Capturing Design Ideas: A Protocol Analysis Model

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Abstract

This article explores the impact of digital technology on freehand drawing in the wider context of design ideation and the search for a method to capture how designers go about generating and communicating their ideas, both in design schools and industry. In this, the general issue of design methodology is looked at together with a range of specific research methods that might be helpful to the researcher of creative work. The author suggests an assembly of methods within the case study method, notably protocol analysis, and sets out to test these in a pilot study with a second year undergraduate design student. The outcome provided sufficiently illuminating data for the author to conclude that the protocol analysis is a viable research tool for exploring aspects of conceptualisation in design.

Background

The sketch in teaching and learning

When talking to design teachers one gets the impression that there is a revival of freehand drawing in design education, even that it never went away. 'Drawing is central to all that is produced within the broadest spectrum of art and design', to quote from the promotion of an interactive multimedia DVD package funded by the Teaching and Learning Technology Programme, seems to sum up this argument (*Seeing Drawing* 2002).

Yet many design tutors in higher education are aware of increasing numbers of students who are entering design schools without the traditional object and technical drawing skills and sometimes leaving without having acquired such skills. But students are challenging drawing skills: 'I don't want to draw', that is students don't see the point of it, find it boring or unimaginative even, or 'I don't have to', that is they see it as irrelevant in a digital image culture. Freehand drawing or sketching, so what! They may have a point (I have explored this and other aspects of sketching elsewhere; see Jonson 2002).

Although few would argue that drawing on the computer at its present levels of sophistication could entirely replace freehand drawing and, notably in the conceptual phases of designing, students are increasingly using computers as a design medium. Whereas a few years ago computers in colleges were mainly used for essay writing and fanciful graphics, students now can be seen going straight to the computer at the beginning of an assignment. In other words, the computer is no longer just a tool for final presentations but a medium for seeing and experiencing design in new ways. But also, to quote one of my second year design students, 'You can cut corners with the computer'. Indeed, performance says little about learning – think karaoke (Japanese = empty orchestra)!

Such informal observations highlight approaches to teaching and learning design in general and drawing in particular. Because we may have to ask ourselves 'Is sketching the 'natural' way into a design project or is it just one of many means of self-expression and communication to start the design process alongside written and spoken words, computing, sketch modelling and direct manipulation of materials?' Indeed, a wide range of skills, from the use of ICT to drawing, is being recommended for children learning design and technology in schools (Benson 2002). Thus there might be a risk of making simplistic assumptions about the role of sketching in a digital image culture based on teaching and learning drawing alone.

The sketch in commercial practice

Extending my preliminary drawing research from design schools to industry through visits to commercial studios in 2002 (architecture, furniture, product, graphics and textiles), I found that freehand sketching was part of working practice. Yet design concepts were increasingly being 'built' on computer screens rather than on drawing boards. And although, according to senior designers I interviewed, it would still be just possible for a designer to get by without design-specific computer skills, without them the designer would nevertheless be dependent on computer operators within or outside the design team. Thus the computer has become an indispensable design tool in professional practice, used not only at the information, research and production stages but also in the more creative phases of design. However, significantly, none of the designers I interviewed thought that you could sketch either imaginatively or effectively using a current computer drawing package (CAD).

But despite the computerisation of design studios, graphics tablets were not widely used among practitioners other than specialists such as illustrators and CAD operators. Instead, to most designers the digital sketch meant the scanned sketch, that is the manipulation of the original sketch using software applications, such as PhotoShop or 3D Studio Max. Such digitised sketches, however, tended to compliment rather than substitute freehand sketching. Still they remained parts of the conceptual phase and were also used for presentation purposes reflecting clients' expectations of photo

realistic imagery increasingly making traditional rendering virtually redundant.

