Title	A groupware system for product innovation management
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Publication Date	2004
Publication Information	Cormican, K. and O'Sullivan, D. (2004) A groupware system for product innovation management 9th International Conference in Human and Organisational Issues in the Digital Enterprise Galway, Ireland, 2004-08-25- 2004-08-27
Item record	http://hdl.handle.net/10379/4074

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 strategic partnerships and networks are replacing simple market based transactions and traditional bureaucratic, hierarchical organisations. Visionary firms 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 seeking to adopt new approaches or ways of working in order to compete. Product innovation is a continuous and cross-functional process involving and integrating a growing number of different competencies inside and outside the organisation's boundaries. Consequently, product managers are focusing on managing partnerships and facilitating communication, collaboration and co-ordination in a distributed work environment. This paper examines some of these issues. First, the changing business environment is considered. Then, the shifting workforce paradigm is examined. Within these new forms the changing role of information communication technology is discussed. Finally, a web-enabled prototype which was specifically designed to enable effective product innovation management in today's dynamic environment is presented and discussed.

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

1. Introduction

We are experiencing a major discontinuity 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. An organisation's success lies more in its intellectual assets and systems capabilities than in its physical assets (Nadler, and Tushman, 1999; Ruggles, 1998; Bassi, 1998; Ulrich, 1998; Davenport, and Prusak, 1998; Sveiby, 1997). 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. Some of the major driving forces behind this transformation include:

- Globalisation: This refers to the emergence of cross border activity and global markets. In recent years, world trade has expanded and international markets have become more accessible. Customers, suppliers and competitors can now come from any corner of the earth.
- Information communication technology: The growing breadth and depth of information communication technology enables information to be communicated instantaneously within and between organisations. Furthermore, the ever declining cost for information processing has made technology and information ubiquitous (Bassi, 1998).
- Growth of knowledge intensive work: Organisations are developing innovative products and services in shorter time frames, causing an increase in knowledge work and a gradual replacement of capital and labour intensive firms by knowledge intensive firms. Consequently, there is a rapidly growing interest in managing knowledge and the intellectual capital that it creates as a new source of competitive advantage.

This transition has a major impact on today's manufacturing enterprises. In order to survive in this new era of business, they must change the way they do business. Timeliness and responsiveness are now critical to success (Boardman, and Clegg, 2001; Mendelson, and Pillai, 1999; Browne, and Zhang, 1999; Wright, and Burns, 1998; Bukowitz, and Petrash, 1997). This is particularly evident in the product innovation process where development cycles are now being measured in days and weeks. 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. It is becoming more difficult to accurately delineate their borders. The trend is towards virtual supply networks and flexible structures (Browne and Zhang, 1999; Walters, 2000; Walters, and Buchanan, 2001). 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 manufacturing enterprise. The new organisation focuses on core competencies and emphasises partnerships between firms, teamwork among members of the organisation often with members from two or more co-operating firms, sharing of responsibility for developing converging and overlapping technologies and often less emphasis on formal control systems (Nadler, and Tushman, 1999; Kalakota, and Robinson, 1999; Richardson, 1995). As a result of this transition, certain strategies and some specific technologies are required to create an enabling environment. More specifically, effective methods to facilitate communication, co-operation and collaboration throughout the enterprise and the supply network are needed. The technologies that support such a strategy must be able to deal with distributed environments and databases, must ensure reliability and security and must be practical.

The aim of this paper is to examine the new workforce paradigm and address the need for a coherent communication solution that leverages the universal communication environments of intranets, extranets and the internet to enable connectivity across the inherently complex organisational and geographic boundaries. A web-enabled prototype is presented. This groupware based information system was developed to facilitate the sharing and integration of product related information and knowledge in a distributed manufacturing environment. More specifically, the system enables (a) co-ordination of distributed product innovation projects, (b) effective deployment the project goals, strategies and key customer requirements (c) knowledge capture and reuse and finally (d) visibility and clarity.

2. The New Workforce Paradigm: The Networked Organisation

Kathryn Cormican and David O'Sullivan

As a result of the changes described above we are experiencing a radical shift in the way the workforce is organised. 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). Virtual teams create value by synthesising information and knowledge across geographies and organisations 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. Consequently, a new organisational form is emerging that promises to complement this new way of working. It is called the networked organisation. According to Kanter (1995), networked organisations can provide companies with the linkages needed for international success.

Networks incorporate a confederation of specialists and they are often used to maximise competencies in areas such as new product development. New product design, development and deployment requires unique core competencies. Thus, several small specialist companies can increase their potential customer base by forming a network and pooling their resources (Kayworth, and Leidner, 2000; Richardson, 1995). Networks are lauded to promote knowledge sharing, learning and change as well as faster and more effective decision making (Mendelson, and Pillai, 1999; Richardson, 1995; Kanter, 1995). They are characterised by flexibility, specialisation, and emphasis on relationship management instead of market transactions. These organisational forms were pioneered in industries such as fashion and computers where markets often span geographic boundaries, technology is complex, products change quickly and doing everything yourself is impossible. Network structures emphasise multidisciplinary work arrangements linking people and activities across formal organisational boundaries, less clearly defined authority patterns and continuous, flexible and multi-directional communication patterns.

