

Is Sketching Still Relevant in Virtual Design Studios?

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Abstract

Sketching, as a particular subset of drawing, has for a long time, been valued within design activity. Although they can appear rough, inaccurate or incomplete, sketches have been presented as both valuable output from, and evidence of, essential activity in designing by individuals and groups. This paper reflects on this value and asks whether sketching is relevant today, given the advances in computing and communications technology seen in modern virtual design environments. Is it time to let go of the metaphor of drawing or can this ancient human capability still tell us something relevant for the improvement of the virtual design studio?

While freehand line drawings may not have the same importance in current virtual design studios the support of incompleteness, ambiguity and shared meaning in solution-focused and problem-focused thinking remains essential. The paper proposes that attention to 'graphic acts' has improved our understanding of sketching within collaborative designing. A particular type of fast, transitory 'thumbnail' sketch would appear to be important. If this is so then attention to its modern counterpart in the latest 3D, multi-user, immersive virtual design studios is overdue if they are to support the cognitive processes of creativity vital to design.

1. Introduction

Publications on drawing are not new. Whilst many manuals of technique exist, publications articulating the exploitation of drawing are harder to find but some go back a surprisingly long way (see, for example, Ruskin 1859). Sketching has variously been shown to support the investigative and creative activities of designers working alone (Garner 1992). The 1980s and early 1990s saw much research into how sketching operated within collaborative design. The objective for much of this research appears to have been an attempt to transfer the functionality of sketching observed in traditional face-to-face environments to new computer mediated environments - the early virtual design studios (VDS). In the former, participants drew with pens or pencils on a shared pad of paper or a studio whiteboard (Figures 1 and 2). In the latter, participants were often given facilities which attempted to directly emulate these tools - a graphics tablet replaced the pad of paper, a stylus and keyboard replaced the pencil and various systems for the on-screen presentation and mediation of these tools was devised (Figure 3). We have moved a long way from the early 'first generation' VDS which were little more than extended teleconference environments. Sophisticated as they were at the time they attempted to achieve the qualities of proximal working whilst participants were located remotely. While sketching seemed to be very relevant in early VDS research, how relevant is it today given the new environments and new possibilities of 'second generation' VDS? Does sketching still have a role in the making, sharing and modification of VRML models. What form might sketching take in a virtual world inhabited by avatars?

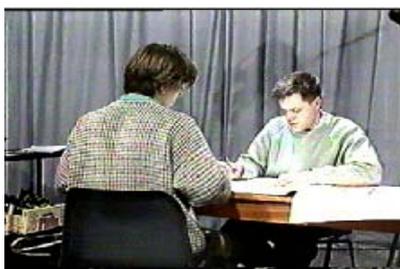


Figure 1 An early study (1988) by the author into sketching within collaborative designing



Figure 2 Sketch output from studies of proximal collaborative designing

2. Pointers to the functions and value of sketching

Even the earliest studies of sketching highlighted the dual function of sketching. Research revealed the potential and actual support of both the communication of information and the creative exploration and generation of ideas. Communication was the more transparent of the two and received general support and easy acceptance. How sketching supported creativity was always less easy to identify and evidence has only slowly emerged from fields as diverse as cognitive science, neurophysiology, computing and design research (see Goldschmidt 1991). It was assisted by parallel studies which informed us about how designers think (Lawson 1980) and the reflective nature of their cognitive processes (Schoen 1983).

The significance of conjecture in design activity was eloquently reviewed by Bruce Archer in his Presidential address to the Design Research Society in 1998 (Archer 1999) and, before this, Goel (1995) presented sketches as ambiguous conjecture which function to hold emerging concepts open to continuous development. Fish (1996) dissected this notion further to reveal how external, constructed models in the form of sketches make unique contributions to cognitive transformational processes central to creativity and the emergence of ideas.

More recently, Casakin and Goldschmidt (1999) suggest an important relationship between the ability to exploit visual analogies and successful design problem solving. Like Fish, they also propose that the type of visual analogies represented via sketch drawing assist the structuring of design problems through transformation - a process of interrogation and reformation of information. Design progression, it would seem, requires an integrated strategy for creatively interpreting and transforming the partly-known problem, and for creatively responding via the generation and expression of ideas. The widespread use of sketching in design activity would seem to suggest that it offered appropriate support to both the defining and resolving of design problems.

