

# Depth of shadow; research and design

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Changes in technology and the Australasian Masters in Architecture Professional degree structures have changed the way design is taught in our architecture schools. There is increasing emphasis on research that goes with the territory of a higher degree and is evident in recent course structures and design teaching practices. There is a lack of clear demarcation of what differentiates design and research by design outcomes that can create an academic void where design and research may be confused and conflated. This paper teases out implications of emphasis on research by design for the teaching of design.

The Depth of Shadow project is considered as a case study demonstrating research through the medium of design in action. Characteristics, strengths and problems associated with research undertaken through design as methodology are identified and considered. Advantages and limitations of design understood as research medium are identified and documented. Clear definition of how design may be applied as research method occurs. Criteria for assessment of design as research method are identified as being required to avoid confusing operative design research and findings from procedural design processes and outcomes. A design research matrix is proposed as an academic tool to aid assessment of research through the medium of design and the quality of design research outcomes.

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## INTRODUCTION

Some of us have experienced big changes in the way architecture is designed, represented, reproduced and practiced. We have seen changes from ink and pencil hand drawings on tracing paper and film originals, from hand setup and mechanically drawn one off perspective drawings with hand coloured or watercolour renderings, from Letraset or stencilled text and beautiful hand drawn lettering, and drawings that could each take up to a week of time to complete. These practices and tools have been replaced by suites of specialist modelling, architectural, image, text and numerically based computer software, and associated hardware with seemingly endless extending memory. We have moved from dyeline printing, large format photocopies and typewritten letters and specifications to large format scalable printers, plotters and colour photocopies. From an era of snail mail exchange of letters in envelopes, the speed of communications has also increased and moved through an era of electronic information translation through fax machines to the current immediate electronic written and moving image exchange via interconnected electronic networks. Architectural archives and libraries have also been affected by this. Library capacities have been extended greatly by electronic interconnections to other libraries, and library content is increasingly becoming available remotely through electronic media directly to the user.

In architectural practices most drawing boards have disappeared. Draftspeople and architectural technicians were replaced by a new generation of CAD technicians, experts in particular software suites, parametrics, and the digital translation of architecture into a virtual building information model and matrix. Inevitably these changes affect the design and teaching of architecture.

It is inconceivable today to imagine designing buildings without the use of computers. They are used at every step of the architectural process, from conceptual design to construction (Iwamoto 2009:5)

Design of architecture now occurs predominantly as a digital praxis augmented by hand sketches and modelling. Physical changes are evident in the design studios of schools of architecture where drawings boards have been the gradually replaced with increasing numbers of computer and network access points. Output and workshop machinery has also changed with digital files driving two and three dimensional printers, cnc routers and laser cutters. The current generation of students access ready digital production for simple assembly of precise physical models.

## 1. CONTEXT

A major change to the format of Australasian architectural education has also occurred since 2007 where degree courses have moved from three plus two or five year undergraduate bachelors degrees to three year Bachelors degrees followed by two year 'professional' Masters degrees (Ostwald Williams 2008 Vol 1: 29). This paper refers specifically to recent VUW degree curriculum emphasis changes as a specific example of the recent changes in architectural pedagogical emphasis. These exist at differing levels in the changes to Architectural degree structures in Australian Universities and the other New Zealand Universities, Auckland and Unitec. With the change in degree structures has come an increasing emphasis on research and teaching.

Alignments are also sought between staff research expertise and design teaching as a means to maximise potential research outputs. Increasingly this teaching is from full time academic lecturers with higher degrees commensurate with the expectations of a Master's degree programme.

Fractional "academic-practitioner" positions are disappearing from the University sector because they do not meet the needs of research intensive Universities (Ostwald Williams Vol2: 31)

Course structures and contents are also changing. Architectural research and research methodologies courses have been introduced as separate subject areas at the expense of other predominantly technical curriculum areas. The emphasis on research has also permeated the design studio component of architectural education. What is called variously, design research, research through design, and research by design is taught and expected to be demonstrated in studio particularly in the second tier Master degree courses.