Although not necessarily artistic, practitioners saw sketching as an aspect of drawing that improved through practising, from doodling to life drawing. As part of all-round design skills, sketching was a valued and integral part of design practice, a skill that, it was argued, ought to be encouraged and supported in design education. But although the alleged lack of drawing skills among recent design graduates entering industry was picked on, only a few of the designers I interviewed professed to doing sketching on a regular basis. Moreover, when recruiting, not all designers expected to see candidates' sketchbooks although they agreed that the sketch often reveals more than just drawing skills, such as aptitude, 3D thinking ability and imagination. The sketch is personal

Research question
What emerges from this preliminary round of friendly interviews in design schools and professional practice is a rather fragmented picture. On the one hand, cherished beliefs and desires were frequently expressed in what might be characterised as a 'lower level' or common-sense approach to sketching rather than, as it might be perceived by design academics, a 'higher level' critical engagement of how sketching may be located within cognitive states and processes. On the other, it seemed fairly clear that there is an ongoing shift from analogue to digital drawing modes in everyday design practice. What then is the impact of digital technology on design conceptualisation, particularly on uses of sketching?

Design research
Although design researchers and practitioners in industry may share a common language, I found little interest from practitioners in the application of academic design research ('design methods') confirming what Cross has called 'the application gap' (Cross 1984). A typical practitioner view is that of the furniture designer Jasper Morrison: 'Design is above all a practical pursuit' (Morrison 1990:20). In this, the application gap reflects not only design as a practical art form but also a business activity.

Yet the application gap might also represent a mistaken description of design thinking at higher levels that could have a negative impact on research at lower levels, a view reflected in the reluctance by designers in industry to engage in academic design research. Still, too much emphasis on design as a practical activity, at the expense of

theory, might damage the status of design as a 'proper' academic research subject.

But if 'higher' and 'lower' levels of design research compliment rather than substitute each other contributing to increased understanding of design as both process and product, then researchers may have to get better at formulating meaningful research questions that attract industry collaboration. This agreed, design researchers, by celebrating the learner experience common to teaching, research and practice, might build bridges between the academic and commercial worlds.

Research methodology
Design has been described as a 'hybrid activity' (Jones 1970:10), a description that reflects the multitude of meanings given to the word design, from traditional engineering-based design to post-modern philosophical discourse. The ensuing ambiguity of what design is also has consequences for academic design in that design research, unlike other relatively new academic disciplines, such as sociology, communication and business studies, has not established a distinctive methodology. As a result academic design has become reliant on a humanistic methodology in general and social science-oriented methods in particular. Not surprisingly, design has been described as the sociology of art in which artists and designers are cultural producers (Wolff 1981:143), spanning from product design to cultural studies.

Such rich pickings for design researchers, however, suggest a questioning of routine methodologies but also a critical interdisciplinary approach. Critical because research in economic theory, for example, has failed to decide key economic issues turning policy-making extremely ideological and partisan (Business Week: December 30, 2002: 122) or the risk of taking the social science route and its heavy reliance on text. 'Sometimes, writing is even seen as the core of social sciences' (Flick 1998:241).

True, the growing trend of conceptual design, of 'putting ideas on top of objects' might favour a strong theoretical input and design has its own strong intellectual culture (Schon 1983). This trend, however, might suggest an emerging paradigm of conceptual design, a shift from design practice to design studies, from 'making' to 'thinking' design. Positively, this suggests a broadening of the concept of the discipline that not only adapts and reacts to contexts but also creates and generates contexts (Jonas 1997), or, negatively, a further fragmentation of academic design.

The fragmentation becomes topical in the paradigmatic shift from analogue to digital, the rhetorical 'digital revolution'. Rhetorical because 'revolution' suggests a disruptive rather than an evolutionary change. But if revolutionary, how to find common criteria between the analogue and the digital when in paradigmatic shifts there are no shared sets of criteria? (Kuhn 1970). That is, the analogue and digital modes become so distinct from each other that no rigorous comparison of the two would be possible. Digitisation then might limit interpretation of design to concerns of either aesthetics ('art studies') or commercial effectiveness ('business studies') resulting in yet more of what has been described as 'superficial and fashion-oriented aesthetic definitions' and 'bland, market-led 'safe' solutions' (Walker 2002:3).

A counterpoint to such a development, however, might be a shift towards design in terms of values and beliefs, as a branch of ecological studies or philosophy. Thus design research may have to contend with not one but several paradigmatic shifts and whether induced by digital technology, socio-political factors, such as the 'unitary concept' of design and technology in schools (Davies 2002) or design philosophy. Because 'Any going paradigm at any particular time is by no means the final solution to problems in a particular field of research' (Broadbent 1979:278).

