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A Groupware System for Virtual Product Innovation Management

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ABSTRACT

We are experiencing a radical shift in the way organisations are designed, structured and organised. New organisational forms such as virtual strategic partnerships and networks are replacing traditional bureaucratic, hierarchical organisations. Business leaders are adopting project focused, re-configurable e-business models or networks to maximise core competencies in order to fulfil customers' needs. This is particularly evident in the area of product innovation where organisations are adopting new approaches or ways of working in order to compete. Product innovation management is a complex process because of the range of technical issues that must be addressed and the variety of competencies that must be employed over the life of the development effort. Such initiatives require a substantial

investment in terms of resources such as time, money and effort, all of which are limited. Therefore it is imperative that this process is properly managed and supported by effective structures and systems. This paper focuses on product innovation management in a distributed or virtual environment. It reports on a qualitative case study targeted at product managers. The challenges to managing a portfolio of product innovation projects in a virtual environment are identified and discussed. From this analysis, a web-enabled groupware system is presented.

Keywords: Networked Organisation, Virtual Teams, Product Innovation Management, Software Prototype

1. Introduction

We are experiencing a major change in the world economy. This transformation is described by various terms in the literature notably, "*the move towards the post industrial society*" (Toffler, 1990), "*the emergence of the knowledge society*" (Drucker, 1993) or "*the rise of the knowledge based economy*" (Nonaka, and Takeuchi, 1995). Contemporary business systems have become more knowledge intensive. Much work now consists of converting information to knowledge, using creativity, skills and competencies. Managing the organisation's knowledge base in order to design, develop and deploy successful products and services is fast becoming a critical component of competitive success. Consequently, new and more complex organisational forms are evolving every day. They are becoming increasingly distributed, flexible and responsive to environmental and market changes (Wright, and Burns, 1998; Voss, 2003; Daniels, 1998; Gunasekaran, 1999). The new forms show an ongoing transformation of value chains. The balance of work is moving from stable, physically collocated functions to dynamic, competency-based, electronically collocated business networks (Voss, 2003; Walters, and Buchanan, 2001; Wright, and Burns, 1998). Many terms such as the virtual enterprise, the next generation manufacturing enterprise, the knowledge-based organisation and the networked organisation have been used to articulate the structure for the 21st century global enterprise.

In this new paradigm virtual teams create value by synthesising information and knowledge across organisations and geographical borders in order to create new products and services (Prasad, and Akhilesh, 2002; Johnson, Heimann, O'Neill, 2001; Ratcheva, and Vyakarnam, 2001; Pawar, and Sharifi, 2000). Work is organised around value adding projects that are carried out by small multi-skilled self managed teams. Teams co-ordinate their efforts through free and open communications nourished by trust and shared values, enabled by

frequent meetings and supported by digital networks. Effective communication structures are essential to integrate the knowledge and skills required by these teams to design, develop and deploy a successful product. Communication always has been a fundamental problem in complex projects (Kayworth, and Leidner, 2000; Griffin, and Hauser 1996). Costly breakdowns in communications often occur even in the traditional world of collocated groups engaging in physically oriented activities. However, in a distributed environment where team members are spread across geographical boundaries, it is imperative to make substantial efforts to ensure adequate and effective communication. Consequently, moving to this new workforce paradigm demands support structures to enable communication, collaboration and project co-ordination. These structures must be capable of configuring both internal links between the functional activities in the process as well as external links between suppliers and customers.

The primary objective of our research is to improve the effectiveness of product managers operating in a distributed or virtual environment. This paper reports on a qualitative case study targeted at product managers from multinational organisations based in Ireland. The goal of the study was to determine the key challenges facing these managers operating in a virtual or distributed environment. The lessons learned from this initial analysis acted as key design goals to guide the development of a web enabled groupware system. The system was designed to enable a participative and systematic approach to product innovation management in a virtual environment. More specifically, the groupware system provides a structure for product managers to help control their knowledge base across the entire value chain. It also helps them to generate, select and prioritise product innovation projects that strategically align with their existing portfolio so that the projects that are selected for implementation provide

good returns on the resources and capital invested. Findings from this analysis are presented and discussed.

2. Research Methodology

The case study involved visiting ten multinational organisations based in Ireland whose principal activity is product design and development and interviewing members of their senior management team. The sample chosen for this analysis was selective. It focused on multinational organisations based in Ireland with a reputation for being innovative. The industrial sector of the organisations selected varied from healthcare and pharmaceuticals to telecommunications and electronics. All organisations surveyed operated in a virtual environment. Table 1 provides a brief profile of these companies.

