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4D PRODUCT DESIGN , MECHATRONICS and MULTIMEDIA TECHNOLOGIES : SOME CONCEPTUAL CHALLENGES.

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Abstract.

This paper discusses some conceptual challenges for the application of mechatronic and multimedia technology within consumer products.

The author suggests that most physical products today have matured and innovation will increasingly be focused on adding value with non-material components.. He asserts that the design of 'personality' into consumer goods, can both assist the use of complex machines and also significantly 'add-value' .

The notion of 'personable' products is discussed in the context of what is becoming known as 4D design, which could have an impact on the curriculum of product design education. Models for thinking called CYBERG and FORMAT are outlined that can assist idea generation for new 4D product development.

The paper concludes with a provocative discussion on how a video recorder could be designed using notions of 4D design.

Introduction.

Science fiction writings and films still incorporate robots of increasing sophistication, and the role of science fiction as a catalyst for real design has not perhaps been fully appreciated in the dynamics of innovation and new product development. It is not the intention of the paper to provide an in depth analysis of this, however it is contended that what appears in science fiction inspires generations of designers, engineers and scientists and design futures.

The walking and roving robot has received a great deal of attention in film, and the attentions of much theoretical engineering research. (1) The machine with 'personality' is a common theme within films from Star Wars with R2D2 to the UK's TV programme "Red Dwarf" and its 'angry toaster', but design research with a more practical perspective (2) has given little attention to this. The significance of latter versions of robots is not with the anthropomorphic physical form, but the introduction of human personality. The fixation with 'walking' and 'roving' robotics in the consumer area has perhaps held back robotics based product development in the consumer products.

It is contended here that this is a symptom of product design that has been up to recent times substantially 3D design - the design of the physical object for manufacture, and significantly of a visual form. A new paradigm for product design is developing as the focus of adding value to consumer products -that of the 4D design (3), where the design added-value through non-material components, such as computer software, and dynamic form are important. This is where 'the design of 'product personality' is relevant.

4D design is defined as the

" the dynamic form resulting from the design of the behaviour of artifacts and people in relation to each other and their environment" (4).

4D Consumer Product Development.

The gap between what can be dreamed about in science fiction and what can be done with robotics technology is closing fast. The appeal and acceptability of tomorrow's consumer products are a challenge of 4D design.

4D design within everyday consumer products we are familiar with will involve one or both technologies of mechatronics and multimedia. But how does 4D design relate to the application of mechatronics and multimedia technology? Before outlining this through a some speculation, mechatronics technology and multimedia technology are outlined together with the aspects of product development and evolution.

Mechatronics technology.

The integration of electronics and mechanical technologies along with the theory of control design has led to the growth of mechatronics. It enables a more holistic approach to be taken to engineering of dynamic physical products ,processes and systems. The main area of mechatronics work is in production systems but the miniaturisation of components is leading to more application in consumer products, such as Automatic Teller Machines (ATM) for cash dispensing at banks to video camcorders, and CD players.(5)

Multimedia Technology.

The integration of media and computer technologies along with the theory of information design has led to the growth of multimedia. It enables a more holistic approach to be taken to design of dynamic informational systems . Application is currently in areas where text, graphics, animations, and sound are useful, such as in teaching and learning programmes eg CD ROM Encyclopaedias and computer shopping information points. Entertainment is another areas of growth e.g. computer games and a hybrid term infotainment is used when 'fun' has a functional purpose.(6)

Evolution of Artifacts.

One can assume that all products have in varying degrees physical and intellectual/psychological aspects and properties. However a common difficulty in creating and designing new products, or modifying existing ones, is to know to what these should be. The kind of questions that arise include 'Can the product be advanced up an evolutionary path, in a Darwinian way?'(7), and 'What versions of the product are possible using design policies of human-enhancement or human-replacement?

All products, old and new, can be described in functional terms relating to the degree to which they assist people to handle materials physically and/or to use information in their work. For example, an electric drill can help a do-it-yourself enthusiast to drill holes easily; a pocket calculator can assist every businessman with tedious arithmetic. Products can thus be described as 'physical' and 'intellectual' capabilities, and a typical example is a word processor that takes both the physical and intellectual tedium out of prolific writing.

When there is a need to develop new products or improve those already established it is helpful to ask a few questions about product design. For example, 'Can the product be made to evolve in its design and further enhance the skill and ability of its user to do a job? '; 'Would the job be better done if the design of the product replaced aspects of the work done by its user?'; 'What forms of the product could be designed?'. In addition we could ask: 'Is the product's design obsolete due to the advent of new technology ? '; 'Is the current product a "horseless-carriage" because new technologies have been used with old ideas about design rather than innovative ideas that use the new technology in completely different ways ? ' .

