THE RE-CONVERGENCE OF ART AND SCIENCE: A VEHICLE FOR CREATIVITY

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Abstract. Ever-increasing complexity in product design and the need to deliver a cost-effective solution that benefits from a dynamic approach requires the employment and adoption of innovative design methods which ensure that products are of the highest quality and meet or exceed customers' expectations. According to Bronowski (1976) science and art were originally two faces of the same human creativity. However, as civilisation advances and works became specialised, the dichotomy of science and art gradually became apparent. Hence scientists and artists were born, and began to develop work that was polar opposite. The sense of beauty itself became separated from science and was confined within the field of art. This dichotomy existed through mankind's efforts in advancing civilisation to its present state. This paper briefly examines the relationship between art and science through the ages and discusses their relatively recent re-convergence. Based on this hypothesis, this paper studies the current state of the convergence between arts and sciences and examines the current relationship between the two by considering real world applications and products. The study of such products and their successes and impact they had in the marketplace due to their designs and aesthetics rather than their advanced technology that had partially failed them appears to support this argument. This text further argues that a re-convergence between art and science is currently occurring and highlights the need for accelerating this process. It is suggested that re-convergence is a result of new technologies which are adopted by practitioners that include effective visualisation and communication of ideas and concepts. Such elements are widely found today in multimedia and Virtual Environments (VEs) where such tools offer increased power and new abilities to both scientists and designers as both venture in each other's domains. This paper highlights the need for the employment of emerging computer based real-time interactive technologies that are expected to enhance the design process through real-time prototyping and visualisation, better decision-making, higher quality communication and collaboration, lessor error and reduced design cycles. Effective employment and adoption of innovative design methods that ensure products are delivered on time, and within budget, are of the highest quality and meet customer expectations are becoming of ever increasing importance. Such tools and concepts are outlined and their roles in the industries they currently serve are identified. Case studies from differing fields are also studied. It is also suggested that Virtual Reality interfaces should be used and given access to Computer Aided Design (CAD) model information and data so that users may interrogate virtual models for additional information and functionality. Adoption and appliance of such integrated technologies over the Internet and their relevance to electronic commerce is also discussed. Finally, emerging software and hardware technologies are outlined and case studies from the architecture, electronic games, and retail industries among others are discussed, the benefits are subsequently put forward to support the argument. The requirements for adopting such technologies in financial, skills required and process management terms are also considered and outlined.

1. Introduction

The development of powerful computer technologies and the complexity of design demand that designers reexamine the design process and consider the adoption of such tools that will provide for creativity, improve the overall design process and at the same time reveal new insights. According to Bronowski (1976), science and art were originally two faces of the same human creativity. However, as civilisation advanced and works became specialised, the dichotomy of science and art gradually became apparent. Hence scientist and artist were born, and began to develop work that was polar opposite. The sense of beauty itself became separated from science and was confined within the field of art. This dichotomy existed throughout mankind's efforts in advancing civilisation to its present state.

Mayall (1979) has studied the reconciliation of art, science and technology in design. He draws distinctions between the mathematical engineer who creates new devices mainly through the alliance of specifications and working drawings, and designers interested in the form for whom it '... was a matter of observing what they regarded as proper combinations of forms and colours'. Stewart (1987) highlights the contrasts that exist between what is inspired to what is formal and what is practical to what is academic and at the same time emphasising the need for a contingency approach to design.

While the need to integrate design was recognised in the 1977 Conway Report, Rawson (1987) emphasises the importance of conceiving forms that can be turned into functional products with available resources. The challenge for us is to find the appropriate means and effective ways to integrate the arts and sciences and reduce the gap between the two domains.

2. Design and the Role of the Designers

According to Papanek (1971), designers should be aware of their social and moral responsibilities. Design is a powerful tool which allow designers to shape their products and environments in a way that may affect the well-being of people in general. He further argues that design is a 'function complex' where Method, Use, Need, Telesis, Association and Aesthetics are all strongly related to Functionality. Method is, with regard to the interaction of tools, processes and materials to build a product. Use is concerned with the question whether the product served its purpose and how its introduction affected other parts of its users' lives that are not planned for. Need is about addressing genuine needs rather than a designer's own desires and urges. Telesis content should reflect the times and conditions that have given rise to it. Association presents a psychological conditioning where an empathy or antipathy is predisposed towards a given value. Aesthetics is considered to be one of the most important tools that helps the designer to shape, colour and texture into forms that please, excite and inform.

