social change and action is not only supported but triggered by digital communication tools, the design disciplines stand to lose credibility if they will not take initiative and tap into the existing expectations of collaboration that today's society now harbours.

The following paper puts forward a new research direction for the design of digital tools that aims to investigate ways in which to make the design process more open and approachable by non-technical stakeholders. A design never exists independently from the tools that are used in its creation and vice versa. As such, it is important to note that this entails both a technological development effort as well as the elaboration of a methodological package that supports the meaningful usage of said tools - essentially an active tectonic study that manifests as an accelerated feedback loop between both tool and process development.

STRUCTURE

In the first section we put forward the concept of mass creativity as an extension of mass collaboration. Within this context we introspectively define the role of an architect as a translator between the various interests of the stakeholders involved in the design process. The second section subsequently looks at the tools that a designer has at hand to accomplish this role. We critically analyse the notational paradigm upon which contemporary digital tools are based on and outline both their disadvantages and strengths that can be speculated. Following this, the third section concerns itself with outlining a case study which reveals how a different approach to using digital

design tools – one that renounces the classical notational paradigms – can be applied. Two more similar examples are outlined in the fourth section in support of "de-aesthetised" digital design. We subsequently conclude by acknowledging the importance of creating digital tools and methodologies that support the designer in fostering the emergence of mass creativity, thus responding to one of the main challenges of today.

A CASE FOR MASS CREATIVITY

Collaboration has become embedded within today's design environment as projects are no longer the result of an isolated creation process, but an emergence of a myriad of interactions between various human and non-human actors. Architects, engineers, banks, communities, politicians and various other animate and quasi-inanimate agents contribute towards the final embodiment of a specific design and its subsequent evolution.

As such, we can justly state that the built environment is, at a global level, an emergent feature that results from countless interactions of material and social flows. Extrapolating further, there is no fundamental difference to speak of between the laws that govern the processes that give birth to cultural artefacts, and those of natural artefacts: they both share the same generative principles loosely aggregated under the umbrella term of "emergence".

The contemporary new materialist school of thought, spearheaded by science and technology studies and anthropology, have gone further and argued for the dissolution of the Modern dichotomy between Nature and Culture (Latour, 1993), (Descola, 2013). Furthermore, the concept of a static, finite, encapsulated object is no longer valid. In its place we now observe the emergence of large-scale patterns from the interactions of various flows of matter-energy. Bruno Latour calls them quasi-objects: objects that are only defined by their web of interactions - a conglomeration of threads representing process flows that give birth to recognisable features (DeLanda, 2000). These ideas lend themselves well to aspects of computational design that we shall elaborate on in the following section.

One of the most powerful implications of this "non-modern" context is that we, as designers, are part of the swarm of decision makers whose actions lead to the crystallisation of the built environment. Our creativity and contribution to the development of a project is equally valuable as that of all the other stakeholders involved in the process, both animate and inanimate.

What seems initially to be a harmless statement of the *status quo* becomes a game changer if properly embedded into the rationale of design methodologies: it entails a redefinition of the architect's scope of action and role. To a certain extent this has always been the case - nevertheless by centring the above statement as the core of the designer's position we do raise the need to adapt both the methodologies that we apply when designing as well as the tools we are using to communicate and enact that respective design. The role of the architect as "master builder" is no longer feasible due to its scope which, within the contemporary practice, expands to unsustainable dimensions.

Nevertheless, one can argue that the designer - within the group of stakeholders associated with a project - has a polarising position because he needs to process information flows coming from a wide array of sources: architectural, economical, social, etc. This does not translate to a position of control, as "classical" architectural education would teach us - it is a position of greater responsibility. If we define a design project as an emergent feature from the interactions of various agents, then the architect's main role is thus revealed as

being the facilitator of meaningful interactions between all the relevant stakeholders.

Consequently, the designer is a conduit of communication, constantly translating between the languages of expression of the various stakeholders involved in the project, including his own. Among the many languages spoken we find, for example, financial analysts talking in future values and internal rate of returns, engineers articulating finite element analyses that evaluate a design for its structural consistency, local communities voicing their ideas in social terms that do not lend themselves easily to quantification, and so on.

Essentially, an important point to acknowledge is that all stakeholders are creative. For example, the financial design that enables the project to be built embodies the same qualities as the innovative concept that the designer brought to the table. The expression of this creativity takes various forms and is not universally translatable across different groups without active effort. Ideally, the design process is not one of just mass collaboration, but one of mass creativity that results from a harmonious negotiation process.

DESIGN TOOLS & ARCHITECTURAL NOTATION

The means of communication and tools an architect has access to need to enable the expression of creativity from all involved stakeholders. In such a diverse environment, as usually is coagulated around contemporary design projects, the lack of good communication channels and/or the inability to translate between disciplines and interest groups usually leads to friction, dissatisfaction and compromised results.

Classical architectural notation, developed by Alberti in the 15th century, has focused on developing identical copies between the design of the building (virtual) and its embodiment in reality (construction) (Carpo, 2011). Plans, sections, elevations, and so on, are essentially schematic notations that encode architectural information into a language that is controlled by a certain set of standards. As such, one can design, communicate and build within a single system.

Digital design tools have evolved as analogues of the same paradigm as classical architectural notation, their main goal being that of making identical copies of the information that they encode. For example, Ivan Sutherland's Sketchpad program, considered the precursor to all CAD software, was essentially a digital drafting tool: it replaces the draftsman's traditional pen with a "light-pen" and paper with "digital" paper. As such, we can argue that the notational mechanisms of today are identical to that of classical architectural script, which has remained unchanged since the Renaissance. To this day, all architectural drafting software is essentially a direct transposition of Albertian notational principles into the digital medium.

Another notable evolutionary step in the design of digital tools is that of the increased linkage with fabrication techniques and construction site management. By weaving together building and material constraints, digital tools have greatly expanded the geometrical vocabulary that is now accessible to the designer. This movement, which began in the early 1990s, has been appraised as "The Digital Revolution". In its first stage it negated the principles of mass production and standardisation by introducing a new formal agenda based upon the new found expression liberties offered by the "isolated" digital medium (Carpo, 2013).

This leads us to the second stage of the digital revolution in architectural design; going beyond mass customisation, by speculating the qualities of the "connected" digital

medium. In this way, we would argue for the transition to mass collaboration and, subsequently, to mass creativity, thus empowering the contemporary design process – one in which every stakeholder is creative and is able to define value.

In the past, exploration of variation was limited due to the friction of the analogue medium (pen and paper) in which architecture was expressing itself. The virtual realm has effectively eliminated this barrier and thus paved the way for a comprehensive exploration of the "objectile" (or quasi-object) (Latour, 1993). Software like Grasshopper or Dynamo enable the architect to no longer be author objects, but processes whose result is not a single finite object, but, as mentioned above, quasi-objects, or families of objects. Various performance measures – feasibility, material constraints, etc. – usually act as selection criteria which collapse the objectile into a single object that is subsequently built.

Here we have to make a technical distinction between the "isolated" digital and the "connected" digital. Current digital design tools rely mostly on the qualities of the "isolated" digital medium, i.e. embodied in a single technological unit: the designer's computer. Collaboration is achieved by packaging finite designs and exchanging them via emails or other surrogate management systems. The connected digital medium - i.e., the internet - offers a wildly different set of qualities that are yet to be integrated and repurposed for the use within design process.

Generalising, the current Albertian notational paradigm does not address the need for a flexible and interchangeable language that would allow the designer to enact his negotiator role. While being extremely efficient for aesthetic and technical exploration, digital tools still structure communication in a non-agile way that is focused on describing the "final" object. The vocabulary it uses is not always flexible enough in order to be articulated in an accessible way for all stakeholders, both technical and non-technical.

CASE STUDY: PROBLEM & CONTEXT

When we are faced with a set of tools for a linear process, for instance, packaging a finished design to email to a client, the space for unexpected encounters (emergent possibilities) is narrowed, forcing a design environment that lacks in dialog. Non-technical stakeholders (communities, financial analysts, government authorities, etc.) are not yet integrated in the (digital) design chain - on the contrary, current practice usually positions them in an adversarial role and does not allow them to exceed their pre-assigned conflictual position due to the limitations of existing design tools and methodologies.

This problem manifested itself during the development of a feasibility study for a future large-scale urban development in the heart of Brussels, the "traditional" design approach failed and a new, flexible design process had to be developed and communicated in order to meaningfully respond to the questions posed by the assignment. This study was undertaken by the author while employed at Bogdan & Van Broeck, an architectural consultancy and design office based in Brussels. Specifically, the assignment called for an exploration of the possible directions in which a large site owned by the Flemish Government could evolve within the context of a PPP (public-private partnership) development. Initially the brief required an investigation into the functions that would meaningfully fit on the given site coupled with volumetric explorations on various organisational principles that would accommodate the given proposed functional programmes.

