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Knowledge and the Artifact.

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Introduction

This paper discusses ways that knowledge may be found in or through artefacts. One purpose is to suggest situations where artefacts might be central to a narrative, rather than secondary to a text. A second purpose is to suggest ways that design and production of artefacts might be instrumental in eliciting knowledge.

Four general situations are proposed:

- **Simple Forms** - an artefact demonstrates or describes a principle or technique.
- **Communication of Process** – artefacts arising from a process make the process explicit.
- **Artefacts Within the Research** – artefacts are instrumental in advancing the research by communicating ideas or information.
- **Knowledge Elicited by Artefacts** – artefacts provide a stimulus or context which enables information to be uncovered.

Simple Forms

An artefact may describe itself, a principle or another artefact. In research projects the authors have found situations where an artefact is the only reliable way to communicate across the whole community served by and engaged in the research. This section starts with a relatively simple mechanical example, then discusses a more subtle problem concerning people with severe disabilities.

A physical model which demonstrates a principle

A mechanical, skeletal arm (fig) was produced in research concerned with analogies for human anatomy, described in detail elsewhere (eg Rust 1999; Whiteley 1999; Rust 1998). The model provides a close analogy for the human skeletal arm substituting conventional mechanical elements for the original joints.

Construction is obvious and the elements will be recognised by a person with mechanical knowledge who handles and manipulates it. Before production of the model there was no evidence that anybody, anywhere, had constructed such a thing, or knew how to. Once the model was available for inspection it became evident from discussions with a wide variety of both professional and lay people that it is straightforward for any person with mechanical knowledge to understand how it works and how to construct one for themselves. More importantly, the model demonstrates principles which can be applied to the design of a number of things, for example prostheses, surgical implants, animatronic devices and computer animations.

Graphical representation of an artefact

Models are a rich aid to understanding principles, but detailed technical understanding may require special tools or instruments for inspection and/or measurement. Drawings can overcome these problems and complement the original artefact. (figs) are from a set of nn which provides a complete description of the artefact. The drawings and the model are an invitation to use these general design principles as a foundation for the design of a useful artefact and one of the drawings (fig) shows how the integrity of the basic mechanical analogy can be preserved in a completely different configuration.

Text descriptions – the Patent problem

This design has been patented. Patents are substantial written descriptions with illustrations, patent specialists are highly trained to use very specific language. It is arguable that very few lay people, no matter how well versed in their own scientific or technical disciplines, could write a patent description which would withstand a legal challenge.

A patent specialist inspected the model and discussed it with the designer for less than 1 hour. Some of the discussion was concerned with the description of the artefacts, most was about possible applications. Subsequently the designer provided 5 pages of technical illustrations with a brief commentary, including (figs). Working only from this material the patent specialist produced two patent descriptions totalling NN pages of text of which NN were specifically concerned with describing the designs.

The patent provides a comprehensive technical and functional description of the artefact, sufficient to establish intellectual property in a court of law. A person with good mechanical and anatomical knowledge could decode it sufficiently to understand the design principles involved.

However the patent description would be of very little help in understanding the most significant aspect of the design – the achievement of natural wrist motion – for anybody who does not have a good understanding of the anatomical principles. The model, on the other hand, has been found to provide immediate recognition of the anatomical principles for any person who can manipulate and compare it with the action of their own arm alongside a basic skeletal model (fig).

The authors do not wish to conflate the immediacy of the artefact with the complexity of the patent text and make any general claims for artefacts over text but this example shows how a model or drawing can provide direct and useful communication.

The artefact as a bridge

Chamberlain (1999) describes a research project in which designers needed to work with children who were profoundly deaf, or deaf and blind. The project dealt with “vibro sound” therapy using furniture which embodied loudspeaker enclosures in its design (figs).

After some initial work, experimental furniture was constructed and the children were able to engage with the research for the first time. The trials demonstrated the potential of the approach taken but, much more important, they allowed the children to express needs and desires which might be satisfied in this new situation which the artefacts created. Most significantly the researchers came to recognise that children wanted and could have some choice and control of their own experiences and the research moved on to examine the potential for this and the value of allowing the child, rather than the therapist, to choose the sensory experiences.

At the start of the project there was good engagement between experts with theoretical understanding (eg loudspeaker technologists, therapists, clinical researchers, manufacturers, carers) and this quickly resulted in a set of designs which met the needs and priorities of all of these people. However the key group, the children, could not recognise the research and participate in it until the artefacts existed. Up till that point it is arguable that the designers had done a professional job in embodying criteria and knowledge in a design but, once the children were engaged with the artefacts, the research was able to explore completely new territory and the designers’ role was to speculate on and evaluate significant new ideas.