3. Creativity and Innovation

Creativity is concerned with the design of products that in some ways offer added value and functionality when compared to products or ways that have preceded them. It is common that new products are not different and in many cases are not even better. Promoting change for the sake of change is a characteristic of recent revolutions in business that include the ISO 9000 standard, total quality management, re-design and re-engineering, usually responses of Western companies waking up to the competition from Japan. And while companies like 3M and Marks and Spencer have benefited from this approach in remaining or becoming world-class companies the majority that tried failed (Macdonal, 1998). Creativity exists in different forms as they occur in the business environment context. Designers can work creatively within available resources and set limits or they can use creativity and work around these limits. Rothwell and Gardiner (1988) have identified twelve patterns of re-design. When considering creativity in design work, Pugh (1996) argues that 'what we see is not divergent thinking but creative failures and perseverance, determination and resourcefulness, extended revisions and incremental gains'.

4. Total Design

Design in general and engineering design, in particular, is an interdisciplinary activity that normally requires collective efforts of specialists from different fields of expertise (Morley and Palmer, 1984). In today's emerging global markets design has to be seen as a broad business activity in which specialists collaborate in the identification and investigation of markets, the selection of project/s, the conception and manufacturing of products, and the provision of various kinds of user support, or what is termed as Total Design (Pugh, 1996).

He believes that design is central to business success and for that to happen, it has to successfully interact with various business facets. Compromised interfacing and a bias towards any of these facets are likely to increase the risk of designing and the delivering of inferior products.

5. Communication in Design

One of the most powerful vehicles to competent design is the efficient communication from concept to delivery. Focusing on single aspects of a product normally leads to failure. Communicating the concepts to individuals in the design team is a challenge as team synthesis and synergies are needed to broaden communication (i.e. control and aid in decision-making). Such synergies could also work against certain creative or individuals who in some cases choose to express themselves egocentrically at the expense of other team members and ultimately, the customer. Pugh (1996) has shown that linking mechanisms work better when different units are arranged organically rather than mechanistically. He states a number of requirements needed to enhance communication within the design environment. These include a relaxed working atmosphere, open communication, interpersonal trust, autonomy of the individuals, participation and provision of opportunities for individuals to exercise their expertise.

6. Computers in Design

The continuous emergence of new tools leads to change in awareness that in turn leads to technological development. While the Computer Aided Design (CAD) in general is part of the design process in many organisations there is still a marked need for improvement in computer interaction and the effective modelling of the real world. In virtual worlds, users could communicate in a more intuitive and natural manner (without interfering the design process) rather than by using a keyboard or mouse and traditional interfaces to build complex 3D models of systems on 2D screens. A good example of this concept is the success the Apple Macintosh in the middle and late 80s. Users could directly insert and view images in their documents, type in the typefaces of their choice and size, thus creating attractive and accurate documents in real time. In contrast, PC word processors of that time achieved similar type of output through the issuing of complex commands where it was only possible to visualise the results using a long winded and slow preview option.

Apple's fortunes changed for the worse during the following decade as sales of the Power PC did not deliver the financial figures expected by investors. Where Microsoft's Windows evolved to overtake Apple's operating system, Mac OS had hardly evolved in terms of design when compared to its competitors. However, fortunes changed with the release of the *iMac*, that despite its relatively low technical specification, oozed of design values offering ease of use, trendy looks and an 'out-off-the box' solution turning Apple's fortunes around for at least the medium term future. Superior design and innovation had delivered the goods where technology had failed. Apple having recognised the mistakes of the last decade, decided to build on its current success that emphasised on design. Apple is currently planning the release of its new operating system, Aqua, that is heavily dependant on colour. Apple's experiences seem to go hand-in-hand with Vinograd and Flores (1990) who argue that as new devices are created, the possibilities for innovation arise, and at the same time the creation of a new device or systematic domain can have a far-reaching significance.