Insert Table 1 Here

The methodology employed in this study consisted of two separate but related phases. The first phase focused on identifying the key challenges to product innovation management in a virtual environment. The aim of this activity was to understand the product innovation process in specific industrial contexts. The goal of these interviews was; (a) to identify the strengths and weaknesses of each organisation's product innovation process; (b) to identify critical challenges facing product managers as they operate in a distributed environment; (c) to identify key factors that facilitate product innovation in industry and finally; (d) to discuss how companies must improve in order to maintain long term competitive advantage. From this analysis a groupware system was developed. The second stage in the research methodology focused on populating the system with case related data from three of the participating organisations in order to evaluate its effectiveness (i.e. how useful, applicable

and appropriate the system is) as well as its practicality (i.e. how pragmatic, functional and deployable the system is).

3. Design Goals for the System

The rapid emergence of the connected or networked economy has urged organisations to consider the implications for themselves, their industries and their market places. The findings of our case analysis revealed a number of issues or critical success factors that product managers should consider when managing a portfolio of product innovation projects in the new networked environment. These must be taken into consideration when designing a system to support this process. They are grouped into the following categories.

3.1 Customer focus

Product innovation must be customer driven in order to sustain competitive advantage in international markets. A clear understanding of user needs is critical to effective innovation and all operations must be driven by these needs. The product development team must seek to continuously establish the voice of the customer and translate these needs and expectations into commercial products and services.

3.2 Goal definition

Product innovation team members incorporate representatives from a wide variety of functions, disciplines and locations. Therefore, it is a major challenge to keep everyone focused in the same direction. This can be particularly difficult when team members are distributed across geographical borders. The overall direction for the company's innovation endeavours must be identified and communicated to all so that all team members are working towards a similar goal.

3.3 Idea generation and problem solving

Lack of employee involvement limits the number of potential innovations that may be exploited by an organisation. Organisations must therefore generate ideas and resolve problems in a conscious, purposeful and systematic manner. Active participation harnesses the creative talents and skills of as many individuals as possible, and lowers resistance to change by engaging everyone in the development process.

3.4 Process management

Product innovation projects require a substantial investment in terms of resources such as time, money and personnel, all of which are limited. Therefore it is vitally important that a high quality, rigorous product innovation process with pre determined decision points is in place to help convert needs into commercial solutions that provide good returns on the resources and capital invested. Systematic processes and methods ensure a proven series of steps are used every time. They also reduce redundancy and rework thus improving productivity and cycle time.

3.5 Portfolio management

Successful product innovation depends on exploiting synergy among projects, such as reusing existing designs, market knowledge and customer requirements. In this view, attention moves from single isolated projects to the project family, or project portfolio. One of the key skills in effective product innovation management is balancing the composition of this portfolio and matching it to the firm's competencies and capabilities in technology and markets. Therefore product managers must also exploit relevant information to generate, select and prioritise projects that strategically align with their existing portfolio and business strategy.

3.6 Performance management

The role of information relating to performance is a key factor in determining a project's ultimate success. Specific metrics should be used to quantify the efficiency and/or effectiveness of all projects in the portfolio. A well designed performance measure is a powerful tool for controlling business objectives. Such measures provide the project stakeholders with information necessary to make intelligent decisions and are recognised as an important element of all continuous improvement programmes.

Upon analysis of these implications, it is evident that product managers must locate and connect to a broad range of information and capabilities across the entire value chain. Therefore, organisations must begin to examine how they can make their knowledge base accessible and use it effectively (Jones and Jordan, 1998). Furthermore, it is increasingly clear that in a knowledge based, project focused environment product managers must exploit information communication technologies to enhance communication, co-ordination and collaboration. In particular, this technology must facilitate communication across functional areas and with geographically dispersed sites (Grantham and Nichols, 1993). Knowledge must also be integrated by co-ordinating across phases of the product innovation process.

