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MULTI-BOARD CONCEPT - A SCENARIO BASED APPROACH FOR SUPPORTING PRODUCT QUALITY AND LIFE CYCLE ORIENTED DESIGN

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ABSTRACT

This paper will describe the multi-board concept, which is a working approach for supporting life cycle oriented design and product quality. Aspects of this concept include construction of a common working environment where multiple display boards depict scenarios of the product life cycle, creating a shared quality mindset amongst designers, and developing creativity and synthesis in product design. The appropriateness of scenarios for supporting life cycle oriented design will be argued and preliminary results from early experimentation will be presented.

Initial results lead us to believe that the multi-board concept promises to be a useful means of communication amongst the design team. We believe that it fosters a thorough understanding of life cycle events, which, in turn, inspires the design of innovative products of the highest quality.

KEYWORDS

Life cycle oriented design, product quality, scenarios.

1. INTRODUCTION

Product development is an ongoing cycle of new product development projects that seeks to maintain, if not enhance, the competitive advantage of a company. Successful companies, e.g. market leaders, recognise that the competitive advantage they have over their rivals is due to superior product quality, value for money, service and closeness to their customer (Simon, 1996). More importantly, the customers of these companies also recognise these characteristics as being important to them. Therefore, they cannot be ignored.

In order to achieve competitive advantage in product quality, a cornerstone of new product development should be life cycle oriented design. Whilst a full argumentation for this approach will not be detailed here, the principles are outlined below. Life cycle oriented design is a foundation of design for quality, which focuses upon creating high quality products with appropriate quality properties that satisfy the needs of everyone who has a stake in the product during its life cycle.

We are well aware that considerable efforts have been made to enhance manufacturing quality with improved speed, repeatability, reliability, cost, etc., all of which reflects in the overall quality of the product. However, the creation of a high quality product relies upon more than just manufacturing quality. Product quality starts in the design process with the design team. In life cycle oriented design, the design team must anticipate all the life cycle demands made of the product and create designs that will have the appropriate properties to fulfil the quality expectations of all the stakeholders. The failure to consider or anticipate a likely mode of use, context of use, or type of user may result in the product being used in a manner that had not been considered and where failure could have fatal consequences on product quality and acceptance.

Once again, we are well aware of the current efforts being made to support life cycle oriented design. However, the approaches used in manufacturing industries tend to rely upon specifica-

tions to communicate quality needs and procedures, e.g. ISO 9000, to monitor and control the design processes. On the whole, these procedures and processes are improving all the time and are necessary for industry to operate effectively. But we are conscious that they do have limitations. For example, significant efforts are made in a product development project to correct quality problems, which arise from decisions made earlier in the design process. Additionally, these procedures and processes do not directly support creativity or synthesis – the two most important aspects of successful or innovative new product design.

If life cycle oriented design is to be successfully implemented in product development, then we require a working approach that can support the product definition and the creative, synthesis, evaluation and process control aspects of product design. We believe an approach, which we refer to as the "Multi-Board Concept", provides a significant step in this direction. Therefore, the purpose of this paper is to describe the role of the multi-board concept in product development, its construction, its evolution and what occurs with its use, and in particular its influence on life cycle oriented design and product quality.

2. PRODUCT QUALITY AND LIFE CYCLE ORIENTED DESIGN

During the "cradle to grave" life of a product, many different people will interact with the product, each in a different context and with a purpose different to the others. These people are known as stakeholders and each will have a set of needs to be satisfied. The work of Mørup in "Design for Quality" (1993), fully describes the relationship between product quality, the product life cycle, and stakeholders. Life cycle oriented design requires the designer to consciously consider the totality of the life cycle of the product and all the stakeholders who interact with the product, and create a product that will satisfy everyone.

In order to create a model of the product life cycle, it is necessary to determine each of the discrete meetings, which will occur between the product and the stakeholders. Scenarios are a highly relevant means for describing what occurs in these meetings and, if organised in a sequence, can be used to map the product passing through all the phases of its life. Clearly some meetings occur only once in the life cycle, e.g. those associated with the original manufacture of the product, whereas others occur many, if not several thousands, of times, e.g. those in the use life phase.

Understanding of the events which occur in each meeting enables the needs of the stakeholder to be identified, the functions of the product to be determined, and what properties the product should have to satisfy, and even delight, the customer. The level of abstraction used to describe a meeting will vary depending upon the design context. However, if a meeting is sub-divided into smaller, more discrete events, then a larger number of functions (or rather sub-functions) and properties will be identified.

