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Editorial

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First Step in the Journey of Flexibility

In the journey of flexibility, the first step needs great care

It we want to take up any journey, the most crucial step is the first one. If we do not take the first step, the journey cannot be started. Or else, if the first step is taken in the wrong direction the journey gets misdirected. Thus, if we decide to progress in the journey of flexibility, the first step needs to be taken up with great care. It is very important to understand that from where the journey of flexibility is to be started and what should be its direction.

Some frequently asked questions need to be answered first

If an enterprise wishes to implement a flexible systems management programme, the foundation should be made strong. What should be our starting point? How should we prepare for the journey? How to proceed? Should it be an inhouse endeavour or the help of external consultant is valuable? Whether technology is more crucial or people? What type of flexibility should be addressed first? And many more frequently asked questions are there.

The first step should be the creation of right mind set

Rather than entering the jungle of intricate path ways or preparing a well carved out plan for this journey of flexibility, the first step should be the creation of a right mind set. To begin with, we should adopt "openness" as the connotation of flexibility.

Openness of managers as well as organization will lay the foundation

Openness in the minds of managers as well as in the working of organization will lay the foundation to pave the way for the flexibility journey. An open mindset and an open culture can help in receiving new ideas on the one hand and will foster a creative environment to generate new ideas on the other. With an open mind, one can appreciate more options, assess them and can also create many new options, which is the basic requirement for practicing flexibility.

With an open mind we can exercise more options, remain open to any kind of change and have higher freedom of choice

As flexibility can be defined in terms of three keywords: options, change and freedom of choice, openness will help in addressing all the three of them. With an open mind, we can exercise more options, remain open to any kind of change and have a higher freedom of choice in an open culture.

To enhance flexibility, evaluation and generation of options should be delinked

If we want to move on to the journey of flexibility, let us not be closed by pre-deciding that some option is the best one in all circumstances. Let us come out of our presuppositions, biases and mental roadblocks. A premature judgment stifles both the creativity and flexibility. Let us delink the evaluation and generation of options. First we need to have a wider choice of options, only then we should evaluate them in the context of the prevailing situation. Rather than following a universal approach, which is closed, we should be prepared to generate new combinations; may be of polar opposite options. This would enhance the internal flexibility of managers.

An open culture is the fountain head of external flexibility in organizational environment

The flexible enterprise will have to create external flexibility in the organizational set up for the managerial internal flexibility to orchestrate. An open culture is the fountain-head of external flexibility in the organizational environment in terms of empowerment, innovations, and so on.

Till now we were discussing about what should be our first step in the journey of flexibility and why should we take it. The next fundamental question to answer is how to take this step. How can we create an open mindset and an open culture in the organization? This is a question to be left open to the readers to answer in their own context, as there can be no universal recipe for creating openness in the organization.

There is no universal receipe for creating openness in the organization

giftjourn@l would help the readers in various stages of the journey of flexibility

If we start giving normative answers to this question, this would be self-defeating. Every individual as well the organization will have to evolve its own answers and share the experiences with others. That would be the real start of a collective journey of flexibility, which is the vision of GIFT and facilitated through giftjourn@l. Various research papers, learning lessons, benchmark practices and book reviews presented in giftjourn@l would help the readers in reaching out to their own answers at various stages of the journey of flexibility.

Sushil
Editor-in-Chief

Methodology & Tools

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A Flexible Planning Methodology to Support Global Product Development using CSCW Tools

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Abstract

Integrating distributed product development processes require the timely collaboration of different individuals or teams–from different functional areas throughout the product lifecycle–to develop products that better satisfy customer needs. This integration could be implemented using the techniques and tools of computer supported collaborative work (CSCW). This paper presents a planning methodology to select specific CSCW tools to support the collaborative product development process. The proposed approach consists of six systematic procedural modules that 1) analyze the current product development process and assess its readiness for collaboration, 2) assess the readiness of the organization for collaboration, 3) analyze available CSCW tools, 4) assign organizational resources to product development tasks, 5) analyze the interactions that exist between different resources, and 6) select appropriate CSCW to facilitate the interactions between organizational resources involved in the development process.

