Virtuality and creation? The emptiness of computers in conceptual design

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Computers have been incorporated into the practice of design disciplines without their impact on creativity and innovation having been evaluated first. The computer tools used in design have been and are still being taken from other disciplines where more precision and control are required, without taking into account the fact that the start of creative activity requires much more ambiguity, abstraction and imprecision. Ideas are then created with traditional manual tools, such as sketches and mock-ups, and computers are used mainly to present these ideas and not to design them. The advantages for design that can be provided by computers are diluted within complexity at the level of interface and a particular logic in the language required to communicate with computers. This article presents a new focus of the use of virtuality within the design process. Current computing is criticised and new methods are put forward to incorporate computers into design, enriching traditional manual tools without imitating or simulating them.

Introduction

In order to communicate with themselves and other people during the design process, designers use a language that consists of a variety of techniques of representation. Each is capable of providing a kind of information used by designers to take design decisions. Sketches, technical drawings, mock-ups, elevations, perspectives, 3D computer models and presentation models, to name just a few, go to make up this language and computers have recently joined this list. Computers have been added due to their potential for handling information, improving the different stages in the design process. However, it is principally at the end of the process when digital instruments show their advantages over traditional techniques through the impressive possibilities for presenting and communicating the project with great precision. Bermúdez and King[1], investigating representation media, found that digital media are best for developing the design and that manual representations are more suitable in the conceptual design phase. In spite of this, computers have not been regularly integrated into other manual or analogue techniques. Many digital design solutions attempt to simulate or imitate these traditional tools, offering their digital equivalent without conclusive results. Instead of improving traditional tools with the capacities of the system, the digital equivalents force the user to interact only with the computer during the design process. The computer has become a block as far as representation is concerned during this process. Moreover, because of the complexity of the interface, the system requires specialisation, forcing designers to use manual instruments, particularly early in the process.

When we refer to computer design, we refer to the use of the advantages of a computer to improve the design process. In professional practice, commercial programs have been put forward to help master projects betters. However, professionals use personal computers (PC's): a generic system made up basically of a powerful processor, laser mouse and wireless keyboard, and a flat screen with high resolution. This computer is almost similar to all computers, including those of architects, lawyers, students, etc. The problem illustrated here is that computing systems are not well adapted to specific design tasks. Even when the program is changed to modify its use, the dedication required by the user to carry out an activity still results in specialisation and entails complexity in the interface.

Various systems are based on this focus in CAD research, proposing programs that change the use of the system and thereby falling into the restrictions of a generic interface-user that causes problems. Computers must be a design tool for all designers and not for computer specialists capable of taking on the complexity of current day interfaces. In practice, designers continue to carry out the most important part of the process (ideation) using traditional methods, such as sketches and mock-ups, then using computers to represent and communicate these ideas. The computer as a tool is not applied to design but to communicate and present. Are we therefore talking about computer design or computer representation? This new focus is proposed via two methods, one related to the design of spaces using sketches with virtual reality and the other to mastering shape using rapid prototypes.

2 Drawing Virtual Reality

2.1 Computation and conceptual design

Since computers were introduced in the design workshop, their influence on thinking up ideas has not been verified[2]. Design offices, even with young designers, still use traditional or analogue media such as sketches for their ideas. Computers are then used to represent the idea. The problem seems to be the computer interface (software and hardware) that always requires specific, precise information that limits creativity.

The importance of freehand sketches or drawings has been demonstrated in various studies, where their ambiguous, abstract and imprecise nature help the cognitive process during conceptual desig[3,4,5]. Even before external representation, the cognitive structures related to the mental image help the designer to start the conception[6]. However, in the case of new designers, working with complex geometry requires an intuitive representation in order to understand and resolve design problems. There are various kinds of freehand representations, such as bubble diagrams, that help to resolve design aspects like proximity, location, orien-

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[2] WILLEY, D. (1999) Sketchpad to 2000: From Computer Systems to Digital Environments. Proceedings of the eCAADe Conference, Architectural Computing from Turing to 2000. Liverpool: Education and research Computer Aided Architectural Design in Europe.

tation, circulation and the area of a project. Sketches are also used to represent and model 3D shapes and spaces via orthogonal views and perspective. This kind of sketch is what we are focusing on in this article, particularly drawing sketches in perspective to design a space. Once some decisions have been taken in 2D planes, the designer uses this kind of perspective view to continue to bring up ideas about the space, considering the proportions, ceiling, lighting, materials, colours and furniture.