With this detailed understanding of the product life cycle, functions, needs and properties, the design task is then to create a solution that best satisfies all of these requirements. During the design process, the performance of new ideas will be evaluated for all life phases, and successful solutions for one function synthesised with solutions for other functions. By continually comparing design results with life cycle needs, it is possible to maintain a check upon whether a design solution is emerging with the appropriate quality properties. However, despite all the efforts that can be made during the product development process to validate the design solution, the true quality of the solution can only be verified when the product is realised and each stakeholder can interact with it. In summary:

"The totality of product quality is achieved only when all life cycle phases have been thoughtfully considered, and all stakeholders delighted by their interaction with the product" (Robotham, 1999)

The principles of life cycle oriented design are evident in all product design activities. Current design practices demonstrate there is a high level of conscious design effort that seeks to improve the quality of products, not just in the use life phase, but also in other life cycle phases, e.g. manufacture, service, and disposal. The "Design for X" tools have been devised to provide designers with the capability to address many life cycle issues in the early stages of the design

process. However, in practice, the implementation of a life cycle oriented design approach is fraught with difficulties. From our observations of design practice, we typically see that:

- the identification of the life cycle phases and “meetings” is often incomplete;
- the identification of the stakeholders is also incomplete;
- the commitment to thinking with a life cycle orientation is weak; and
- designers have a poor awareness of how products actually behave in real life.

Consequently, the product design process is hindered by:

- incomplete, multi-stakeholder criteria in the specification of goals;
- inappropriate communication of specifications;
- design flaws with ugly trade-offs, blind spots, and unforeseen life cycle dispositions;
- no supporting mindset common to the design team;
- an inability to overview the life cycle needs and simultaneously evaluate solutions in all life phases (this seems particularly pertinent with computer based design);
- designing as if there was no prior experience to draw upon; and
- weak argumentation for alternative solutions.

The multi-board concept is a proposed working approach for life cycle oriented design, which seems capable of overcoming many of the weaknesses we observe in current design practice.

3. THE MULTI BOARD CONCEPT

3.1 What is the Multi-Board Concept?

The multi-board concept can be summarised as a working approach to life cycle oriented design, which has the following characteristics:

- a design environment for the design team;
- an information resource shared by all;
- a means of communication;
- a stimulus for creativity and synthesis;
- a means for visualising life cycle events and maintaining a high level of awareness of stakeholders' needs during design;
- a means to monitor the progress of design work; and
- a means to support quality assurance efforts in design.

Creating a working environment for the design team is crucial to the multi-board concept. In this environment, a large number of display boards are the focal point of the working area and are accessible throughout the product development process to everybody in the design team (Figure 1). The boards are used for displaying all kinds of graphical and textual information, e.g. illustrations, notes, sketches, diagrams, photographs, printed text, data sheets. Consequently, the boards are not a sophisticated information technology medium. If anything, they are the reverse! This is a deliberate ploy in devising the multi-board concept because we wish to provide an effective support tool for life cycle oriented design, which is not constrained by the designer’s inability to access quickly information and data. Anybody in the product development team can view the boards and anybody can modify or add further information to the boards.

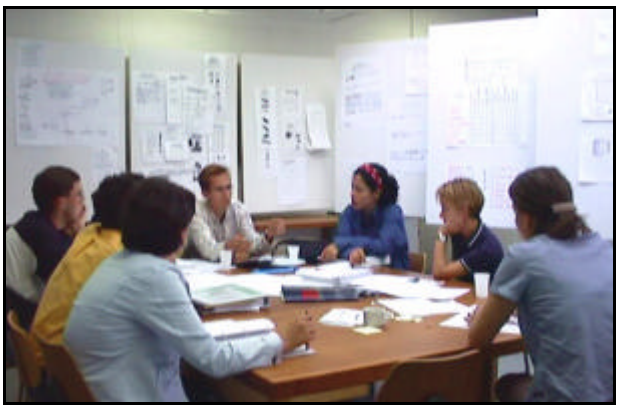


Figure 1 A student design team working in a prototype multi-board environment

We are well aware that computer based information systems can provide very quick, efficient

access to information and data. However, for life cycle oriented design, it is necessary to maintain a continuous overview of all life cycle requirements. By placing this information on a series of boards that are easy to view as a whole, the designer can very quickly and simultaneously look upon a lot of information about the product life cycle without disruption of thought or conversation.