Is then the analogue to digital shift going to cause fundamental changes to how designers think and work? Much seems to depend on the conversion or uptake rate of designers going digital also in the conceptual phases of designing. This in turn is likely to depend on a multitude of factors, from cost/benefit analysis to interface design, from education to client expectations, but also on individual designers' values and preferences by which designers may be bound together, in what Kuhn has called a 'disciplinary matrix' (Kuhn 1970). But whatever the answer, it also suggests an alternative way of formulating my research question: to what extent does the digital paradigm affect design thinking and uses of conceptual tools?

Yet, and although the virtual world is penetrating design thinking big time, design is also about the realisation of ideas in the real world, the materiality of design, the production of materials traditionally associated with the design process. 'An understanding of the nature of the design process requires insight into the nature of the product designed, and vice versa' (Kroes 2002:290).

But if the design process is essentially about the designing of artefacts, what then about intangible design, such as branding? This again highlights the hybrid character of design pointing at, for example, the difference between empirically and theoretically driven research, research that is concerned with generating and developing theory rather than the testing of theory, so-called grounded theory (Burns 2000). One way of dealing with this methodological complexity is to take a pragmatic approach, the path between the positivists of value-free inquiry and post-positivists of value-bound inquiry.

A pragmatic approach
To encourage design students and practitioners to become stakeholders in academic research a pragmatic approach would reject the forced choice between the either/or of positivists and post-positivists accepting that values play a large role in conducting research. Thus pragmatists would 'consider the research question to be more important than either the method they use or the worldview that is supposed to underline the method' (Tashakkori and Teddlie 1998: 21). This may sound an overly expedient approach yet 'Pragmatists believe that there may be causal relationships but that we will never be able to completely pin them down' (ibid.p.28).

A pragmatic approach then would accept sketching as essentially a personal activity, a tool for generating, developing and communicating ideas, and whether in design schools or in professional practice, an activity in which the sketchbook may constitute a book of revelation. However, the emphasis on personal may create problems with data gathering because it can hold back designers' willingness to share their sketches with outsiders – if they sketch at all. Indeed, in a digital image culture that tends to favour slick, computer-generated presentations, freehand sketching has become a somewhat touchy subject.

But when sketching is touching a raw nerve among designers in a period of rapid technological change, to categorise designers as either for or against sketching seems not only an oversimplification but also a value judgement that might contaminate if not obstruct data collection. That is, while accepting that there is no such thing as value-free design research, it would seem nonetheless good practice to signpost what personal values and attitudes the researcher is bringing into his or her inquiry.

Thus, in my role as researcher, I would take the view that I can be neither 'Geek' nor

'Luddite' vis-à-vis any particular designerly way, tools or otherwise. Moreover, such an attempt at an unbiased investigation may facilitate a SWOT analysis of the impact of digital technology on design conceptualisation, that is to try to identify strengths and weaknesses as well as the opportunities and threats posed by digital technology.

Therefore, my research strategy will start from the position not of singling out sketching but of looking at the whole range of conceptual tools used by designers for identifying, developing and communicating a solution to a design problem, a process that I would call 'design ideation'. However, problem-solving in design is not necessarily a step-by-step sequencing of events (Goel 1985). Conceptualisation is a mix of the rational and the intuitive, of verbal and non-verbal thinking. Ideas may start anywhere or happen all at once ('Aha'). So what I am interested in is how designers go about capturing, articulating and recording ideas when they do it. Thus my notion of sketching goes beyond that of freehand drawing to include the use of computers (painting and drawing packages, the Internet), sketch modelling, spoken and written word as well as any other means used by designers in the conceptual phases, say photocopying or photography.

In search of a method
What would then be the most appropriate research model for finding out how designers go about conceptualising? To narrow the search, I have chosen to describe briefly and to reflect upon the following research methods inspired by research in software psychology (Schneiderman 1980).

Case study
Case study, which can be either single or multiple, has been used for 'improving understanding of the psychology of creative behaviour' and for 'identifying features of successful design performance' (Cross 2001:48).

Although often associated with observation and interviews, case study does not exclude any method for collecting data (Bell 1999), although 'the data collection process for case studies is more complex than the processes used in other research strategies' (Yin 1994:100).

Case studies can also be used as a means of identifying key issues (Bell 1999). This may help in providing rich individually identifiable data to compare performance against at one or more sites that might reveal an unexpected usage pattern of conceptual tools.