4. Information Communication Technology for Virtual Teams

Information communication technologies offer the potential to significantly improve product quality and to reduce the cost and time-scale of development projects involving parties with a widespread geographical area. Companies are exploiting this electronic medium to distribute, disseminate and communicate information in house and across organisational boundaries. Organisational computing is evolving from centralised processing to inter and intra connected systems (Mandviwalla, and Khan, 1999; Balasubramanian, and Tiwana, 1999; Dennis, and

Gallupe, 1993). The internet has emerged as a practical and cost effective infrastructure for linking product development team members with each other and key customers and suppliers. Although electronic data interchange has existed for several decades to facilitate business to business information exchange it has increased dramatically since the widespread adoption of the World Wide Web (Leidner, 1999; De', and Mathew, 1999). In recent years, the Web has enjoyed explosive growth and has become a major force in network computing. It is a highly interactive communication super highway where individuals can work together to generate ideas, discuss problems, and make decisions whether they are in the same room, or halfway around the world. Modern enterprises are becoming more sophisticated in their use of intranet-based groupware applications to facilitate collaboration along the external value network, thereby enabling reduction in errors in project design, data entry and manufacturing as well as allowing faster agreement on issues and faster time to market. Groupware is the term used to describe a category of software that is designed to assist the working group in sharing ideas and information (Shani, et al, 2000; Balasubramanian, and Tiwana, 1999; Olesen, and Myers, 1999; Dix, et al, 1993.). It provides an efficient approach to asynchronous communication and the management of project data and documents. Such systems allow closer bonds with customer and suppliers and are lauded to improve project co-ordination. They can provide a consistent user-friendly framework for viewing both dynamic and static data over a network. According to Dennis and Gallupe (1999) groupware systems provide at least five contributions that may improve group interaction. These are:

- They enable group members to break the bonds of time and space. Group members can work on the project together without coming together in the same room at the same time.

- They enable parallel communication. By typing, rather than taking turns talking, all participants can contribute information, ideas, and opinions simultaneously (i.e., in parallel) so that information is collected and shared much more quickly.
- They allow comments to be anonymous. Anonymity may improve group work by separating personalities from the problem.
- They can impose a structure on the work. Groupware enables structures to more closely guide work and makes it more difficult for participants not to follow them.
- They provide organisational memory by electronically recording all information so that participants can immediately see information entered by others.

A groupware system should be user friendly, secure, reliable and scalable. Furthermore, it should be flexible enough to seamlessly handle all the various types of information a development team needs in order to function. This information could be graphical, numerical, tabular, textual etc. The essential components of a groupware system consists of four basic components namely, (a) an electronic mail system, (b) a distributed documentation system, (c) a file sharing system and finally, (d) a distributed applications system. The functionality of all of these is also to be found on the Internet (Andriessen, 2003; Chaffey, 1998).

5. Groupware System

Product innovation management is a knowledge intensive process. Product managers must therefore encourage a participative approach and enable critical information from all members in the product innovation group (including customers and suppliers) to be captured in the right format and leveraged to the point of action. The web enabled groupware system was designed to incorporate a stage gate facility, which allows innovations to be synthesised, filtered and prioritised taking into consideration the organisation's goals, requirements and constraints. It

also allows minimum critical information relating to key elements of the product innovation process to be captured and represented in structured forms. The system provides an instrument to enable the effective identification, communication and measurement of performance parameters and provides a common methodology and language for engineers and managers. The modules in the prototype include; (a) Customers; (b) Goals; (c) Ideas and Problems; (d) Projects; (e) Teams; and finally; (f) Results (see figure 1). They are explained in more detail below.

Insert Figure 1 Here

5.1 Customers

The customers' module deals with customer relationship management. This element acts as a constraint to the product innovation process. It uses structured forms to help capture the voice of the customer so product developers can deploy these requirements into their product designs for effective solutions. Customer information can be generated from existing information such as warranty claims and order requirements. Additional information can be generated by encouraging and capturing complaints and also by soliciting requirements through Delphi forecasting and Kano analysis techniques. The Delphi Technique is used for forecasting future events or products (see Hasson, Keeney, McKenna, 2000; Rowe, and Wright, 1999). It is a structured process for collecting and distilling knowledge from a group of experts. The Kano model is a tool to support product specification by differentiating product features which are perceived to be important to customers (see Tan, and Shen, 2000; Shen, Tan, Xie, 2000).

5.2 Goals

The Goals' module deals with the strategic planning stage of the product innovation process. This is where the direction for product innovation endeavours is identified and publicised so that all projects can be aligned with the strategic direction of the network. This module enables the identification, definition and communication of the requirements of key stakeholders (e.g. customers, corporate etc.). It also enables the measures of performance the organisation wants to achieve in terms of product innovation management and the strategies adopted to achieve these measures. Statements can also be defined (e.g. mission statement, vision statement). The prototype uses forms to capture critical information with respect to each module. By doing this, information and knowledge is made accessible to all team members involved in the product innovation process through simple web browsers.