The product development team uses the boards to visualise the product life cycle, with each meeting of the product and associated stakeholder considered separately. The detail of the information recorded on a single board is limited by the physical constraints of space and ease of visibility, consequently links to more complete sources of data and information, e.g. calculations in designer's worksheets, computer based information, and drawings, must be included. Links will also be used to direct the observer to the next level of detail in the life cycle model, which may be represented by another set of multi-board displays belonging to the design team responsible for a sub-system.

One role of the multi-board concept is to develop a life cycle oriented mindset amongst all members of the product development team. Using the boards to visualise the product life cycle will enable the team to share a common understanding of who all the stakeholders are, what their needs are, and what functions and properties the product must have. The resulting model of the product life cycle will enable the team to fully represent multiple-stakeholder criteria and ensure the design effort considers all needs. Communication and interaction between individuals in the team will be based around a common understanding of the goals to be achieved, enabling a focused creative process, where new ideas can be quickly assessed in all life phases. This will, in turn, further stimulate the creative process as team members adapt and modify new ideas in an attempt to meet the demands of each and every life cycle requirement. Through this repeated process, the design team will become even more familiar with the task in hand, acquire more knowledge about the product life cycle, and become more skilled at devising new ideas that can be suitably synthesised into an overall solution. Where several potential concepts emerge, the multi-board display allows for the comparison and evaluation of the alternative concepts for all life cycle needs, and appropriate choices can be made for more detailed design development.

The multi-board is not a static medium, it will evolve during the product development process. This is a natural occurrence as more information and data is collected, and the results of the product process itself emerge. This will be discussed in more detail below.

3.2 What goes on?

The process of creating a multi-board model of the product life cycle is the starting point of the multi-board concept. Since most product development projects are concerned with improving existing products or developing new products within an existing family, the first life cycle model to be made will be of an existing product (See Figure 2). The information and data may be collected using informal or formal means and is no different from what must occur at the beginning of any conventional product development process. Feedback on the use life phases may come directly from customers, sales personnel or warranty claims. Or it may come indirectly from observations made by company engineers and designers of the product in use. To understand the pre-use life phases, feedback will be required from distributors, manufacturing, and suppliers. Similarly, information will be required about maintenance, repair and disposal. The first multi-board (Figure 2), therefore, will reflect *"what we know"* about the life cycle of the current product, and the accuracy of this model will depend very much upon the quality of information and data collected.

With multi-board #1 in place, the product development team can begin a process of analysis and goal setting. Again, the techniques used need be no different from current practices. However, the use of the multi-board favours using scenarios to describe life cycle events. Since we consider the use of scenarios fundamental to the multi-board concept, their use is discussed in more detail later.

