KNOWLEDGE MANAGEMENT AND NEW PRODUCT DEVELOPMENT: LEARNING FROM A SOFTWARE DEVELOPMENT FIRM

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Abstract

The core of the new product development [NPD] process centers on knowledge creation, utilization and the management of knowledge. This manuscript uses a software firm case to establish a framework to aid managers in deciding on an effective work design configuration for managing a NPD project. A framework is presented which identified five dimensions that affect performance in an NPD work environment including: the business environment; the social subsystem; the technological subsystem; the management system; and, the knowledge management system that provides the context within which NPD efforts are designed and developed. Our case study provided an initial support to the argument that within the context of knowledge-based firm, NPD can be designed as a set of dimensions, each of which fulfills a necessary requirement for achieving NPD sustainability. The requirements for achieving sustainability include formal and informal arenas for exchange of ideas; continuity of support and improvement efforts maintained over a long period of time; team composition reflected in the totality of the business functional areas of expertise; goals, scope and purpose defined and refined on an ongoing basis, and; effective processes for implementing continuous improvements.

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1 Introduction

New product development has emerged as the lifeline for many businesses and industries. This process can be characterized as complex to organize and manage. The management of NDP units and processes requires both maintaining a balance between order and disorder and careful attention to knowledge management.

The core of the NPD process centers on knowledge, it's creation, utilization and the management of knowledge. Within the context of the knowledge-base firm, knowledge has a critical strategic value since it fosters organizational actions and helps the firm establish sustainable competitive advantage. Organizational knowledge is a unique asset and a scarce commodity of an organization. Yet, creating, replicating and transferring knowledge within NPD teams, between NPD teams, and between organizational units is difficult to carry out. Managing knowledge and knowledge creation is a complex task that gives rise to multiple organizing and management issues [Adl00].

The breakthroughs during the last ten years in information and communication technologies have irreversibly altered the ability to conduct business unconstrained by the traditional limitations of time and space [Nad99] The massive demands imposed by time compression fostered increased attention within R&D and engineering units for information and communication technology. One area where enhancements can be made is continuous improvement and change management in the NPD process. The literature on NPD seems to be based on a variety of disciplines and theoretical perspectives - strategy, organization theory and design, organization behavior, marketing, sociology of organizations and engineering.

Strategic management coupled with sociotechnical system thinking provides a basic language and analytical framework to advance the investigation of the relationship

between new product development and knowledge management. The objective of this manuscript is to establish a framework to aid managers in both deciding on the most effective work design configuration for managing a complex new product development project and to explore the potential causal relationships between new product development design configurations and knowledge management. We address these relationships through an illustrative case of new product development in a software firm.

2 Towards an Alternative Framework

The sociotechnical systems perspective considers every organization to be composed of a social subsystem (the people) using the tools, techniques and knowledge (the technical subsystem) to produce a product or a service valued by the environmental subsystem (i.e., [Pas93], [Tri82]). The degree to which the design of the technical subsystem, social subsystem, and the environmental subsystem are integrated determines the success and competitiveness of the organization [Sha92]. While every organization is perceived as a sociotechnical system, not every organization is designed according to sociotechnical system design principles, methods, processes and philosophies. The economic performance of firms based on sociotechnical system design principles has been significantly better than comparable organizations using conventional designs [Van93].

In our proposed framework we identify five clusters of dimensions that affect performance in an NPD work environment. Figure 1 portrays system performance and sustainability as an outcome that is influenced by the causal relationships among the five clusters.

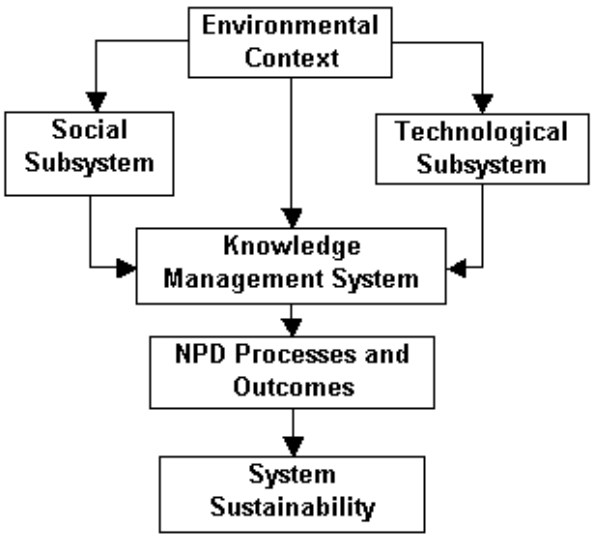

Figure 1: Framework for NPD and Sustainability

The business environment cluster is comprised of elements and forces in the market place in which the firm competes. The social subsystem cluster refers to the persons who work in the organization. Individual attitudes and beliefs, competencies and skills, relationships between group members, relationships between supervisors and subordinates, relationships between groups, cultures, traditions, past experiences, assumptions, values, rites, rituals, work habits and practices, and emergent role systems all are an integral part of the social cluster. The technological subsystem cluster refers to the tools, techniques, devices, artifacts, methods, configurations, procedures and knowledge used by the organizational members to acquire inputs, transform inputs into outputs and provide outputs or services to clients or customers. The management systems cluster refers to the systems that attempt to link the environmental, technological and social subsystems. Business strategy, business design, business capabilities, business processes and change management processes provide the key elements in this cluster. The knowledge management system provides the context within which new product development efforts are designed and developed.

