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PRODUCT MANAGER:
A DECISION SUPPORT TOOL FOR DESIGN ENGINEERS

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Abstract: The new product development process is the lifeblood of all manufacturing enterprises. Many tools and techniques have been developed in an attempt to make this process more efficient and effective. However, in spite of this, product development projects are still prone to failure. A significant amount of products are delivered late, over budget and do not satisfy the real needs of the end users. In the vast majority of cases these development failures are not due to incompetent staff or inadequate equipment, rather they are a result of poor decision making capabilities. Research indicates that design engineers do not have access to sufficient relevant, timely and accurate and information necessary to make decisions and solve problems. This paper presents a software solution, referred to as Product Manager, that can help design engineers generate, access, retrieve, add value to and transfer information and knowledge in order to make informed decisions throughout the new product development process.

Keywords: New Product Development, Design Engineering, Decision Support System, Knowledge Management.

1. INTRODUCTION

Intense international competition along with global markets, reducing product life cycles and an ever-increasing number of product variants continue to put increased pressure on manufacturing organisations to produce better products faster. Over the past number of years researchers and industrialists have recognised the need for and importance of developing approaches to enhance competitive advantage in new product development. In spite of new and effective engineering techniques, product development projects are still prone to failure. All too often complex products are delivered late, over budget and do not meet the real needs of the end users. In the past organisations competed effectively using strategies, which focused on reducing cost, quality initiatives and continuous, incremental product improvements.

While this is necessary it is no longer sufficient. Today product development managers must increase their ability to produce innovative products in shorter time frames more efficiently and effectively than their competitors.

spent solving the "right" problems, and of this, management have the right competencies for one third of the time. This is illustrated in the following equation;

$$^{1}/3\ .^{1}/3\ .^{1}/3 \approx 4\%$$

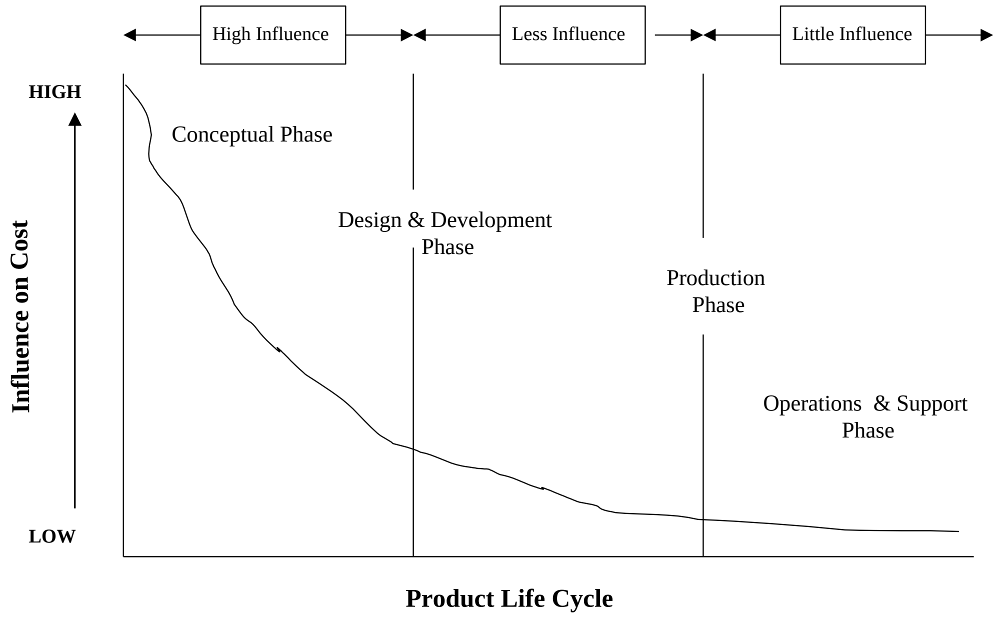


Fig.1 Influence of product development stages on total life cycle cost

It has been highlighted that by concentrating efforts early in the new product development process (i.e. the design stage) significant improvements can be achieved. This is illustrated in figure 1, which shows the relationship between the principle product development stages and their ability to influence the total life cycle cost. If design engineers get their process right the first time, time consuming, costly iterations and re-work can be significantly reduced or eliminated. Furthermore, by reaching the market earlier with an optomised design solution an opportunity is provided to recover a large part of the development investment cost. It also results in being further ahead on the learning curve when a competitive product is introduced.