Keywords : CSCW tools, global product development, planning methodolgy

Introduction

The growing depth and breadth of new technologies impacted both organizations and their customers. Organizations have an enormous number of technological options to use in product development; these options include marketing tools, design tools, production tools, and distribution tools. As for customers, new technologies enabled them to reach new markets, learn about new products, and compare products quickly. This widespread use of new technologies has dramatically increased the number of companies capable of producing quality products in any given sector. Furthermore, companies worldwide are changing their practices to allow for global product design and development. That is, organizations are attempting to develop global product development strategies that can capture the requirement of global customers, and produce products by utilizing global workforce.

Computer Supported Collaborative Work (CSCW) is considered one of the most promising new technologies that can facilitate global product design and development if implemented effectively.

This paper addresses the issue of using CSCW in global product development and presents a planning methodology that assists organization in selecting CSCW tools to support global product development. The paper begins by defining cooperative/collaborative work, and highlights CSCW application domains in engineering. Next the benefits and barriers of CSCW are discussed, and the flexible planning methodology is implemented. Finally, a case study where the flexible planning methodology was presented is presented.

Defining Cooperative Work and Collaborative Work

Cooperative work can be defined as multiple individuals working together in a planned way in the same production process or in different, but connected, production processes (Antillconea 1999, Bannon 1991, Smith 1994). This definition shows that the core of cooperative work is built around the existence of content-related work processes that are characterized by being planned or premeditated. It is important to emphasize here that cooperative work is not better, or worse, than individual work. It is merely technically necessary or economically beneficial in certain work environments. Another term that is usually used synonymously with cooperative work is collaborative work. Both cooperative and collaborative work share many aspects but they also have some differences. Collaborative work is more flexible and refers to a goal-oriented process involving direct communication between two or more individuals working on the same task. The difference between cooperative work and collaborative work can be defined by how work processes are managed as shown in Figure 1.

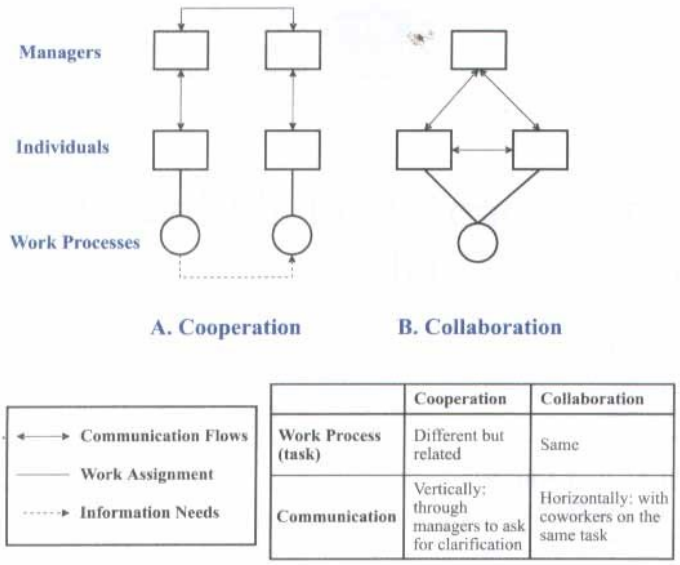

Figure 1: Cooperation vs. Collaboration

In cooperative work, processes are assigned to individuals who do not communicate extensively with other individuals working on the same project. Also, in cooperative work communications occur vertically. That is, an individual working on a certain process and needs some information can access that information by contacting the project manager or the facilitator. While collaborative work involves two or more individuals working on the same work process with direct horizontal communication taking place between the collaborating individuals.

CSCW Application Domains in Product Development

The product design and development process comprises an enormous number of work processes or tasks that can be facilitated by the use of CSCW systems. Following is a list of these work processes along with the CSCW systems that can support them:

Organizations have an enormous number of technological options to use in product development; these options include marketing tools, design tools, production tools and distribution tools.

