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# Visually mediating knowledge construction in project-based doctoral design research

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## Abstract

*Practice-based research projects in design often require students to construct contextual reviews of multiple fields. In this interdisciplinary territory of an emerging academic field, supervisors and students must work jointly to construct a mutually satisfactory outcome and avoid producing a body of dissonant voices. Knowledge and practice precedents must be actively constructed into a coherent map of the research terrain so that the project focus can be foregrounded. While the project-based component of practice-based doctorates is familiar creative territory for design students, balancing this with textual scholarship can lead to loss of focus and unstructured proliferation of sources.*

*The use of two-dimensional visualization strategies, such as mind-mapping, can contribute to clarifying research positions and gaps but has limited capacity to dynamically integrate visual and textual sources. Digital visualization tools can facilitate the mutual student and supervisor organization of knowledge, exploit the visual literacy of design students and respond dynamically to project changes. This article shows how one visual tool may better mediate supervisory dialogues with students particularly in the context of practice-based doctorates of design incorporating project components. Following a review of existing research visualization strategies, I exemplify the potential of a hypertext tool to mediate the supervision and knowledge construction process with two narrative cases of student work.*

## Keywords

design
research
visualization
supervision
dialogues

## Visualizing research

Academic environments are saturated by visual data although their form, significance and function in relation to the text vary between disciplines. In science-based disciplines, visualization data in figures, tables and graphs aims for accurate descriptive representation (Gustavii 2003). In the social sciences, visual data and research methods are also significant (Banks 2001; Hamilton 2005). While both empiricist and social science approaches are employed in doctoral design projects, a broader set of visual strategies is relevant to practice-based doctorates in arts and design. Sullivan (2005) suggests that visualization strategies in the visual arts and design may be divided into four categories: the interpretive visualization of texts, the descriptive visualization of data, the explanatory visualization of objects and the creative visualization of ideas (see Table 1).

| | | |
|---|---|---|
| Strategy | **Texts** Visualizing | Visualizing **Ideas** |
| Purpose | Interpretative | Creative |
| Examples | Representing and narrating | Conceptualizing and designing |
| Strategy | **Data** Visualizing | Visualizing **Objects** |
| Purpose | Descriptive | Explanatory |
| Examples | Mapping and modelling | Systematizing and indexing |

*Table 1: Dimensions of visualization (from Sullivan 2005).*

Visualizing texts is the interpretative transformation of texts or histories into visual form while data visualizing involves modelling and mapping in both empiricist and social science texts. Attempting to explain the complex workings of physical and social objects in symbolic form through taxonomies is another research strategy common to many fields. The creative strategy of visualizing ideas in concept design is a familiar process to design students. Sullivan notes that conceptualizing 'plays an important role in creating and critiquing phenomena' (2005: 203) and has a signal role to play in contextual enquiry for art and design research projects. I suggest that symbolic representations of multi-modal research review fall at the intersection of visualizing ideas and objects.

The active construction of a research position comes through a juxtaposing of existing knowledge and practice in the field, a process typically referred to as the literature review. Even in fields with more established traditions of academic research than design such as education the review of the literature still appears to be problematic for students (Boote and Beile 2005). Novice research students find the concept of reviewing the literature and defining the scope of their review challenging (Bruce 1994; 2001). For art and design, the limitation of the term literature review is that it presupposes the exclusive relevance of text sources. Thus, Hart (1998) reviews a range of visual mapping techniques, such as concept maps, but excludes visual sources from his rhetorical and textual focus. Hart (1998) and others (e.g. Cooper 1998) tend to focus on an exhaustive indexing of prior text-based research offering little sense of the active construction of a position by the student.

Referring to visual arts knowing, Sullivan (2005) defines it as 'a way artists think as they make use of a cognitive coalition of ongoing dialogue between, within, and around the self, artworks, viewers and settings, where each is used to create new understandings' (Sullivan 2005: 190). While not

all design research projects engages fully with this artistic dialogue, project-based work often does require such a 'coalition'. Design research students may, however, underestimate the potential of visual strategies to generate and enhance the research process (Shreeve, Bailey and Drew 2004). Reviewing a number of visualization techniques for art and design, Gray and Malins (2004) refer to 'mapping the terrain' as important to map existing work to establish the significance and relevance of the student topic and at the critical review stage for the active construction of a position relative to the existing work.