As these findings emerged in the 1990s so virtual design studios began to change. Partly this was in response to advances in computing and telecommunications. The functionality of sketching began to be disconnected from the traditional output. Experiments with CAD and multi-user virtual space took place which seemed to offer some of the advantages of sketching presented above and yet gave rise to very different forms of output. Tovey's work in the domain of computer supported car styling was a case in point (Tovey 1997). Here new digital techniques were shown to support the cognitive processes of creative transformation but which gave rise to very different output when compared to the traditional line drawings or renderings previously seen in automotive concept engineering. A quality of 'process' was retained (for example, the support of ambiguity) while the nature of 'output' changed. The influence on idea progression and the effect on the quality of the emerging 'product' is still the subject of debate. After all, if only parts of the process are supported, leading to impoverishments in quality of design product then these must offset any advantages accrued through computer supported collaborative designing.

3. Sketching within early virtual design studios - Research findings from the AGA project

There is a problem in the investigation of sketches and sketching. Evidence suggests that design sketches which appear to have little integral quality can actually possess fundamental value. They may superficially appear rough or rushed but within them may reside the essence of a concept or a major decision. Similarly, other sketches may attract a label indicating quality

and yet they actually serve only a minor function in the progression of a design idea. A further problem arises from the fact that sketches can develop over time. Corrections or changes as a result of drawing into or over existing images means that sketches can have multiple meanings during their manufacture and use. Indeed, the sharing of sketches within collaborative designing would seem to be an important indicator of design progression. Some of the author's early analysis of sketching attempted to categorise the drawn 'output' but many contradictions emerged - not least in what the output seemed to suggest and what the maker said was the intention! So, if the outputs could not be relied upon to provide a suitable foundation for investigation then maybe the 'process' could be more revealing. This emphasis on process is best illustrated with reference to more recent graphic analysis known as the AGA project (from analysis of graphic acts) undertaken on data which emerged from studies of collaborative design using pairs of undergraduate student designers.

In 1998 the author returned to a collection of research data generated in studies of computer supported collaborative working undertaken as the 'Rococo' project, led by Steve Scrivener and involving the author, at Loughborough University between 1988 and 1992. Sceptics might be critical of a return to 'old' data for new research studies. After all, there have been significant technological developments, reductions in real costs have allowed the exploitation of computer mediated collaboration in many fields of work and research studies in the intervening years have added considerably to our knowledge regarding user requirements and the application of computer based tools. The original project data had allowed the original research team to examine a variety of issues concerning verbal and non-verbal communication but it seemed that embedded within the data was further valuable information regarding the use of sketching for researchers of virtual design environments.

The Rococo project was a comparative study of pairs of student designers engaged in collaborative designing. In one condition (Phase One) subjects worked proximally or face-to-face in much the same way as Figure 1 depicts. In a second condition (Phase Two) subjects were located remotely from each other but had audio and video links plus a computer mediated shared drawing surface (Figure 3). Essentially they worked in a basic virtual design studio.

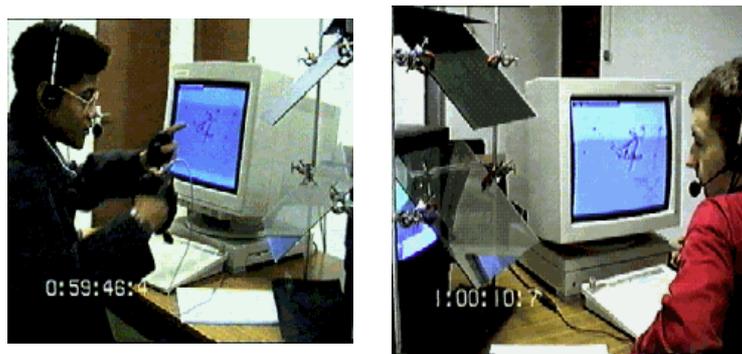


Figure 3 'Rococo' project studies of computer supported collaborative designing revisited in the AGA project