At present, in interior design, the process of thinking up ideas is based on technical plans, followed by freehand perspectives or precise perspectives created by computer. On the one hand, the problems of freehand sketches appear: feeling inside the representation, understanding complex shapes, unconscious errors of proportion and lack of respect for the human scale from the observer's point of view[7]. On the other hand, the typical problems of computer representations also affect the conceptual design process: the interface and precise images.

Most of the solutions put forward to integrate sketches into the digital design process seem to take a particular path, imitating or simulating the real sketch[8]. There are also filters that automatically translate precise shapes into "sketch type" representations when calculating the image, insinuating that the advantages of drawing freehand have been preserved. A sketch is also used in Virtual Reality (VR) but this time in 3D, floating in space[9]; a kind of sketch that has never been used before without *psycho-motor perception*[10] provided by a rigid support, normally paper or a graphic pad.

2.2 The perspective of virtuality

VR and photo-realistic images are used particularly to present projects. Initial studies show the efficiency of VR to communicate complex shapes more successfully than using technical drawings, as the designer does not need to encode and decode the information for the project to be understood[11]. However, no difference has been found between analogue design tools, such as sketches, and VR during the conceptual design process. In spite of the direct manipulation, the complexity of the user-interface in 3D modelling is due to the fact that computers need to handle abstract data in order to calculate the representation of the 3D model[12]. These data need to be entered using commands shown on the menus, respecting a specific geometric system responding with special data. This distances the designer from the cognitive thought of creation. The designer is not concentrating on the design task but on responding to the system's requirements[13].

Principally due to scale, VR has been seen as a powerful design tool for architectural design. The project can be visited before it is built and design decisions taken using a better instrument in terms of the natural proportions and the sensation of being present inside the project compared with traditional tools such as sketches or mock-ups. The challenge is therefore to design within a virtual world as easily and intuitively as with sketches, without all the problems of interfaces as in the current case of 3D modelling.

At present, the CAVE[14] and other VR systems[15] seem to be passive with regard to the creative process within the virtual world. Navigating and visualising, and even moving shapes and opening doors, makes us interact with the virtual environment passively from a design point of view. 3D models continue to be made using generic PC's and using 3D modelling programs outside the virtual world, interacting with the mouse in a graphic user-interface of menus. In the past, it was possibly on a simple cocktail serviette where the idea was born and the concept made. The system was used simply to visualise an idea that had been conceived a long time before.

2.3 The cocktail serviette

The strength of freehand sketches using pen and paper is due to the fact that there is no computer. From a creative thought, the designer does not need to activate the system, wait a few minutes for it to boot up, look for the appropriate application, wait again for it to be loaded, choose the ideal tool and finally draw. This process can interfere in the creative flow as the designer is thinking about the tool.

This reality highlights a traditional problem in conceptual design and shows the superiority of the cocktail serviette interface in preserving creative flow. The advantages of sketching are based on the fact that the use of pen and paper does not require specialisation[16] and that this knowledge has been innate in the designer since infancy. However, we should recognise that a new generation of computer users are familiar with the interface and are used to working with it. Even here, specialised designers are required and the usefulness of computer solutions for conceptual design compared with the focus of the cocktail serviette are still uncertain.

2.4 Do we need to sketch digitally?

The answer is yes, if we maintain the characteristics of this conceptual representation tool and if we increase its advantages and reduce its problems with the computer.

Simulating or imitating real sketches with particular representations "like sketches" (SketchUP®) is not an appropriate focus for conceptual design. This kind of representation can be aimed at clients, making them feel as if the concepts are still evolving and that the project is not finished or built, instead of using typical photo-realistic representations.

Another element is maintaining the personality of the representation. Designers have their own "hand": a sketc-

[3] GOEL, V. (1994) Sketches of Thought. Cambridge: The MIT Press.
[4] GROSS, M., i E. Y. DO (1996) Ambiguous Intentions: A Paper-Like Interface for Creative Design. Proceedings of the ACM UIST Conference. Cambridge: User Interface Software Technology.
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[12] KALAY, Y. (2004) Architecture's New Media. Cambridge: The MIT Press.
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hing style and a mastery of technique that allows us to recognise them. Synthetic images are homogeneously perfect and photo-realistic. The driving force of calculation has accustomed us to this kind of "almost perfect" images but they are not useful in conceptual design.

Using sketches to enter information in the system, then being translated into perfect forms[17] is to go against their characteristics. Sketches have also been used as a trigger to activate commands recognising gestures. Here sketching is not a conceptual representation but a command interface.