The literature mentioned above depicts the reviewing process as an individual affair for the student working in established academic domains where discovery is a case of locating textual sources in familiar databases rather than actively constructing coherence from scattered multi-modal sources; such is often the case in art and design fields. Although students can independently employ visual representations of research, such as mind maps, in making sense of their work but it is often through the guidance and advice of research supervisors that knowledge management and critical review are achieved. This is especially true given the current climate of ongoing scholarly legitimation that art and design research are experiencing. This suggests that more attention should be paid to the active construction by students and advisors of the contextual review.

## Supervision dialogues and sensemaking

At different points in the research process the active or passive involvement of the supervisor varies although with some students and fields, such as art and design, direction may continue throughout (Gurr 2001). Although supervision practices vary and develop over time, all supervisors act as the mediators of the textual cultures of disciplines in their conversations with students (Dysthe 2002; Hockey 1997). Wisker et al. (2003b) describe the general function of dialogues and the relationship to visualization in the following way,

> Supervisory dialogues require logical connections to be made and argued through, asking students to 'tell the story' of the research, to develop and argue a visualisation of the research journey. For some, logic and for others, metaphors help. All benefit from being involved in both activities. Students can literally see where the gaps and fissures, impossible leaps, crossed paths and blank spaces appear in their work, and discuss how to deal with such difficulties. Dialogues clarify boundaries to the research, encouraging students to choose methodologies and methods which will yield manageable and appropriate data, steering them away from accumulating so much data that the actual process could be swamped.

Supervisor–student interaction tends to have particular discursive characteristics, 'the supervisor needs to engage in a variety of modes of interaction: to guide, prescribe and inform, confront, elicit, clarify, support, summarise' (Wisker 2004: 124); Clark and Ryan (2006) take up this discursive nature to show student–supervisor interaction to be an ongoing conversation mediated by texts. Through this conversation, students come to demonstrate knowledge of recent advances within the field, understand

research methodologies and their applications within the field, develop skills of critical appraisal, and develop information management skills (Taylor and Beasley 2005). This outcome is potentially more problematic for students in art and design.

The current complexities of supervision in the emerging academic disciplines of design research have combined with angst about what form of scholarship is appropriate to practice-based doctorates (Hockey 2003). Finding an analytic and creative balance in the text and project outcomes is critical for art and design students as trained researchers (Newbury 2002). As Wisker et al. (2003a, 2003b) have noted many students, and particularly international ESL candidates, can develop an overwhelming accumulation of 'dissonant' sources for their work. Strategies for halting and redirecting the 'accumulation approach' to research include modifying supervisor dialogues. It is in this context that technology-enhanced tools for contextual inquiry and sensemaking have a role as tools *for both student and supervisor* in supervisory dialogues. In art and design fields, Hockey and Allen-Collinson (2000) point out that supervisors who facilitate student development through the use of visual devices and mechanisms may achieve better outcomes.

As a number of studies have shown the different communicative tasks and strategies, including symbolization, in workplaces are used by individuals to make sense of organizations and decision making (Mark 2001; Paul 1997). The concept of sensemaking is that of Weick (1995) who developed it to refer to how individuals retrospectively make sense of uncertainty and ambiguity in workplaces through interaction with people and other resources such as documents. The use of computer-based tools for sensemaking through visualization of arguments and knowledge is a developing field (e.g. Kirschner 2003). ClaiMapper and its current manifestation as Compendium™ is a particular hypertext tool, which developed out of the multi-institutional Scholarly Ontologies Project at the Open University (http://www.compendiuminstitute.org/default.htm), and enables the mapping of claims and arguments in the scholarly literature (Shum et al. 2007). Uncertainty, information and strategies of sensemaking are characteristic of the doctoral contextual review task where 'people may explore several interrelated topics' (Uren 2006: 424).

In combination with bibliographic management software like Endnote™, visualization tools responsive to the dynamic construction and modification of doctoral knowledge domains are needed. It is such a tool which the author has found particularly useful in mediating knowledge construction with design research students and avoiding the dissonance students can experience though an overwhelming accumulation of sources and ideas.

## Practice-based doctorates and project work

The varied forms of doctoral education in design including traditional, practice-based and project-oriented formats typify the variegated and emergent doctoral design territory (Rust 2003). In contrast to conventional doctoral work, Winter, Griffiths and Green suggest that practice-based doctorates involve a 'claim to knowledge which is context-bound, and in which the subjectivity of the producer of knowledge cannot be eliminated' (2000: 28). This articulation of the knowledge claim is the combined effect of project work and exegesis and embeds a reflexive account by the student of the

process of production and analysis. While offering a welcome space for 'considered introspection' (Dallow 2003) practice-based doctorates incorporating projects challenge institutional conventions of academic scholarship. The challenge may be realized as institutional resistance to alternative doctoral forms. However, Candlin views current art and design practice as 'an opportunity to re-think academic norms' (2000: 101). The inclusion of project work creates another challenge to traditional scholarship. Reflecting on the inherent ambiguities in the term practice-based, Pedgley and Wormald note that one possible representation of such work is 'research incorporating a design project' (2007: 73). Such work requires high quality design and a conscious albeit challenging construction of text and project work.