5.3 Ideas and Problems

Ideas and problems are the seeds of innovation activities and are inputs into the product innovation process. Problems can be identified proactively (e.g. failure mode and effect analysis) or reactively (e.g. warranty analysis). Ideas can be generated through focus groups, benchmarking, competitive analysis etc. These modules help to structure formal ideation and problem solving definition for the user. Again forms help to capture critical information (see figure 2). The user is encouraged to deploy goals into the idea or problem so that their impact can be evaluated. Ideas and indeed problems can also be ranked according to their priority. This feature empowers everybody to participate in idea generation and facilitates the cross fertilisation of ideas. Minimum critical information such as title (i.e. name of the idea), stimuli (i.e. what prompted the creation of the idea) and creator (i.e. the person who developed the idea) are captured on a form. The form also allows ideas to be mapped on to the organisation's goals so they can be ranked according to their practicality and effectiveness.

Insert Figure 2 Here

5.4 Projects

Innovative actions are implemented through projects. Projects can be defined as actions that require significant resources in order to be implemented. Management must decide how appropriate potential projects are relative to the organisation's current goals. As projects are developed, they are refined, merged or split, based on the constraining forces such as the goals of the organisation, or the teams available to implement the project. The eventual projects that are implemented by the organisation should better contribute to the achievement of the goals than would occur from an ad hoc process. The projects module permits the entire team to share project information effectively. It also enables project managers to structure workflow and schedules, and to respond promptly and effectively to unplanned changes. It provides easy access to schedules, resource allocation information and activity status information for all projects in the portfolio. This facility also provides the integration that enables managers throughout the firm to see how schedules and events impact the projects underway. Managers can be aware of disrupted schedules and take steps to manage their individual projects effectively in response.

5.5 Teams

The Teams' module represents the human resources that are available to the product innovation process. It acts as a constraint on the process since the availability and quality of people limits the amount and type of innovative actions that can be undertaken by the organisation. The level of constraints imposed by this module can be reduced through training and education. By providing more employees with the necessary skills, they can engage in the process and allow more actions to flow through the process. This module

facilitates the effective co-ordination of team activities by organising and prioritising tasks, activities and deadlines. It can use an organisation's existing e-mail system to disseminate new or updated information and regular status reports between team members so everyone has access to complete, accurate and timely information. A performance review tool can also be included in this module, which incorporates skills, competencies and progress. It enables reward and appraisal systems to be linked to participation levels that can increase motivation towards change.

5.6 Results

This module deals with performance measurement and evaluation. It helps to ascertain whether the product development actions implemented led to the results envisioned. The results module enables the status of the organisation's strategies, measures and deliverables to be viewed. Each of these modules contain a special results section that allows those team members who are responsible for the success of these goals to monitor and update the status of each activity. Metrics may include the time to market, the number of engineering change requests and the cost reduction per part. Critical knowledge is captured about these results such as; percentage complete, status (green meaning good, red meaning poor and amber meaning fair and finally, a check mark meaning complete). An exception report allows the product manager to focus exclusively on those activities that are performing poorly.

6. Summary of Case Study Findings

The groupware system was implemented and tested in three case organisations. The findings from this exercise reveal that there are a number of benefits that can be attained by implementing and using such a system. The main benefits derived from the use of the system are grouped into the following categories.

6.1 Connectivity and integration

A major challenge in distributed product development is ensuring that project teams are focused in the same direction. The system was found to provide an infrastructure that drives the organisation's strategies and their associated performance measures down the organisation to the operational level. In other words, the company's goals are deployed into each action and deliverable. This helps to focus and integrate team effort and permit delegation.

6.2 Requirement driven design

The system enables customer centric, requirement driven design. The system enables the product development team to establish the voice of the customer by analysing complaints, warranty and customer satisfaction rates using internet technologies. This value can then be deployed into the product concept. In addition, a better understanding of the target markets needs means that an organisation's products will be more readily acceptable by the potential customer base. This can lead to lower costs of production as well as shorter lead times to market.

6.2 Effective use of information and knowledge

The development process involves synthesising and reusing existing knowledge. The system was found to support the knowledge process by helping to; develop knowledge (i.e. identify, generate and acquire information and knowledge), combine knowledge (i.e. find synergies, reuse existing knowledge), consolidate knowledge (i.e. prevent it from disappearing) and distribute knowledge (transfer it to the appropriate points of action).