Sproull and Kiesler (1991) adopt a socio-technical systems approach to defining networked organisations. In their opinion, the technological view is one in which computers are connected to one another through an information transport medium that carries bundles of information. While, the human view is one in which people are connected to one another in diverse forums to exchange ideas and other resources. Central to the networked organisation is the concept of partnership. An enterprise partnership can be defined as a collaborative alliance of independent enterprises such as customers, suppliers, competitors, service providers etc. They aim to obtain competitive advantage from sharing knowledge expertise and resources. Enterprise networks share the following common characteristics:

- They are composed of a series of bilateral relationships, which tend to be horizontal rather than vertical
- They are adaptive. In other words, they have the ability to reconfigure themselves quickly to meet changed conditions.
- Leadership is value driven. In other words, it tends to be based on competence and personality rather than on social and organisational position.
- Power turns over frequently and more easily than in bureaucracy, changing hands as new circumstances arise that require new skills.
- Information communication technology (ICT) provides them with new platforms to collaborate efficiently.

Moving to this new workforce paradigm demands support structures to enable communication, collaboration and project co-ordination. For example, in the product innovation process, effective communication structures are essential to integrate the knowledge and skills required 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.

3. 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 geographic 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 (EDI) 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 World Wide Web has enjoyed explosive growth and has become a major force in network computing. The web 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 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; Dennis, and Gallupe, 1993). This 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.

4. The Prototype

Based on these guidelines our team developed a web enabled groupware prototype. This prototype allows minimum critical information relating to key elements of the product innovation process to be captured and represented in structured forms. It also provides an instrument to enable the effective identification, communication and measurement of performance parameters and provides a common language and methodology for engineers and managers. The modules in the prototype include: Customers, Goals; Ideas and Problems, Projects; Teams; and finally Results (see figure 1). These modules are explained in more detail below.
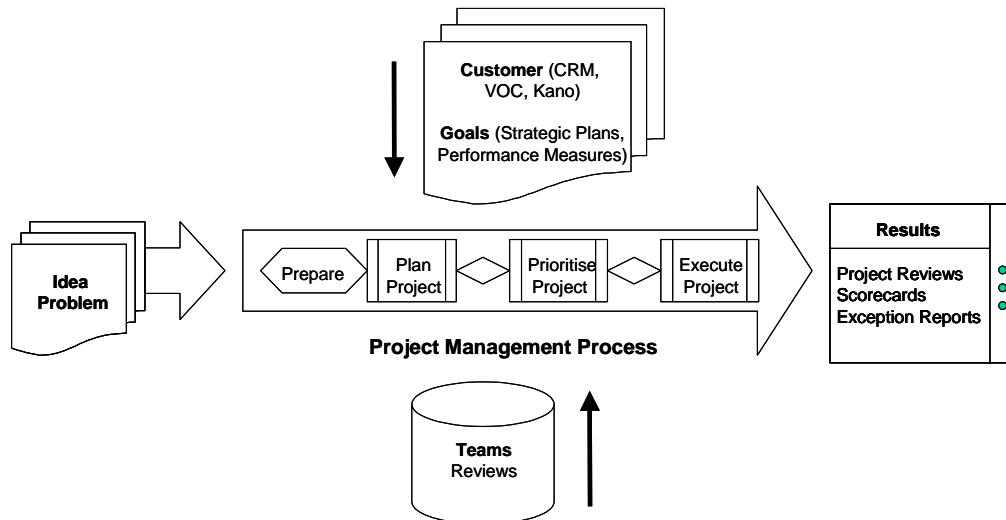

Figure 1 Product Innovation Management Model

4.1 Customers

The customer's 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. Delphi forecasting is a structured process for collecting and distilling knowledge from a group of experts while Kano analysis is a tool used to prioritise customer requirements. The Customers module promotes customer focus by providing a link to all relevant players in the supply network.

4.2 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.

4.3 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.

Figure 3 Forms to Capture Critical Information

4.4 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 organisations 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.

4.5 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 though 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.

4.6 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. Critical knowledge is captured about the results of the organisation's activities 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.

5. Interacting with the Prototype

The prototype can support multiple users across the entire product innovation process (see Table 1). Key players involved in the process include:

- Customer and supplier: logging warranties, complaints, value network feedback and generating requirements
- Sales and marketing: logging customer requirements, market information, competitive analysis
- Top management team: managing goals, strategies and measures
- Designer, analyst: and engineers: generating problems and ideas, viewing goals and projects, logging process and technology information
- Operations manager: investigating ideas and initiating process improvements
- Functional manager: managing goals and measures, developing core competencies
- Project manager: managing projects and quick wins, projects and cross functional teams

Module	Interacting Roles
Customer	Customer
	Supplier
	Sales and Marketing
Goals	Top Management Team
Teams	Designer
	Analyst
	Engineer
Ideas	Employees
Problems	Management
	Partners
	Customers
	Suppliers
Projects	Operations Manager
	Product Manager
	R&D Manager
Results	Top Management Team
	Product Manager
	Functional Manager

Table 1 Key Roles Interacting with the Prototype

Direct access technologies or self-service technologies allow workers to access records, documents and companies strategies and measures. This technology eliminates redundant paperwork, reduces the number of transactions and requests requiring staff intervention and decreases input errors. 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. The prototype allows information about all product innovation options to be captured using simple forms. It can also consolidate 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 perform consolidated searches. With one integrated system, all information for reach customer is automatically updated and is easily accessible.

6. Conclusion
Increased cross border activity, growth in knowledge intensive work and developments in information comunication technology have enabled the shift from hierarchical, bureaucratic organisations to decentralised networked organisations where information and decision making move horizontally. Recent attention paid to these networked organisational forms

suggest 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. Furthermore, we found that 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. The principle lesson learned is that internet based information communication technologies can be exploited to enable the new workforce paradigm. 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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