The main stakeholder groups involved in the project consisted of The Flemish Government (VO), The Developers and Private Investors and, finally, The Policy Makers. Bogdan &

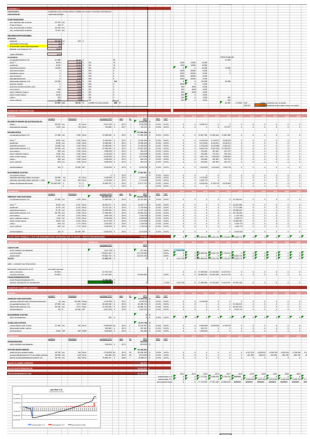


Figure 1 Initial Excel Model: this was developed together with REBEL Group, a financial consultancy office. The model embeds architectural and urban constraints (functional and spatial) coupled with financial logic based on current investment profiles

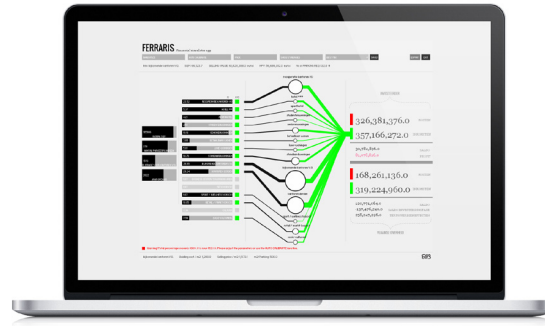


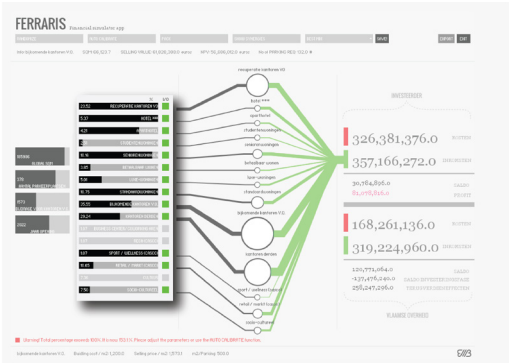
Figure 2 Final Application: A cross-platform app was developed that allowed any user to manipulate the model in an intuitive way, using standard interaction conventions (sliders)

Van Broeck, as the office in charge of elaborating the study, was situated as a mediator between all three parties. When the initial outline of the study was being formulated, the traditional approach was failing due to the fact that the representational means were not adapted to the interests of the stakeholders that had vested interests in the project. "Classical" architectural notation and drawings, while being seductive and incorporating a great amount of information in an efficiently small package, were not embodying the right message and were forcing a specific approach that was destabilising the design process.

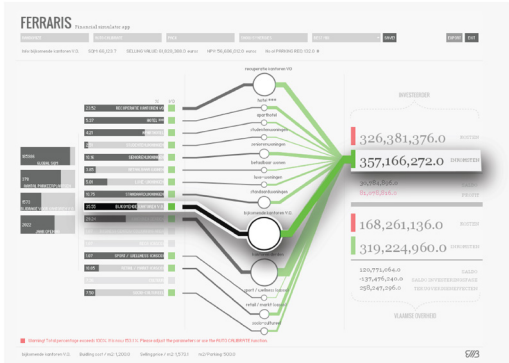
With hindsight, we can say that the main problem was the language used to communicate and synthesize the decisions being taken. Urban and architectural plans, coupled with textual descriptions, were not versatile enough to translate between the interests of all the involved parties. For example, variations of the masterplan were proposed in a traditional form, with schematic drawings. These were coupled with textual descriptions that presented social implications and financial outlooks that emerged from the design process.

While initially an unassuming presentation mode, this was triggering The Flemish Government's representatives to request more detailed and eye-catching designs, while the policy makers were increasingly sceptical due to the apparent lack of "substance" that the increasingly realistic presentation drawings were making. At the same time, the developers were becoming convinced of the fact that the proposals were not actually financially feasible due either to their too "glossy" nature or due to their too high "socially-aware" functions. This led to the development of mistrust between the involved parties, subsequently halting the design process.

While the proposed solutions were, essentially, the embodiment of the negotiations between all stakeholders involved, they were not revealing the inner mechanics of the synthesizing process that we were undertaking. The negotiation process required to develop the proposed scenarios was not visible – even if value was defined taking into account the priorities of all stakeholders, it was not collaboratively defined. As such, consensus was



▲ **Figure 3** Parameters were split into two main categories, global financial assumptions and functional percentages. Easy to use sliders allowed for their modification and real-time visualisation of changes



▲ **Figure 4** Information flow: by graphically displaying the relationships between input parameters and output, the system revealed its dynamic structure, thus allowing for the global understanding of the trade-offs involved

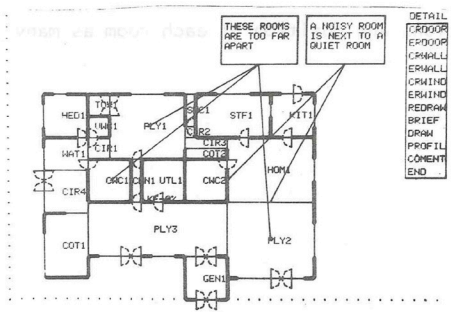
impossible to reach: the three parties involved did not understand each other's priorities and what impact they have on the other's set of parameters.

To sum up, the stakeholders did not speak the same language. Classical architectural notation, based on the representational paradigm, was not enough to enable communication between the project's actors – on the contrary, we can argue that, because it was forcing the designers to present "finite" objects/geometry, it was detrimental to the design process.

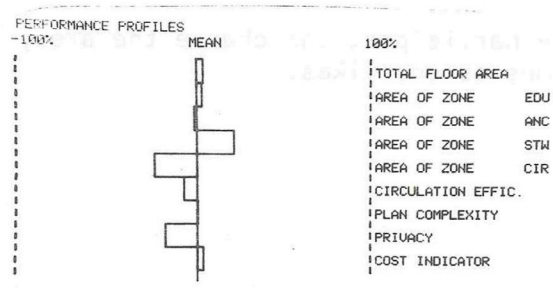
CASE STUDY: RESOLUTION

We realised that the value of the feasibility study we were elaborating lay not in the actual finite designs that we were delivering, but in the processes of communication and translation that we were undertaking. As such, we decided to package the negotiation process itself into a deliverable tool by creating a simulacrum of a "dj mixer" that will allow intuitive control of relevant parameters, provide users with direct feedback regarding choices and be relevant to all stakeholder groups, regardless of their background. This was achieved by developing, together with a financial consultancy firm, a parametric model that took into account architectural, urban and, most importantly, financial parameters (figure 1). Subsequently, this model was transformed into an interactive negotiation application that was made accessible to the extended group of stakeholders as a base for negotiation (figure 2).

During the development and (brief) testing of the application, several important aspects were revealed as being critical. First, the categorisation and selection of parameters played a crucial role in alleviating the "paradox of choice": when confronted with a wealth of modifiable inputs, the users were unable to reach a satisfactory solution. As such, reducing the parameters to the minimum – without sacrificing any critical ones – was instrumental to reach the increased accessibility levels desired. Second, the inner logic of the model was hidden from the end-users. Parametric models can be daunting to the non-expert, and, subsequently, discourage them from their usage. This resulted, in isolated cases, in a diminishing of trust in the calculations being performed. Nevertheless, this negative aspect was outweighed by the fact that previously non-technical stakeholders, previously shy but expressing a strong passive discontent, were now willing to approach and join the



▲ **Figure 5** PARTIAL interface & design evaluation, based on participant's own subjective criteria of evaluation. © Robert Aish, Jan Fleming



▲ **Figure 6** PARTIAL performance profile of the participant's design, compared within a self-referential frameset. © Robert Aish, Jan Fleming

conversation due to their new-found empowerment. Their inclusion was instrumental to unblocking the design process.

Third, and most importantly, we emphasized the flow of information by graphically displaying the links between all relevant parameters and their implications (figure 4). This allowed the stakeholders to understand and grasp the implications of their preferences with regard to the others' definitions of value (and profit). A global understanding of the system resulted: all actors involved in the design process were finally aware of each others' priorities and ways of thinking. It was through this distributed global understanding of quality and value that the proceedings were unblocked. Essentially, the study's main value revealed itself in the creation of the aforementioned sense of understanding between the stakeholders.

BEYOND AESTHETICS

Up to now, the flexibility of the digital medium has been leveraged purely for the aesthetic exploration and technical optimisation of designs which, ultimately, are collapsed into one "single" or "final" solution. Nevertheless, we strongly believe that, to a certain extent, digital tools can now go beyond aesthetics. How can digital tools go beyond aesthetics and help the designer in his role as a conduit of communication? We have presented above one example of how a parametric model can act as a translation tool between the various languages employed by a specific set of stakeholders, both technical and non-technical.

Another recent example can be found in the work of Dominik Holzer and Steven Downing, *DesignLink* (Holzer, 2010). The authors propose "optioneering" as a design methodology that encourages "a form of discourse where design partners negotiate the criteria space for a design problem at the outset of their collaboration" (Holzer, 2010). Coupled with DesignLink, a software specifically developed to enable this kind of high-frequency collaboration, albeit amongst technical stakeholders only.

An outstanding example of using digital tools as a communication instrument that leverages collaborative design principles can be found in the work of R. Aish and J. Fleming from 1977 (Robert Aish, 1977). The authors devised a parametric computer aided design system (PARTIAL) geared towards defining a context in which both professional designers (architects) and end-users can collaboratively design and evaluate a particular building type. The authors' intention was to "provide a context where the designers/

participants could combine their own subjective design ideas with the necessary technical requirements" (Robert Aish, 1977).The research presented by the authors is from a time when the "connected" digital medium (the internet) didn't exist yet in a form that was accessible to all, or, for that matter, had a name. Nevertheless, it shows great foresight by aiming to enable all participants to "operate directly on [...] a complex, multivariate, but nevertheless, extremely real decision making process" through the use of digital design tools.