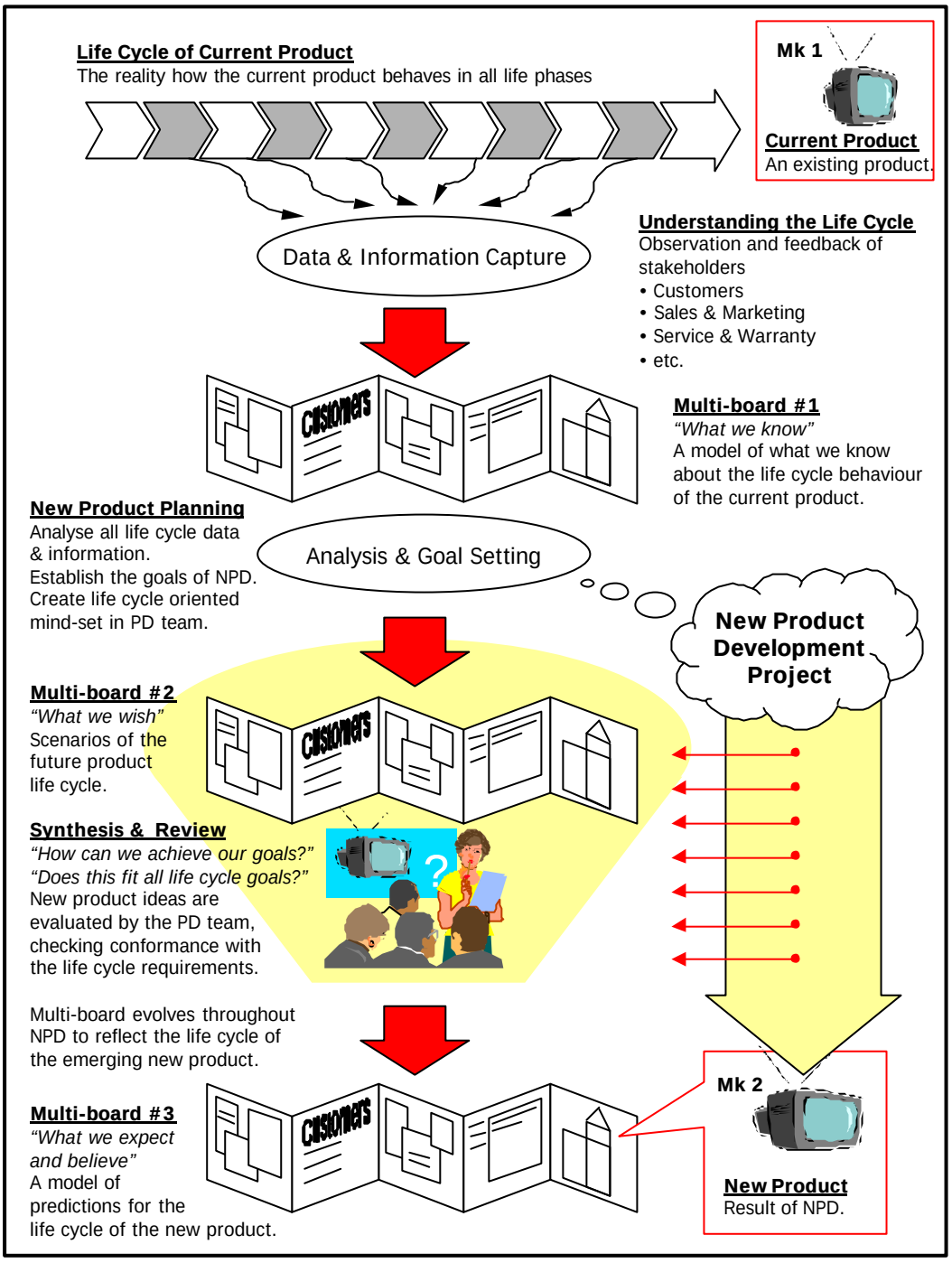


Figure 2 The multi-board concept supporting new product development

Scenarios provide an effective means of describing life cycle events and the meetings, which occur between the product and a stakeholder. A scenario provides a succinct means of describing how the stakeholder and product interact. By analysis of the information about the behaviour of the current product and the requirements of the stakeholder, the product design team can begin to define the performance targets for the new product. During the goal setting process, the scenarios will evolve from being historical records of the existing product to become scenarios describing a future model of the new product life cycle. Consequently, multi-board #2 (Figure 2) will portray a vision of *"what we wish"*, i.e. the design intent. Here, the life cycle of the new product will be visualised with statements of its

functionality and properties. It will show how stakeholders will interact with the new product and what will be their expectations of quality. During this process, the design team will be specifying goals, controlling unification of stakeholders' requirements, seeing the consequences of one life phase requirement upon another, identifying the supporting product life systems, and agreeing upon the "guiding stars" for new product concepts.

With the analysis of needs complete and goals defined, the product development activity is properly activated. The multi-board now becomes a focus for synthesis and review. The design team can use the scenarios that model the new product life cycle for continuous review of ideas. This working environment will foster dialogue, creativity and synthesis amongst the team. The use of scenarios will enable transient, multi-disciplinary members of the project to be quickly presented with a clear vision of the goals to be achieved, enabling them to make contributions with a full knowledge of their impact upon the life cycle. We consider this will be particularly beneficial where the design task is sub divided into discrete aspects and the results from this division of activity can be quickly brought into the master level model of the product life cycle, its contribution verified, and all dispositions considered.

In this way, product design proposals can be properly adjusted to integrate fully with the project goals, synthesis can be co-ordinated on a continual basis throughout the project, decisions can be made with a full awareness of the life cycle consequences, and emerging results documented by modification of the multi-board itself.
As the product development process draws to its climax, the multi-board will have transformed once again. In multi-board #3 (Figure 2), the scenarios and life cycle model depicted here will represent *"what we expect and believe"* the new product will perform and what reactions the stakeholders will have. This multi-board no longer describes actuality, nor does it describe wishes, but rather it describes the product development teams results and expectations of their new product. The reality may be different, but only when the cycle of gathering data and information about the behaviour of the new product has been performed and we have the feedback of the stakeholders, will we be able to begin the comparison of expectations with reality. Only then can we truly begin to "close the loop" on product quality control.