Hockey notes that art and design continues to show 'uncertain quality control in the selection of research students' (2003: 87). In Australia and the UK, the selection process, which currently privileges professional and artistic competency, does not guarantee the encounter with academic norms is easy. Students experience significant culture shock in entering the domain of academia from the familiar territory of design practice and vary in their view on the relationship between practice and text (Pritchard, Heatly and Trigwell 2005). Hockey and Allen-Collinson (2000) also note that supervisors in art and design themselves grapple with traditional conventions of scholarship that institutions often impose on projects. Doctoral supervision may involve academics working outside their field of expertise where the mutual construction of understanding and outcome between supervisor and student is critical. In his interview-based study, Hockey found that all the student respondents 'encountered the problem of analytic documentation and recording of demonstrable evidence' (2000: 85) and situating their creative work in broader intellectual contexts lead students to fear that 'creativity would be frozen by objectivity' (2000: 86). It is with this acknowledgement of the current debates and uncertainties of practice-based doctorates in art and design that the descriptions and proposals in this article should be understood.

## Narrative case studies of supervision

In this current culture of supervision, the use of tools to facilitate knowledge production and opportunities to reflect on these challenges and learn are valuable. In this paper, I reflect on hypertext visualization tools in supervision dialogues through narrative case studies. Given the general relevance of these issues to the supervisory community of practice in art and design, such case studies are used here also to invite others to reflect on parallels with their situation and to propose strategies of visualizing that may prove useful to their own situation. The value of narrative case studies for both supervisor and student has been recognized in the literature on research supervision as a valuable complement to theoretical discussion (Mercer and Bartlett 2001; Ryan and Zuber-Skerritt 1999; Taylor and Beasley 2005; Wisker 2004).

In my current contexts of co-supervision and thesis writing support for doctoral student projects, supervisor (author) and student need to organize a potentially overwhelming accumulation of sources through mutual negotiation. The following two student case studies from two professional doctorate projects illustrate some of the challenges and complications for

students and supervisors alike alluded to in the literature. In my current role as co-supervisor and thesis writing advisor one of my main functions has been to intervene in doctoral projects where the structuring of textual and visual sources has lagged behind project work.

## *Case Study 1: Making sense of digital virtual heritage and seventeenth century Taiwan*

This first student project is from a project focusing on the design of a digital virtual heritage site of seventeenth century Taiwan to accompany a museum exhibition. The student had already spent some time in the doctoral program and had accumulated a number of scholarly and other sources, including hypertext links to graphic and audiovisual files of comparable projects. There had been some shifts in supervision arrangements including my own recruitment into the project at this advanced stage. The student had done considerable multimedia design work and had some text outcomes as well, in the form of draft chapters. The student was at a consolidation stage in the doctoral process where regular text output should have been emerging but this was not as forthcoming as the supervision team wanted. I had the impression on first meeting that the student was potentially overwhelmed by his multiple sources, as I was. Although his creative project work had proceeded well, we needed him to scaffold a genre structure of the knowledge domains and sources relevant to his project in parallel with his attention to drafting.

The scattered sources and drafts, including outlines, which the student had produced, did not give either the student or supervisor team a strong purchase on the relationships between the numerous sources nor an overview of potential gaps. The image produced (Figure 1 is a left-hand screen grab) was generated by the student one week after being introduced to the software following some initial scaffolding with the supervisor. The screen shot shows the home page of the project and five maps (purple web icons) identifying domains addressed in the project (e.g. seventeenth century Formosa and VLHE), indexed with representative images. Each of these icons is accompanied by a number (e.g. Living History 7), which identifies the number of concepts, ideas and sources within a particular dimension, which opens to reveal another hyperlinked layer or interface. Although the image appears two-dimensional and static in Figure 1, it is 'live' in the computer interface and continuously updated over the life of the project in both mediated student–supervisor dialogues but also individually by the student.