Enabling participation and, through which allowing for the emergence of mass creativity, should be a key driver in the development of future design tools. Non-technical stakeholders must be included in order for one to be able to properly define value in a collaborative manner. "Quality" can mean one thing for the developer and a completely different thing for the designer, and hold yet another meaning for the surrounding community. As such, digital design tools must start to respond to the need of communication and translation between various stakeholders.

CONCLUSION

Today's society is expected to be digitally involved: from Facebook and Twitter enabling social change to platforms such as Github (which allows anyone with the right skills to creatively contribute to the development of a software project), Peer-to-Peer networks and Bitcoin (a digital currency which exists as decentralised entity on all its users' connected computers), and so on and so forth – the examples are endless.

Bringing together the non-modern context in which the design disciplines currently stand with the realities of the business environment reveals a complex web of interaction that requires careful articulation and negotiation. Creativity is not an isolated phenomenon under the exclusive rights of the designer, but a distributed quality that emerges from numerous interactions. As such, the role of the designer is transcending its simplistic understanding of "master builder" towards a "master negotiator" and an enabler of meaningful interactions.

It is in this context that, in order for a project to go forward, value needs to be defined collaboratively and as a shared sense amongst all the involved stakeholders. Current communication methods that are available to the architect rely on a notation that does not fully cater to these needs, and, as explained in the case study, sometimes can hinder it. Designers need to be able to orchestrate "a positive and spontaneous co-creative and emergent process" (Wood, 2007).

Digital tools have inherent qualities that have yet to be purposed towards these applications. We are already no longer designing finite objects, but rather processes that give birth to a set of objects. These "objectiles" are only defined by their network of interactions – of which, we, as designers, are in control.

Digital parametric models can go beyond aesthetic and technical exploration: they can embody a narrative and subsequently be the base of collaborative decision making. The flexibility of computational design can and should be used outside the architectural office and its technical collaborators. Nevertheless, we would like to end on a note of caution: "the choice of representation affects the process of design and should be understood prior to the creation and use of intelligent computational systems" (Sean Hanna, 2011). Tools can be used for good or for bad: a hammer can be used to build a house or to destroy an ancient statue, social media can be used to organise a legitimate protest or manipulate

people towards dubious causes. The responsibility of articulating a meaningful design is still in the hands of the agents enabling it to happen.

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Insights from NTNU live studio

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ABSTRACT

This paper will explore the context and conditions for co-curricular live projects in architectural education at the Norwegian University of Science and Technology (NTNU), Trondheim. We have named it 'NTNU Live Studio: beta'. In spite of their 'global dimension', live projects are local. They are anchored in the particular cultural, local and institutional setting that constitutes the very driving forces behind the student-initiated activities at NTNU. The challenges and opportunities of the NTNU live projects model will be discussed thought three lenses: local conditions, learning outcomes and impacts on the profession and society. The discussion will be guided by this question: is a live project just a tool for learning and teaching, or does it hold strategic potential in contributing towards a transformation of student, teacher, profession and community?

The NTNU model applies a pragmatic aesthetic approach towards building, yet challenges the prevailing professional paradigms by acknowledging the societal forces calling for a different type of professional. We will be discussing not only NTNU Live Studio: beta's recognition of the professional importance of practice, but also highlighting Live Studio:beta as an entrepreneurial catalyst for business and professional reorientation. The staff and students participating in live projects at the Faculty of Architecture act within a community of practice (CoP). This secures the balance between students' freedom and project ownership on the one hand and the necessary academic and professional follow-up by the institution on the other. Research on Live Studio:beta is a work package in the faculty's research program on transformative learning in architectural education, Transark.

INTRODUCTION

This paper presents the approach and acumen of the NTNU Live Studio:beta at the Faculty of Architecture and Fine Art, a program recently granted the 2015 Quality Enhancement Award from the Norwegian Ministry of Education & Research. The program emerged both in response to teachers looking for more relevant and thus more efficient approaches to learning and to the energy and engagement of students trying to circumvent the limitations of the traditional studio. There is a tradition and culture for Design –Build and Live Projects in the NTNU curriculum as well. This paper, however, concentrates on the co-curricular student initiated projects and program. NTNU Live Studio is organized as a dual model with a mentor hub and the student hub, hence Live Studio:beta.

The paper is based on written reflections from participating students over the last 5-6 years and our own experience as teachers. It ends up through an analysis of the student feedback in a set of new questions. These drive

at the institutional challenges relating to mainstreaming this approach both in educating professionals in general, but specifically in how to generating relevant insights and strategies for future architects to also actively engage with the economic and social challenges we all face.

The pedagogical-didactic approach in architecture education has for a long time been dominated by so-called 'studio teaching', i.e. simulation of architecture and planning projects in controlled learning environments sheltered from the social and material realities that confront all projects that are to be implemented. This approach is rooted in the Beaux Arts tradition, and deeper down in the mind-body dichotomy. Weaknesses in studio teaching have been acknowledged and discussed for many years. Bauhaus, for instance, was established in reaction to this approach. Frank Lloyd Wright, in 1931, openly warned against entering an architecture school "except as the exponent of engineering" (Kaufman & Raeburn, 1931/1961). Fifty years on Peter Buchanan wrote, *What is Wrong with Architectural Education? Almost Everything* (Buchanan, 1989). He sluggishly followed up 20 years later (Buchanan, 2011; 2012), so did Till (2009) and Skotte (2009; 2014) – and many, many others. Still, very little change has taken place. The reason for this institutional inertia may rest in the nature of academia and its power structures, but also, as Ivison and Vandeputte (2013) claim, in the present utilitarian, or neo-liberal nature of higher education.

The proposals by writers and alternative practices already applied at many schools all suggest that the present day challenges require not only new skills and knowledge, but also a new understanding of our professional role, a new concept of knowledge and new methods. It requires active dialogue, real interdisciplinarity and empowerment of users and citizens based on what Salama (2015) would label 'trans-critical pedagogy'. This is what we humbly have been trying to abide by.

UNDERPINNINGS

We have to be honest, not merely academic. The NTNU Live Studio:beta program evolved over time, not as a resolute decision grounded in theoretical speculations. Several contingencies overlapped in time to ground the program within the faculty. New staff conceptualizing architecture in a more practical sense. Staff realizing the deficiencies in 'studio teaching' setting up alternative workshops. New and existing faculty programs adapted, or demanded, a more pragmatic and socially responsive academic approach. All this was taking place against the backdrop of students eagerly exploring the fields outside the 'academic box'. It has been a reflexive process where insights gained through experience have affected subsequent strategies. Beneath it all was the realization that architecture constitutes a societal strategy, and 'what' students learn depends on 'how' they learn.

Since 2013 research on our Live Studio:beta experience is a work package in Transark, the centre for transformative learning in architecture education at NTNU.

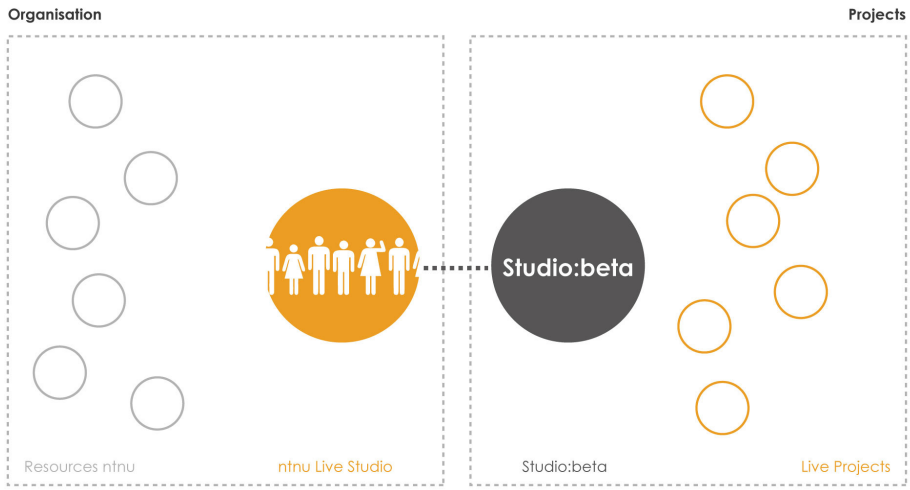
Of course, we did not start from scratch. We were well aware of the extraordinary work undertaken by students at Rural Studio (Oppenheimer and Hursley, 2002; 2005), and the design-build programs already established at many architecture schools worldwide (www.liveprojectsnetwork.org). We had read some of the writings of Donald Schön (1987, 1993) and were at the time working with Nabeel Hamdi (2004). But most importantly, we were, through reflections on our own architectural and planning practice, drawing guiding insights onto our teaching. We were, in our humble way, trying to be 'dual professionals'

where reflective practice modulated our academic contributions.