Communication of Process

Rivka Oxman (1997) suggests that a “sequence of sketches can act as a record of reasoning processes which can be inferred from a transition of states from one representation to a subsequent representation”. In exploring possible analogies for the human arm, the designer, Graham Whiteley, used drawings as the main process for learning and evaluating anatomy, exploring geometry of the joints and interaction between elements, examining possible mechanical analogies for the joints and developing detailed designs. The designer’s use of drawings is described in detail elsewhere (Rust, 1998). Two examples are shown here (figs)

These processes and outcomes might be described in text but this would impose an interpretation on material which could be available to speak for itself. In considering how to record and archive the research we are investigating an approach in which the full archive of drawings and experimental models is available for reference and a narrative is constructed from selected images supported by the least possible text. This is particularly important for the designer who will not be required to switch into a new mode of description and can exploit his graphical skills, and the material which he has compiled, to communicate the research.

The problem of having to switch hats and become a writer has been described by colleagues in several disciplines as “doing two PhD’s”. Many people may feel that this opens the door to less rigorous reporting of research but we would like to record the concern of a senior colleague in engineering who sees students with good writing skills and relatively weak practical research work being regarded more highly that those with excellent research who are not so fluent in text. Any approach which could allow good work to be recognised and understood is worth keeping under review.

Artefacts within the research process

The research by Paul Chamberlain (above) is one example of artefacts used within the research process. Here we describe two other examples of artefacts used to bring about a useful change.

In the work on analogous arm mechanisms, which aims to support future designs for prostheses, the researchers wished to engage with a group of people who had missing arms to explore their needs and aspirations. From informal contacts it was apparent that most of these people were disenchanted with the products and services available to them and had lost hope of any beneficial improvement. This was seen as a barrier to involving them in a speculative discussion and it was necessary to do something to “unlock” this situation.

A video was compiled, bringing together material from documentaries and fiction. For example documentaries demonstrated the relative success of artificial legs and some of the design thinking behind animatronics. The movie “Edward Scissorhands” illustrated problems of excessive specialisation (one of the problems with current approaches to prostheses) and other science fiction movies such as “Robocop” and “Bladerunner” represented some of the ideals which people have and questioned whether an artificial limb is part of the individual and whether it dehumanises them.

As a result the group engaged in a speculative discussion that was not possible before and a number of important ideas were identified. For example, people who dealt with children argued for a prosthesis which was both highly functional and constructed of soft materials, something which is not available and which had not been raised in previous discussions with this group.

In the same research, it has been a priority to produce a number of good quality models since collaboration depends on other researchers having access to prototypes. The first of these models was taken recently to a research centre concerned with artificial muscle in order to evaluate their technology. It was discovered that researchers in the centre had previously attempted to construct a similar model as a test rig and had found the task impossible with the resources and knowledge available to them. As a result the researchers had not been able to investigate the use of their materials in an anatomical context, even though this was their expressed aim.

Not only did the model provide the researchers with the test-rig that they needed, but it provided an important source of anatomical understanding. The researchers did not have direct contact with a medical school or medical physicists and had made a number of erroneous assumptions about the design requirements for an artificial muscle. However, once in possession of a model arm and an anatomical drawing showing muscle routing and attachment, they were in a position to proceed to realistic tests.

Knowledge elicited by Artefacts

The final section is concerned with the manner in which artefacts can unlock knowledge held by individuals. Often this is tacit knowledge which is very difficult to uncover by other means.

C.Thomas Mitchell (1995) has described how simple, adjustable floorplan models were used in a housing design project in Jordan and a commercial development in the United States to gain a much richer understanding of the activities and needs of the people who would use the buildings. In Jordan, it was found that men and women had entirely different priorities and requirements of different families varied greatly, requiring an individual design for each house.

During the research into anatomical analogies it was discovered that the models produced in the research could be interrogated directly by experts who were used to palpating human arms and this provided very rapid evaluation of the models and their relationship with the original anatomy. This qualitative approach was taken with a medical physicist, two surgeons and an osteopath.

In each case the response was detailed and informative and delivered in a combination of words and actions (we intend to make a video record of future sessions to capture this). Not only did the evaluation provide useful information and validation of the design approach but the responses of each of the different specialists helped us to understand the priorities and experience of the different disciplines represented.