An asterisk also identifies a note (visible with mouse rollover) within each icon. In icons indexing references (not shown in this screen shot) I have encouraged student to use the text space available within each icon to copy and paste key quotes and notes relevant to the source. Each project domain is articulated around a central review question at the centre of a particular map, such as 'How do museum studies address digital virtual heritage.' Within the mapped domains the sources indexed include word (doc) and acrobat (pdf) references to primary research articles, QuickTime (mov) files, links to relevant websites. In explaining any particular domain with the computer at hand, the student could 'go live' to the relevant source and verbally clarify its characteristics and relevance to the project. Although relational links between concepts and maps as shown below have default

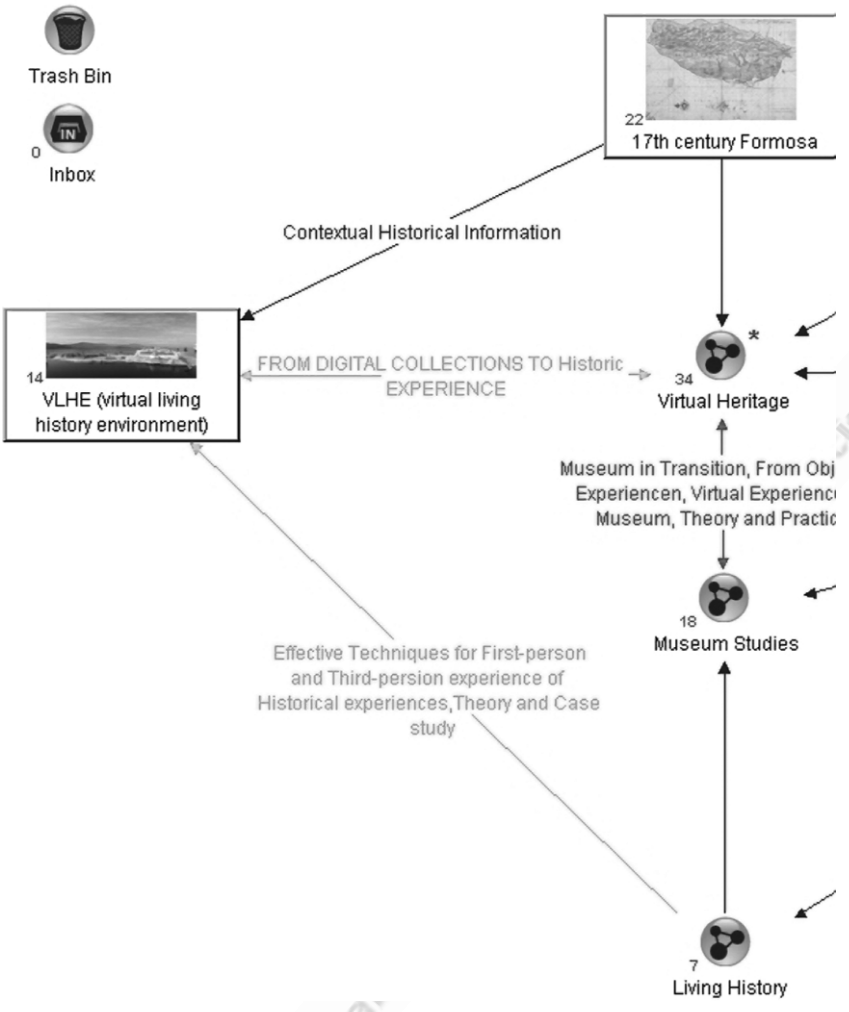


*Figure 1: Digital virtual heritage in seventeenth century Taiwan.*

labels such as responds to, expands on, exemplifies, the student has developed the link labels into personally meaningful narratives and phrases, such as 'Museum in transition from…'. Part of the value of the tool is that it is modifiable and can be exploited in various ways.

The need to organize multiple sources requires design decisions by students about representation formats. For example, in a recent supervisor meeting the student was enthusiastic about the way in which the tool enabled him to organize his multiple sources. A pertinent observation he made on knowledge maps containing many concepts, such as virtual environments with 54, was that arrows linking sources to a central idea or question made the visual output unwieldy and 'busy'. In consultation, we made a design decision to explore the possibility of removing the arrow links and clustering relevant sources (grouped into type, such as text, visual) around a concept or idea they responded to thereby eliminating the need for arrow links by using proximity as a measure of relationship.