Juhani Pallasmaa, representing the phenomenological movement in architecture (Holl, Pallasmaa and Perez-Gomez, 1994), has been a guiding thinker in shaping our approach. His wonderful *The Eyes of the Skin* (2005) and *The Thinking Hand* (2009) highlight the role of our senses in understanding architecture. This bears heavily on the 'how students learn'. Dagur Eggertson of Rintala-Eggertson Architects confirms having said that "only when you have carried stone, do you understand how to use stone in your buildings". This leads us on to the power of embodied cognition. Neuroscience has uncovered how our senses generate understanding, i.e. affects our cognition directly without filtering or abstracting it through our brain. It is a discovery especially important in architecture in that its very nature is material yet experienced and appreciated through our senses (Mallgrave, 2013; Robinson and Pallasmaa, 2015; Skotte, 2009; 2014). This is actually how the built environment makes sense to people, if not to architects. Because, as Aravena says, "Nobody cares what architects do, only other architects" (Aravena, 2011).

This sensory experience is at the core of John Dewey's approach to learning, or rather, the transformation of the experience into insight or knowledge. The process of transformation is hinged on reflections. Dewey never propagated a 'learning-by-doing' approach. What he claimed was "We do not learn from experience... we learn from reflecting on experience". (Dewey, 1916). Not reflecting is not experiencing. It is like being drunk on sensations. Reflecting represents "slow learning", according to Archipovaite (2015). It takes time to reflect on what you have been through, on what you have learnt or understood, not least in relation to other people and society at large. This is where Dewey links education to democracy and thoroughly debunks the notion of education being teachers filling the empty "knowledge sacks" of students. Instead, he sees education bringing about inquiring students. Much the way Hanna Arendt saw educational excellence, according to Sennett, "A good teacher imparts a satisfying explanation; the great teacher – as Arendt was – unsettles, bequeaths disquiet, invites argument" (Sennett, 2008).

The power of reflecting, or the effectiveness it holds on learning, is exhaustively presented in a recent Harvard Business School Working paper (Di Stefano et al., 2015).The authors make due reference to Kolb's (1984) four stages of learning, grounded in 1) experience, 2) by reflecting upon it, 3) forming abstract concepts, and 4) building insights. They also refer to the efforts of codifying tacit knowledge through reflections, a hot issue within architectural circles. Architects, or any particular profession, it is often claimed, hold knowledge outsiders cannot fathom because it is non-verbal and belongs to the profession alone. Polanyi (1966), later also others, claims that reflective efforts of untangling tacit knowledge gives a deeper understanding of its properties. This claim is further strengthened through the findings of Daniel Kahneman and his two systems of thinking; the omnipotent System I (intuition, tacit knowledge, spontaneity) and the 'lazy' system II (critical reflection). We live by the first, but insights and knowledge necessary for societal progress stems from system II (Kahneman, 2011). Most significantly the Harvard working paper for the first time empirically shows "that the capacity to reflect on action improves learning" (di Stefano et al., 2015). Formulated slightly differently, and based on qualitative investigations, Donald Schön set forth theories on how professionals, including architects and planners, reflect and thus learn in action as a matter of course, and how students may learn to by engaging with those more experienced (Schön, 1983; 1991). This leads directly to the notion of "communities of practice", where "groups of people who share a concern or passion for something they do and learn how to do better as they interact regularly" (Wenger, 2006). Students and teacher can in the best of cases constitute such a community, the authors of



▲ Figure 1

this article definitely make up one, and engaged student groups do. The relevance to the Live Studio:beta program is that the intra-action of these communities, i.e. the engaged student groups, act as a living curriculum as it acknowledges the role social structures play in learning with and from each other. We may also see them as arenas for horizontal and thus extra-curricular or autonomous learning.

What characterizes these communities of practice is that they acknowledge the plethora of components or properties a community consists of and depend upon, its complexity, so to speak. This brings us to our last and perhaps most important buttress of the Live Studio:beta underpinnings, that of the theory of simultaneities. The term refers to "events or phenomena that exist or operate at the same time" (Davis, 2015) better illustrated, perhaps, by conceptualizing the knower as inseparable from the knowledge he holds. Again, we are debunking the image of the "knowledge sack" of the learner. Education, and learning, is thus always dealing with the knower-knowledge duality - simultaneously. Even though knower and knowledge can be considered separately, they cannot be considered separate. There are numerous claims in the complexity theory in which the notion of simultaneities is embedded that point toward the NTNU Live Studio:beta praxis. The tension or balance between attention to and ignorance of detail echoes Nabeel Hamdi's warning to our students "Don't think too much before you do, and don't do too much before you think." Another one would be taking responsibility for the externalities of your doings, because these consequences are there – embedded as it were, in the project.

As we shall see in the next section, our empirical material and feedback from students is a throwback to the explanations given by the writers above. We are still in the process of distilling our experiences into theoretically grounded claims. Remaining honest, methodologically we realize we are within the realm of Grounded Theory (Glaser and Strauss, 1967), but it is an approach we have not yet pursued theoretically. We will.

WHAT WE DO

NTNU has a long tradition of students undertaking 'live projects'. Many schools of architecture do. What sets our projects apart is that they are generally initiated, organised

and managed by students themselves, not faculty. The 'live projects' have varied from small traditionally crafted boathouses on the coast of Norway to large community development plans on other continents. Students apply a context-based design approach whereby they have to work closely with members of local communities, municipalities, professionals, contractors and other stakeholders. This collaborative nature is what allows the projects to take flight.

THE ORGANISATION

NTNU Live Studio:beta makes up a common platform with two nodes, one for faculty and one for students (figure 1).

This ensures the independence of the students, yet opens an arena for negotiations on academic, practical and social issues between teachers, students and involved partners, most notably through the monthly 'Live Studio:beta Roundtables' established for strategic discussions and exchange of experience and reflections.

The student node, *Studio:Beta*, organizes students into what over time becomes a "community of practice" (Wenger, 2007) through joint discussions and guidance on each other's projects (peer discussion and mentoring). This also ensures stability and robustness through common social practices and recruitment.

The faculty node also forges a 'community of practice' among engaged staff and external consultants by ensuring that insights, reflections and lessons learned are gathered, processed and relayed through learning materials, guidance, and coaching. Academic quality is secured by teachers and consultants acting as 'mentors' of the various projects. Over time, this has forged structures that ensure stability and thus enabled the participants to mature into "Dual Professionals" (i.e. simultaneously be and act as professionals and teachers) (Beaty, 1998).

Each project is organized separately, defining participating students, engaged mentor(s) and consultants. Planning and the required measures to ensure implementation, i.e. cooperation with local suppliers, engaged interest groups, local and national public bodies – and often sources of funding, are all organized by the students, and are seen and experienced as an important part of the learning process. Projects abroad are always undertaken in close cooperation with local organizations and local authorities.

EMERGING REFLECTIVE PRACTICE

The reflective practice in learning entered the Live Studio:beta program from an international NTNU master course in 'urban ecological planning'. Through regular reflection papers the students documented their growing insight both individually, pertaining to group work, but not least their understanding of the context. We have continued the practices of students writing weekly feedbacks in the Live Studio:beta projects ever since. The importance of this practice cannot be overestimated as it gives us empirical evidence as to what students actually learn – which we all know is different from what the grades tell us. What follows rests squarely on student reflections. We have grouped them under two broad headings, Mastering Constraints *in* and *of* Practice, and Social Sustainability.

MASTERING CONSTRAINTS *IN* AND *OF* PRACTICE

Working with real people and real impacts bring all kinds of challenges the students have never had to deal with before. "What we did was real, important and true.

Unfortunately, this is a feeling I have never had at NTNU" (student, 2009). Reality calls for skills in communication, interpersonal trust, adhering to time schedules, funding limits etc. Even though students are exposed to and simulate some of these skills in their studio environment, whereas through Live Studio:beta they are acknowledged learning opportunities, not merely sources of despair or frustration. As one of the students stated: "For me, it's essential to be able to work 'live', in collaboration with others, and with high complexity and short deadlines. That's how I become creative" (student, 2015).

PROJECT MANAGEMENT

How much does a wall cost? What do we do first, the wall or the roof? How do you regularly inform your partners? These are the types of questions students raise when leaving the studio and stepping onto the building site. When going 'live' they face challenges they did not even know existed, and that are not even visible in the finished project. Their notion of what architecture is gradually changes through the experience of practice:

> "We spent all our time making phone calls, writing emails to manufacturers, negotiating with the municipality, doing budgets and even talking to the local newspaper. We agreed that next time we had to focus on the "architecture". Of course, now I know that the "architecture" was what we did. It's worthless to have an idea or vision if you're not able to build it, negotiate it or finance it. And that's why I think it's extremely important to do projects live, because what we learn in studio projects maybe only make up 10% of our [the architects'] daily work" (student, 2014).

The crucial importance of budget limitations, building logistics and progress plans etc. suddenly opens up a completely different world for the students: "A thin budget challenged the design of the project, but it generated innovation and creativity" (student, 2014). Others developed entrepreneurial skills:

> "We needed to generate a project from the very beginning, coordinate all the involved disciplines, make all the decisions and adapt the project to the limited budget we had. In the end, we founded a non-profit organization that took care of the operating expenses of the pavilion" (student, 2011).

Again, we see students experience – and hence learn, that a problem and its perceived solution changes as they start working with it.

> "When playing along with the limitations, you're more likely to find a good answer. But this skill requires training, and I suppose that's why we have architecture schools. If you go through architecture school without facing any real-life constraints or problems, you will base your choices of intuition only, and the designs will be artificial and lofty. They merely build up your ego" (student, 2015).