However, observation in case study research differs from experiment in that the experiment takes place in an environment that is largely controlled by the researcher (Yin 1994). The lack of experimental controls in case study means that there is no guarantee that results are replicable or that they can be universally generalised.

A radical approach to case study is using an analytical model from social science that proposes that it is possible to generalise from the existence of any case ('tap into whomsoever, wheresoever and we get much the same things': Sacks, 1984:22 quoted in Silverman 2000:108-109). Applied to design, however, this approach suggests that there is basic structure to conceptual thinking and behaviour across design domains reflecting a uniform design community speaking the same visual language.

Controlled experiments
This method is at the core of scientific research, making it possible to verify hypothesis within stated confidence levels through statistical tests. Controlled experiments, however, depend on a reductionist approach that may limit the scope of the experiment. For example, Gruber has argued that research in creativity cannot be based on a ten-minute pen and paper test. 'Creative works are constructed over long periods … the laboratory simply cannot measure them'. Thus Gruber escapes from the laboratory of $N = 30$, $N = 60$, into the case study, where $N = 1$, because the individual is worth knowing (quoted in Lavery 1993).

Goel gives an example of controlled experiments where the subjects were divided into two groups using in turn freehand sketching and computer drawing systems (MacDraw) to test the hypothesis why sketching should be correlated to the conceptual phase of design problem-solving (Goel op. cit.). Although Goel confirmed the hypothesis that replacing freehand sketching with a drafting-type computer system hampered idea generation, the experiments also proved how difficult it was to instruct the subjects to use the computer drafting system during the conceptual design phase when they would normally sketch freehand.

However, as a method of triangulation, the result of well-conceived experiments might illuminate uses of conceptual tools.

Subjects in experiments
Finding willing designers for controlled experiments can be particularly difficult. Their time is valuable and they may be reluctant to submit themselves to what can be

seen as personal enquiry and thereby object, either overtly or covertly (obstructing behaviour), to the researcher's probing their creative activity. For example, research has revealed that being watched, whether by someone peering over the shoulder or by video cameras, is not conducive to good work (Stanton 2001). To overcome this, observations would have to be arranged and conducted freely and openly on a careful case-by-case basis (Gardner 1988).

Also, there are difficulties in assessing variations in the background and ability of designers, and not only in respect to analogue and digital drawing skills as the formulation of concepts rely on a wide range of abilities and experiences, both within and outside the design domain. This also highlights the question of transferable skills. Furthermore, in a comparative setting there are different design traditions, for example in Italy and Spain, 'Concept sketches serve only to convince the designer himself and his assistants within the studio that a design proposal is possible' (Pipes 1990:38).

Overall, these difficulties in experimental design might explain why most experiments take place in primary and secondary education where pupils are a more easily controlled ('captive audience').

Interviews
The interview is a widely used research method across disciplines not least because the interviewee can be given the opportunity to reveal, say, the reasoning behind his or her actions (Seale 1998). Thus the researcher can monitor what is being said, ask for clarifications and intervene gently in a non-directed manner (Flick op. cit.).

Interview data can be either of a quantitative or qualitative nature or both. According to Seale (op. cit.), the classical, quantitative survey tradition of treating the interview as resource, that is as real facts, has been criticised for applying standardised meaning in the form of, for example, fixed choice attitudinal questions (or questionnaires). In contrast, qualitative interviews offer greater flexibility through freedom from the need to construct a data matrix, inviting the interviewee to talk about whatever they feel is relevant. But also, 'When interviewing key persons, you must cater to the interviewee's schedule and availability, not your own. The nature of the interview is much more open-ended, and an interviewee may not necessarily co-operate fully in answering questions' (Yin 1994: 68). Thus, and similar to the experimental situation, an important consideration in seeking to interview designers is that designers may be reluctant to

participate in what can be seen as the researcher's probing their creative activity.