This highlights that there is considerable scope for substantial improvements and efficiency gains at this stage in the product development process. Duffy et al (1995) cite a comprehensive study undertaken in the mid 80's which revealed that the overall effectiveness of development engineering is merely 4%. The basis for this statistic is that on average, engineers reported spending about one third of their time on "real" design, of this one third was

This suggests that manufacturing managers should focus more attention on managing the design process. Evbuomwan et al (1996) note that "*it is highly desirable that more research will start to focus on the synthesis aspects of design, examining ways to support creativity, innovation and generation of conceptual design solutions*." It seems that by addressing this deficit, opportunities will be provided for design and manufacturing companies to excel.

2. DESIGN ENGINEERING

There are many definitions for the term design. For example, Pugh (1990) takes a process-oriented view and postulates that "…. *design is the systematic activity necessary, from the identification of the market/user need, to the selling of the successful product to satisfy that need*…" Luckman (1984) explores this process in more detail. He asserts that "*the process of design is the translation of information in the form of requirements, constraints and experience into potential solutions which are considered by the designer to meet required performance characteristics*". While in a review of the literature, Evbuomwan et al (1996) believe that design is, "*the process of establishing requirements based on human needs, transforming them into performance*

specifications and functions, which are then mapped and converted (subject to constraints) into design solutions (using creativity, scientific principles and technical knowledge) that can be economically manufactured and produced".
From these definitions it can be seen that there are two principle characteristics of design. It can be said that;

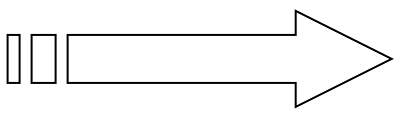
- Design is as a systematic information transformation process where information is converted from general statements into more definite design specification statements.
- Design is a problem solving activity where designers tend to solve problems by synthesising disparate pieces of information.

Evbuomwan et al (1996) undertook a comprehensive survey of design. They found that the design is a(n);

- Investigative process
- Creative process
- Rational process
- Decision making process
- Iterative process
- Interactive process

Design types can range from the continuous, incremental product changes (such as minor iterations) to major radical change (such as the development of a new core product). The design process can be classified into four different types. These are; routine design, redesign, innovative design and creative design.

- **Routine design:** In general an *a priori* plan for the solution exists for this type of design
- **Redesign:** Redesign deals with minor iterations or modifications to the original design to satisfy new requirements or improve its performance
- **Innovative design:** In this instance, new variables or features are introduced which are somewhat similar to the existing variables and features
- **Creative design:** Here new variables or features are introduced which do not resemble an existing design



Routine Redesign Innovative Creative

Fig 2. Types of Design

This is illustrated in the form of a continuum in figure 2. At the routine end of the spectrum the design process is precise, predetermined, systematic and radical. While at the creative end of the spectrum, the design process is spontaneous, chaotic and imaginative.

3. KNOWLEDGE AND INFORMATION

It is widely accepted that knowledge and information are essential elements in the new product development process in general and the design process in particular. Information and knowledge are often used synonymously in the literature however they are different concepts and it is important to distinguish the two as separate entities. According to Glazer (1991) information is "*data that have been organised or given structure - that is placed in context - and thus endowed with meaning*". Knowledge on the other hand goes further; it allows the making of predictions, casual associations, or prescriptive decisions about what to do.