COMMUNICATION

The studio environment does strengthen the students' skill in communicating – but only to other students, teacher and examiners and hence tend to become tribal-speak. In a 'live' situation, the audience is calling for a much wider communication repertoire. More like what professionals face in their daily line of duty. This is how one student comments on the issue:

> "Why do we (architects) complain of not being taken seriously? Why blame the others? Have we forgotten that we should be communicators? Have we forgotten

> that we are translators? […] If there is a discipline that appeals to the general public, it must be architecture. And yet we remain the experts that no one understands" (student, 2014).

In preparing for presentations and negotiations with people outside our profession, e.g. lay people from the community, the students also have to clarify the issues among themselves. No chance of using tribal 'archi-speak':

> "When we had visually communicated the information we had gathered to the community, did it become clear to us what our project could become. We showed the barangay council something that proved we had invested time and efforts in understanding the area […]. I believe this was significant in gaining their trust and being met with enthusiasm in the meetings that followed" (student, 2014).

HANDLING RESPONSIBILITIES

The students have to shoulder serious responsibilities when building real structures in an open society. As the students wrote in the NTNU Live Studio:beta Handbook: "Stepping on someone's studio project model may cause some tears, but the outcome of the roof flying off a building during a storm is far worse." Taking risks and responsibilities challenges the conventional students' role. The live projects represent a reality check on their decisions and their consequences, (and again we see the link to the notion of simultaneities):

> "I have gained a unique understanding of the gravity our choices hold once it will affect a building that will exist for years to come. How incredibly important it is to make right choices when the stakes are so high, not only for me, but for all the others. This is something we never experience in a studio situation" (student, 2014).

TEAMWORK

In live projects students hardly make decisions alone. This will sometimes make things easier, but working in Live Studio:beta teams seem to require other sets of individual skills than those expose to or trained for in a studio environment. In live settings, the team has to deal with new complexities, personal responsibilities and the fact that other stakeholders are now part of the team. All this under the threatening time pendulum.

> "We think that collaborating with a local carpentry workshop is very beneficial for architects. The fact that we could sketch a solution together, and go straight to the workshop and try to make it in full scale, was a liberating feeling for the whole team" (student, 2011).

Working in a live project team may expose the members to different perspectives. This may become its strength.

> "The experience of building together, particularly with Intit (our hired 'professional') challenged our understanding on how they do things, and equally challenged him to understand what we were up to" (student, Philippines, 2014).

Teamwork makes all collectively responsible for the result. This can also be threatening – and often frustrating. As one of the student demonstrates:

> "One has not really experienced teamwork until, after ten days and 150 man-hours, we still argue about a window. Should it stand in the middle of the wall, or 10 cm off centre? One must, in a group, dare say what one thinks. One must stand for

what one believes is right, but one must also endure compromises. When 'in flow' teamwork is a delight. In adversity it is hell" (student, 2014).

Any experienced architect would recognize the statement.

PARTICIPATION AND OWNERSHIP

Live Studio:beta project always involve others, not only students. These are 'real people'. They are in most cases 'clients' and will be the ones who will care for and maintain what the students leave behind. In order to make the projects long lasting, or 'sustainable', it is important to build a true sense of ownership around it. In order to achieve this, the students have to stand back. The locals are the ones who know what makes the community tick, a requirement for securing the future. Hence it is not about "letting" stakeholders participate, it is about acknowlegding their insight and making sure it informs the project in order to make it 'theirs', and it must be theirs in order to make it last. One of the student state:

"A question I think everyone has to ask themselves when working with so-called "participation" is whether one adheres to a call for participation and ownership in itself, or whether one also takes hold of the knowledge and experience that comes forward, and let it shape the project. Throughout the entire process this was a recurring challenge" (student, 2014).

Throughout the years, and particularly amongst the students working abroad, these questions are constantly raised in their reflections. Opening up, standing back, critically examining your own references, but relating to, and learning from local knowledge is part of the prescription the students give in realizing and securing the future for their projects. "The open dialogue depended on trust and respect for each other. If I thought we could have done without their contribution, we would not have taken their input so seriously. But we depended on being able to transform their words into important factors for the project" (student, 2014). Another group states a similar approach:

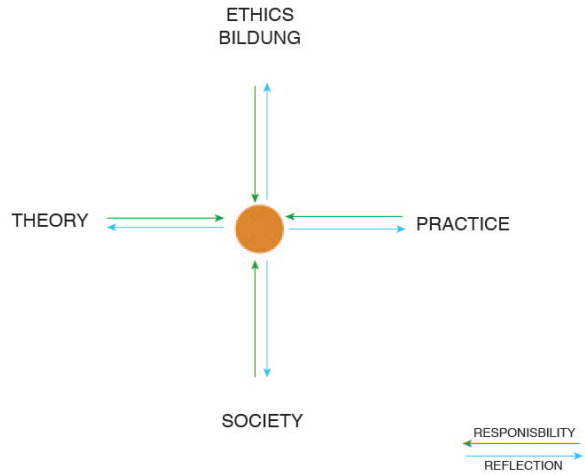
"As architects we tried to process the thoughts of the users into good and user-friendly architecture. It was important that people who were involved in the process could recognise that our discussions have had an impact on the finished project. […] Our work with FRIrom has made us see our discipline in a new perspective. In addition to being architects, we worked to inspire commitment, and give ownership to the leaders of the hospital, the clinics and the potential users" (student, 2011).

THE LEARNING PROCESSES

"The main reason for going was the opportunity for learning. However, it was vital that our work was relevant for a society that is still recovering from the devastation caused by typhoon Haiyan. Learning and doing useful work were parallel throughout. We believed that more meaningful work would lead to better learning opportunities as well was helping people less fortunate than ourselves" (student, Philippines, 2013).

We have throughout subscribed to the notion of knowledge emerging from discoveries. As a member of a student group going to Port-au-Prince after the earthquake 2010 did:

"Learning new things often means jumping into deep water – trusting you will find ways of getting back up. You can always prepare yourself better, you can always seek more information, study and learn more before you jump, but when is the right moment to jump?"(student, Haiti, 2010).



▲ **Figure 2** Negotiation space of project

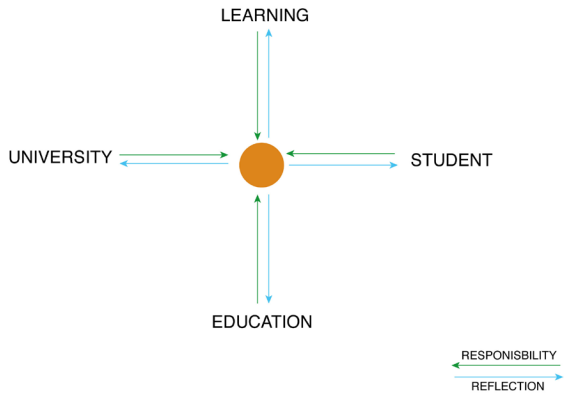
It is to be noted that he made a first-rate return to dry land. This is at the same time an exquisite presentation of the notion of liminality in learning. i.e. the passage through a 'uncertainty-phase', a liminal zone that once passed generate new understanding (Meyer & Land, 2003).

CONTRIBUTING TOWARDS CHANGE

When the Ministry of Education & Research gave us the 2015 award for Norway's best university program, they forecasted its educational potential being applicable also to other disciplines. They did not, however, give us the answers on how to transfer and transform its qualities. The biggest challenge now is how to adapt and implement this educational approach to other fields of the university and, furthermore, how may this affect its teaching and learning environment? To respond we have to dig further into the students' reflections.

What emerges is the notion of 'negotiation space', a fusion of context and content of the Live Studio:beta projects. This discussion is meant to map the space that NTNU Live Studio:beta holds between students and university. How is this space formed? What impact does it have? How may it influence and contribute to the broader university-learning environment? These question marks indicate the uncertainty of our position as this space is not given or defined by any one rule. When re-examining the student reflections, four main domains shape our experience: Practice, Ethics, Society and Theory. These four domains hold the negotiation space of the projects (figure 2).

The negotiation space of the platform or the program holds a distinct set of domains as experienced students, now members of a true community-of-practice, are drawn into the negotiation space of the platform. These negotiations take place between mentors, the Faculty and experienced Studio:beta students. Student, Learning, Education & University are the active domains creating another set of simultaneities and (fruitful) tension (figure 3).
This culture of constant negotiations is a key characteristic of the NTNU Live Studio:beta approach. There is adaptable space for negotiations in every project and within the organization as well, all defined by a given context and its given limitations. All in line with



▲ **Figure 3** Negotiation space of platform

Alejandro Aravena's claim that creativity sparks from constraints, e.g. where "there are rules, you have freedom" (Aravena, 2011) These negotiations create the unique type of ownership that has proven to be such a central part in formulating future scenarios of Live Studio:beta.

INDEPENDENCE AND OWNERSHIP

Community of practice (Wegner, 1998; 2011) is embedded in the nature of all live projects. The students are bound to find ways of helping each other and work together. This sense of mutual trust, and constant negotiations, also include the mentors. This 'responsible independence' creates a sense of 'ownership of process'. It has come to be the very keystone of Live Studio:beta.