2.5 Immersive Drafted Virtual Reality (iDVR); ideating space

Non-immersive VR[18] uses computers to generate a cylindrical panoramic pattern based on basic shapes that, once printed, serves as the basis for a designer's freehand drawing (fig. 1). Once the panoramic sketch is digitalised, the QuickTime-VR (QTVR) technique allows the designer to experience the VR of a freehand drawing. The designer uses the skills already acquired according to the desired technique for the hand drawing.

The Panoscope[19], which projects a spherical panoramic view around the user to generate immersion without the complexity of helmets (HMD) or CAVE, is an ideal tool for DVR, this time immersive (iDVR), sketching in real time without the delay of the transition from the panorama to the corrected perspective in QTVR. The drawing is done directly in the immersion with the help of a pad or digital pencil on the spherical panoramic base using basic shapes made by the computer (fig. 2). The user draws a spherical panoramic view but observes around him or her the space represented in real time (as they draw) without deformations, thanks to Panoscope.

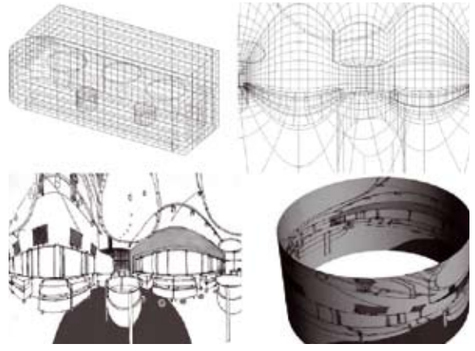

Figure 1: : Basic shapes | cylindrical panoramic pattern | drawn pattern | QTVR technique.

To illustrate the use of this method in its two versions (DVR and iDVR), let us imagine an interior designer who must design a space. Via a 3D modelling program, the designer constructs basic shapes without any detail. The aim is to use these shapes to build up a panoramic pattern that is difficult to carry out without a computer. The role of the pattern is to assist the designer, allowing him or her to model by hand, providing a visual reference of the proportions of the objects and the space in the panoramic deformation (like templates for axonometry and perspective). Once the pattern has been built up, the interior designer draws directly on it with an illustration program such as Corel Painter® and a digital pad (Wacom – Interactive Pen Display). Panoscope projects the corrected sketch around the user at the same time as the user is drawing the space. In order to make it easier to see the whole space (360°), the digital pad is mounted on a pivoting table inside the Panoscope (fig. 3).

Once the sketch has been made in immersion (iDVR), the designer can print it in order to complete it with traditional drawing techniques (markers, charcoal, etc.). To visualise the sketch, the design digitalises it (scanner) and, once in the computer, the QTVR technique allows its non-immersive viewing (DVR) on screen.

3 Hybrid modelling

3.1 The craftsman and mock-ups

Hands, including the fingers and all their possible axes of rotation, are ideal for modelling[20]. Hand to eye coordination, joints, skin and muscles also allow designers to feel the shape evolving in their hands. The sense of touch is very important in human perception and allows us to fully understand 3D geometry.

Representations in the real world are balanced compared with those of virtual environments. There is a closed network between the mental images, visual perception, hands and representation[21]. The connection between these elements is very strong and allows greater control of the representation, in this case the physical model. The interface of digital tools sometimes affects this network. The problems are the actions structured with menus, default values and system messages that break this balance and lead the designer to take premature decisions[22].

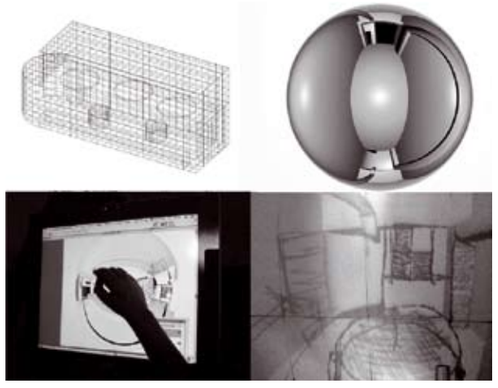

Figure 2: Basic shapes | spherical panoramic pattern | sketch on pattern with digital pad | perspective view inside the Panoscope

Figure 3: iDVR system: Panoscope with pivoting digital pad.

[17] DO, E. Y. (2001) VR Sketchpad. Proceedings of the CAAD Futures Conference. Eindhoven: Computer Aided Architectural Design Futures.
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[19] COURCHESNE, L. (2000) Panoscope 360. Proceedings of the Siggraph Conference: New Orleans.