After the launch of the new product, the multi-board can remain as a model of the design intent, which is otherwise often not well documented. As feedback from reality is acquired, this information and data can be added to the multi-board. If modifications to the product are required, then designers responsible for this work can utilise the original model of the product life cycle to verify the suitability of the changes they propose. Consequently, the "quick fix" will no longer be merely attending to the immediate problem whilst disregarding all other life cycle consequences. The designer will have access to the complete life cycle model and be in a better position to provide solutions that continue to satisfy all life cycle needs. In doing so, the model itself will be adjusted to reflect the modification and the changed functionality, properties and expectations of the product.

The multi-board model of the new product should also be continually updated with feedback from the stakeholders as information and data is collected. If this is carried out, then any new product development project will be able to start with a model of the life cycle of the current product already in place, and the sequence illustrated in Figure 2 can begin once again.

4. SCENARIOS

"Scenarios are not formal; they are not scientific in any fancy sense. We know that they can be used because they already do play many roles in the system lifecycle. Perhaps the time has come to consider how a more integrative scenario perspective for system development can be constructed" (Carroll, 1995: 15)

"Multiple scenarios allow us to explore different visions of the future – "cover the field" as much as possible." (Verplank et al.*, 1993)*

Scenarios have become a popular vehicle in a problem area central to all design efforts: management of change. By offering a down-to-earth middle-level abstraction between models and

reality, scenarios promote shared understanding of the current situation and joint creativity toward the future (Jarke et al., 1998; Weidenhaupt et al., 1998). The main purpose of introducing scenarios in design is to stimulate thinking, e.g. scenarios are *"a creative tool that facilitates the leap from observation to invention"* (Verplank et al., 1993). This is also apparent in Carroll's definition of the concept:

"The defining property of a scenario is that it projects a concrete description of activity that the user engages in when performing a specific task, a description sufficiently detailed so that design implications can be inferred and reasoned about" (Carroll, 1995: 3-4).

People use scenarios for a variety of different tasks and to accomplish a variety of specific goals, for example:

- in requirements analysis to embody the needs apparent in current work practice (see Jacobsen, 1995);
- in user-designer communication as a mutually understood means of illustrating important design issues or possible designs (see Kyng, 1995);
- in software design as a means to identify the central work domain objects that must be suitably included in the system;
- in documentation and training as a means to bridge the gap between the system as an artefact and the tasks users want to accomplish using it; and
- in evaluation as a means of defining the tasks the system has to be evaluated against (Nielsen, 1995).

The web of diverse areas in which scenarios are used means that scenarios take many forms with respect to form, contents, purpose, and life cycle

Table 1. The roles of scenarios
(adapted from Jarke et al. (1998))

Domain	**Scenarios are used as a means to**
Strategic management	Recognise unexpected changes
	Protect against judgement errors by flushing out invalid mindsets or assumptions
	Use the most plausible ones as a basis for development
	Monitor fallback scenarios for possible modification of development strategy
Human-computer interaction	Focus design efforts on use
	Suspend commitment but support concrete progress
	Provide a task-oriented design decomposition that can be used from many perspectives
	Codify design knowledge as a 'middle-level abstraction'
	Encourage and support participatory design
Software and systems engineering	Make abstract models concrete
	Reach partial agreement and consistency of understanding
	Provide a decomposition mechanism for managing complex projects
	Provide a linkage mechanism between development phases
	Support object models by functioning as design aids and boundary conditions

issues. Some use narrative text to produce extensive descriptions of how the system interacts with its environment, and use these descriptions in a range of activities throughout the development process. Others use diagrammatic notations to produce dense descriptions of interactions among internal system components, and use these descriptions to ensure agreement among partial views at a few clearly defined points in the development process (see Weidenhaupt et al., 1998).

Jarke et al. (1998) span three different domains – strategic management, human-computer interaction, and software and systems engineering – in their survey of how scenarios contribute quality to analysis and design activities. Their findings, summarised in Table 1, show some variation across the three domains but also point to a common underlying role of scenarios: to ground decisions in a sound and easily communicable understanding of the use situation. Scenarios are, however, not simply available for use, they have to be managed. The need for scenario management increases, as scenarios become increasingly pervasive artefacts used throughout the product life cycle and for manifold purposes.