General CSCW Support

Administrative Work Processes

Engineering team members need to carry out administrative processes to manage the design processes. Such processes include scheduling meeting, sending out memos, and distributing documents for verification and joint authorship. These processes can be time consuming if performed manually. Several CSCW systems (such as email, calendaring, and scheduling systems) can provide efficient and effective means to conduct these activities.

Decision-Making and Problem Solving

Product design and development can be thought of as a decision-making process which involves determining many unknown variables that are used to describe the concept/ product being designed (Marston and Mistree, 1997). Decision-making and problem solving requires gathering and prioritizing information, and hypothesizing alternate paths to lead to an optimal solution. It is believed that Group Decision Support Systems (GDSS) (Monplaisir 1997)-which is a type of CSCW- can help in this process.

Creative Design

Developing creative designs require that engineering design teams communicate design ideas rapidly especially during concept design and detail design processes. This can be done by using CSCW systems such as Computer Aided Design (CAD) visualization and sharing tools, and whiteboard systems. Using CSCW systems at this level ensure that early designs can be presented to clients for comment and ratification.

Coordination of Activities

Current trends in product development are moving towards using a holistic design approach where the whole development process within a certain organization is supported. CSCW can provide the tools required to coordinate and support communication, information sharing, and decision-making.

Supporting Group Processes

During a meeting, teams go through several group processes that include generating, organizing, and evaluating ideas. Electronic Meeting Systems (EMS) -a type of CSCW systems- provide the necessary functionalities needed to support group processes within a meeting environment.

Managing Knowledge

In the "Information Age", managing information is crucial to the success of the engineering design process. Even more important is transforming information (facts and figures) into knowledge (the wisdom to make intelligent decisions) (Lockledge 1999). The process of transforming information into knowledge includes gathering information, accessing information, and sharing information. It is believed that CSCW systems can be effectively used to manage knowledge.

Specific CSCW Support Types in Engineering

As discussed in the previous section, there are many areas within the product development process where CSCW can be valuable. This section investigates some specific types of CSCW support to the engineering design process.

Use of Multimedia

Engineers communicate "visually" (Lockledge, 1999). That is, engineers and designers communicate and formulate their ideas using sketches and graphics, which usually enhance the group's collective understanding leading to better results. Engineers need to communicate complex ideas which means they have to use all kinds of media in communications. Low-

resolution representations like sketches are necessary to elicit comments on starting points and the basic principles of interaction in a design. High-resolution representations like 3D models are needed if the design is viewed as definitive, and are usually used to depict design details.

CSCW systems provide the tools to work collaboratively using 2D/3D models of objects. These systems are mainly used to assist in "interactive design reviews" or "3D annotation" where comments (textual, spoken, or graphical) could be attached to the original image or the virtual prototype of the object being designed and sent back to original designer.

Communication Support

Communication is the process by which information originating in one function (sender) is transferred to, and put to use by, another function (receiver) Paashuis, 1998). Information comprises knowledge and expertise, such as ideas, concepts, data results, analysis, and plans (Pugh, 1991). Team communication is usually enabled and facilitated by meetings, committees, telephone calls, emails, standard forms, memos, and reports. CSCW systems can support team communications at all different levels. It is thought that using computer-mediated communication systems such as electronic meetings is more efficient and effective in accomplishing group objectives (Coleman 1997).

Collaborative work is more flexible and refers to a goal-oriented process involving direct communication between two or more individuals working on the same task.

Tele-working

Tele-working or Tele-commuting is a specialized form of CSCW, in which workers use information technology to perform their jobs at a site away from the organization's physical location. Usually, tele-working is done by employees who already use computers for large parts of their jobs. There are many benefits of tele-working (Goldman, 1998) for both employees and organizations. For employees it is mainly the flexibility they get; as for organizations it is cost savings. The major drawbacks of tele-working are the loss of social interaction, the loss of informal communication, loneliness, and convincing others in the team that the work is actually occurring.

CSCW can help in easing some of the drawbacks of tele-working; especially as more advanced technologies become available and affordable such as video and audio conferencing.

CSCW: Benefits and Barriers

There are many benefits that can be gained from using CSCW systems, and there are many barriers to implementing CSCW system. These benefits and barriers are presented next.