6.3 Integrated product realisation

The software also enables integrated product realisation. This involves the continuous and highly concurrent involvement of all necessary functions and organisational elements (e.g. customer, marketing, engineering). The groupware platform supports a collaborative environment thus promoting integrated product development.

6.4 Promotes transparency and traceability

The system allows issues, problems and assumptions to come to the surface where they can be examined, analysed and rectified. Managers can take quick effective action to bring projects back in line if necessary. This visibility facilitates the necessary dialogue among project managers, ensures integrity in reporting and allows everybody to see how projects are progressing.

6.5 Supports new workforce paradigm components

This new paradigm focuses on teams and projects and implementing the prototype in three organisations demonstrated that the system can support and bring efficiencies to these work group models. For example, the case study analysis demonstrated that the prototype can support multiple users across the entire product innovation process. Table 2 demonstrates how team members can interact with each other using the system in a distributed environment.

Insert Table 2 Here

On the whole, it can be said that the web enabled system facilitates the product innovation process. The technology is easy to work with and the process is easy to follow. The case study analysis also discovered that improvements could be made. For example, more

emphasis could be placed on optimising effective resource management. The case study analysis discovered that R&D organisations have an abundance of ideas but do not have systematic processes in place to assign people, equipment, tools and machines to projects. Activities should be structured in such a fashion as to give optimum performance. In other words, resources should be effectively used to carry out tasks for the right reasons, at the right time, to meet the right requirements and to give the right results. Organisations are investing heavily in customer relationship management (CRM) systems to help manage; (a) sales force automation, (b) marketing automation, (c) business intelligence and, (d) customer service/support automation. Such an application could link up to a Customers module in the system in order to integrate this information and add more value to the system. Finally, the system could link up to project management applications such as, Microsoft Project 2000 to enable managers acquire more detailed information on an individual project if necessary.

7. Conclusion

Increased cross border activity, growth in knowledge intensive work and developments in information communication technology have demanded and enabled the shift from hierarchical, bureaucratic organisations to decentralised networked organisations where information and decision making move horizontally. An examination of these networked organisational forms shows that companies will need to become increasingly distributed, flexible and responsive to environmental and market changes to stay competitive. This has a major impact on activities such as new product development where organisations are forming networks, based on partnerships, to pool resources and maximise competencies and capabilities. For example, in a project focused team based structure, skills acquired on a development project can be lost and not available for tasks such as product modification or maintenance after the team is disbanded. In order to avoid repeating mistakes, reinventing

solutions and expending resources into solving problems that might have already been solved, it is important that the critical information is captured and available for reuse.

Communication, collaboration and co-ordination are key elements in the foundation of creating a durable competitive advantage in a distributed environment. Consequently, new product development project teams need support technologies to facilitate communication, collaboration and co-ordination. Much interest has risen in the use of web enabled computer based collaborative working technologies. They are lauded to facilitate the creation and implementation of virtual development teams. Internet technologies enable internal and external constituents to work in tandem and collaborate efficiently unhindered by geographical constraints. Consequently, a web-enabled prototype was developed that was designed to facilitate communication, collaboration and co-ordination in a distributed work environment. This system enables information captured anywhere in the enterprise to be instantly available to workers across the extended value network.

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Name	Function	Industry	Size	Structure	Culture
Roche	Operations Manager	Pharmaceuticals	Medium	Function	Bureaucratic
Nortel Networks	Product Manager	Telecommunications	Large	Process Oriented	Dynamic
IBM	Product Manager	Manufacturing	Large	Team Based	Innovative
Elan	R&D Manager	Pharmaceuticals	Large	Team Based	Innovative
Thermo King	R&D Manager	Climate Control	Large	Function	Dynamic
Hewlett Packard	Supply Chain Manager	Manufacturing	Large	Process Oriented	Innovative
Analog Devices	R&D/ Product Manager	Electronics	Large	Process Oriented	Innovative
Abbott	Supply Chain Manager	Pharmaceuticals	Large	Process Oriented	Innovative
Sifa	Product Manager	Pharmaceuticals	Medium	Team Based	Dynamic
Honeywell	Managing Director	Aeronautics	Medium	Team Based	Dynamic