Scenario management involves:

- capturing/generating scenarios;
- structuring and co-ordination of scenarios;
- evolution and traceability;
- reviewing scenarios; and
- documenting scenarios.

Weidenhaupt et al. (1998) note that scenario management has not received the attention it deserves, at least not in the literature, and Jarke et al. (1998) identify four key research questions for scenario-based design and at least the first three of them are about scenario management, see Table 2. The fourth question points out that whereas the benefits of using scenarios are reasonably well known the costs are not. To determine whether scenarios are applicable in a specific situation it is, for example, necessary to know whether and how scenarios link up with the other techniques used during design. Due to the somewhat fluid nature of scenarios and their broad scope such data are usually not available. This lack of data is exacerbated when it comes to issues such as version and configuration control – a critical issue in large-scale applications of scenario techniques. Rather than considering scenario management a separate issue, we believe there is a need for techniques that incorporate major aspects of both the management of scenarios and their use in an integrated approach to scenario-based design. The multi-board concept is our attempt to lay out such an approach.

5. SOME INITIAL EXPERIENCES AND RESULTS

In August 1999, the Department of Control and Engineering Design at the Technical University of Denmark hosted a Summer School entitled "Creating Innovative Products for Global Markets". It was attended by 24 students from 16 different countries and a variety of disciplines, e.g. mechanical engineering, electrical engineering, computer science, material science, architecture, graphic design, industrial design, management. During the two weeks of the Summer School, these students were required to work in 3 teams of eight on a variety of tasks related to product development. This gave us an ideal opportunity to experiment with the multi-board concept.

For the first task, each student was required to collect as much information as they could about

Table 2. Key research questions for scenario-based design (from Jarke et al., 1998)

How do we deal with collections of scenarios?
How do we deal with coverage?
What detail is necessary?
What are boundary conditions for scenario applicability?

coffee, coffee making and the culture of coffee drinking in their own country. At the Summer School, each team had to use the information collected by each person and create a multi-board display of the life cycle of coffee. Not only did the display have to tell the story of coffee from "bean to cup", but also identify the stakeholders in the life cycle, and outline the similarities and differences of the coffee drinking cultures of the different nationalities represented in each team (Figure 3). From this information, the team had to identify an innovative coffee related product. Each team was given a large working space that included 10 display boards, each 1000mm x 700mm and made from low density, foam-board. Despite their size, the boards were lightweight and easy to handle. For simplicity and safety, each board was hung from the ceiling with a system of runners and hooks. This enabled the boards to be organised in a variety of patterns to suit the needs of the team. The teams were also supplied with a good quantity of stationary including paper, marker pens, sticking tape, Post-Its™, pins, etc.

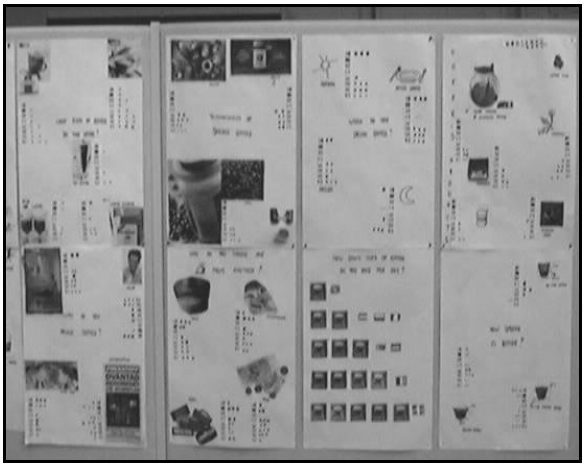
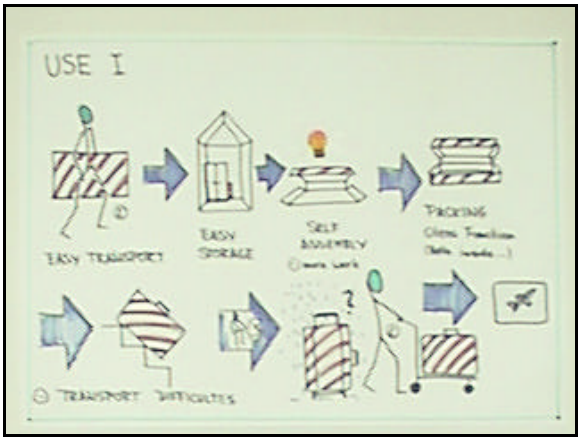
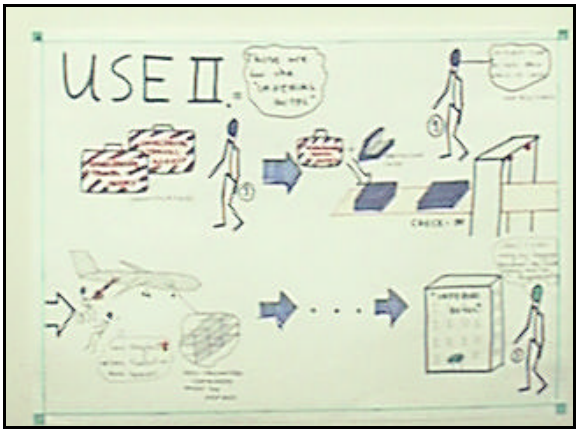