CSCW Benefits

CSCW systems can lead to many benefits if (and only if) implemented successfully. These benefits can be viewed from two perspectives: the process perspective, and the organization perspectives as following,

Benefits to the Engineering Process

- Better communication between team members (Mills 1998).
- Better utilization of the collective knowledge and expertise of all participants by integrating geographically dispersed teams (Chen and Wei 1997, Coleman 1997, Kayworth and Leidner 2000)
- Enhanced participation by ensuring anonymity and equal participation for all team members i.e. less influence to influential participants (Coleman 1997)
- More common or shared understanding (Adelson 1999, Mills 1998)
- Quick generation of new ideas (Coleman 1997)
- Enhance the decision-making process performance (Adelson 1999, Monplaisir 1997)
- Better coordination of development activities (Abdalla 1999, Liu, Luh and Moser 1998)
- Improved employee moral and responsibility (Mills 1998)
- Improved respect for cross-functional team members (Adelson 1999)

Benefits to the Engineering Organization

- Reduce time-to-market (Abdalla 1999, Chen 1997, Kayworth and Leidner 2000)
- Improve product quality (Chen 1997, Monplaisir 1999)
- Improve product innovation (Chen and Wei 1997)
- Reduce product development and production cost (Hartley 1992, Monplaisir 1999)
- Reduce the need to travel by providing the capability of remote teamwork (Goldman 1998, Gordon 1995)
- Raise customer satisfaction by including the customer in the engineering process (Rezayat 2000)

CSCW Barriers

Technological Barriers

Interoperability : Interoperability barriers are encountered at all levels while building CSCW systems. These levels include network, machines, and versions of software. The inability to move seamlessly between applications will hinder the cooperation process and result in abandoning the implementation of the CSCW system.

As the acceptance of CSCW continue to grow, it is expected that more standards will be developed to ensure the interoperability of different systems.

Security : One of the main concerns organizations have about implementing CSCW -especially in a global environment- is the security of the system. Security threats can be summarized as following:

- Leakage: access of information without authorization
- Tampering: alteration of information without authorization. This includes the changing of program's behavior through viruses
- Resource stealing: unauthorized utilization of resources
- Vandalism: information forge without any gain to the perpetrator

CSCW system must incorporate security features that can reduce the abovementioned threats. These features include:

- Access Control: services locally or remotely accessed should be validated against unauthorized users. This can include the validation of permission to gain a specific information access
- Authentication: it is necessary to be sure that the interlocutor at the other side (human or computer) is what it claims to be
- Integrity: it is necessary to believe that the received information is what was sent
- Accountability: it is necessary to guarantee that the sender and/or receiver do not deny the transaction after it took place
- Privacy: eavesdroppers should not have access to sensitive information

Electronic Meeting Systems (EMS) – a type of CSCW systems – provide the necessary functionalities needed to support group processes within a meeting environment.

Cost : Many benefits can be gained from implementing CSCW systems. But CSCW systems or information technology based systems tend to be expensive. The cost of CSCW systems includes:

- Software Cost: the cost of the CSCW application itself
- Equipment Cost: Includes the cost of new computer hardware, and the cost of new network infrastructure if needed
- Training Cost: Training employees to use the new CSCW system
- Support/Maintenance Cost: Includes network support, hardware support, and software support. Sometimes Network and hardware support may be already available, in that case the cost of supporting the CSCW systems solely is considered

Although it is expected that the cost of CSCW systems will continue to decline as more systems and technologies become affordable, the benefits of CSCW should be presented in a way that justifies the cost.

Organizational Barriers

Resistance to change : Like most Information Technology projects, the implementation of CSCW systems require significant amount of change to work practices, which is always faced with people resistance to change (Ozer, 2000). Since the success of CSCW systems relies on the support and acceptance of all individuals expected to use the system, organizations attempting to make the shift to CSCW should start by conducting internal assessments of the proposed CSCW systems and try to fine-tune it to gain more support and acceptance. Furthermore, management needs to clearly explain to employees how CSCW will tie to the organizational values and how it is expected to improve employee's productivity (Townsned, Demarie and Hendrickson 2000).