3 An Overview of the CDM Company

CDM is a firm devoted to building, implementing, and supporting agent-based “Cooperative Decision Making” tools for distributed problem solving. Application areas include: facilities management, transportation planning, military logistics and control, and engineering design. The organization of CDM on the surface does not appear to be untypical for a software development firm. The various departmental units function with a minimum of supervision. Frequent meetings, a good infrastructure of networks and electronic communications, and a well-thought through layout of workspace facilitate the firm’s operation.

The department structure appears to be straight forward. However, much of the product work is conducted by supporting groups. The leadership of the product team is divided between a product leader and a technical leader. One product example is a contract for developing a product (e.g. the Collaborative Infrastructure Assessment Tool [CIAT] for the waterfront operations at the San Diego Naval Station). The product, once developed, can then be marketed to other customers (e.g. the Naval Station at Pearl Harbor). Responsibility and direction is divided among two leaders, the Product Manager and the Technical Lead, and the various departments (e.g. testing, customer support and training). This division of responsibility could dilute the direct management-line for product management – in effect, disputes or differences either have to be worked out through discussion or are

brought to senior management for resolution. This has not been a significant problem because the work content and work constituency is relatively homogeneous. New products evolve from existing products and involve technology transfer and adherence to grounded technologies.

4 The Product Development Process

CDM has a well defined process for product development. Figure 2 presents a graphic of this process. As in many firm's there are several points where an iterative cycle is depicted. Preceding the process is the product initiation phase where RFPs (Requests for Proposals) or to prepare bids for sole-source contracts.. A good deal of this effort involves customer liaison and knowledge acquisition. The product responsibility is divided among the product manager, the technical lead, and various support

The choice to have a dual set of product leaders – the product manager and the technical lead is a clear example of the rationale for stocks of knowledge. The technical lead devotes his efforts to insure that the product evolves by developing coordination mechanisms to support software version control, libraries of shared and re-usable code, and the application of agent-based technologies. In addition, the technical lead oversees the production of the software team, makes assignments and reviews the work of the software developers. The technical lead coordinates and schedules testing and quality control. The product manager interfaces with the technical lead but is not involved in the actual software development. Instead the product leader handles the external interfaces with the customer and management. Knowledge about customer needs and expectations can be tempered and translated to agent technologies using a standardized framework for work definition.

The program design and testing are completely the responsibility of the technical lead in coordination with the programming team. Similarly the hardware, services and supplies, management and customer liaison, training and documentation are completely under the responsibility of the product manager in coordination with the service groups. When the product work is completed the product is delivered to the customer by both the product manager and the technical leader. Since CDM deals primarily in a military environment most of these contracts are modular and are spread over a series of years or periods. Thus, there is not always a clear, precise product delivered. Instead, the product evolves by adding features and capabilities. CDM markets a core product (e.g. The CIAT system) that consists of a basic set of agents.

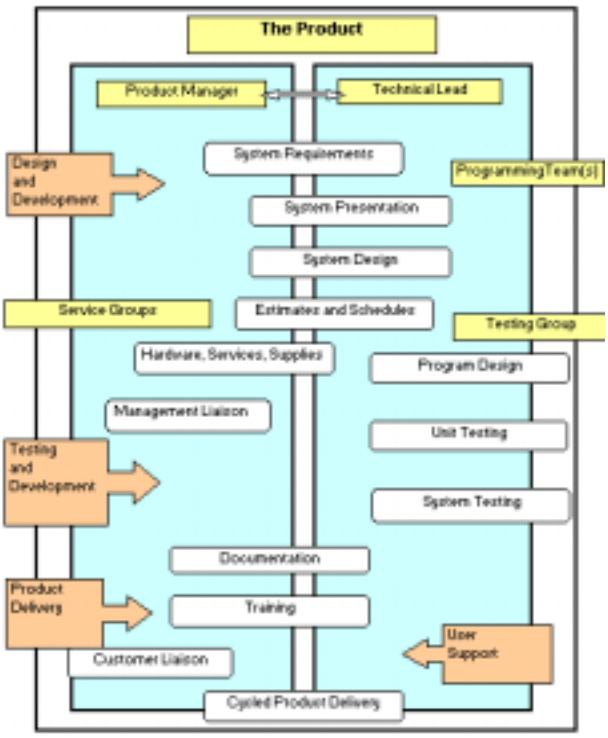

Figure 2: New Product Development Process

The typical system can be retrofitted to a particular customer (e.g. the Naval Station at Pearl Harbor contracts for the CIAT system for it's waterfront operations -- the system is then tailored to the pier configurations and special needs of the station.) Each product takes on a particular flavor by adding agents, some of which have been previously developed and modified to meet special customer needs, or agents that are specifically developed to meet unique needs. Because of this agent-based technology CDM is successful in it's NPD and is more able to sustain product development and viability.