The term design research is confusing and is often used to describe research through design. It more accurately describes research into design, the design methodology research of people such as John Zeisel, Geoffrey Broadbent, Donald Schon and Peter Rowe engaged in during the 1980s. Research by design, research through design or Research through the medium of design more accurately describe design activities associated with research that are the focus of this paper.

At VUW an implication of the change from the five year BArch to the two tier MArch (professional) has been that a group of students that were taught a similar course in a similar manner in sequential years 2009 and 2010 were awarded different degrees. Under the professional Masters structures, the final two years studio courses previously named architectural design were renamed architectural design research and architectural research thesis. The key differentiation between the original and new structures of the degrees is the extent of hours taught and the relative research components of the courses, the masters having increased hours and research requirements for similar courses of study.

Research is the key element that differentiates higher level design teaching from what might be called procedural, everyday, perhaps practice based or oriented design – and that would necessarily include design as it was understood before the period that research was emphasised within design praxis. Higher architectural research as historically taught also continues in traditional research based masters and PhD programmes. It is notable that a significant amount of research for and through design also occurs in practice. Practitioners research to keep up with a changing world, to gather data on programs and sites, survey the relevant work of colleagues via case studies, investigate the performance and availability of products, and monitor building performance after its completion. Project specific, precedent and typological research also occurs as a key part of education and practice. Research is also the activity that occurs prior to and as a basis for a project design. Research, design and relations between them can therefore be seen as diverse and sometimes confusing to students, practitioners, and I suspect many academics.

It is also confusing when design processes that interact in some way with research activities are considered to be research through design, and when these same interactions between design and research occurring in different contexts are considered to be conventional design processes. An example of this is when research activities are included in practice based design activities or undergraduate design courses. In my experience undergraduate students regularly confuse predesign research with design activity. So how do research components of architectural design activity operate? Accepting that design and research interact in a complex way and that these interactions have been changing over time, when might design be research? Are there circumstances when research becomes design? And when are design processes not research? Is there a point where a procedural design process becomes research? In what ways are design and research different and in what ways are they similar, and do they sometimes overlap? How might an academic and practitioner discern the limits and quality of design and research?

The next section of the paper documents a VUW research through design case study titled Depth of Shadow. The case study is presented as a means to tease out characteristics of research through design and issues around design and research differentiation. Analysis and critical reflection then occurs and a reference tool is formulated as a possible means to assist assessment of research through design processes and outcomes.

## **2. DEPTH OF SHADOW RESEARCH THROUGH THE MEDIUM OF DESIGN**

The Depth of Shadow project investigated means to address the relative lack of variation and depth of shadow able to be projected through a typical architectural shade element. It adopted an iterative design process recorded in series as research methodology and applied to resolve a simple architectural problem. Its intention was to identify and explore through applied design and critique the characteristics, potentials and limitations of design as a means of research investigation. The motivation for the project was observations regarding the relative lack of variation and depth of shade and shadow quality from typical architectural pergolas and projections compared with the richness of shade through a tree canopy. A thin sheet product was proposed as the means to investigate the architectural problem. It was selected as the least likely material to be able to achieve the variation and depth of shade and shadow approximating the qualities of shade below a tree canopy, and because it allowed a built prototype to be constructed as evidence to measure the design iterations against. A secondary goal was for the experiments to provide a means to experiment with and learn about the technical requirements of CNC production.

## 2.1 Methodology and description of process.

The architectural problem was clearly defined, contextualised and framed as a clear research proposition. As a second step, implications of the research question were defined by creating a visual reference datum of images that quantified the visual qualities sought. This occurred through a field research process. Naturally occurring shadows and shade generated by a variety of different tree canopies were sourced through primary research, and photographed. The initial images were then visually assessed for the qualities and depth of shade they provided, then sorted and selected as the most representative images for the qualities sought. (Fig.1) They were then documented as a series of seven images across a grid matrix. These datum images providing a visual description of the qualities sought, and a reference point to refer back to as the design research progressed.