Figure 3 Multi-board showing information and data about coffee drinking cultures

A second exercise also required the students to work in teams. In this exercise, the teams had to create a multi-board that depicted the life cycle of luggage of an airline passenger, identify an opportunity for an innovative product, and demonstrate how their new solution would enhance product quality. Although the detail of the information used was quite limited, each student had a lot of personal experience of travelling. Consequently, the teams were able to quickly create scenarios describing major events in the life of luggage. Information about the variety of products on the market was obtained from the Internet and included in the multi-board display, which was prepared.





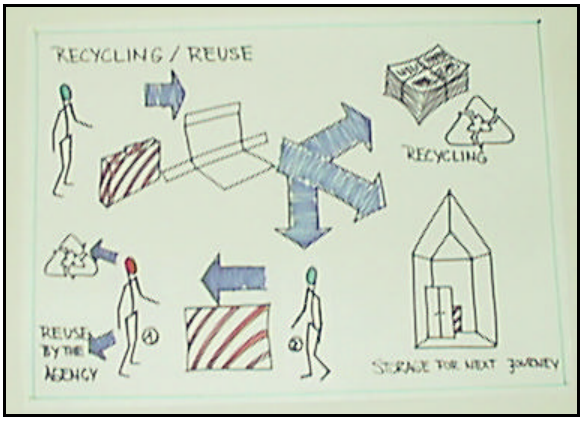


Figure 4 A sequence of scenarios showing different life phases of a new luggage product

From their analysis of the luggage life cycle, each team determined quite different opportuni-

ties for an innovative luggage product. Subsequent design work developed solutions, whilst paying close attention to all life cycle implications, and the display evolved to reflect the design intent. At the end of the project, each group used the multi-board display as the principal medium for the presentation of their concept for a new luggage product (Figure 4).

The Summer School provided a good vehicle for evaluating the usefulness of the multi-board concept. Each group was made up of eight people, who had never met before, from different academic disciplines and from different countries. In a very short time, these groups had to become effective design teams, able to identify and agree common project objectives, manage the progress of discrete activities, share ideas amongst each other, synthesise proposals into single solutions, and communicate their solutions to third parties. During the Summer School, we observed that the multi-board concept provided:

- a good working environment for discussion, multi-disciplinary team working and communication;
- high visibility for the ideas, thoughts and questions of the design team;
- support for life cycle oriented design, product quality and innovation; and
- a simple means of viewing the progress of the project.

We also observed that this working approach forced the design teams to sketch, use natural language and devise a graphical (symbolic) language to ensure that the information on the boards was easy to access and understand. In the presentation of their results the teams chose to use only the multi-board as a support medium, despite the availability of other devices, e.g. overhead projectors. Each team spoke without notes, using the display as a prompt to the content of their talk.

We do not claim the evaluation of the multi-board concept has been exhaustive or rigorous, but we find the results from the Summer School very encouraging. Many of our beliefs about the appropriateness of this working approach were supported by our informal evaluation, and the comments from participants endorse the concept as a suitable support for product design. In evaluating the multi-board concept one participant said:

"It is very helpful to have a multi-board during the whole development process of a product, particularly if you are working in a team. It is communicative and you can discuss problems directly on the board. Every change is visible and documented."

6. CURRENT RESEARCH

At the moment, we are working with two manufacturing companies in Denmark developing a life cycle oriented design approach for improving product quality. In one case (Company A), we are examining the documentation of a recently completed product development project to determine the type of information that was exchanged between project team members.

We are also interviewing key project personnel. Our purpose is to evaluate the effectiveness of documentation and its contribution to achieving product quality as well as to identify the opportunities for improving access to product life related information. Our ambition is to persuade the company to utilise the multi-board concept as an approach for their next product development project and observe the effectiveness of its use by the design team.