Protocol analysis
Protocol analysis, like the case study, can obtain important insights when the participant is a capable, sensitive designer who has experience of a wide range of conceptual tools. However, such insights are bound to the individual participant designer as there is no guarantee that two designers given the same problem task will use the same conceptual tools or even that the participant will repeat the same process in a different project. Another drawback is that carrying out protocol analysis even for relatively small numbers of individuals can be a complex and time-consuming exercise. Yet protocol analysis is a method that can illuminate design thinking as it manifests itself in the human design process, also known as 'intuitive design', as opposed to 'machine design' and 'design methods' (Akin 1979). However, Akin also points out shortcomings with this method, notably the problem with 'missing data' that must be carefully interpolated in the analysis of protocols (Akin 1979:193).

The problem with 'missing data' associated with protocol analysis is similar to those experienced with interviewing. For instance, the respondents might have faulty memories, might post-rationalise on their studio activities and find it difficult to describe non-verbal design processes in words (Darke 1979). Moreover, 'We are conscious only of the end states, not of the means for getting there. As a result, in this view of the mind, our explanations of our own behaviour are always suspect, for they amount to stories made up after the fact to explain the thoughts that we already have' (Norman 2000:117).

Action research: direct and participant observation
Action research is often used for finding out about professional practice, notably in education (Barnes 1992). However, although this approach seems suitable for research in design school settings, direct observation of conceptual behaviour in the commercial studio environment, although desirable, and over which the researcher has no control, can be problematic both logistically and ethically. Participant observation can work well when the researcher and the participant share the same practice but shortcomings then include how the researcher may become too involved influencing the outcome and losing perspective of the aim and purpose of the research (Barnes op. cit.).

A methodological assembly
There are strengths as well as weaknesses in all the above methods applicable to my

enquiry. On the positive side, the case study method can provide data to compare performance against that might reveal unexpected usage pattern of conceptual tools. Although controlled experiments would be difficult to apply to conceptual work, the result of well-conceived experiments might be used for checking uses of conceptual tools (triangulation). The qualitative interview can offer greater flexibility through inviting the interviewee to talk about whatever they feel is relevant to their designs, while the researcher can monitor what is being said, ask for clarifications and intervene gently in a non-directed manner. Protocol analysis might offer subtle yet rich insights into how individual designers generate and communicate ideas. In short, by drawing from a variety of methodological sources it might be possible to assembly a case study method that would best serve the aim and purpose of the investigation.

The research strategy: the case study
'The case study as a research strategy has a distinctive advantage when a 'how' or 'why' question is being asked about contemporary set of events over which the investigator has little or no control' (Yin 1994:9).

The aim of the study is to find out what is the impact of digital technology on uses of conceptual tools (Primary research question), how it impacts various design disciplines and how it impacts the ways ideas are being communicated (Derived research questions).

The case study consists of 12 cases, a number that seems small enough to be manageable yet large enough to provide rich and reliable data. The study, by way of being both descriptive ('what'), exploratory ('how') and explanatory ('why'), is intended to reflect situational and subjective aspects of conceptualisation (context) involving an analytical description (inductive method) of uses of conceptual tools, both as means of self-expression and communication with others.

The 12 cases include six design practitioners one year after graduation (2001) and six second year design students from the domains of architecture, ecological design, fashion, graphics, product and textiles thus representing both industry and education. For practical and ethical reasons all participants were recruited on a voluntary basis through recommendations from the course directors of respective design disciplines at three of London's leading design schools (Bartlett, Central Saint Martins and Goldsmiths).

The pilot case
In preparation for the formal case study, a pilot study (hereafter called 'pilot') was carried out during the autumn term in 2002 to test the feasibility of the method, notably the relevance of questions, the recordable data and data collection techniques. For this purpose, a second year student volunteered to take part during a five-week design assignment on the BA Design programme at Goldsmiths College. An interview was scheduled for the end of the project but I also met up informally with the participant once a week while the assignment was running. These brief encounters, in addition to a research meeting headed by my supervisor, provided feedback on the workings of the data gathering process prompting tuning of research questions and techniques. 'Within the process of a single work's coming into being we can often observe a fairly surveyable approach to the solution of a given problem' (Arnheim 1986:273).

The pilot's first challenge was how to capture the conceptual events, the creative 'sparks' (Kimbell 2002), as they happened from the outset of the design process (data collection techniques). But before I could think of how to capture such events, I had to try to figure out what conceptual tools and materials would be available to the participant (relevant questions) that could also be recorded (recordable data). So how could this be done?