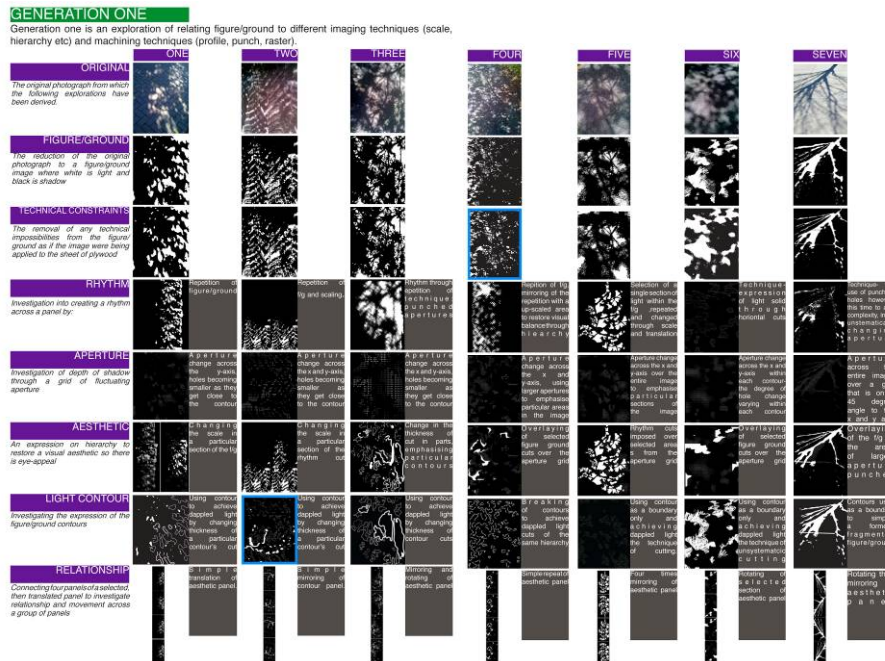


Figure 1: Generation 1 design matrix

## 2.2 Design iterations.

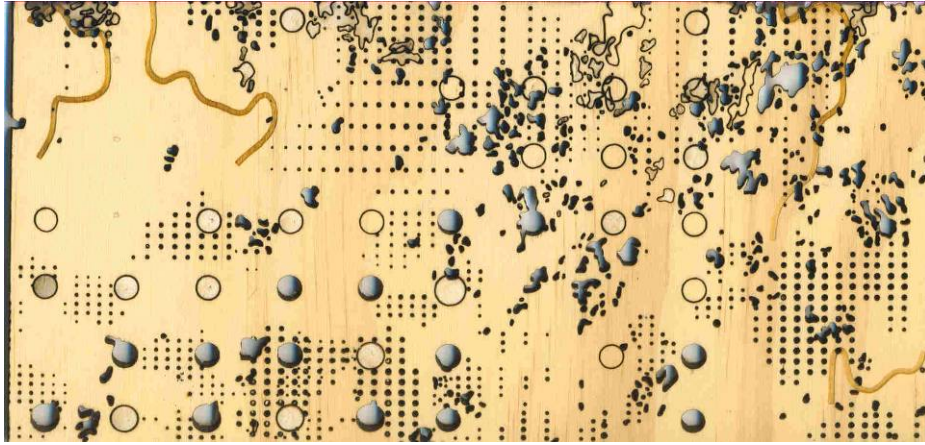
The selected photographs of naturally occurring shadows were digitally manipulated to become figure ground swatches to approximate the lack of shadow variation problem in natural form. This material was critiqued and a method to proceed for the next generations of work then formalised from the critique. A matrix was proposed as an ordering device. Up to seven iterations would be undertaken of each of the seven base images for each generation of work that followed. A body of work would be produced in each iteration, significantly more than would occur in conventional design praxis.