Vast amounts of information and knowledge are required by designers to integrate customer requirements and design changes as the development process progresses. In order for information and knowledge to be useful it must be;

- Available
- Accurate
- Effective
- Accessible

Without access to accurate, relevant and up to date information mistakes or misjudgments will continually be made on many aspects of the products design.

Furthermore, not only are they continually acquired, created and processed but both knowledge and information must also be transferred from one activity to another and between the relevant players involved in the design process. In addition, information and knowledge must be stored and retrievable when the generation and use of the information are separated by time so that designers can access previous designs. This creation, use, transfer, storage and retrieval of information and knowledge is essential to support communication and collaboration within the design process.

In this view, information and knowledge are key resources that must be managed if improvement efforts are to succeed and businesses are to remain competitive in global markets. Like the materials used in the manufacture of goods, knowledge is a transferable unit, whose value is enhanced when it satisfies a practical need in a timely, cost effective manner. Companies that manage knowledge as a strategic asset will gain competitive advantage over companies that do not. However, much of an organisation's knowledge is personal. In other words, it resides in the individual and remains in their minds. Manufacturing enterprises are currently failing to convert individual skills and competencies into corporate knowledge, and know how. There is little evidence (anecdotal, empirical or otherwise) to suggest that adequate provision is made for capturing, sharing and disseminating knowledge in organisations for product and process innovation.

We have shown that information and knowledge management are crucial to the success of the design activity. However, Court (1997) cites a study which found that engineering designers spend as much as 30% of their time searching for and accessing engineering design information. This suggests that the engineering designer requires tools to help them generate and access information and also to help them to analyse, synthesise and evaluate that information in order to solve problems and make informed decisions.

However, intuition and experience provide the only support available for the majority of designers to make necessary decisions. But intuition alone is not sufficient for making complex crucial decisions. This indicates that the flow of information and knowledge between people and activities in the design process is not as efficient and as effective as it should be. Engineering designers need a mechanism to have the required information and knowledge available in order to make informed decisions. Tools and methodologies must be established to aid the acquisition and synthesis of both internal and external information. Such a system must adopt a holistic approach to the design process and new product development in general.

Adelson and Soloway (1985) studied the design process used by novice and expert designers. They stated that the usefulness of a tool for designers would depend on the experiences of the designer and the design discipline itself. They identified the following situations;

- If the designer has designed a similar object before, he or she will need tools to help access previous designs.
- If the designer has some experience with elements of the design, he/she will need tools that help to retrieve and assemble elements in a simulation.
- If the designer has no experience, he or she will need tools that help to infer constraints on the design.

New knowledge based communication technologies can provide opportunities and challenges for organisations to change their ways of working. Manufacturing organisations can now adopt a more inclusive and integrated approach to product and process development. More emphasis can be placed on co-operative working, which incorporates information sharing, process management, integration and communication of human and computer resources.

Our research group is currently developing a software tool referred to as Product Manager that is grounded in research and supported by a sound methodology, which seeks to incorporate these aspects.

4. PRODUCT MANAGER

The principle aim of the tool is to incorporate requirements (e.g. customer requirements, warranty requirements, engineering change requests etc.) into the entire new product development process. It also aims to increase communication between teams and between functions in order to minimise misunderstandings and rework and maximise synergy and cohesion. In other words, the tool aims to enhance team building and decision making skills for both product and process development. It can also act as an effective idea management process.

More specifically, Product Manager aims;

- to address the end users unique requirements
- to put together disparate pieces of information to generate new ideas
- to leverage customer information inside the organisation to create value
- to synthesis customer information across the value chain

- to get the right information to the right person at the right time
- to increase effectiveness of the decision making process
- to facilitate team based decision making
- to build solid consensus quickly

Knowledge sources (i.e. engineering change requests, warranty requirements etc.) are gathered, synthesised and transformed into projects where resources are allocated and