Live projects attract particular kinds of students. Even though self-confidence is at the heart of the Nordic democratic (school) system, live projects are not the main choice for all. The ones that join are driven by curiosity of the process and the project and are willing to take the risks and responsibilities this entails. The acquired sense of ownership cultivates not only independence, but also demands an ethical stand towards the third person or to greater society. These are powerful learning processes and it is obvious that they will affect the students' understanding of their future role as professionals.

Extra- or co-curricular projects represent a major institutional challenge. It has to do with funding. Projects undertaken outside the regular curriculum do not generate 'financial faculty credits', on which basis funding is disbursed within the university. Yet, the faculty covers the salaries of mentors and fees to consultants and sometimes give financial support to projects. They still do so because of the proven learning efficacy of the Live Studio:beta activities. To proceed we have to resolve this issue – most likely on a university level.

LEARNING THROUGH REFLECTIONS

The sense of ownership does not stop with projects and processes. The students start to take ownership of their own learning processes. Reflection processes have come to take an important role in the Live Studio:beta learning program. Reflections require "concrete experiences" according to Kolb (1984). The processes linked to projects and platforms are such sensory and cognitive processes where students through reflections go "from



▲ Figure 4



▲ Figure 5

learning by doing to learning by thinking" (di Stefano et al., 2015). At this point the role of learner and teacher becomes more interactive, communicative and collaborative. We are into the type of learning environment Ashraf Salama talks about where "Learners identify problems and resources with the aid of teacher-facilitators; they learn to develop problem solving tools and techniques as well as set standards for solution, and work with both the abstract and concrete" (Salama, 201).

Students' reflections and observations by the staff and through the Transark research initiative show that managing risk, taking responsibility and acknowledging being vulnerable are held as essential driving forces in the learning process. This also shapes the negotiation space of NTNU Live Studio:beta. Reflections are processes of abstraction, of theorizing, so to speak. Reflecting in a state of vulnerability or uncertainty is the start of theorizing, to understand the domain of Ethics/Bildung and Society. All the while getting closer to the core of architecture.

Through these learning processes the students start positioning themselves in the world of architecture, much in line with Snodgrass and Coyne (2006): "architecture is interpretational in so far as it involves positioning. To position something is to invoke a primary architectural moment. To be positioned is also to hold a point of view, an interpretation, or is perhaps the start of an interpretation."

END NOTE

The overriding message rising from NTNU Live Studio:beta is linked to the ownership issue, the negotiation space, the mutual trust within the community of practice – and embedded complexity (figure 5). The existing educational approach in architectural education (figure 4) will not be able to meet the challenges of the future, not even today's complex reality. The world will undergo dramatic changes and we thus have to focus on releasing the creative potential of our students. We have to ensure that their education will foster appropriate "knowledge for a better world" to echo NTNU´s vision statement.

Experimental education programs are required to move into an unknown future, a claim supported by Ashraf Salama: "Effective learning - oriented towards collective problem

solving depends upon reflections, discourse, and experimentation" (2015).
The experimental nature of NTNU Live Studio:beta was given due recognition by The Norwegian Ministry of Education & Research by bestowing the award on the program. They acknowledged the value in its alternative approach in university education. In an interview with Dezeen after receiving the Pritzker Prize, Alejandro Aravena elaborated on the education of architects and sums it up by simply stating that "We're never taught the right thing at university." In our small way we try to do the right thing.

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Living architecture: currencies between architectural pedagogy and time-based media performance

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INTRODUCTION

The rise of pervasive computing (Weiser, 1991) and networked technologies has resulted in a hybrid structure of Mixed Reality Architecture (Schnadelbach et al., 2007; Benford and Giannachi, 2011) and Augmented Environments (Aurigi and De Cindio, 2008). This offers 'new tools' that may modify our perception, and even alter our bodies. Human bodies can be used for all sorts of cognitive purposes, not just to act on the world or co-create a personal world, but also to represent, model, and ultimately self-teach (Kirsh, 2013). Accordingly, human bodies can be used as simulation and modelling systems that make it possible to project to unseen things that would otherwise be more inaccessible. The rapid development of 'digitally mediated' interactions and the use of sensors designed around the body (such as in wearable tech) changes the way the human body relates to its -responsive and potentially interactive - surroundings. Arguably, this new development promotes new modes of engagement with older questions, it influences the way to prepare architects for new challenges in the field and calls for providing new tools and methods to be incorporated into the architectural education.

In this paper, I describe my research-based teaching for the unit 'Embodied and Embedded Technologies' on the Architectural Computation programme (MSc/MRes AAC) at The Bartlett, UCL. The unit consists of two modules exploring sensory environments and 'digitally mediated' interactions in Media Architecture and Urban Digital Interaction.

I present an attempt to foster new ways that extend beyond traditionally applied modes in architectural education and Human Computer Interaction (HCI), through integrating space, the body, digital media and computation in a module taught to students coming predominantly from architectural design background (Fatah gen. Schieck, 2012). The teaching adopts the design studio culture, which integrates: teaching, discovery (research), and application (practice). It draws on my research that intends to build a collective of researchers and practitioners spanning design, interactive technologies and media and the performing arts and applies a multidisciplinary approach where architectural space, the body and body movement, interaction design and performative interactions (Salter, 2010) come together. The teaching starts in term one with exploring the body as a design material in the 'Body as Interface' studio; and extends in term two towards the city context in the 'City as Interface' studio, which engages with the social agenda and the various aspects of participation in the networked

city. In the paper, I focus primarily on the 'Body as Interface'.

Donald Schön's concept of the 'knowledge in action' and Kirsh's concept of the 'thinking with the body' provide a useful framework for interpreting my approach.

MEDIATED SPACE AND THE EMBODIED EXPERIENCE

Conceptual ordering, spatial and social narrative are essential to the way we design and experience buildings (Psarra, 2009). Buildings are defined through a thinking mind that organises and creates relationships between the parts and the whole and they are experienced through use and movement. We use our bodies to move, navigate and communicate, and change our posture relative to the space we are in, and the people around us.

At the heart of the 21st century, 'interactive' and increasingly 'adaptive' architecture will become part of our experience, forming an important shift in rethinking the public space and its social importance. With the new development, digital media extends into the physical and temporal aspects of architecture, creating visual and auditory interaction spaces. These spaces enable various types of embodied experiences as we interact within a shared space, which, in turn, may motivate new social interactions or disrupt the habitual nature of everyday interactions, creating new stages on which people can play out a variety of engagements. People are no longer limited to the role of the spectator or passive actor but are rather active in defining the emergent mediated collective experience.

Interactions with and through technology are performed with a variety of bodily situations, by being present at a location, for instance, or through movement. Research areas are merging, such as architectural design, HCI (Human Computer Interaction) and interaction design, which can be considered as a discipline of movement practice (Larssen et al., 2007). Several design approaches seem to emerge that support explicit bodily involvement by designers as part of the design process "*if one truly likes to design for movement-based interaction, one has to be an expert in movement, not just on theoretically, by imagination or on paper, but by doing and experiencing while designing*" (Hummels, Overbeeke and Klooster, 2007). In the learning environment, however, research into the design and development of digitally mediated environments and the way it is supported through full body interaction, is less considered in the academic arena.

As we find ways to incorporate digital media and computation in architectural teaching we need to rethink the role of architectural education. We need to develop new ways that extend beyond conventionally applied methods, which may in turn, challenge the traditional teaching model, and support re-inventing it as a mediated social and spatial experience. I argue that in order to capture, respond and regulate people's experience, understanding the body and body movement, as a design material is key. The body sense of space is a combination of many sensory inputs including visual, kinesthetic, auditory and olfactory. In this sense, looking at the space-in-the-body (Laban and Ullmann, 1974) in addition to the body in space, postures and gestures will open up the possibility to better understand behaviour, and body movement and to develop new ideas and principles about spatial experience and interactions.

From the Human Computer Interaction (HCI) perspective, and as our experiences are increasingly mediated through tangible digital technologies (in different forms situated, mobile and networked), it is said that the theory of embodied cognition (Kirsh, 2013) offers new ways to think about bodies, mind, and technology. Accordingly, body movement can

literally be part of thinking, as a distributed and interactive process. Making a substantial change in the body might literally affect how we think; when we interact with the world we begin to simulate processes that shape our internal anticipations of how things may turn out. This is done through a form of implicit cognition buried deeply in our perceptual system. But it results in changes in how we mentally simulate the future. Moreover, by exploring how we think through things, designs may draw upon our embodied, distributed, and situated cognition, our 'physical-digital coordination'. In other words, communication is not only media specific, but also body specific. According to Kirsh (2013), embodied cognition can provide us with new ideas and new principles for better designs as:

> "*(1) interacting with tools changes the way we think and perceive – tools, when manipulated, are soon absorbed into the body schema, and this absorption leads to fundamental changes in the way we perceive and conceive of our environments; (2) we think with our bodies not just with our brains; (3) we know more by doing than by seeing – there are times when physically performing an activity is better than watching someone else perform the activity, even though our motor resonance system fires strongly during other person observation; (4) there are times when we literally think with things*"

In the following section, I describe my teaching approach, in the 'Body as Interface' studio, which focuses on the human body as a design material and builds on lessons from time-based performance pedagogy. I then outline aspects highlighted through students' projects followed by qualitative feedback from this year's students, before finally drawing conclusions about the light this approach throws on the nature of the body-based design process and the explicit bodily involvement by designers as part of the design process towards time-based architecture.