Several parallel permutations of design research iteration occurred within each matrix generation of work. Digital image manipulation occurred in series, following a reflective critique on each permutation of work. Strengths and weaknesses of the series of work produced were identified, objectives for following iterations of work were formalised and design strategies to achieve the objectives applied. Subsequent generations of design would then proceed. New design strategies and techniques were applied to each part of each series of work according to the project changing needs. Sometimes this occurred as the design iterations proceeded, and the design strategies adopted were formalised post design iteration.

Aesthetic devices and compositional strategies tested in initial generations of design work included figure ground, rhythm, aperture, scale, contour, and linear pattern. Middle generations of work introduced the grid, series, translation, mirror, rotation, technical constraints, and balance of figure ground. Later generations of work introduced hierarchies, and increased complexity through an overlay and layering and depth of contour.

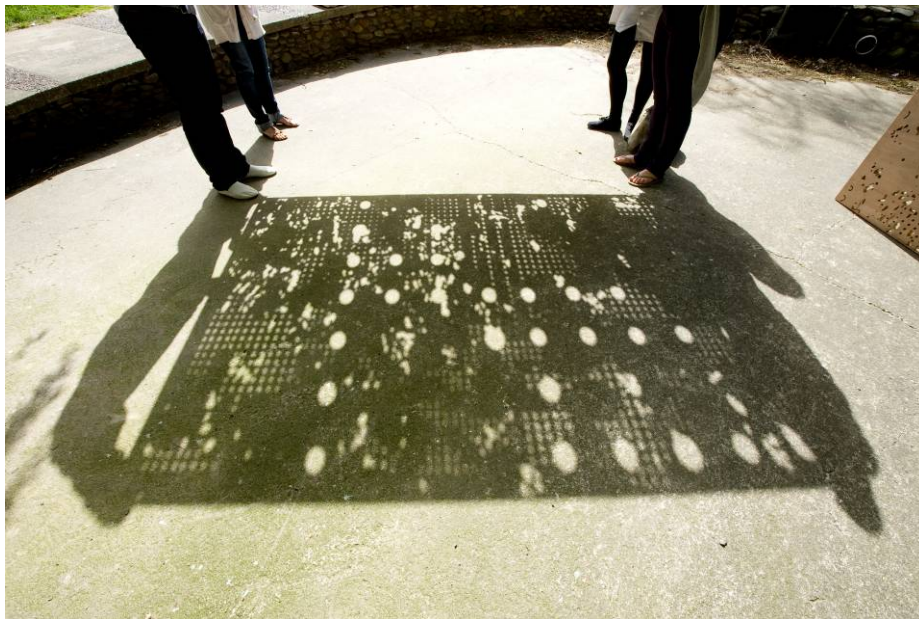
Digital shadow projection and physical shadow projection from scale models (Fig 2) occurred as a part of the design testing process. Laser cut scale models allowed shadows to be projected through them to test the actual shadows produced against the shadows that were expected.

The final series of design iterations was informed by reflecting back on the whole process to date. As the process progressed, it was focused by selecting only the more promising experiments to bring forward and develop as a basis for following design iterations. These were selected from criteria applied comparatively across the series of design results, their potential shadow variation and depth and the aesthetic qualities of the images produced. The last series of design iterations was focused by basing them all on the single most promising design permutation to date. These last two matrix series of design work were eventually selected down to a single best design option.



**Figure 2: laser cut model**

Consideration of substructure and structure required to support a sunshade then occurred, and the effects of these elements on the design were considered. Changes to the panel design were made to accommodate and integrate the locations of an orthogonal structure, its required fixings and likely shadow projection. The final design selected was fabricated at full scale on a CNC router. This process also influenced the final design. Tool paths required for CNC fabrication increased the size of apertures, and required closing off and opening up of figures within the design so that they could be either fully cut out or not cut out at all. The full sized panel was subsequently tested in full sunlight to determine the qualities of the depth of shadow produced and conclusions that could be drawn from the full scale outcome. (Fig 3)



**Figure 3: Shadow projections**

### **3. ON PROCESS AND RESULTS**

After the research through design process the method and procedures applied were considered against the results found. How a research through design methodology had operated in this instance was established, and conclusions that could be drawn about differences to conventional design processes were made.