To get a clearer understanding of the relationship between these and many other factors involved in the creation and development of new products, it is becoming necessary to make use of models of one kind or another. One such model is CYB-ERG.(8)

CYB-ERG

The CYBERG model, in essence, comprises a framework for creative thought. It enables long-term trends in the design and development of products to be taken into account along with the application of new technologies. Regarded as particularly important are new power sources like solar cells, or control devices like the microprocessor, and ideas about human-enhancement and human-replacement relating to the use of products by people.

The framework of CYB-ERG is shown below in Figure 1. It consists of a form of graph with a horizontal and a vertical axis. The horizontal axis shows levels of human-enhancement or human-replacement, and the vertical axis shows the evolution in time of products as new technologies are used. The left-hand side of the graph is concerned with physical product functions; the right-hand side is concerned with intellectual functions.

The starting point is at the base in the middle where a person has only his hands and body, brain and senses. 'Craft tools' are developed in order to assist the handling of materials, and 'instruments' are developed in order to obtain and assist the use of information. These develop in sophistication to a point where additional 'power' is required to enable the tools to evolve further. This represents a point of 'automation' where the policy for human-enhancement or human replacement has to be decided upon.

CYBERG can assist the creative identification of possible functional evolution . However the acceptance of a new product into the world is often unduly ad hoc. and many failures are created for each success. The creation of an acceptable product form is central to success but there are few guidelines to assist the formulation of an appropriate form. What is required is a strategic view of form evolution as well as functional evolution. FORMAT is a creative tool which could contribute to this. (9).

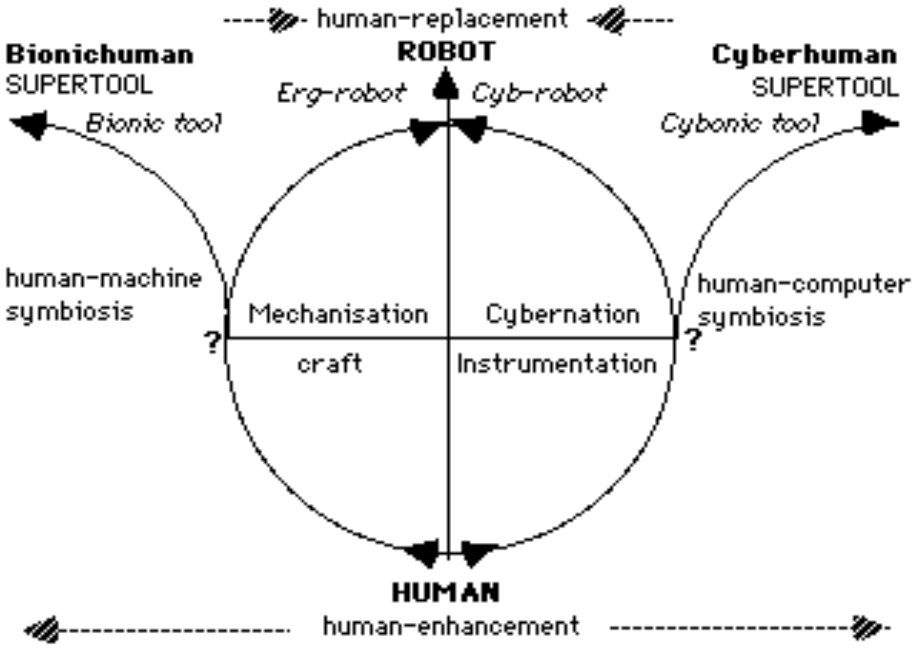

Figure 1 The basic CYB-ERG framework

FORMAT : method and metamorphosis.

The definition of a desirable product form depends entirely on the point of view taken: technological, commercial, ecological, cultural and social. However any design using new technology will incorporate old and the new design elements. The probability of acceptance of a new product is enhanced by maintaining a fine balance between imaginative and creative new form and that with which people are familiar and prefer: a new design may be rejected if it is too novel and unfamiliar, or too traditional . FORMAT uses key words representing states of form. Figure 2 shows the FORMAT diagram.