For the purpose of the AGA project a drawing refers to a discrete and identifiable graphic output which might have pictorial (sketch) or written elements or both. Having given every drawing from both conditions its own identifying number it was possible, by using video recordings, to chart the history and development of each drawing by documenting the individual contributions. These contributions have been termed Graphic Acts. Some drawings consisted of only one Graphic Act. Others consisted of several Graphic Acts over a period of time - often by both partners. For this analysis, Graphic Acts were defined as 'continuous sketching or writing activity where pauses, interruptions etc., are less than one second in duration'. Scrivener & Palmén (1991) exploited one-second interrupts in their analysis of 'Drawing Acts' and this seemed to provide an appropriate level of detail. Graphic Acts were further divided into written graphic acts (e.g. annotation, listing) and sketch graphic acts (pictorial imagery). The logging of the number and duration of Graphic Acts for each study in each condition (6 studies in Phase One and 5 studies in Phase Two) provided a relatively simple and robust coding system requiring only the identification of discrete drawings and the recording of each Graphic Act which was added to it. It facilitated, for example, the construction of profiles of graphic activity for each pairing in the form of graphs (showing, for example, numbers of Graphic Acts produced within 5 minute time bands within each one hour study) and it facilitated comparisons between Graphic Act output within proximal and remote pairings (involving the aggregating of data from all the studies in each condition). The AGA project focused on sketch graphic acts (SGAs) and some interesting findings concerning these appear below.

4. A statistical comparison of drawings and graphic activity

Any test for significant difference between the findings of Phase One and Phase Two had to acknowledge the particular

characteristics of this research - not least that it used very small samples. While the subjects were all drawn from the same student group the two phases used independent samples and since a number of parametric assumptions were violated then nonparametric statistical tests offered the most relevant means for analysing the data. The Mann-Whitney test was adopted via the computer-based statistical program SPSS (v.6). Levels of significance were determined for the differences in the data obtained and compared. Significance at the 5% level ($p < 0.05$) was termed 'significant', and significance at the 1% level ($p < 0.01$) was termed 'highly significant'. The following percentages derive from the aggregation and comparison of the data from all Phase One studies with that from all Phase Two studies.

No significant difference was found between the two conditions regarding assessment of the quality of final design proposals. However, remote participants spent 51% more time making graphic acts than their proximal counterparts and this was significant. Partly this can be explained by the existence of extended periods of non-drawing time in the proximal studies. There was a highly significant 30% decrease in overall drawing production when subject pairs worked remotely. This might be associated with a lack of familiarity with the computer tools or inherent restrictions such as screen (page) size.

In spite of producing a 17% lower mean number of sketches in the remote condition, the mean number of shared sketches was 31% higher. While not statistically significant this might suggest that remote pairs found it preferable to work-up their own sketches, and those of their partner, in their collaborative designing rather than begin new sketches.

No significant difference was found in the production of Sketch Graphic Acts (SGAs) overall. However, there were 37% more SGAs per sketch in the remote condition and, statistically, this was highly significant. Again, remote pairs preferred to work-up existing sketches rather than create new ones.

52% more SGAs were committed to shared sketches in the remote condition. The remote condition presented a highly significant 42% decrease in the production of sketches with three or less SGAs (characterised as fast and transitory 'thumbnail' sketches). When this was corrected for variation in overall sketch output there was still a 31% decrease in the output of this type of sketch.

5. Implications for the future support of 'sketching'

Research studies have begun to reveal how fast and imperfectly formed pictorial representations, constructed during designing and taking the form of sketches, are important to designing. They impose both order and tangibility on the one hand, while on the other hand their ambiguity stimulates reinterpretation. It is not just the potential speed of sketch generation which assists cognitive processing. The very lack of clarity inherent in freehand drawing may be an important catalyst in creative transformation of information. If designing - and particularly conceptual designing - is a process of problem formulation, conjecture, evaluation and improvement then designers require a modelling tool which has the speed and flexibility to support this.