Media dexterity: Electronic media dexterity means that team members must all become proficient in the use of technologically sophisticated communication tools, such as video-conferencing, web-cams, computer supported collaborative work, software and hardware (Gluesing 2001). Cooperating team members should be comfortable with using the CSCW system, and have enough knowledge about how to operate the system and fix any potential technical problems. It is expected that this problem will be obviated as both computer and communication technologies become user-friendlier.

Trust : Another challenge in building CSCW systems is the issue of trust between collaborating partners, especially when the collaboration is being performed with other organizations. Trust problems may also exist within the organization itself, in the sense that participants may wonder whether the technology is used to monitor and evaluate them (Townsned, Demarie and Hendrickson 2000).

Solving this issue is not trivial. It may be required to have many face-to-face meetings before the implementation of CSCW systems to establish trust relationships between participants. Furthermore, management needs to establish clear policies regarding communication privacy.

Willingness to share information : Another issue–related to trust–is willingness of people to share information with others. Sometimes, sharing information is perceived as a career threatening decision, in the sense that people usually try to make themselves indispensable to their organizations, making cooperation or collaboration hard to achieve.

Organizations should try to present collaboration and cooperation as a vital step for corporate success and there should be commitment from the organization to evaluate individuals based on their performance with respect to collaboration and cooperation.

Cultural barriers : Implementing CSCW systems to leverage distributed knowledge and expertise can give organizations a competitive edge. However, CSCW system implementations are faced with the challenge of integrating many diverse cultures whether it is departmental cultures (marketing, engineering, etc.) or national cultures. Some of the problems encountered include language differences and sense of urgency with respect to timing to complete projects (Kayworth and Leidner 2000).

Organizations implementing CSCW systems need to create a "common negotiated culture" (Gluesing 2001) where participants can reach a shared understanding of the team's work and the expected contribution of each team

member.

Computer Supported Collaborative Product Development

Computer Supported Collaborative Product Development (CSC-PD) is the set of all activities needed by people working in teams according to engineering methodologies and supported by technical tools to conceive, design, produce, and sell a product. Teams share resources and information using integration technologies to utilize the collective effort and knowledge of all team members in order to reduce product development time, reduce cost, improve quality and enhance flexibility.

Building CSC-PD systems should be based on sound methodologies that analyzes current processes, assesses the need for collaboration, and selects appropriate collaboration systems' components that best support the intended collaboration functions.

An analysis and planning tool called Collaboration Planning Framework (CPF) has been developed to assist organizations in implementing computer supported collaborative product development systems. The CPF consists of six procedural modules as shown in Figure 2.

CSCW systems provide the tools to work collaboratively using 2D/3D models of objects. These systems are mainly used to assist in "interactive design reviews" or "3D annotation".

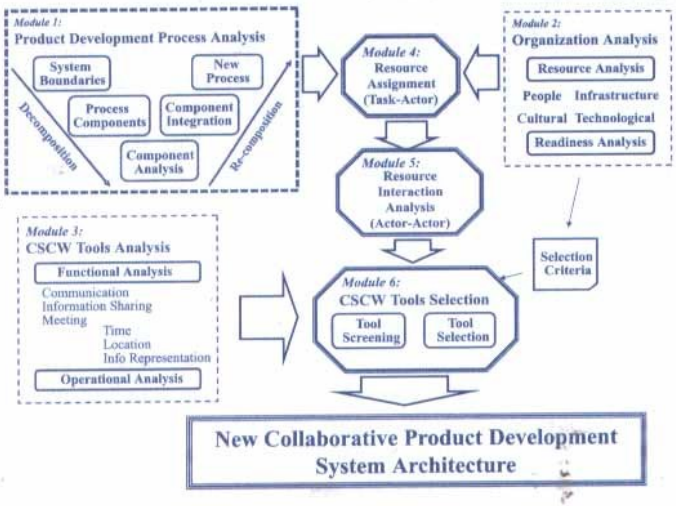

Figure 2: Collaboration Planning Framework (CPF)

Each Module is further explained in the following sections.