Table 1: Profile of Organisations Analysed

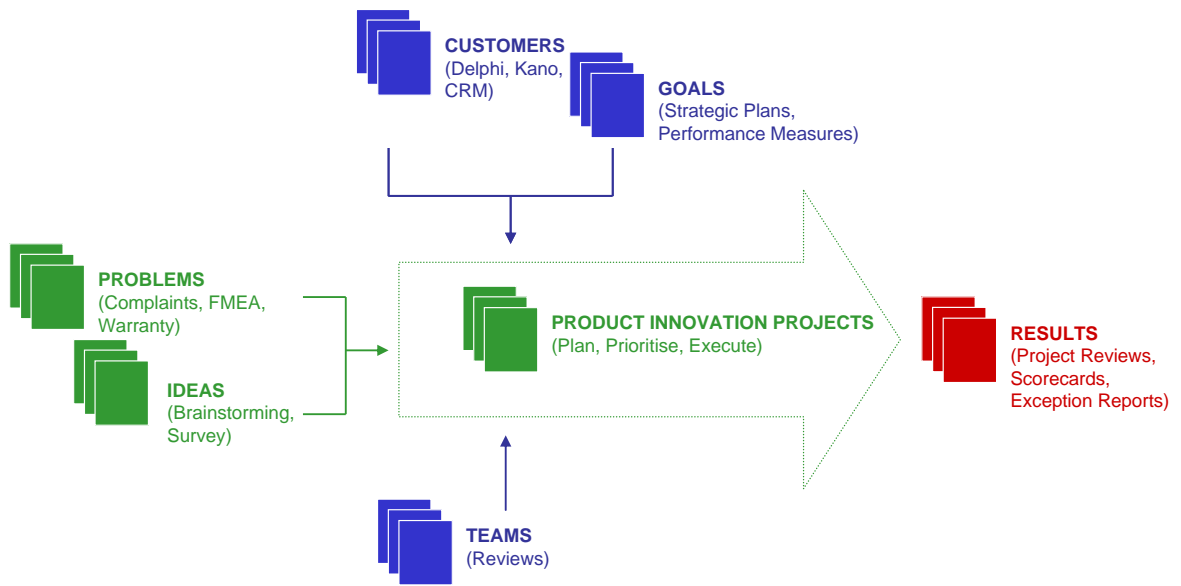


Figure 1: Modules in the Groupware System

Idea
Edit Submit

Title Environmental Model	Stimuli Problem
Creator Mulligan, David	Responsible Madden, Liam
Description To develop an environmental model that will assess the impact of the different EOL options on the environment. This should aid in decision making and ensure that the factory is keeping to environmental targets and legislation.	

GOALS
(select which goals this idea addresses)

Strategies ISO14000, Environmental Performance Evaluations, Te Software Development	Requirements Environmental Impact, Redu
--	--

RANK
(rank this idea according to its practicality and)

(A) Practicality **Very Good - 4**

▶ **RESULTS**
Delete

Project
Edit Submit

Title Windows 2000	Team
Responsible Ramone, D.	
Description Updating servers and network to Windows 2000	

GOALS
(select which goals this deliverable addresses and its impact horizon)

Strategies Implement ECCL	Measures Maintenance of System
Requirements Facility Utilisation, On Line Tutorials	Horizon Containment

RANK
(rank this deliverable according to its fit with the above strategy and measure)

(A) Fit with Strategies Excellent - 5	(B) Fit with Measures Poor - 1	Rank (A)+(B) 10
--	---------------------------------------	------------------------

SCHEDULE
(please use mm/dd/yyyy format throughout)

Start Date 01/02/2001	Date Due 02/02/2001
Duration 1 Months	Date Completed

▶ **RESULTS**
▶ **FINANCES**
Delete

Figure 2: Forms to Capture Critical Information

Module	Interacting Roles	Description
Customer	Customer Supplier Sales and Marketing	Logging warranties, complaints, value network feedback and generating requirements
Goals	Top Management Team	Managing goals, strategies and measures
Teams	Designer Analyst Engineer	Viewing goals and projects, logging process and technology information
Ideas Problems	Employees Management External Partners	Generating problems and ideas
Projects	Operations Manager Product Manager R&D Manager	Investigating ideas, prioritising projects and initiating product and process improvements
Results	Top Management Team Product Manager Functional Manager	Managing goals and measures, managing projects and quick wins, developing core competencies and cross functional teams

Table 2: Key Roles Interacting with the Prototype