My first thought was born out of how designers use notebooks to keep track of their ideas. Also how, in order to facilitate data collection in research projects, participants keep creative journals during the length of the project. In other words, I was looking for conceptual traces, the making and leaving of tracks such as sketches that, according to Gruber, is part and parcel of the process itself, a kind of activity characteristic of people doing creative work (in Lavery op. cit.). The tracking of ideas also found resonance in Schon's 'reflection-on-action' theory (Schon 1983) as did other published research methods, for example, the notion of the 'data protocol', 'a kind of researcher's checklist … recommended for increased reliability' (Yin 1994:63).

The self-analysis protocol
I developed these ideas into designing a self-analysis protocol to be used in a hands-on fashion by the participant for recording uses of conceptual tools during the design assignment. In this way, the participant, through 'reflection-in-action', became a co-researcher, a stakeholder in my enquiry. The basic layout of the protocol (A4 double spread) was that of a grid in which individual design sessions were marked out as squares with a hole in the middle (see Fig.1).
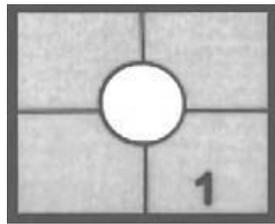
Fig.1

Each numbered square represents a unit of one half-day working session that is laid out in two grids of a total of 72 squares thus accommodating roughly a five-week period. Each square, in turn, has inscribed symbols for conceptual tools; S = sketching; W = spoken and written words; M = sketch modelling; C = computing. Using the numbered squares as a recording device, the participant's task is then to answer four questions (I–IV) on uses of conceptual tools, as indicated in the guidelines accompanying the protocol.

Guidelines:

Notes:

I. For each session worked, circle the tool(s) (S,W,M,C) you used in that session. If other than S,W.M,C, describe in numbered footnote (1–72).
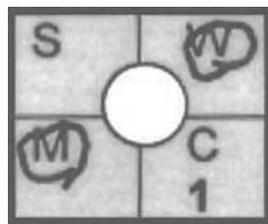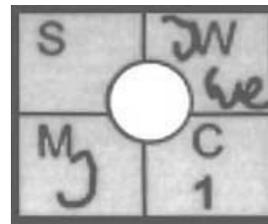

S = freehand SKETCH
W = spoken and written WORDS
M = sketch MODELLING
C = COMPUTING (CAG/CAD/Multimedia)
1 (1-72) = other tools in numbered footnote.

II. Draw a frame around the tool you considered the most important in each session worked.
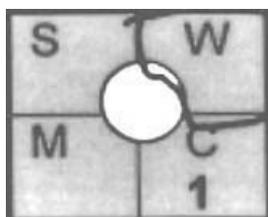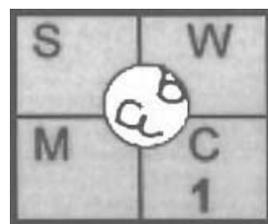

III. Add 'I' and/or 'we' next to the tool you used to indicate mode of communication.

'I' = inner-personal communication
'we' = inter-personal communication

IV. In the circle, indicate the reason(s) (a,b,c,d) why you chose the tool(s) you did.

a = because I could not do without it.

b = because I liked it (personal preference).

c = because of tutor/peer/client influence.

d = because of assessment criteria.

Below the grids, a footnote apparatus provides further space for adding any tools used by the participant other than S, W, M and C as well as space to add comments about any particular conceptual events experienced during the sessions, notably so-called 'Eureka' or 'Aha' moments.

The interview protocol
As a complement to the self-analysis protocol, I designed an interview protocol (eight page A4 spread) containing a mix of focused and open-ended questions intended to capture 'reflection-on-action', that is reflection on what had happened in the self-analysis protocol. The core questions of the interview protocol had taken shape during the literature review and the preliminary interviewing phase preceding the set up of the pilot and were further developed during the pilot as a result of feedback from the participant, as well as from tutorials with my supervisor.

The interview protocol was designed initially as an aid memory as the interview was being taped and transcribed as separate data. However, to facilitate the reading and interpretation of the protocol data, I added to the interview protocol empty charts into

which would be transferred the data collected in the self-analysis protocol.