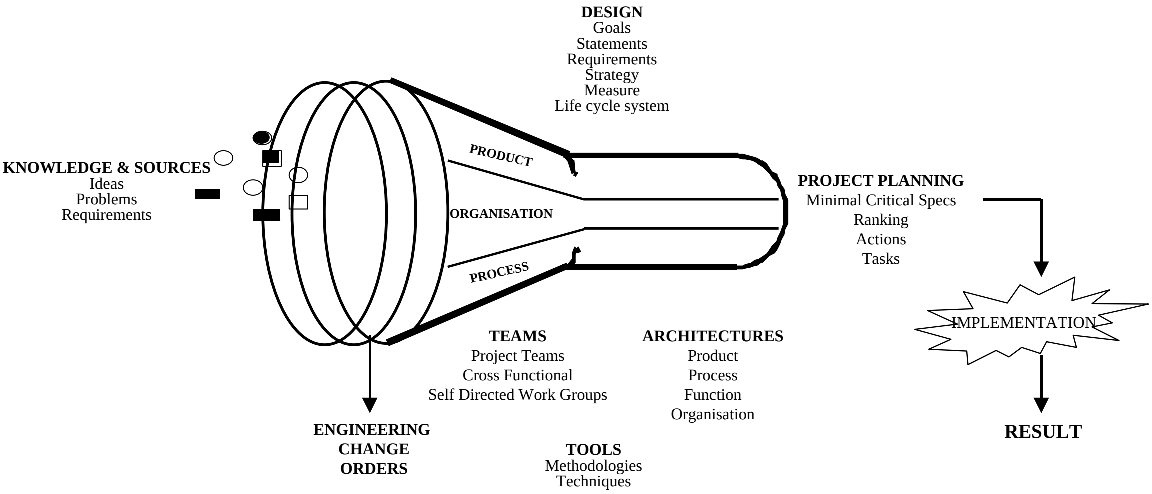


Fig. 3 Product Manager

Product Manager is a decision support tool to encourage a systematic approach to product development. It enables a dynamic framework for capturing the next generation product development process. It is targeted at engineering designers wishing to translate abstract ideas into concrete functional specifications and ultimately successful projects. It is useful for designers wishing to undertake all types of design e.g. routine designs, redesigns, innovative designs and creative designs. It also allows product managers to co-ordinate numerous product development projects simultaneously.

The tool has been developed to incorporate market profiles, customer profiles, project planning, organisational entity analysis and product development metrics. The goal is to help identify, acquire, synthesise and integrate disparate pieces of information, knowledge and ideas and translate them into successful product specifications. Product Manager encourages all employees in the product development process to actively identify problems and generate ideas. The tool incorporates a stage gate process. To this end a decision hierarchy structure is defined and decision points are placed in a step-by-step format using clearly defined measurable criteria. This allows ideas to be synthesised, filtered and prioritised taking the specific organisational strategy into consideration.

people assigned responsibility. This tool offers an impressive decision making capability as all workers can access and manipulate the data.

Product Manager can be visualised through the development funnel as highlighted in Figure 3 above. The front end the funnel concentrates on market analysis, competitive analysis, supplier feedback, engineering change requests, quality function deployment (QFD) results etc. to generate ideas and requirements for products. These knowledge sources are gathered and collated and inputted into a database to produce ideas. Some of these ideas can be either dropped, amalgamated into others, filtered or developed further. They may represent both small redesigns or add on developments as well as ideas for radical large-scale innovations.

Ideas that lead to minor redesigns do not require major resources need not flow fully into the funnel and can be implemented immediately by the individuals or teams concerned. These are referred to as "quick wins". Ideas or projects which do require major resources flow into the funnel until they become constrained by a number of important factors - the operations strategy, performance goals, available budgets and available personnel required to implement the proposed development. They can also be constrained by the agreed architecture or model developed for the product. Product designs, which are aligned with the design strategy and goals, are considered appropriate and can proceed through the funnel. These are referred to as approved projects, and eventually find their way onto the organisation's 'product innovation plan'.

The ideas go through clearly defined stages in which specific tasks must be undertaken. This involves rigorous and demanding, Go/No Go decision points at the end of each stage using clearly defined measurable criteria. Such a process allows for the objective review of actual versus planned performance for every new product, after its introduction to the marketplace.