The motivation for the project was recorded as written text, and visual reference. As the project proceeded it became apparent that visual references that demonstrated the lack of design variation in shading devices could have been also recorded as a beginning point and to demonstrate the extent of the design research progress. These would have assisted to explain the aesthetic qualities of the architectural problem to be addressed. Documentation of the qualities of shade and shadow sought did occur, and this provided clear visual references to refer back to as the project progressed. Seven initial exemplars were selected to demonstrate the range of visual qualities sought. The criteria used to select the reference images was however latent. Images that most closely represented the qualities sought were identified as a basis for a second generation of design work.



Multiple design iterations could be generated from each source image using the matrix grid as a device to generate shades of design breadth and depth. Generative strategies could be readily tested across an ordered range of related source visual material and the results readily compared.

Design processes and procedures were found to occur and develop at a rapid rate and have potential to usefully feed back into the process as it unfolded. Design process occurs in layers some of which can be predicted and some of which arise out of the qualities and characteristics of the work and its potentials. Embodied or embedded knowledge became apparent in processes of reflection on the results of particular design iterations. In this way the design results affected the method and informed it at two levels. For example at an iterative level an earlier permutation of design sometimes suggested a later permutation that worked in a complementary way to achieve a desired result, such as with a scale shift between design iterations of a particular aperture screen to create a hierarchy of shadow. There was also a meta critique where the overall methodology was adapted to focus and develop the research process on two occasions. This occurred when a single design permutation delivered at the end of a particular generation of design became the basis for a full spread of subsequent design iterations.

An issue of subjectivity arose. How do you know what part of a design iteration to develop and how far to take a thread of design investigation? Aesthetic preferences and compositional criteria are material to a project such as this. An aesthetic proposition became necessary and was introduced as a device to order and guide the experimentation. The proposition was that a 'natural' variation of shade and shadow could be simulated and negated so that a compositional play between these factors occurs. The intention became for the composition to be more than the replication of a naturally occurring aesthetic, for it to have the qualities of random, dispersed and varying depths of shadow without direct imitation. It was the shadow qualities we were going after, not the natural aesthetic. Construction and fabrication issues also emerged. The sheet needed to retain its structural integrity, be able to be fabricated and be supported.

The shadow variation criteria defined at the start of the project were also found to be subject to interpretation regarding the qualities of the shadows projected and produced. The physical tests showed a gap between projection and experience, and outside factors such as the quality and strength of light to have a significant effect on the shadows produced. Light factors such as refraction, diffusion and orientation also had effects. Shadow and shade move and change with sunlight intensity and position. Design methodology changed and evolved as the project progressed.

A level of complexity and variation was necessary within the design to achieve the level of subtlety and depth achieved in the original reference images. Design tactics were also found to be interrelated and to affect outcomes in a relative, interdependent, complex manner. Changes in one design strategy affected others.

#### **4. DISCUSSION**

The project was framed clearly and utilised an iterative design matrix as clear design research methodology. The number of iterations achieved, the range of results, and their documentation provided a rigour and accountability to the design beyond what would be expected of a conventional student design project or professional design in practice. The extent of the material generated by the investigation and its rigour are comparable to that of a systematic qualitative research project. The manner of the visual investigation is also similar to a conventional design process except that the process was carefully documented and annotated with a written commentary so that it was tracked and traceable.

The context for the research was theoretical. It was also designed to be tested for a particular height, and orientation to give specific results. It was fabricated as an architectural element which allowed physical testing of the shadow effects generated at different scales. This gave feedback on design assumptions made. The number and range of design iterations explored was notable here compared to a conventional design process. It can be concluded that the extent of the design investigation and its written and visual documentation of design experiments are indicators of research processes operating through design as a methodology.