Product Development Process Analysis Module

A process consists of a series of actions or operations that transform a set of inputs into a set of outputs. Product development process is a set of interrelated actions that are performed by an organization to transfer a market opportunity or a product concept into a manufacturable commercially viable product (Eppinger 1991, Goldman 1998). The development process usually consists of hundreds or thousands of activities that should be performed according to a logical sequence that allows the process to proceed in an organized and structured manner. This logical sequence allows the organization to monitor the progress of the development effort and assess the feasibility of continuing the effort.

Modeling the product development process is an extremely challenging task that is evident due to the complexity of the development process itself (Bajaj and Anupam 1993, Eppinger 2001). Product development is a dynamic, non-deterministic process that evolves over time which makes it necessary to have a model that can capture incomplete information (Gluesing 2001). Furthermore, the process model needs to be updated as new information becomes available.

In general, the success of the modeling process is affected by; 1) Selecting a suitable and effective system decomposition method that can fully and clearly identify all sub-systems or components that form the system; 2) Documenting the interactions that exist between the subsystems/ components accurately.

There are several techniques available to model the interrelated tasks associated with product design and development such as Directed Graph (Digraph) (Chang, O' Neil and Herl 1999), Project Evaluation and Review Technique (PERT) (Chen, Frame and Maver), Integration Definition for Function Modeling (IDEF) (Cohen, Eliashberg and Ho 1996), and Design Structure Matrix (DSM) (Gerson and Star, 1986). These four techniques can be used to model the product development process, but each technique has its pros and cons as shown in Table 1.

Table 1: Product Development Process Modeling Techniques Pros and Cons

	Pro's	Con's
Digraph	• Simple and intuitive • Effective for small projects (small graphs)	• Effectiveness decline as the project size increases • Precedence relationships are hard to follow (graph positioning is arbitrary)
PERT	• Effective in expressing the time required to complete a project (mostly used in project management)	• Can not represent loops or iterations
IDEF0	• Used to document complex processes	• Loops or iterations are included but are difficult to trace
DSM	• Compact representation • Offers a mechanism for improving the process through row and column operations	• Assumes a well defined task decomposition exists priori

The Design Structure Matrix (DSM) is selected as the tool to be used in analyzing the product development process. This selection was due to the following reasons (Bannon and Schmidt 1991, Bruno and Agrawal 1997, Gerson and Star 1986).

1. DSM can manage the design of complex systems based on the information flow that occur within the system,
2. DSM can identify the dependencies between tasks, and
3. DSM can sequence the development process

Next is a description of a proposed procedure for analyzing and enhancing the product development process:

Identify System Boundaries

As described earlier, the product development process is treated as system. The boundaries of this system should be determined in order to focus the analysis work on the system's components while taking into consideration any outside interactions the system may have with other systems.

Decompose the System into Components

The method used to decompose a system into its basic components or modules that comprise that system depends on the nature of the system under study. In the case of "hardware" systems such as mechanical products, a physical decomposition method (Cheng 1996, Clark and Wheelwright 1993) can be used. Physical decomposition is a hierarchal decomposition technique where the system is broken down into smaller sub-systems and those in turn are broken down into components that form the basic elements that comprises the system. Other systems such as process or function oriented systems- may be analyzed by asking a group of experts from different functional areas related to the system understudy to collectively list all components, elements, or tasks that comprise the system, such a method can be used for project management or team based systems where the system analysis investigates the operations of the project or the dependencies between teams.

Team communication is usually enabled and facilitated by meetings, committees, telephone calls, emails, standard forms, memos, and reports. CSCW systems can support team communications at all different levels. It is thought that using computer-mediated communication systems such as electronic meetings is more efficient and effective in accomplishing group objectives

In general, the development process is decomposed into (Dicesare 1993).

1. Phases: Defines the scope of tasks assigned to individuals or teams;
2. Steps: Defines the major logical actions that must be performed in order to complete a phase; and
3. Tasks: Actions that are needed to complete each individual step. Tasks describe what is to be done and why it is to be done.