Organization design is characterized by three key elements: differentiation, coordination and integration. Since knowledge, compared to other assets is characterized by its intangibility, tacitness and action relatedness, it is harder to manage in comparison to other organizational assets. Coordination refers to the binding together of the various tasks, activities and efforts. The choices made to facilitate coordination will influence the organization's ability to accomplish goals. The designer's choice about how to bind together the tasks and activities influences the extent to which the different stocks of knowledge held by individuals will be shared and acted upon. As such coordination is not only combining the tasks, activities and efforts but also combining the unique stocks of knowledge held by individuals.

The design of the CIAT product consisted of identifying system requirements, deciding on a format for system presentation, and specifying the system design. The spatial agent technology employed relied on the acquisition of

data by artificial intelligence techniques in the form of data definition and rule specification. The initial customer contact was the product manger. Here the data collection and rule acquisition process was defined. Area specialists consisting of system analysts from the programming teams that collected the requisite data. The database schema and rule base were initially defined -- this process was one of refinement, an iterative cycle leading to greater and greater detail.

All of these agents must be defined jointly by the technical lead and the product manager along with area experts during the product design phase. The product manager and the technical lead together compile the estimates and schedules for the product construction, Here arrangements need to be made with programming teams, testing groups, service groups, as well as preparing for documentation and training. All of these teams or groups are independent of the product itself. They transcend the product, existing as entities beyond the product work. This is a key element for sustainability. Since they have major ongoing products with the military that are now in the maintenance mode these business areas must exist to support those products but on the other hand they can ramp up to provide the needed services for new product developments.

The product construction consists of parallel operations. Here the technical lead and the product manager work somewhat independently. The computer programs are written by the programming team. Many reusable modules are deployed – taking advantage of existing technology/expertise and work already tried and tested. This is another ingredient in sustainability, they do not have to create a new product from scratch. The programming team members may be involved in multiple developments at the same time. The product definition and design are such that coders and programmer are somewhat interchangeable.

As modules are developed they are turned over to the testing group. Each module goes through a variety of tests – unit testing of each module and system testing of the modules together. The testing group is accustomed to working with agent technologies and is familiar with their presentation system. Before any product is presented to the customer it is tested for internal reliability and adherence to specifications. As the testing and programming proceeds documentation is initiated. CDM has an independent group that produces professional quality manuals, online and web-based materials. They liaison with the technical lead, the programming team and the testing group. While the CIAT programs are being developed, tested and documented the service group arranged for the purchase and configuration of the network and workstations for the customer.

4.1 CDM's Product Development and Sustainability

There are several factors that make CDM unique with respect to supporting and enhancing product sustainability. There is a clear path for product development. The CIAT team was supported by permanent support staff throughout the development. Unlike most of the software product (or more specifically project) development efforts there is a small nucleus formed for the actual development. There is not the project "ramp up -- team assembly" that often occurs in software development. Instead, an ongoing set of teams (e.g. programming, testing, and service) provide stability and an external perspective.

The intelligent agent and modular software components form a software warehouse that allows CDM to roll-out alternative versions. Once an agent is developed it stands as a sub-product or feature that can be interfaced or included in the system. In this way business results can be sustained. Even though CDM has a strong social atmosphere and optimal working conditions there is little "ego" involvement in the product development -- the main concern is making certain that the system is a quality product. The focus is on "how" best to design the agents not "who" is doing the design.

5 Discussion and Conclusions

The study of the NPD at CDM provides an initial support to the argument that within the context of knowledge-based firm, NPD can be designed and managed in various ways. These "various ways" can be described as a set of dimensions, each of which fulfills a necessary requirement for achieving NPD sustainability. The set of necessary but not sufficient requirements for achieving sustainability can be referred to as design requirements. Looking at the CDM case the following are a few of the design requirements that seem to have been utilized: Legitimate formal and informal arenas for exchange of ideas were created; the continuity of support and improvement efforts for the products was maintained over a long period of time; the composition of the NPD team reflected the totality of the business functional areas of expertise; goals, scope and purpose for the NPD teams were defined and refined on an ongoing basis, and; there were effective processes for implementing continuous improvements during the NPD process.

One of the key findings from the case is that CDM established some type of a legitimate forum for exchange of ideas and actions. From an organization design perspective, the forum is seen as a mechanism with a structural configuration and processes that are devoted to improvements and learning. The iterative cycles approach coupled with the deliberation mechanisms for information-sharing and sense-making provided an ongoing opportunity to improve and sustain business

results and a way to foster learning at all levels and across all levels of the firm. Our case suggests that not only is a learning mechanism an integral part of sustainability but that the type of the learning mechanism is a clear managerial choice that has a significant influence on the organizational ability to develop and nurture sustainability.

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