The AGA project suggests that the support of sketching within first generation virtual design studios was only partly successful - partly because it sought to emulate its proximal counterpart. In this particular study, sketching was shown to be significantly impoverished in certain key respects. Participating pairs who were remote but linked by computer tools spent more time than their proximal counterparts engaged in sketching activity; they produced fewer sketches overall but used a greater proportion of shared sketches and each sketch contained a greater number of Sketch Graphic Acts (SGAs). Also, there was a 31% decrease, in real terms, in the production of what has been termed 'thumbnail' sketches. So what are the implications for second-generation VDS?

Clearly design is about model-making, model-sharing and model-changing. When design was a largely individual activity our models and modelling activity could be idiosyncratic but times have changed. Collaborative working is now a normal work requirement and no more so than in design - particularly architecture, product design and transport. Product complexity, pressures to reduce lead time, the need for specialist contributions, multinational companies, client demand and our litigious society have created the demand for sophisticated multi-designer collaborative virtual environments where models can be shared and acted upon. As Mary Lou Maher et al noted in their DCNet paper in 1999 "a recognised aspect of the design of virtual places is the short time between design and redesign" (Maher, Simoff et al 1999). Successful collaboration is therefore not merely about sharing models. It demands that models can be modified and evaluated quickly by the participants in an attempt to collectively add-value to a proposal. Although some virtual models can be very helpful for communication, sketches have often provided a means of sustaining fast iterations. The significant use of sketches with 3 or less sketch graphic acts in face to face collaborative designing reported above supports this.

Some of the VRML shared models require high levels of knowledge of object oriented programming in order to contribute

modifications. Sketching, on the other hand, requires only a low level of entry skill to exploit it. One thing all models have in common is that they are incomplete in some respect. They are simplifications of reality in order to achieve a particular function. Sketch drawing, as with 3D sketch constructions, can deliberately exploit this simplification process to provoke creative reinterpretation of perception. That is, sketches can be sufficiently ambiguous to instigate, and not merely facilitate, creative development by the drawer and by the viewers of the drawing. Sketches are models which can provoke and inspire. They are dynamic not passive. Sketch drawings may still offer a superior facility for introducing metaphor into design dialogue. Models within virtual collaborative environments still seem to be too wrapped up with their own identity to facilitate a confident ambiguity.

However, the potential is there. Virtual collaborative design will undoubtedly become the norm for many design professionals. But for this to be the case designers will need to reflect on their model-using and create a demand for a hybrid modelling capability. This should combine the advantages of sketching with the opportunities afforded by virtual models and allow participants, as Smith points out, "to move around the virtual space and interact with objects in a multi-user virtual space" (Smith 1999). The AGA project was helpful in illuminating the use of sketching in a basic virtual design studio. Computer supported pairings revisited more drawings and created less new drawings - particularly those potentially valuable thumbnail sketches which contain 3 or less SGAs - than their proximal counterparts. One may speculate on the reasons why remote participants preferred to work up existing drawings. Perhaps lack of familiarity with the input devices meant that over-drawing was preferable; perhaps it was easier to bring a remote partners attention to an existing rather than a new image on screen. Perhaps, as Maher, Simoff et al (2000) suggest, shared sketches acquire significant levels of shared understanding during collaborative design. If this is the case, communication of intent between participants would be easier using existing sketches than creating new sketches which potentially contain little or no shared understanding.

The status of research into design sketching has been considerably enhanced in recent years. Purcell and Gero (1998) point out that sketching is no longer viewed as a mere 'skill' but as 'an essential part of the process of thinking about a design problem and developing a design solution'. New studies now need to be undertaken using second generation VDS. Are we likely to see avatars producing sketches? I think this would be to miss the point. We need to move away from the metaphor of traditional studio practices whilst retaining the original advantages. The objective may not be to support the generation of sketches as 'output', but to support new 'processes' of sketching using virtual models.

The author acknowledges the contribution of the other members of the Rococo team to the early work described in this paper (Scrivener S., Connolly J., Clark A., Schappo A., Clarke S., Palmen H., & Smith M.)

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