The projects on the plan are screened by management to reflect the environmental and organisational conditions at the time of implementation and not when the project was included as part of the system innovation plan. Thus, any changes which are made with respect to the constraints on new projects making it to the plan, also effect the projects which are already on the product innovation plan. This ensures that the projects, which are chosen for selection, will correlate with the organisational direction at that time.

All projects, although part of the product innovation plan eventually go through a new process of specification by the individual project groups involved, budget approval by senior management and eventual implementation. It must be highlighted that projects approved for the plan may still be discarded due a sudden reduction in budgets bought on by such things as lower than expected sales figures.

The projects, which are not selected for implementation, will remain part of the product innovation plan and will be included in the 'ranking process' on the next occasion, along with any new projects, which will have made its way to the plan. This plan provides the product manager with minimal critical specifications for all the projects, which fulfil the strategies of the organisation, and thus they can decide on the projects to be undertaken in the future. Once management has decided that a performance improvement project from the product innovation plan is to be implemented, then it will be project managed. The project management process uses effective techniques such as Gantt Charts to support the process.

The main objective of product manager is to maximise the effort and resources that are expended on new product development. Empowering employees and involving all personnel in problem solving secures ownership and increases the resources available to generate, exploit and implement ideas (Davenport and Prusak, 1998). Developing a consensus-based strategy among managers focuses ideas towards goal-centered projects. In addition, strategically important projects can be structured into a product innovation plan that acts as a blueprint for implementing effective innovation.

Product manager provides seamless information about all product design options. It consolidates all customer, warranty, engineering change orders; strategy and project related issues in the manufacturing enterprise. In other words, it can act as a knowledge repository. By providing one source for this information, any manager can easily perform consolidated searches. With one integrated system, all information for reach customer is automatically updated and is easily accessible. As well as coordinating and communicating the designs and projects to the workforce, such a system can also offer continuous learning opportunities. Manufacturing companies can dramatically increase the success of their business and retention of their workers if they continually provide such learning opportunities. Moreover, increased worker knowledge at any level of the organisation can impact productivity.

The tool can support multiple users across the new product development process. It can deliver productivity enhancing, collaborative workflow and self-service capabilities by using advanced technologies such as the GroupWare and Intranets. Self-service technologies not only extend the tools capabilities to the workforce, but also add additional value by promoting a more collaborative work environment. With the new workforce paradigm focusing on teams and projects, the new system must support and bring efficiencies to these work group models.

5. CONCLUSION

As we approach the 21st century it is increasingly apparent that the survivors in this new era of manufacturing will be those companies that are rigorous in their pursuit of designing innovative products in shorter time frames than their competitors. It is also becoming clear that in order to achieve this goal managers must concentrate on improving the efficiency and effectiveness of the design process. Product managers must try to optomise design solutions to reduce cycle time in order to achieve higher returns on investment. To this end expensive, time consuming iterations must be minimised, or if possible, eliminated.

Design engineers must increase their ability to capture their initial designs correctly. In order to do this accurate, up to date and timely information must be available to them. Therefore, manufacturing organisations must provide the appropriate support systems and infrastructures to facilitate this. It is believed that an integrated tool set based on a sound methodology associated with some effective processes will facilitate the product innovation process (Lyons, 1997). Product Manager is a software tool, which, not only allows an organisation to encapsulate an ever-growing body of human, know how, but also increases corporate transparency. This could become a valuable strategic resource that could not be replicated quickly by competing companies. Therefore, this tool could make a competitive difference to manufacturing enterprises.

However, it is important to remember that tools and technologies are a means to an end and not an end in themselves. They can certainly facilitate the design process by generation, transfer and retrieval of information. It must be taken in context and implemented as part of an overall effort to leverage organisational innovation. It will have to be adapted to the way people work, taking into consideration their organisation's culture and value systems.

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