The result is designed and fabricated and so exists as design outcome containing traces of evidence of how it came to be. However to be accessible as research more explicit communication is required about what has occurred, what is found and its significance. To be identified as research design outcomes needed to be written, reflected on, contextualised and to have their significance articulated. The significance of the design outcome was that it demonstrated how the research question could be answered. It provides visual evidence of the qualities of shadow able to be projected by a thin sheet. There is a significant difference here to conventional design. The design is object, a research result that provides evidence that the research question has been addressed. Its significance however is only made clear through this associated written and visual material, its associated representations. Evidence of research is provided through articulated description, commentary and critical contextualisation.

The research through design characteristics teased out above were then collated and compared with the equivalent characteristics from procedural design processes and text based research processes. The material is presented as a comparative table as a means to clarify and unpack possible assessment criteria, their implications and shades of difference between them. The research by design comparative matrix (table 1) is a potential tool to assist identify and assess research through design..

**Table 1: Research by design comparative matrix**

|  | <b>Research</b>   | <b>Design</b>  | <b>Research by design</b>  |
|--|---|--|--|
| <b>Framing</b><br><i>Clear motivation and objective. A background contextualising and referencing of work.</i>                                       | Clear focused written statement of research question or problem. Relations to architectural disciplinary and theoretical contexts demonstrated. Unlikely to have physical site.   | Clear statement of architectural problem. Written formalised brief. Specified or conceptual site. Physical and disciplinary context.   | Clear focused statement of research question or problem and its architectural contexts. May have brief and actual, theoretical or abstract site. May have theoretical, disciplinary and physical contexts.   |
| <b>Methodology.</b><br><i>Planning of methodology procedures, process and techniques.</i>  | A research plan or methodology and structure set out as a basis for research enquiry that follows. Data collection. Analysis, evaluation, ideas, findings.  | Design process methodology may be latent. Predesign research, analysis and design as resolution of brief site and design problem. Design emerges from process.   | Critical methodology explicitly recorded as a basis for design research process and enquiry that follows. Analysis documented. Methodology may be influenced by design research outcomes.  |
| <b>Discursive.</b><br><i>Structured discussion of relative position. Refers beyond an internal process.</i>  | Intentions written, tested, discussed, reflected on, developed, contextualised in clear structure constructed to support stance and conclusions. Includes contextual material reviews and descriptive material.   | Intentions may or may not be clear in the work - they are latent, experiential, visual spatial and unwritten. Object and space based knowledge.  | Intentions demonstrated visually. Also reflected on, written, photographed, tested, discussed. Ideas testing through application to specific architectural context and example. Material developed through series of design iterations recording, investigating and demonstrating implications of ideas.                       |
| <b>Stance.</b><br><i>A critical position, attitude, proposition evident in the work. Objective evidence of intent and idea provided by the work.</i> | Critical attitude, stance, proposition declared and reflected on throughout the text. Interpretive, argumentative. Hypothesis proposed. May be abstract or specific, general, theoretical, and untested on a physical context.                                | May not have a written, developed or articulated attitude towards architectural problem. Ideas applied via object and spatial representation and may be evident or latent in the work.                               | Critical attitude, stance, proposition declared, written, reflected on and tested throughout design process, and grounded in specific, particular, site, context or problem. Proposition evident in designed object and space.   |
| <b>Rigour</b><br><i>Depth and detail.</i>  | Rigour apparent from the clarity, quality and relevance of references, and grounding of the text in relation to the discipline. Academic rigour apparent in the focus, clarity and depth of the research.   | Rigour apparent from mastery, range, consistency and development of architectural depth and detail. Evident in the architectural design via consideration through scales and levels of design detail.                | The rigour and extent of development and refinement is evident from traceable recorded process. The number of design iterations and shifts between each iteration formalised, documented, reflected on. Applied design development as evidence of written intentions.  |
| <b>Expression and modes of Representation</b>  | Primarily written mode of representation.   | Primarily visual and object based modes of expression and representation.  | Visual modes of representation necessarily augmented by parallel written modes of representation with explicit critical reflection.  |
| <b>Conclusions and significance</b>  | Written conclusions with implications for architectural discourse beyond the single text. Provides evidence of critical action and argument. Invites question, draws and sustains enquiry or contemplation. Influencing architectural discourse and practice. | Physical architecture or design proposal as outcome – a resolved formal, spatial design instance. May be published or attracting critical commentary as a means of influencing architectural practice and discourse. | Significant, new, original, innovative results. Has significance and influence beyond the single instance. The architectural object provides evidence of critical action, draws and sustains enquiry or contemplation. Influences architectural discourse and practice. Secondary representations as measure of its influence. |