Analyze the Subsystems/Components

The components or tasks that comprise the product development process are analyzed in order to determine the relationships or dependencies that exist between them. The focus here is on how these tasks interact with each other. The interactions or dependencies between the tasks can be categorized into (Bruno and Agrawal 1997, Cleland 1996, Gerson and Star 1986).

1. Data Dependency: occurs when a task needs data that will be generated by another task. This dependency may be avoided if alternative data sources can be found. If not then data-generating tasks must precede data-demanding tasks.
2. Resource Dependency: if several tasks require the same resource, then these tasks need to be scheduled according to resource availability or additional resources need to be allocated to the development process
3. Product Architectural Dependency: exists between tasks that correspond to physical constraints imposed by the product architecture
4. Development Strategy Dependency: exists when tasks are organized according to a certain development strategy. For example in a "Market-Pull" development strategy, marketing tasks precede design tasks, while in a "Technology-Push" strategy, design tasks precede marketing tasks

In this framework, the focus will be on Data or Information Dependency. This dependency is used to organize the development process resulting in a logical precedence structure of the tasks. This structure will be used as the main foundation for building the rest of the collaborative system.

Construct and Validate the DSM

An initial DSM is constructed to depict the basic dependency structure and information flows between various system elements or process tasks. A binary DSM can be utilized for preliminary analysis; however, a better understanding of the system (or project) might require the use of a numerical DSM (Chang, O'Neil, and Herl 1999) that will provide better system understanding and allow for more detailed analysis. Once the DSM is constructed, it is given to engineers and managers to comment on it, and possibly revise it by adding/removing components or tasks. Also engineers and managers may have to add or remove interactions between components/tasks. This process of revising or validating the DSM helps engineers and managers gain better insight into the process and understand the communications and dependencies that exist between the individual components or tasks.

Re-sequence the DSM

The DSM in its initial structure may have feedback loops above the diagonal [Figure 3.A], which means that some needed information is generated by tasks that occur later in the process, i.e. upstream tasks need information from

downstream tasks. If the sequence of the tasks is kept this way, earlier tasks have to proceed with incomplete or incorrect information and this will lead to rework of some tasks. To minimize the amount of feedbacks or loops and thus rework, the DSM should be re-arranged in a way such that required information is generated before it is needed. That is, downstream-information- generating-tasks are pulled upstream.

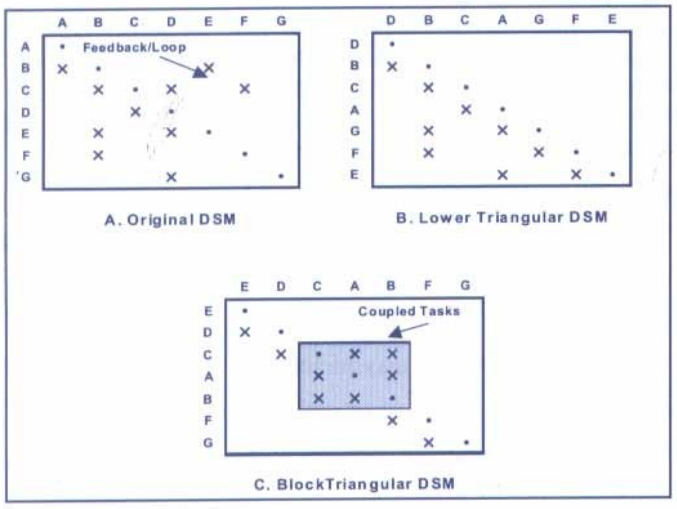

Figure 3: Design Structure Matrix

Partitioning (Gerson and Star 1986) and/or clustering (Fafchamps, Reynolds and Kuchinsky 1991) algorithms can be used to assist in re-arranging or re-sequencing the DSM. A fully partitioned DSM (lower triangular matrix) [Figure 3.B] will have no loops and thus all tasks will have all the required input information before starting. If a full partition cannot be reached and partial partitions are found (block triangular matrix), blocks of tasks or components should be identified [Figure 3. C]. These blocks are viewed as "candidates for collaboration". That is, the tasks that form blocks are to be carried out using a collaborative process. Other tasks that reside outside blocks will be considered as tasks that should be coordinated and the interactions or information needs are met by means of cooperation and communication tools.