7. Virtual Reality: An Overview

Virtual Environments (VEs) provide a way for people to visualize, manipulate and interact with computer-generated environments and exceptionally complex data where other human senses can be engaged (i.e. haptic, smell, peripheral vision etc.). VE applications domains include engineering and manufacturing, training, simulation, layout planning, health and safety training, virtual prototyping and product visualisation, healthcare, entertainment and architecture in which testing in the real environment can be hazardous and uneconomical especially to predict or represent the past and future. In the last few years, a shift has been observed away from graphics programming interfaces and what can be better described as turn key systems that depend on high adaptability or the visual programming paradigm of visualisation toolkits. VR Toolkits is useful for rapid prototyping, designing and visualisation. These include DV Mockup, RX Scene, EON, Opus, VR Toolkit, and Realimation.

8. Dissemination of Information and Knowledge

Virtual Reality (VR) goes beyond the software and hardware technologies (Burdea and Coiffet, 1993) that underlay it. In 'Becoming Virtual' Levy (1998) argues that VR goes beyond the Internet, computer games, simulation and high-tech software used by doctors, engineers and scientists. He argues for a world where the 'virtual', the 'actual' and the 'possible' co-exist and how the Internet is now transforming the virtual into a 'collective intelligence' linked to digital communications. While skeptics like Jonscher (1999) outline the limits of the current technologies and how they will inhibit Levy's 'collective intelligence' model, it is likely that they may only in part delay it. Hewlett Packard's printing division, Chrysler's Extended Enterprise, Sun's supplier partnerships, and Java

Business Network have all greatly benefited from relying on a model of each individual being an entrepreneur in a network of individual enterprises that work together to achieve a common goal. However, this revolution is not a characteristic of large corporations only. Smaller and new companies have set up on-line businesses that trade on information and have become multimillion-dollar enterprises within a few years (Judson and Kelly, 1999; Easton 1999). The rapid evolution of low-cost Internet-based networks in a number of cases has greatly contributed to the evolution of synergies. One example is the rise of the Linux community. Within a period of three years the non-profit making Linux community grew to thousands of people from all over the world, working together and without the aid of managers, managed to turn Linux into one of the best versions of UNIX ever designed and developed (Malone, 1999).

9. Designing for the Leisure Software Industry

Developing multimedia titles in general, and games in particular, has made significant progress since the 1980s when a leisure software industry expansion began to take place. The leisure software industry has accelerated significantly in the late 1990s surpassing the global films industry in revenues. According to Datamonitor (1998), this growth is going to continue. Creating a successful game is very challenging and requires experts from the fields of sciences and arts, thus a high degree of integration is expected between the two disciplines. Game design (Willits, 1999) and development (Sawyer, 1998) now encompasses the fields of real-time computer graphics, prototyping, visualisation, art, animation, and content creation. It has entered new fields such as immersion, applied artificial intelligence, physical-based modelling and real-time communications using the Internet as a method for delivering content. Rollings and Morris (1999) have studied 'the best practices for game design and programming' and have concluded that most of the works behind development lies in design. They also concluded that object-oriented design, core design, gameplay and game balance contribute the most in producing a successful game title. Subsequently game designers have successfully adopted real-time design and visualisation tools to great effect since the late 1980s.

10. Architecture and Virtual Reality

Technological changes have entered the field of architecture at a considerably slower pace when compared to the field of electronic game design and visualisation. Architects have only recently begun experimenting with digital media that reach beyond the purpose of presentation. These now include tools for conceptualisation, design synthesis, design presentation, desktop publishing, animation, Internet authoring, as well as multimedia and hypermedia authoring.

Uddin (1999) argues that the major activities involved in the creative and dynamic process of architectural design deal with conceptualisation, visualisation and expression of alternate ideas through 2D and 3D models. Emerging and affordable computer based real-time interactive technologies are expected to enhance the design process (giving alternatives) through better decision-making, improved communication and collaboration, error reduction, increased spatial awareness, interactive design and real-time visualisation.

With VR, the need of relying on sketches and drawings (e.g. perspectives and 3D drawings) to convey a building concept is not necessary, instead the viewer has the ability to freely walk in the virtual building even before construction begins. Through VR the viewer can suggest and interactively apply changes in the design, materials, textures and lighting. Through the use of immersive hardware he or she can, for the first time, experience scale. Furthermore, viewers have the ability to visit a building from their offices and share their designs over the Internet where they can discuss design issues and visualise alternatives while viewing the same real-time photo-realistic 3D model. Affordable VR software tools useful to architects are now available such as Autodesk's VIZ and Lightscape, the Unrealty Engine, Navisworks and Architect III from Geometric Computing.