The visual organization of information took advantage of his visual literacy as designer but the translation to text remained to be achieved. As I suggested to him each domain in the map represented a section in the doctoral text which could be separately addressed and incorporate the sources and quotes in the visual diagram. Translating the reconstructed representation of the knowledge domains, sources and draft texts has not meant that the translation into running text has been easy. On the one hand, this is a consequence of the limited academic writing competency characteristic of this student and many other practicing designers. On the other hand, the familiarity of the visual interface and processes is contrasted with the fact that the doctoral text must still pursue the linear logic of conventional scholarship to conform to institutional standards of presentation. We are not yet at a stage where the student could offer a fully developed multi-layered hypertext document as an alternative mode of submission in keeping with some recent proposals (see, for example, the UK Higher Education funded project Writing Purposefully in Art and Design at http://www.writing-pad. ac.uk/).

### *Case Study 2: Mobile Communication Device Design*

The second case I examine here addresses concept designs for a mobile communication device by an experienced product designer from Malaysia. Here again the capacity of the design student to produce concept sketches and designs in a short time frame following industry practices was not an issue. The student, who is a competent designer with a background of training in Sweden and experience in Malaysia, had approached the doctoral project as an industry brief. After spending some time in the doctoral program and having made limited progress in structuring his resources and ideas his was a case for speedy intervention. However, requiring the student to take a more open approach to the design process and engage in a scholarly examination of physical and textual precedents demanded that the student revisit his approach to design research and step back from the industry imperative to produce a marketable response.

He needed to think outside the design brief itself and the media, advertising and marketing context, which presented stereotypical images of the target group he would design for. I suggested he incorporate sources from the sociology of mobile phone use, gender and technology, some existing online sources addressing design in this area, research literature on user-centred methods and work with youth and children, and also consider technical and material constraints and processes from product design. This generated a large database of references and exemplars which required categorization and critical review. I worked together with the student to develop a systematic and updated bibliographic record of his sources. He then attempted to map the information and sources while he continued to draft. The co-constructed maps of the research terrain (see below) were generated in supervision dialogues.

Figure 2 shows a screen grab of the entry page to the project with the central question of the project encircled by multiple knowledge and textual domains, which also represent the dissertation structure. Two hypertext links [one with the icon for the International Telecommunications Union – (ITU)] also sit on this page. Each knowledge domain (represented by a purple map icon) shows a number of concepts embedded within them.

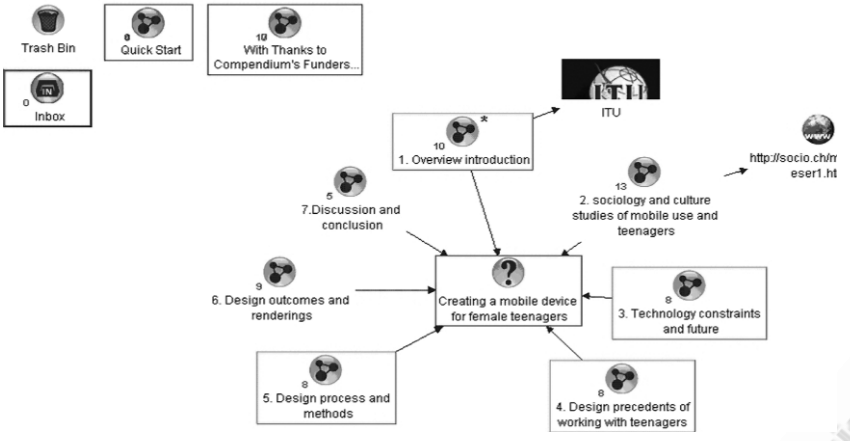


*Figure 2: Mobile communication device project.*

An exploded view of the overview chapter is shown in Figure 3, where the student sequentially numbered the sections that structured the overview at the draft stage.

Figure 3 shows the latest version of the overview chapter with the draft introduction chapter in Word™ format, which can be opened directly from the interface. As is evident here, there are always multiple layers to any project structure. The asterisk next to the question icon indicates that the text box of the icon properties contains further brief information that shows with mouse rollover. The student is now being encouraged to develop this visual map and simultaneously draft further text sections.

The map has become the conversation point in supervisory meetings and is reviewed for progress and updated as an outcome of conversations.