The evaluation was particularly useful as the only other source of information on skeletal motion came from physical measurements of living subjects. All measurements in this project and previous research (eg Besson 1997; Karabinova 1997) used similar methods and were subject to the same danger of inaccuracy due to interference from soft tissue. Qualitative evaluation by experts was a new source of data and provided a form of triangulation which would not be available without a good quality physical model.

The final example comes from an exhibition curated by Scott Hawkins (2000) as part of an investigation into economic opportunities in narrow timber from biomass plantations, The exhibition was intended to raise awareness of the wide range of products and production methods which employ wood and wood-based material and to stimulate rural craftspeople to consider the possibility of producing higher value products which would benefit the regional economy and the environment.

During the exhibition a number of people with different creative and technical backgrounds were invited to explore the idea that objects in the exhibition might elicit useful ideas and thinking, particularly about new opportunities for craftspeople and designers. Participants worked in pairs (of people who had not met previously) to explore specific objects and report their findings to the group, followed by a more open discussion.

It was apparent that some objects did not "break the ice" while others drew the pairs into animated discussion and close engagement with the objects. All the discussions resulted in ideas from different individuals being combined to synthesise new thinking. The researchers noted that the artefacts provided a common reference point for people from different disciplinary backgrounds and allowed individuals to bring their knowledge into the arena with very little evidence of misunderstanding between participants despite the diverse views being expressed.

The greatest debate, arose from a West African beer cooler, of woven construction (fig) which challenged ideas of how to produce a watertight container, raised questions about the status of artefacts in different societies and stimulated a direct emotional response from several participants.

In the discussion it was agreed that the artefact had great emotional appeal (one member of the group hugged it for most of the discussion and all wanted to hold it) and represented some progressive values such as engagement with quality of production for personal satisfaction rather than utility or reward. However it was not relevant to our lives in England today. The discussion moved on to the idea that we might seek to make artefacts which would be useful and relevant in our own lives and have the same values for us that the beer cooler provides in its context. Ironically, it was then revealed that the beer cooler had been purchased as a tourist souvenir and there was no evidence of its authenticity, however this did not invalidate the effect it had on the group or the insights that were developed.

Conclusions

Most of the examples given here arise from the authors' own research. Apart from the last case, in which a specific activity was planned and recorded to explore these issues, evaluation has been through reflection during and following the activities described. We suggest that the examples are persuasive, that they indicate methods which others may find useful, but a good deal more work and many more examples are needed to support proper understanding.

To summarise, the examples demonstrate that artefacts, in this case drawings and prototypes, can provide clear descriptions of designs, principles and processes. They can communicate across boundaries of discipline and experience. They can be support the progress of research and they can be instrumental in eliciting knowledge, including tacit knowledge, in and from individuals.

Besson, D. et al. 1997. "Mechanical Model of the Back and Neck Using External Markers" Medical and Biological Engineering and Computing – Proceedings of World Congress on Medical Physics and Biomedical Engineering. Supplement to Vol 35, p202

Chamberlain, Paul. et al. 1999 "Pictures and Conversations – a Case Study of Design-Led Collaboration in the Field of Vibro Sound Products" Snoezelen World Congress, Toronto Sept 1999

Hawkins, Scott. 2000. "Wood You Believe It" Exhibition at Barnsley Design Centre, Barnsley South Yorkshire UK, April/May 2000.

Karabinova, E. et al. 1997 “Model Of The Lower Limb Based On Experimental Data” Medical and Biological Engineering and Computing – Proceedings of World Congress on Medical Physics and Biomedical Engineering. Supplement to Vol 35, p198

Mitchell, C.Thomas. 1995 “Action, perception and the realisation of design” Design Studies, 16 (1) 4-28

Oxman, Rivka. 1997. “Design by re-presentation: a model of visual reasoning in design” Design Studies, 18 (4) 329-347

Rust, Chris. Whiteley, Graham. 1998 “Analogy, Complexity and Holism – Drawing as 3-D Modelling” POINT Art and Design Research Journal, No 6 Autumn/Winter 1998

Rust, Chris. Whiteley, Graham. Wilson, Adrian 1999 “First Make Something – Principled, Creative Design as a tool for multi-disciplinary research in Clinical Engineering” 4th Asian Design Conference, Nagaoka, Japan, Nov 1999

Whiteley, Graham. Wilson, Adrian. Rust, Chris 1999 “Development of Elbow and Forearm Joints for an Anatomically Analogous Upper-limb Prosthesis” European Medical & Biological Engineering Conference, Vienna. Nov 1999