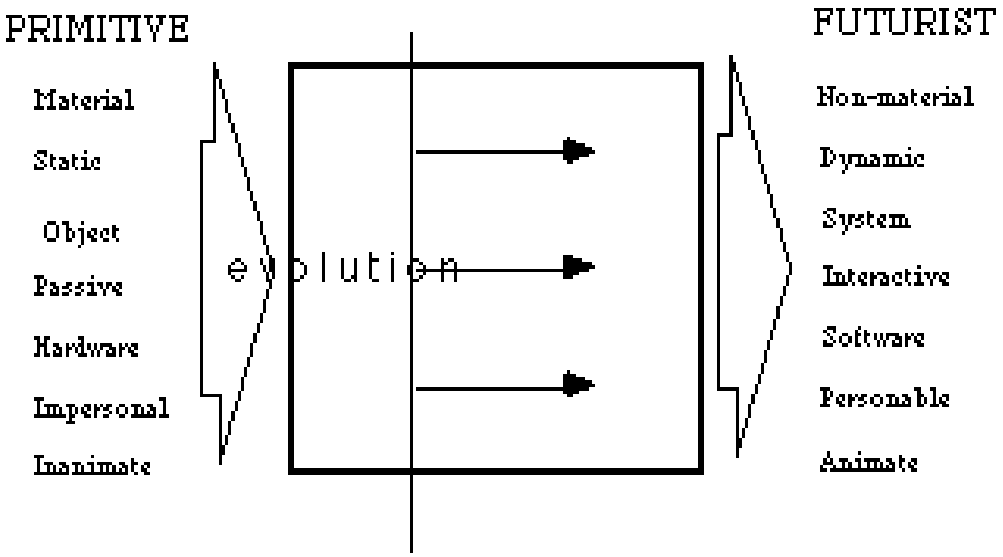

Figure 2 The basic FORMAT diagram

On the left is what might be referred to as "primitive" form states and on the right "futurist" form states where for any artefact one assumes a possible evolution of form from the primitive to the futurist. Therefore key questions to ask are: What "form state" is a product? Is it realistic to change the product from a primitive form state to an futurist form state?

At a basic level product classification is usually done by function e.g.. washing machine, and then by specific model features e.g... BMW 325 i. However, many products have similar models with similar features competing in the marketplace. How can they be classified from the perspective of form? To help classification by form four archetypes of products , derived from FORMAT, are suggested as being helpful which can be applied to products:

a. "horseless carriage" products (HCDs) - designs embodying new technologies using traditional design concepts and forms by default.

b. "pathfinder" products - planned "horseless carriages" assisting the assimilation of new technology.

c. "pioneer" products - innovative designs incorporating an educational function.

d. "radical products" - designs with new forms introduced without user testing.

These can be independent but they can also be viewed as evolutionary phases of a products form development. Figure 3 places the above archetypes in an evolutionary context.

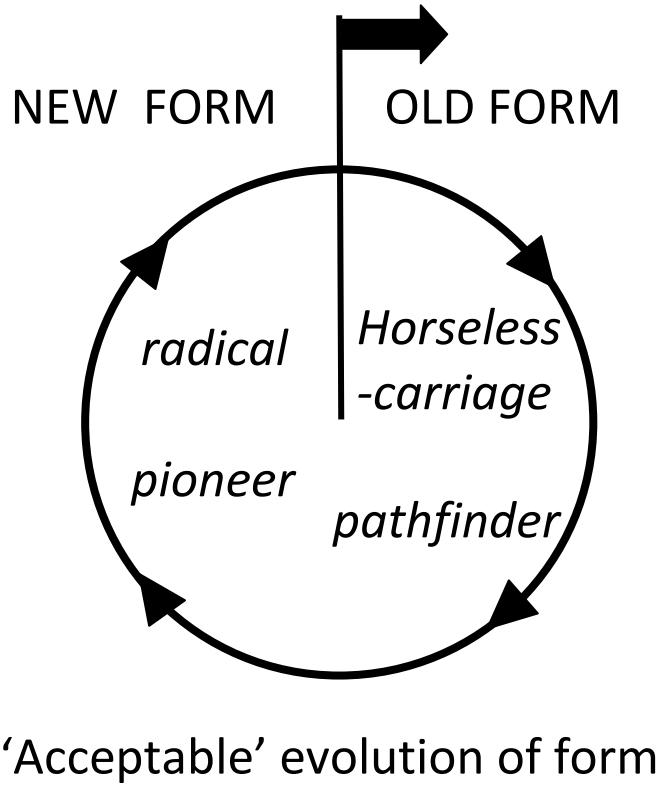

Figure 3: Circle of 'acceptable' product form.

CYBERG and FORMAT can be used to assist conceptualisation of new product design. In CYBERG we see products in their purest form may therefore become either Supertools or Robots, depending on the goal of design. Most products, however, are likely to be hybrids having both human-enhancement and human-replacement aspects and thus evolve into Robotools.