Source: (Southcombe 2010)

#### 4.1 Implications of an increased emphasis on research for the practice and teaching of design

Clear definition of research, design and research through design potentially affects teaching quality and assessment. It should be clearly articulated in course documentation as a basis for a critical teaching praxis. Assessing design research outcomes may be problematic where there is a lack of clarity about the status of design process as research means or result. In an era of easy digital iteration and increment, any one of which might become a final design outcome or milestone, design research has also become a real time proposition. This has merged process and outcome into shorter incremental separations than has historically been possible and has resulted in ever more detailed design process, a seamless becoming of design. In this context, clear definition and assessment of how design may be applied as research method is essential to avoid confusing operative design research, and findings from procedural design process and outcomes.

Determining how the quality of design research is measured remains a challenge. A range of new qualified metrics and mechanisms are required (Alpress 2007:2)

Lack of clarity regarding differentiation between design and research practices undermines the value of both. Research is not design and design is not research.

Design seeks to reach a solution, research, instead, looks at what has been or what is, with the goal of evolving or discovering knowledge (Pressman, A : 2007:973)

Confusion of design and research has consequences for the design of architectural curriculum and the teaching of design and research. Design and research are different activities with different pedagogical needs. Course structures and teaching currently emphasise research at the expense of design, the core fundamental of the architectural discipline. Increased emphasis on research has also resulted in the prioritising of formalised academic research experience as a basis for senior teaching of architecture. This practice marginalises the potential of non academic expert design practitioners to teach at senior levels, the key area their expert design experience is needed.

Fractional "academic practitioner" positions are disappearing from the university sector because they do not meet the needs of research-intensive Universities. Ostwald Williams Vol 2: 31

#### CONCLUSIONS

Peter Downton argues that

Design is a way of inquiring, a way of producing knowing and knowledge; this means it is a way of researching. (Downton 2004:02)

For Downton design is a research method. This definition of design relations to research also describes the nature of design and research relations observed in the Depth of Shadow case study and documented in the matrix above. Design is not research although it may be a basis for research. Research is not design. Design may be a method employed to research, document, test or demonstrate permutations and implications of a research proposition, but it is not research.

The employment of design as a method to undertake research places additional burdens on design practices and processes not required in a conventional design process. Design as research method necessarily introduces research techniques into design operations as teased out from the case study and documented in this paper. Research through design like research through scientific experiment requires a clear research question or hypothesis. It requires a structured methodology and careful and complete visual and written documentation of design as experiments. Research through design results in new knowledge with articulated significance beyond the single instance. Research through design is slower than conventional design. Its process is repeatable and traceable. The application of research techniques to design is what differentiates research through design from design.

Research through design is suited to design teaching. Its articulated design process structure is traceable and assessable. What is stilted by research through design is the fast and sometimes loose evolving improvisational nature of design processes observed to modify the research in the depth of shadow process. Design process in practice integrates large expanding amounts of complex information and feeds on itself as it progresses. It is an emerging seamless process and outcome that occurs in realtime. Current architectural pedagogical focus on research through design neglects potentially critical design education focused on design. Recognition of the differences between research and design suggest possible design teaching practices that develop student embodied experiential based design knowledge.

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