The most important aspect regarding craftsmanship and manual media also concerns the skills acquired. Already skilled at working manually with certain materials, designers often feel "their hands are tied" when carrying out certain tasks with the system interface. Manual media allow 3D modelling to be mastered using stereoscopic vision and both hands, without the intermediary of images on a computer screen.

Mock-ups vary in terms of scale, precision and materials depending on why they are made. They are abstract representations and not replicas of reality[23]. Physical models therefore become models of the designer's thoughts[24]. Like sketches, designers can maintain a conversation with these representations, ensuring that certain questions remain unanswered, allowing a margin of flexibility and providing an explicit visual for the decisions that must be taken[25]. Working mock-ups have the same characteristics as sketches, making room for creative flow.

The main problems of mock-ups are related to scale: when it is very small and the field of vision is highly deformed, hindering a correct evaluation of the proportions.

3.2 Digital conceptual modelling = premature

We have carried out an experiment with two designers competent in 3D modelling, starting to think up the shape of a computer mouse using manual methods, one with sketches and the other mock-ups[26] (fig. 4). They then entered the visual world, the first via 3D modelling and the second via 3D digitalisation.

On the one hand, going from the sketch to 3D modelling was considered as premature as, arriving at an almost completed result, some aspects of the geometry were not sufficiently determined in the sketch to input the 3D modelling program with the necessary precision. The 3D program also required geometric descriptions of the shape, the idea still being somewhat ambiguous and abstract for the designer. On the other hand, going from the physical mock-up to the digital world, in spite of the primitive nature of working mock-up, was a better portrait of the understanding of shape, scale and proportions of the object. The transformations were easily carried out.

3.3 Rapid prototypes and ideation

Applied to representations in design, the essential objective of the technique is to produce a physical model based on its digital description. The logic behind these systems is to produce precise objects later in the design process, instead of serving conceptual design. According to Kvan and Thilakaratne[27], these systems prioritise illustrative and semantic models instead of motivating a design conversation as proposed by Schön[28]. In our focus, RP techniques are highlighted in this way instead of being used for digital production[29].

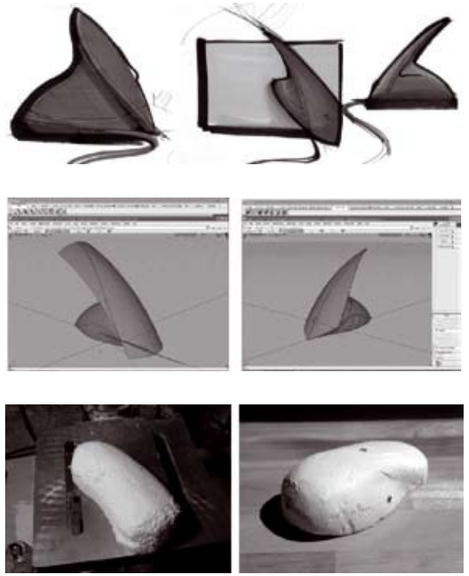

Figure 4: Sketch to 3D modelling (Landreville) | mock-up, 3D digitalisation and 3D modelling (Moussette).

The focus we take with RP techniques is to use them to generate 3D matrixes or patterns to explore shape during conceptual design. Instead of waiting for the shape to be completed in order to produce a prototype, RP is used to print working concepts and to manually explore the idea. Instead of producing a precise prototype, the aim is to create a model that can become a matrix for other physical models to help the designer, providing him or her with a physical support to manual exploration.

In this way, taking the model outside the virtual world, designers can apply their skills and obtain complex shapes, achieving their design intentions without the geometric requirements and limitations of the interface. The virtual world can then be re-entered to take advantage of digital tools and the techniques offered by 3D modelling: "Boolean" operations, appropriate transformations, curve generation, etc.

3.4 The hybrid mock-up: thinking up form

The hybrid mock-up consists of using both modes of representation (manual and digital), modifying 3D modelling with manual and digital procedures. It is a cycle of frequent repetitions, going to and fro between the virtual and the real, via 3D digitalisation and RP technologies.

In order to illustrate this method, we will take an industrial designer who is starting to formally model a device. Taking into account the implications of passing the sketch onto 3D modelling, he or she starts to think up ideas

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by working with physical materials, such as a block of "Styrofoam", modifying it manually to create the first idea. This concept is then digitalised and visualised, consequently using digital techniques as differences and additions. The return to manual mode is via RP. The object created is relatively malleable and can be easily modified, being sculpted by removing material (cutting, filing, etc.) or adding material (clay, Styrofoam, etc.). The RP model can also be produced as a mould, becoming a template to reproduce other models that will serve as 3D patterns to explore the shape. With regard to computer modelling processes, instead of using orthogonal images as a basis for 3D modelling, the digitalised model is used intuitively as a 3D pattern for modelling (fig. 5).