The crucial question for managers of innovation to answer is 'Where on the CYB-ERG graph is an established product, and how can it be advanced in its design to fit the market opportunities opened up as a result of the introduction of new mechatronics and multimedia technology ? ' .

The use FORMAT is somewhat 'fuzzy logic' as that of a 'pathfinder' product development strategy (10) in respect to 'personable' and 'animate' characteristics when applying mechatronics and multimedia technology. However a 'pathfinder' strategy is likely to be more successful an a 'radical' design.

A key question is - how can we envisage the affect of such 4D form on established products?

4D Consumer Product development.

The common goal of designers is to create an 'appealing', 'useful' and 'acceptable' product at the right time in the right place for the right customer to do the job required. In design practice cross-disciplinary teams are increasingly required to do this as consumer products become more complex. Designers with different perspectives increasingly contribute to product development. At one extreme there is the ethos of engineering and ergonomic functional capability, and at the other extreme - artistic aesthetics and emotional value. The former has tended to receive more attention, indicated by the value of research grants for engineering compared to industrial design.

What would 4D product design research involve in this area?

Three research questions to ask are :
- what characteristics will a 4D product have that a 3D product does not have?
- what specialist knowledge is required for 4D products that is not required in 3D products?
- what non-technical functional components are involved?

Non-technical functional 'performance'

Technologies that enable articulation of components and their control are developing at the same time as multimedia information technology, and the quality of technical engineering design can increasingly be relied upon. Consumer rights and legal product liability legislation are ensuring the basic characteristics of any product are good - the product will do what it is said to do, and it is safe and increasingly environmentally benign. However the 'emotional' value attributed to any product is of crucial importance in the consumer market. The question of whether a product is a appealing and pleasant to use has to be answered. Richard Guyatt, once Rector of the Royal College of Art, aptly said to an audience sympathetic to 'form follows function' - " there is such a thing as the ergonomics of the heart'.

Static visual design has been of fundamental importance, and many design schools have been instrumental in the growth of designers, who as well as capable of technical design, are

visually aware about qualities of 2D and 3D product form . However, even here, the dominance of the 'visual' has left other form attributes to fend for themselves. Dynamic form, such as the sound of a product and the way it moves are just two non-technical performance attributes that have not received the attention they deserve. Noise has been tackled but not musical composition. Animation as a linear form of narrative entertainment in 2D and 3D has developed with film and video technologies, but the issue of 4D form, where the behaviour, especially as a metamorphic non-technical performance attribute, increasingly needs to be addressed. How can this be done? A knowledge of 'personality' and 'behaviour' in people and animals is an initial requirement for any designer

To illustrate some 4D issues and how 4D form would affect the humble video recorder some teleological design thoughts on the humble domestic video recorder/player are described below.

4D design of video recorder.

The forces on product design to reduce component cost etc. tend to dominate the design decision process. Folklore has it that someone was told what an industrial designer does. The surprising response was ' Oh they are the people who make things less enjoyable, as the person recalled the aesthetic qualities lost from of old cars and machines - the materials, smells and sounds 'experienced' in for example driving a Morris Minor car, to using a classic Singer Sewing Machine. So as a wave of innovation is about to sweep through consumer products through application of mechatronics and multimedia technologies this response is worth a second thought with reference to CYB-ERG and FORMAT.

Evolution of the video recorder could take either of the two routes towards robot or supertool. Loading of a cassette may be eliminated with on-line download through the internet. Alternatively, pop out/up cassette loader could evolve into something more kinaesthetic, responsive, and dare we say enjoyable.

At a more complex level of 4D design, the video recorder has a notorious reputation for many years for being 'unprogrammable' except by the most technologically adept. It took the development of VideoPlus - the bar code based swipe invention for programming a video recorder before progress was made. VideoPlus significantly automates the process and it adds value by subtracting hassle. It too is on the path to 'robot'. If the path to "Cybonic-tool' was chosen then the action of programming would have been made not only easier but enjoyable too - it would be designed as an 'event'. So how could this be been done?

Useability and emotionability.

The communication of ideas, mood and emotion through action is the bedrock of the performing arts - music, theatre, and dance. This is an untapped source of knowledge for product design and development. It is a necessary input of knowledge for 4D design, which together with multimedia and mechatronics technologies would be used within our 4D video recorder . What 'character' would the video recorder have? Would it be friendly?