The formal interview was scheduled for the end of the five-week studio assignment. It so happened, however, that the participant turned up for the appointed interview without the self-analysis protocol so the interview was conducted and taped without access to the protocol. Thus a second interview was arranged in which the data from the self-analysis protocol were transferred to the interview protocol. The meeting lasted about an hour of which half was taken up by the taped interview.

The transferring of data from the self-analysis protocol to the interview protocol turned out to be a collaborative activity. As the participant read out the data, I turned them into matrices and bar charts. As the transferring of data took place just before the formal interview, it occurred to me that the transferred data could in fact act as visual prompts for the participant in responding to the interview questions. Thus the interview was conducted with the protocol data laid out in front of us in a visual and easily read format.

Outcome

Having found that there were recordable data of conceptual activity, or at least tracks thereof, and captured in the self-analysis protocol and interview protocol, how then could the pilot data be interpreted?

The student assignment was a RSA brief on the subject of reinnovation calling for ideas to identify and solve a problem with an existing product or service. The participant's idea was for a child's breakfast bowl designed so the child could leave an imprinted message 'thanks mum' on the table after the meal was finished. The final design was presented in sketches and on a video clip.

The self-analysis protocol confirmed how the conceptual stage is not a step-by-step linear process (Goel op. cit.). Indeed ideas popped in and out well into week four of the five-week long assignment. The first ideas came during Internet search and chatting with fellow students but ideas came together significantly first in week four using both sketches and computer graphics.

In transferring self-protocol analysis data into charts, it became easier to interpret the uses of conceptual tools according to their distribution, frequency and sequence in the design process. Thus, the conceptual stage started mainly with words [W] including the Internet, moving into the sketch [S] mode in the middle of the conceptual phase, and back to verbal [W] and computing [C] modes

towards the end. Although distributed differently, the number of sketch [S] and word [W] instances was roughly equal (20) with a few instances of computing [C] (5) and only one sketch modelling [M] instance. The data on modes of communication ('I' and/or 'we') transferred into charts revealed that sketch [S] and computing [C] instances were exclusively in the 'I' mode. In contrast, words [W] were almost equally distributed between the 'I' and 'we' modes, that is as means of both self-expression and communication with others.

Transcripts from the interview protocol revealed some rich descriptions and explanations, such as: communicating using words [W] was 'either in a group or one-to-one with a tutor about the brief or with a friend I was doing research with. And then it spilled out into sketching and almost a bond between sketching and written words.' The most important conceptual tools were expressed as: 'Probably the most effective ways were not written words but almost spoken words and most to myself as well ['I'] working through the project in my head, thinking about it and from there it spread out into the sketchbook'.

The computer was used as 'a way of presenting ideas at the conceptual stages, almost a kind of signpost as part of your design'. But also: 'it wasn't so much for the developing of ideas'. Also, 'I think [the Internet] can be overused quite easily because it is so user-friendly. You click at a button and you get all this research in front of you.' On the lack of modelling: 'I would have liked to use model making because the end-design was a product … but the project was also about the idea behind it … I focused more on the idea.' As to landmark events: 'there were great moments [in week three] when I sort of found the information I had gathered [Internet search and sketchbook] helped me to develop ideas and really think, yeah'.

Conclusion

A significant outcome of the pilot was how the search for a method became a conceptual phase, something not yet fixed but becoming through the process of trial and error, of roughs, refinements and detailing, of what Burns calls 'progressive focusing' (Burns op.cit.). A pragmatic approach, asking straightforward questions such as, 'how is it done?' 'and 'what is needed?' helped framing the task of how to design, and later evaluate, the pilot, progressively turning it into a viable research launcher for the main case study.

However, a few inconsistencies emerged in the interview transcript, notably the uncertain role of the computer as a conceptual tool. This was of concern for data reliability but I would

like to argue that the lack of consistency had less to do with shortcomings of protocol analysis than with the difficulty of pinning down moments of 'digital creativity', the discrepancy between what we do and what we say we do. In other words, such inconsistencies would be treated sensibly as 'missing data' rather than 'system failure' (see above In search of a method).

Significant too was how the transfer of self-analysis protocol data into the interview protocol enhanced transparency providing both participant and researcher with an at a glance picture of uses of conceptual tools. In this, protocol analysis seemed not just a method *about* research but also *for* design or, to quote the participant: 'Wow! I didn't know I was going about conceptualising like that.'

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