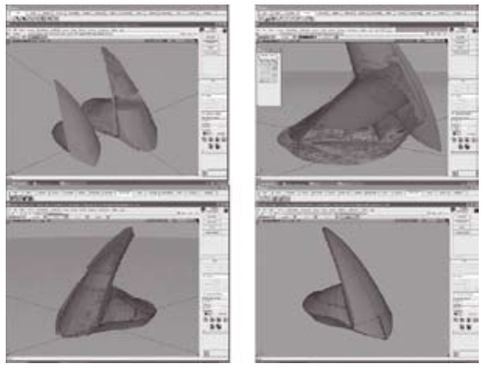

Figure 5: Digitalised mock-up as 3D pattern for modelling instead of orthogonal images (Landreville).

The aim of this focus is to benefit repeatedly from the advantages of digital and manual modes, allowing designers to chose the method they feel is most suitable for a particular action.

4 Conclusions

Experiences with designers and students of industrial and interior design show that these techniques allow them to respond well to design expectations with less frustration and greater satisfaction than with traditional digital media. The forms made with the hybrid mock-up are more complex and richer than those made only with 3D programs, thanks to the information introduced manually (fig. 6). With regard to space, iDVR allows greater understanding and the detection and correction of design errors. Representations also show the personality and style of the designer (fig. 7) and it only takes a few minutes to adapt to spherical panoramic drawing.

Figure 6: Complex, rich shapes produced from the hybrid mock-up (Gaulet-Thomas).

Figure 7: Spherical sketch (iDVR) | Cylindrical sketch (DVR) (Bussière-Bonnet).

In the design process, intentions should remain ambiguous until the designer is ready to go on to the next stage. The border is being built where virtuality is accessible to explore concepts without affecting creation. The information must be handled by designers themselves, without fear of imprecision. Computers must not be seen as a vital instrument for design: it is proposed that we re-evaluate manual action and the dominance of design tools. In this new approach to computers in design, the computer must be integrated with basic traditional tools to thereby improve them and make them more effective. Designers must concentrate on their work of creation and the tool must help this task, responding to the demands of designers as well as recognising their

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Design Transformation

Ignacio Germade

Ignacio Germade heads Motorola's UK and Singapore's design Centres and is responsible for Motorola's industrial and interface design for the EMEA and South Asia regions. Prior to joining Motorola, Ignacio led design groups in multinational firms such as Sapient and IDEO, creating global solutions for companies such as Xerox, Polaroid, Fila and IBM.
Ignacio Germade has received several design awards, such as the IDSA Design Excellence Award, ID Interactive Media Awards and ID Magazine Awards. His work has been exhibited in Boston, London, and Hong Kong.
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KEYWORDS Innovation, Technology and design, Marketing.

Innovation is necessary but not the only factor to ensure the success of a design. Great products and services need to be created that satisfy people's desires. We need to know what people want and to set up interdisciplinary teams that ensure the operation is successful.

Looking at the role that design plays is very important in any company. Some of the questions we've been considering at Motorola are: how can design help change the focus of a company from being technology driven to being user driven? How we can use design to drive innovation?

Everybody is talking about innovation; innovation is rapidly becoming a buzz word. As with any other buzzword, the problem with this is that we run the risk of forgetting its real meaning and turning it into just another marketing spin. (One could argue that the same thing is happening with 'User Experience'). I often hear people saying things like 'innovation is the most important goal for a company'. I believe this is a mistake. Innovation should not be the goal but part of the process we use to achieve the goal. The real goal is to create great products or services, and great products and services can only be achieved by understanding the people you are creating them for. Occasionally it is necessary to re-examine your primary aims to ensure they address your customers' need.

This may sound like a semantic problem but there is actually a very important distinction to be made. If the goal of a company is to achieve technological innovation, large amounts of money can be spent following the wrong path. If the goal is to create great products, products that fulfil the needs of the people that will use them, then we shift our emphasis to creating a better understanding of these people. You have to know what makes sense to them and what their needs are. Then and only then you should look for the technologies that will allow you to achieve those goals. Simply put, innovation is the process that allows you to fill the space between the product you ***can*** create and the products you want to ***create***: the products that people will love.

In the past, Motorola was a prime example of a company too focused on technology. We have a heritage of techno-