The term user-friendly has been one used by the ergonomist and human-computer interaction specialist. However inspection of 'user-friendly' designs show such specialist do not really mean 'friendly' but just non-problematic. How would a really user-friendly video recorder

'behave' ? How would it 'act' when you switched it on? It will have a technical performance through speed of cassette loading but how will it 'perform' in non-technical performance?

How will a video recorder 'sound'? The sound of the cassette loading and its ejection not been 'designed-in'. 'Worrying' clunks and winding sounds have been design-out' but what about 'audio aesthetics' that are pleasant to hear. Are the silent designs of today's electronic products appreciated more than the clunk of mechanical ones of the past? What is the alternative?

How would a video recorder move? The mechatronics technology required for ejecting a video tape is relatively simple, but one can only but notice however that the design of its dynamic form is only functional. Kinaesthetics has not been considered for the loading or ejection of the video tape, nor has it had a major influence on the 3D form of the video player's ' black box'.

Movement has been designed-out of many products. The 'performance' of the mechanical arm in a 1950's Juke Box was an 'event' that contributed to the experience of 'playing' a record. Imagine the possible movements using today's mechatronics technology.

Would the video recorder talk? The art of conversation between people can be fascinating experience to be part of. With speech synthesis and voice recognition now on the threshold of practical application a dialogue with your video recorder could be designed. Natural language conversation is not the aim here, but random verbal annunciation based on recognition of words you might say, or the conditions of the environment could provide some interesting 'infotainment'. Would the accent of a voice have - that of the chief executive in the original company head office - a Japanese owned company product speaking English with a Japanese accent? If you are Scottish would you expect the recorder to speak in your regional accent?

Conclusion

The design of such dynamic non-technical performance attributes through notions of 4D design would, it is contended here, add-value to a video recorder/player, and even make it more useable. It might move on product design from the 'black-box' syndrome into something completely different. Mechatronics and multimedia technologies could facilitate this.

Robotic devices currently in service (11) are unlikely however to be the main thrust of evolution in 4D consumer products. Techolust (12) and the walking - roving video recorder/player should no more be the goal for the 21st century than the robot waiter holding a glass of wine for you at a party, but the consumer product with 'dynamic personality' could well be a goal worth exploration.

Will 'form follow fun' in the 21st century? Which do you prefer, the silent internet delivery of a music-video or the evolution of the 50's Jukebox to a personable product joining in the event? Which do you think would be the the most socially and ecologically responsible design? What do you think will happen, and importantly have we any choice?

References

1. Warwick, Kevin. 'March of the Machines' (1997) Century , London. ISBN 0 7126 7756 9

2. Robertson Alec. et al. "Research & its Assessment in Art, Design & the Performing Arts" Working Party Report. De Montfort University, Leicester. England Feb. 1993.

3. Robertson, Alec. '4D Design: The Interaction of Disciplines at a New Design FrontierÓ. Design Management Journal, Boston USA. Summer 94 pp 26-30.

4. Robertson, Alec " 4D Design Futures: Some Concepts and Complexities" in 4D Dynamics Conference Proceedings. De Montfort University, Leicester (1995) ISBN 1857211306.

5. Parkin, Rob. "4D Product Design: A Challenge of Integration". in 4D Dynamics Conference Proceedings. De Montfort University, Leicester (1995) ISBN 1857211306.

6. Sutton, Mark. "To examine the topic of CD-ROM", unpublished report, (1994) MA Information & Graphic Design Course. De Montfort University. Leicester.

7. Darwin C " Origin of the Species by Means of Natural Selection", 1995, Grammercy Books.

8. Robertson, A., "CYB-ERG: A proposed model for assisting innovation in products, and their design". Paper in Creativity and Innovation Network Journal.Vol. 9, No. 3, July-Sept., 1983. Manchester Business School.

9. Robertson, Alec and Schybergson. Olof ,"Product Form - Creative Research using Cyberg and Format with reference to multimedia products". Design Management Research & Education Conference- .Nov. 1996 Barcelona.

10. Robertson, Alec. "Pathfinder products: reducing risk is design innovation", Proc. The International Forum on Design Management Research in Education. 1-3 June 1994. Design Management Institute/ ESCP Senior. Paris.

11. Engleberger, J.F. "Robots in Service". 1989, Kogan Page. London.

12. Robertson, Alec."Technolust versus creative design: some implications of intelligent products for design". Intelligent Consumer Products Symposium. Institute of Electrical Engineers / Chartered Society of Designers. London ,1992. IEE Digest No. 1992/013.

13. CYBERBRIDGE-4D DESIGN WWW site at http://www.dmu.ac.uk/