In the second case (Company B), the multi-board concept already exists (See Appendix A) but its use is being focused upon product definition at the start of the product development project. Our interest here is to help devise methods for working with the multi-board concept and to evaluate how the designer's attitudes about product quality change when using a life cycle oriented design approach.

Overall, we wish to demonstrate the appropriateness of the multi-board concept for life cycle oriented design, gain further insight in to how this approach should be developed, and provide more answers to the questions raised in Table 2.

7. CONCLUSIONS

In this paper, we have described the multi-board concept as a working approach for product development teams, which we believe supports life cycle oriented design and assists the achieve-

ment of enhanced product quality. The use of scenarios to describe product life cycle events enables the design team to empathise with the context of use of a product and the quality demands of the customer. The extension of this approach beyond the use life phases ensures the needs of all stakeholders are considered.

The creation of a multi-board display depicting life cycle events, which forms the focus of the product development team's common working area, supports the continued consideration of life cycle needs throughout the product development project. The boards encourage discussion, analysis, creativity, synthesis, evaluation and decision making to occur amongst team members. The scenarios support transient project team members in quickly comprehending the task and making their contribution, and customers in commenting upon their accuracy and completeness. The scenarios will also change, initially depicting reality and then evolving to depict design intent. Along the way, the multi-boards will provide a means of documenting design activities and monitoring the progress of the project.

Our informal evaluation of the multi-board concept suggests that it fosters shared understanding of quality goals amongst the design team, changed attitudes towards customer-focused product quality, team building and ownership of the project task. We believe that these are properties that result in designs with improved product quality that will enhance the satisfaction of the customer.

Finally, although we have not discussed this in this paper, the multi-board concept is well suited to educational activities. Students can quickly relate to and comprehend the use of scenarios to describe life cycle events and identify product functions and properties necessary to quality demands. The multi-board displays force students to express their ideas visually and provide easy access for observing the results of their work.

8. ACKNOWLEDGEMENTS

We would like to thank the Summer School students for experimenting with the multi-board concept and allowing us to observe their use of it in practise.

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9. APPENDIX A: AN ALTERNATIVE USE OF THE MULTI-BOARD CONCEPT BY COMPANY B

In Company B, the multi-board concept is already used in the early phases of product development. However, rather than utilise one multi-board that evolves during the product development programme, several multi-board displays are created, each with a different role and focus. The company calls their multi-board display concept "The Project Wall".

At the project start, a "storyboard" depicting the product life cycle is created. The multi-board display shows the product life phases, e.g. manufacture by sub-suppliers, assembly, test, sales, transport & distribution, installation, use, service and disposal. Associated with each storyboard will be statements of requirement, i.e. with respect to quality, cost, flexibility, time, environment, efficiency, and risk. At the beginning of a new product development project, the development team spends a week focusing on product quality. They use the storyboards to develop a common understanding of the quality requirements of all the stakeholders, from which they agree the specification of the new product.

A second display is used to depict the function structure of the product, showing the totality of functions the product must perform or support. It is useful to depict functions separately from the product life cycle display, where the same function might be visible in more than one life cycle scenario. For completeness, it is essential that all the primary-functions are depicted. Sub-functions will be added during the design activity, as solutions emerge and the design becomes more detailed.

A third display provides the product development team with the opportunity to record ideas and solutions, and a fourth decomposes information into a functionally related organ structure. This last display is significant, because it reflects the way the overall product development task is organised, i.e. design groups are given the responsibility for designing organs.

The company's enthusiasm for the Project Wall (Ploug, 1999) is based upon the benefits they have experienced by its use in product development projects. The Project Wall allows visibility, communication and co-ordination of information. This is useful and important for the results that are implemented (and those not implemented) and for keeping focus on project deadlines.

The Project Wall provides a means to show ideas that have been generated, the decisions made, agreed specifications, and project plans. It is acknowledged that the Project Wall supports idea generation and synthesis.

It is envisioned that the company will continue to use the Project Wall to support product development projects. The first board will be used to depict the product life cycle and specify the product, process and project goals. It will be a constant source of reference against which the results and information depicted on the other boards will be compared.

In essence, the context of use and purpose of the Project Wall is no different from that described in the main text for the multi-board concept. Its execution may differ, but in both cases the desire is to create an environment that supports and enhances the effectiveness of the product development process.

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