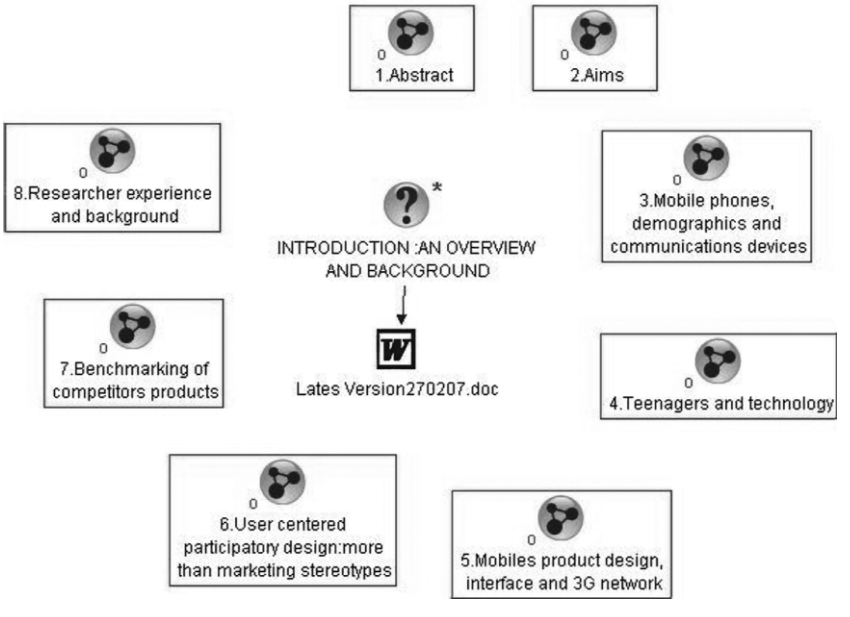


*Figure 3: Mobile phone – overview chapter.*

For archiving purposes both a jpg (and print) and xml file is exported of the current map for the student to work with. For the purposes of supervision the mapping task, even at this late stage, has rescued the project from an unstructured proliferation of textual and other sources. This visual intervention achieved sufficient consensus and convergence between the student and I that current text work aiming for a six-month draft submission has been brought back on track. It has also provided the student with an opportunity to see and show his project in visual context. In addition to allowing me to 'see' the project, the opportunity to produce a visual representation of archived progress has been empowering for the student. The structured representation of the knowledge domains in the project is not a substitute for the text exegesis that will accompany the digitized product design concepts. However, it complements text development and provides the digital repository with a visual interface for progress reviews.

## Discussion

Newbury (2002) has observed that discipline specific research training approaches have proved far more successful in improving completion rates in higher education, including in art and design (and also see the useful resources at http://www.biad.uce.ac.uk/research/rti/rtrc/bibliography. html). I currently teach on one such semester long discipline specific research program and now include an introduction to Compendium™ as a tool for all stages of doctoral investigation.

As has been noted above, visualization plays a key role in research processes and its value to a number of fields, including composition, is widely acknowledged as undervalued (George 2002; Reilly, Ring and Duke 2005). The employment of multimedia visualization tools for the management of the multiple fields of interdisciplinary design projects can bring an order and familiarity to the design process, which is appreciated by students. Given the broader application of the digital tool for knowledge management in the context of workplace project development graduate students may also enhance their capability for work in creative industries (Ball 2002).

I have attempted to show how the tool can facilitate knowledge construction of the doctoral research project in design. The developing archive of student–supervisor conversations means there is a visual record of supervisor feedback and student input, which can be updated and potentially used for progress reports or other academic presentations of doctoral progress. The tool shows its benefits in the dynamic co-construction and revision of knowledge domains and textual outputs in doctoral projects, where supervisor and student negotiate together to avoid the potentially disorienting or dissonant accumulation of multi-modal multi-disciplinary research precedents and parallels.

In the life of a project the knowledge map that underpins the project will change over time as new sources are incorporated and claims and relationships are reviewed. Thus, mapping tools should also be dynamic and change in response to new information and reflection. The final representation of the project, including the network of texts, images and other objects could be employed as an alternative doctoral project interface. For example, the potential of the digital representation of seventeenth century Taiwan could be developed into a form of digital archaeology, making culturally

significant objects accessible to a broader public (Diaz 1998). However, while design research remains wedded to traditional textual exegesis the full potential of digitally mediated knowledge construction and visual forms as an alternative form of academic submission remains unexamined (see Edwards 2004; Gilbert 1998; Seago and Dunne 1999).

This article has not illustrated all the functions of the software, preferring instead to focus on the value of the tool in avoiding what has been called project dissonance (Wisker et al. 2003a, 2003b). In addition, little has been shown directly about the integration of the visual tool with existing bibliography management software such as Endnote. I hope that what has been shown may encourage other academics in similar roles to consider the benefits of research visualization in postgraduate research in art and design, and particularly in the context of the contextual inquiry phases of the practice-based projects.

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