THE BARTLETT'S ARCHITECTURAL COMPUTATION PROGRAMME

The AAC is a one-year taught course in the field of Architectural Computational design, and has been running since 2005. The programme (MSc/MRes) engages with the main technologies by which tomorrow's architecture will be designed and constructed. It perceives computation as a technology driving fundamental shifts in industry and society, and, more radically, one that can change the way we create and think. Students are educated to do research, in the context of industry and practice, to change the way built environment is designed, constructed, and inhabited. To this end, the learning of technical knowledge such as computer coding plays a stronger role than in many comparable courses, not only as a skill but as a framework for thought, which is supported by a broad theoretical understanding of algorithms and philosophies of artificial intelligence and related domains.

These digital tools and design environments provide, among others, increased levels of investigation at micro and macro scale that can be considered in parallel and at multiple accessible stages of the process, which in turn, increases the ability to abstract, a key skill in design (Morton, 2014). However, the focus in the design process on the coding and the computational framework of thinking, coupled with the reliance on visual reasoning and visual relationships of design elements, may raise a question as to whether design is thinking or doing. Furthermore, this could lead to over reliance on virtual digital tools with little understanding of what the digital model is expressing, in particular when it relates to embodied and time-based interactions. To train tomorrow's designers – I argue, this framework needs to be balanced through a time-based embodied approach. Here, I believe, it is essential to support an iterative learning 'loop' of thinking, doing and feeling,



▲ **Figure 1** Another example is related to the design, implementation and evaluation of technologically mediated interactions in the real world, for instance, through collaborative urban play and music making between two remote locations, 2012.

which is key to acquiring knowledge, and forms a fundamental part of the learning and reflective feedback (Schön, 1987).

In this respect, the design studio culture can give the students a hands-on opportunity to create spatial prepositions. Combining computational sketches, sensing and actuating mechanisms that are supported through embodied approaches, will offer an opportunity to learn from the artefact and to close the loops between the design and the outcome. The students are assessed formally, at the end of the process, by giving an audio-visual presentation in action through film, and multi media and a demonstration of a time-based installation activated through a whole-body experiential response.

RESEARCH AND TEACHING: EMBODIED DESIGN THINKING | THINKING WITH THE BODY

There has been interplay between my teaching and my research; an interesting aspect of the approach I present here (and also a challenge). One line of my inquiry explores Media Architecture (combining architectural space, interaction design and choreography) with the focus on the body and the dynamics of the moving body, and how this relates to the design of our affective experience, and digitally mediated situations. I explore this through my scholarly work, and design projects resulting in creative installations and publications. I engage with new modes of learning in architectural education through my studio teaching activities. I believe linking my research and teaching is valuable because it encourages the students to explore and present their own interpretations on the theme, which is an essential part of the whole process. Through engaging with my research the students gain first experience with embodying space and the use of different methods to translate this and create their own experimental interpretations. It is also important to bear in mind that teaching and research may require different kinds of spaces and they may not serve to enhance each other (Rowland, 2006).

The proposed approach, however, differs from traditional architectural education, in that the project is typically created and implemented in the real world setting, and requires applying a range of methods from interpretative-ethnographic to time-based experimental approaches. It emphasises the emerging nature of this new field, and encourages the

students to be active participants in the learning experience and shaping the final outcome.

I have been involved in the AAC programme since its inception, and my approach in developing the teaching is based on action research. I have observed throughout the years how students respond to the various computational methods and thinking-centered framework applied within the AAC course. This was coupled with my reflection on innovative work in the research group for developing an interactive dance-architecture (a conversation between dancers and dynamic digital simulation). The starting point, however, was prompted by the collaboration with a dance choreographer to carry out the first body-centred workshop (2008) and was reinforced after attending a week of intensive workshop and the exposure to a fascinating world of practice focusing on the moving body and the geometry of space through the lens of Rudolf Laban's principles. This training was an eye-opener, and have provided me with essential concepts and a main framing, which has to a great extent informed my approach and my understanding through 'feeling' space.

The 'Body as Interface' studio is supported by a variety of teaching modes, including the general course workshops (Physical Computing and more recently Robotics), seminars, and group tutorials. In the following, I explore the core workshop i.e. the 'Body as Interface' workshop.

THE WORKSHOP: EMBODIED AND EMBEDDED TECHNOLOGIES | BODY AS INTERFACE

With an emphasis on the body as a design material, the studio is supported by a body-centered training workshop aiming to encourage students to rethink the relationship between the human body, behaviour and its architectural setting in particular, as it is increasingly framed through time-based digital experiences. We apply a multidisciplinary approach where concepts of architectural space, body movement, performance, improvisation, and interaction design come together - drawing together, over the years, a broad range of collaborators in the filed of dance and performance, visual arts, choreography and Human Computer Interaction.

The overall intention is to raise awareness of how kinaesthetic perception uncovers different properties than visual perception. These kinaesthetic properties, and the way they are encoded, make it easier to recognise the validity of interpretations that would be near impossible to infer from vision alone, if one did not also move the body (Kirsh, 2013). We utilise dance training methods such as Laban and Forsyth's improvisations techniques encouraging experiential learning through whole body interactions, curiosity, and participation. More specifically, the approach intends to open the body and mind, break routines and rethink various aspects that we take for granted. The premise is that to design for movement-based interaction only through movement, and through practicing the movement, the idea can actually be understood. By engaging the body to help cognise (Kirsh, 2013), the participant is able to understand the possibilities of movement better than observation of someone else doing it as she acquires participant knowledge.

Through practical physical exercises led by dance practitioners, students make good use of their different senses, as our senses pick up different information, and gain understanding of how we embody space and focus on practical aspects related to space orientation / gravity organization.

Aspects of movement and sensing space, in terms of its spatial content (space-in-the-body), are explored with the aim of developing a dynamic moving body, conscious of personal



▲ **Figure 2** The Body as Interface workshop: Laban techniques. The students use their bodies to perform analog computation, and rely on the mechanical properties of their bodies - AAC 2010.



▲ **Figure 3** The Body as Interface workshop understanding subjective space and proxemics (left and middle). Using Forsythe improvisation techniques help students to improvise and develop collaborative emergent performance (right) - AAC 2010.

space and aware of spatial relationships between bodies. Key elements of movement communication are introduced such as posture, gestures in conversation, and the notion of 'proxemics' and sensing 'proxemics', which represents the use of micro-space. In this respect, the interaction and perception in specific situations is framed through culture including the relationship, activity, and emotions present in a given situation (Hall, 1966).

To date, 8 different workshops were carried out. The workshop format has evolved over the years initially running for half a day (attended by 14 AAC students) with introduction to the main body-related concepts and has extended to a weeklong event (attended by 20 students from the AAC, the Place Centre for Contemporary Dance and the Slade School of Fine Art). The workshop combined, theory of body movement and perception, practical sessions and hands-on development and implementation of spatial propositions with simple digital manifestations.

Following the workshop, each student starts working on his/her own studio project building on the design material generated during the various exercises and the experience of the dynamic body in space. The students attempt to create their own experimental interpretations manifested through time-based installations. Body movement and spatial representation were explored through a variety of studies using different methodologies. One of the projects, for instance, created an installation that explores spatial interaction projected on a 2D plane and looked at how different types of the perceptual categorisation of space by different people would produce different ways to occupy and relate to the architectural space.

It attempts to find ways to represent the personal kinesphere (i.e. the space surrounding the body or the movement space), and to explore the relationship between space awareness, perception and body movement; how people relate to their own space and how they relate to other people.

One study tested the possibility of changing the eye location to a different part in the body, and how this affects the way we move in space

Another study explored designing sensory relations with the surroundings. It draws on



Figure 4 adaptable space generation - spatial perception and bodily action operate interdependently (developed in an interactive project using computer vision and processing - AAC 2010).