10.1. MULTIMEDIA SUPER CORRIDOR (MSC): A CASE STUDY

The Faculty of Creative Multimedia developed real-time design and visualisation tools to evaluate various design options prior to and during construction of the new Multimedia Super Corridor (MSC) in particular Putrajaya (e-governance) and Cyberjaya (intelligent city) in Malaysia. This project, started in mid-1990s, is to cost $20 billion and consists of educational establishments, offices, residential, recreational and other mixed development areas. It is offered to local and multinational companies in particular to invest and develop IT-based products and content. It promised fiber-optics networks, research facilities, tax-breaks, new cyberlaws and an environment in which the native high-tech industries could boost the country into a developed nation by 2020. 3D visualisation was adopted early in the project and helped the architects and planners to detect design problems and allowed clients and consultants to freely move inside the virtual model gaining a real sense of scale, look and feel. While the architects created 2D CAD drawings and rendered images on the specific area, the 3D visualisation team used Multigen II Pro from Multigen Paradigm to re-create the exterior and key interior areas. Some of the 2D models were imported from various CAD software to get the exact measurements and scale. The real-time visualisation system allowed designers and users to identify problems at any stage, to explore material selections and space where traditional techniques would have taken considerably longer and would be uneconomical or impossible to employ (figure 1).

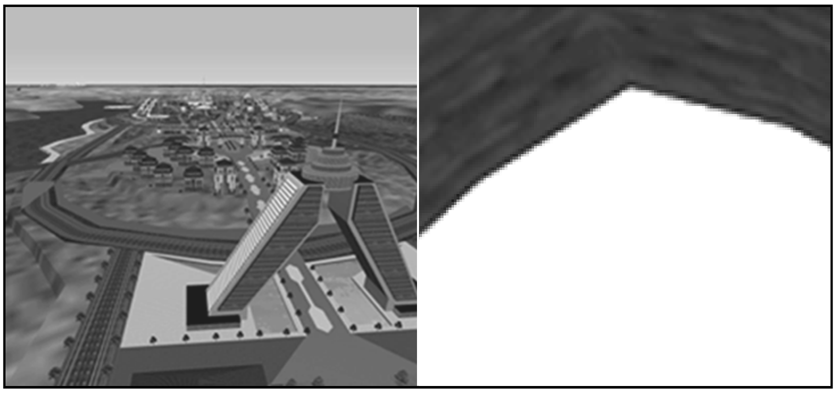

Figure 1. The virtual model of Multimedia Super Corridor (MSC), an aerial (left) and a ground level (right) shot of Purtajaya, Malaysia.

10.2. VIRTUAL PLANT DESIGN: A CASE STUDY

The adoption of real-time 3D environment in plant design is only a few years old (since mid 90s) and as the market offers faster and cheaper machines. Potter (1999) describes how the emergence and recent adoption of VE technologies in plant design is turning 3D CAD models into visualisation tools used in plant operations once construction has been completed. Virtual Presence, a UK firm, modelled ICI's new chemical plant at Teeside UK using CAD data. ICI used the virtual model to allow users without expertise in CAD or engineering to interact and visualise the whole model with relative ease (through the use of intuitive controls and methods). The virtual model is interactive; valves can be manipulated, gauges rotated, hatches opened, vessels moved and pipe routes can be followed. Levels of detail can be switched on and off that exclude the outer shell to provide a better view of the interior and pipe routes, while valves and other components can be isolated and viewed separately. Another major factor is the ability to share, interrogate and visualise plant data over the Internet. Bentley's Enterprise Navigator, Cadcentre's Hyperplant and Intergraph's SmartPlant allow users in different parts of the world access to virtual models making VE the interface of choice (Figure 2).