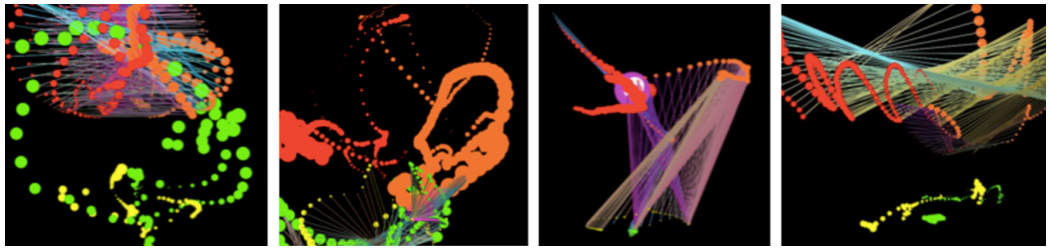


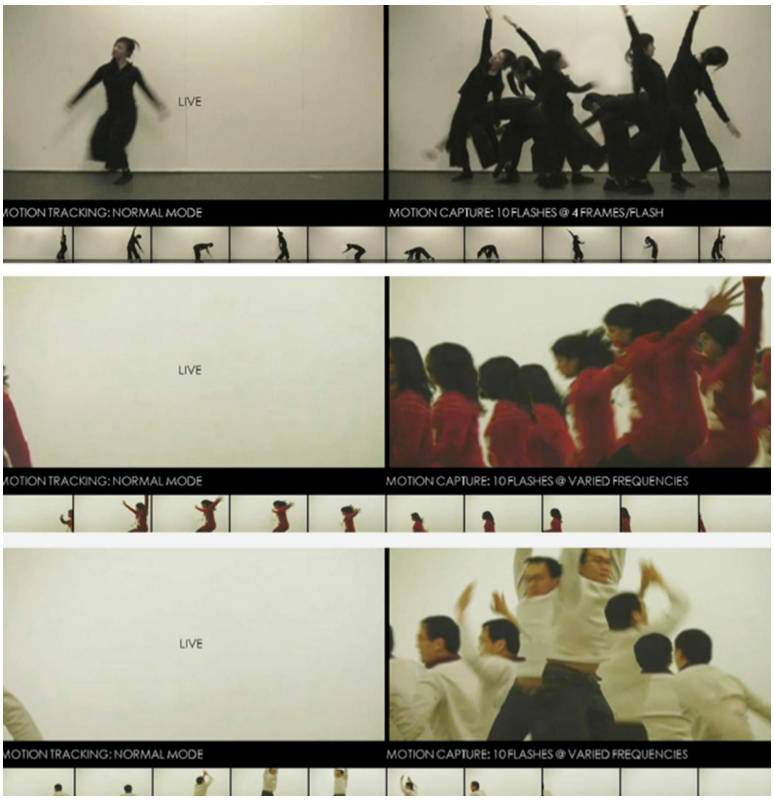
Figure 5 what if the human eyes are in a different location? How would this affect they way we move in space? This idea was tested with the use of a mobile phone and a camera that was mounted on different positions to provide vision mechanism for a moving body –AAC 2015



Figure 6 a way of looking at the role our haptic and kinaesthetic senses play in experiencing tangibles (above) - AAC 2015 and the production and visualisation of different body signatures through spatial drawings in 3D space using hands and feet by 4 different people (using Kinect for depth sensing and processing programing language - AAC 2011)



Figure 7 experiments with whole-body time-based interactions with museum objects (depth-sensing camera captures the person's posture and position in space - AAC 2011)



▲ **Figure 8** what if the human eyes are in a different location? How would this affect they way we move in space? This idea was tested with the use of a mobile phone and a camera that was mounted on different positions to provide vision mechanism for a moving body –AAC 2015

gestural data to explore the rich, interpersonal, non-verbal communication we read, and perform every day and the role our haptic and kinaesthetic senses play in experiencing tangible digital objects in space.

Playful interactions through full-body manipulation of museum objects was developed using depth-sensing camera to captures the person's posture and position in space.

Finally, an interesting example, exploits full body movement with different ranges of interactions in order to develop a new tool for motion studies, where the outcome depends on the speed of the moving body. This was achieved through a reflective process of 'thinking with the body' using the hand, partial and full body motion over multiple iterations performed with the bodies of the students themselves.

In summary, the students' work demonstrates aspects of gaining higher awareness of 'Experiential Bodily Knowing' (Larssen et al., 2007a) and understanding of the importance of the body, how it relates to its own space and to its surroundings. Going through bodily activities enabled them 'as designers' to perform movements, which can extend beyond their bodies to the objects they interact with, and into the way they design time-based interactions with digital prototypes and spatial interfaces. I believe, this offered valuable insights into how interaction with new environments, or interfaces, can frame the design of future experiences.

THE LEARNING EXPERIENCE

An important aspect of the teaching approach presented in this paper, is that students are encouraged to be active participants in shaping the learning experience. We achieved this by framing the students' core experience around the body combined with the expression of movement, and exploring how our bodies create relationships with things around us and how the design of mediated experiences might 'feel' like.

My initial observations indicated that this approach has helped the students 'feel' the relationship between the body, space and mediated interactions and 'think' more critically about it, instead of relying on passing knowledge. It provided tools for design that extend our understandings of bodily aspects of 'technology supported' interactions and offered the students a deeper understanding of the role of the body and the space generated through body movement and the dynamic spatial relationships between bodies, which in turn, helped shape their project development and its direction.

This year, the students were asked to provide feedback through email about the learning process and their experience during the 'Body as Interface' workshop and to outline aspects that influenced the development of their studio projects. Five students responded (out of 8 who were registered for the studio). These comments must be considered only as preliminary and a part of an early development process, however, they proved to be very useful in helping us to develop appropriate techniques for future workshops, and the teaching in the studio overall.

Students' feedback indicated that they have particularly enjoyed the body-focused collaborative activities as it challenged the way they used to do things and provided them with a new lens to view body-space related relationships:

> *"The body class was inspiring to me largely in its success in getting me out of my comfort zone… it gave me a good understanding of the ways in which we can use our bodies within defined spaces and the discussions we had made me think about the ways that architecture and sculpture are only relevant in terms of the human body... The body as interface is a concept about which I had not thought in the ways we were encouraged to do through these sessions. I found it a positive and thought-provoking…".*

Other comments highlighted the importance of being in the action, rather than only observing it: *"It was also interesting how computation can be so physical and human. How we explored the space was also liberating, it is generally a rare occasion that we get to play games with our body."* In this respect, it was important from the teaching point of view that we provide our students with the opportunity to engage in 'real fun', whilst practicing the new concepts and skills.

The role of the so called the 'feel dimension' (Larssen et al., 2007a), as a particular kind of dialogue between bodies and things, was highlighted, where people have different possibilities for action depending on their bodies, which in turn, opens up a new design space of movement-based interactions that so far has not been thought of as the usual material for designers. Here, 'Experiential Bodily Knowing' is realised through moving: *"The exercise of walking backwards… helped me observe different behaviour on each person if their eyes are not in front of their faces and how different spatial assemblage it was versus when people walking forwards."*

Special mention was dedicated to the exercises that emphasised other senses in the body (beyond vision), which helps consider, not just how a design or a technology might look, but more importantly how we might 'feel' or 'hear' it:

> *"I have learnt that sound is a means to understanding space almost as powerful as vision, even if its understanding remains normally underestimated. There are some effects that are necessary to accomplish a certain degree of embodiment and interaction that cannot be achieved only by visual means. Sound has an enormous potential, it is a very vast field not easy to master and not directly understandable, but despite all these challenges it is worth trying to work with it."*

Finally, comments stressed the value they discovered from enacting a set of rules during the emergent behaviour exercise of the 'body as interface' workshop, which resembled the computational techniques the students are introduced to in the Masters programme, in particular, in the computational modules: *"it was a magnificent representation of some of the ideas that we just started studying this semester, such as cellular automata that have simple rules, however produce amazingly complex structures."*

An important aspect, which emerged during the session, is related to how the students worked together to 'perform' an 'improvised' piece - what looked like a highly choreographed and rehearsed time-based performance piece - by following very simple local rules between two or more body points that generated a global outcome of dynamic moving bodies with complex spatial relationships between them (a kind of living architecture). This has provided a strong framework for 'unintended' collaboration. Here, working on the various body-space exercises individually and collaboratively became a game that they enjoyed and consequently this increased their level of collaboration (Figure 4).

CONCLUSION

Schön (1985) has outlined some of the dilemmas presented by the expanding horizon of knowledge within the architectural field. He identified a dilemma facing architectural schools as they start to identify the growing importance of new fields of knowledge to the education they must provide: *"architecture may try to incorporate them in a way that imitates the technical education in other fields, thereby turning its back on the tradition of the architectural studio. Or, out of a wish to remain true to a certain view of that tradition – and to the image of the architect…architecture may turn its back on the rising demands for technical education"* (Schön, 1985, p. 86).

The rise of pervasive media and networked technologies calls for an approach to designing the physical and digital environments as an integral whole and of a coming together of Architecture and Interaction Design. Key to this interdisciplinary integration is the body in space (with its social protocols, conventions and attached values).

In this paper, I presented an embodied perspective to view the contribution the synergy, between time-based performance media, architecture and interaction design, may provide towards an inclusive architectural pedagogy.

Incorporating computation and digital media into architectural teaching raises educational issues of how to infuse it into the process. In the AAC programme computational methods are critical component of the learning experience. The teaching in the 'embodied and embedded technologies | Body as Interface' studio presents an attempt to re-balance this through its emphasis on the body and body movement as a material for design,

and with the intention of helping students understand and gain awareness of important aspects and design principles within an evolving field of knowledge on the cutting edge of the research. Here, the focus is on how the human body relates to its subjective space, body movement and space perception and how this may affect the way it relates to its responsive surrounding and potentially to future adaptive and interactive environments.

I outlined a discussion about the significance of this approach as an architectural pedagogical tool and described the proposed methodology, which suggests a time-based design process promoting a body-based dialogue and exercises that enable students to observe, think and feel space and spatial interactions and in order to understand the critical relationship, create their own learning experience and generate rich and varied responses within time-based architecture. I argue that re-introducing the human body as the main focus will open up more possibilities to capture, understand and react to the human experience as it is mediated through digital technologies and promote the use of experiential learning as a key strand of creative exploration within the design studio.

The paper identified pedagogic issues that influence how students conceptualise the synthesis of body movement, technology and design work and raises a question of the extent to which research could and should 'inform' teaching. Crucially, it highlights factors such as participation, collaboration and understanding curiosity and the role of discovery as fundamental aspects in teaching and learning.

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