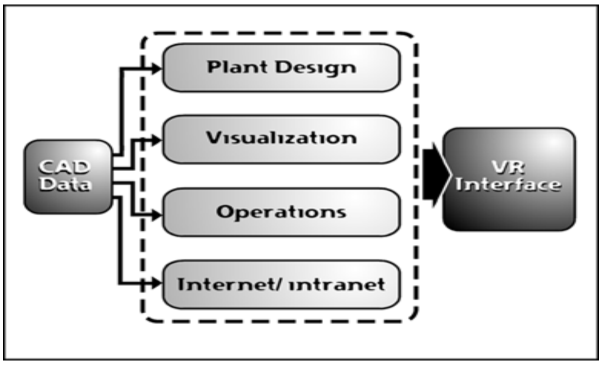

Figure 2. A conceptual diagram showing how CAD data can be combined with other content information to form an integrated VR interface design.

11. Conclusion

Multimedia, Virtual Reality and Internet technologies have the potential to reduce design cycles and enhance the design process though effective communication, prototyping and decision making that goes beyond that of traditional representations. Because of the competitive age and complexity of design, the role of designers should be global ready to attend customer needs at any time and place. Therefore designers can design better when they are aware of people's real needs, how people lived in the past and how they live in different parts of the globe today. And networked VR technologies can help in communicating these concepts effectively to non technical individuals that may be affected by such decisions. The selection of tools should be based on merit rather than trends and should integrate well with a company's practices. Therefore, multimedia, VR, Internet or any other tools must be seen as a mean rather than an end. Lessons can be learned from the electronic games, film, VR and multimedia industries as these have adopted and greatly benefited from such technologies. For architecture, VR in particular, can provoke the users' or designers' illusion and creativity through minimum means while delivering maximum impact. In fact, a virtual model with a high level of detail (e.g. colour, texture, lighting, movement, scale and depth) will significantly reduce visual abstraction especially important to the non-visual literate community (e.g. laymen and professionals). This ability to assign the correct information content to each stage of the design process though the creation of virtual models makes VR an effective tool that stimulates creativity especially in creating a close copy of the real world. The challenge ahead of us now is how to sustain creativity and use the new tools to innovate.

References

Bronowski, J.: 1976, *The Ascend of Man*, John Wiley, London.

Burdea G. and Coiffet, G.: 1993, *Virtual Reality Technology*, Wiley Inter-science.

Datamonitor: 7 September 1998, The Shape of Things to Come, *Computer Trade Weekly*, UK.

Easton, J.: 1999, *Striking It Rich*, Commerce Net Press.

Jonscher, C.: 1999, *WiredLife: Who are we in the Digital Age?* , Bantam Press.

Judson, B. and Kelly K.: 1999, *Hyper Wars*, Harper Collins Business.

Macdonal J.: 1998, *Calling a Halt to Mindless Changed*, Amacom.

Malone, T. W. and Laubacher, R. J.: 1999, Creating Value in the Network Economy, Tapscott, D. (ed.), *The Dawn of the E-Lance Economy*, Harvard Business Press, pp. 55-67.

Mayall, W.: 1979, *Principles in Design*, Design Council, London.

Morley, I.E. and Palmer, H.: 1984, *Report of the ERSC Workshop of the Process of Design at Arden House, Warwick University*, Economic and Social Research Council.

Papanek, V.: 1971, *Design for the Real World: Made to Measure*, Thames and Hudson Ltd.

Potter, K.D.: 1999, A New Role for 3D Plant Models, *Computer Graphics World*, 22(4), pp.37-67.

Pugh, S.: 1996, *Creating Innovative Products Using Total Design*, Addison Wesley.

Rawson, P.: 1987, *Creative Design: A New Look at Design Principles*, Macdonald Orbis.

Rollings, A. and Morris, D.: 1999, *Game Architecture Design*, Coriolis Technology Press.

Rothwell, R. and Gradiner, P.: 1988, Re-Innovation and Robust Design: Producer and User Benefits, *Journal of Marketing Management* 3(3), pp. 372-387.

Sawyer B.: 1996, *The Ultimate Game Developer's Source Book*, Coriolis Group Books.

Stewart, R.: 1987, *Design and British Industry*, John Murray.

Uddin, S. H.: 1999, *Digital Architecture*, McGraw-Hill.

Vinograd, T. and Flores, F.: 1990, *Understanding Computers and Cognition: A New Foundation for Design*, Alex Publishing Corporation.

Willits, T.: 1999, *Game Design: Secrets of the Sages*, Saltzman, M. (ed.), Brady Games.