Tele-working or Tele-commuting is a specialized form of CSCW, in which workers use information technology to perform their jobs at a site away from the organization's physical location.

Identify the Skills Needed

Once an improved logical sequence for the product development process is reached, it is necessary to investigate and analyze the skill requirement for each task. Skill needs are determined irrespective of their availability in organization. The assumption here is that if a certain skill is needed for the development, it will be made available either internally from within the organization or externally from suppliers, contractors, or trading partners.

Finalize the Product Development Process

In this step, a final report that includes the logical sequence of the development process and the skills needed for each task within the process is generated.

Organization Analysis Module

This module consists of two main activities: (1) analyzing the resources available for product development, and (2) analyzing the organization's readiness for collaboration. The description of each activity is presented in the next section.

Analyze Resources Available for Product Development

Product development requires many resources that may or may not be available in a single organization which usually leads to outsourcing some portions of the development process to external organizations. Resources available in a single organization includes (but not limited to):

People: Individuals or teams that reside within an organization are used to perform the development tasks. People referred to as "Actors". Actors are identified and described in terms of their knowledge and skills. Figure 4 shows a possible hierarchical description of actors' knowledge and skills.

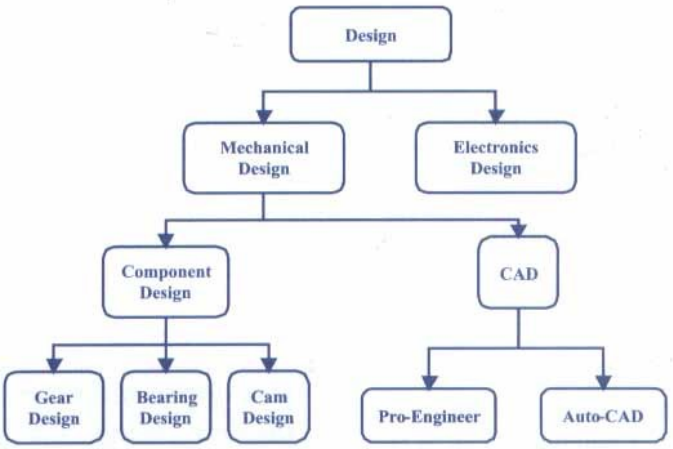

Figure 4: Description of Actor's Knowledge and Skills

Infrastructure : The infrastructure analysis investigates the types and capabilities of the existing communication systems, computer networks, and computer hardware and software.

Analyze the Readiness for Collaboration

An organization readiness for collaboration can be assessed from two perspectives:

Technological readiness : Technological readiness addresses both the availability of new technologies in the organization and the ability of the organization to adapt to new technology. An organization should attempt to reuse its existing technologies if possible; this will lower the cost of collaboration and help gain support to the idea of computer-supported collaboration. In addition, the manner in which the organization handled new technologies previously will give an idea about the organizational willingness to accept and use new technologies. This knowledge is used in setting the implementation plan. That is, if an organization is usually reluctant to accept new technologies, the implementation plan

should use a small to medium size project that can be used to gain support for collaboration.

Cultural readiness : Culture can be defined as the collective programming of the mind which distinguishe the members of one group from another (Case and Lu 1996, Chen 1997). Culture exist at three different levels: national, organizational, and occupational. Culture has a profound impact on how people perceive information, act upon it, and relate to others. Organizations with global operations may face many challenges due to cultural differences, and thus should analyze these differences and try to build a common culture where collaboration can succeed. Furthermore, specific organizational culture plays an important role in the success of collaboration. Collaborating individuals or teams need to be empowered to make decisions, and work autonomously.

CSCW Tools Analysis Module

Many tools can be used to facilitate cooperation or collaboration between people. These tools include both computer-supported tools and non-computer supported tools. The CPF focuses on computer-supported tools to facilitate the collaboration and interaction between different actors within the development process. The analysis of CSCW tools is based on the function that the tool will serve and the characteristics of the interaction the tool can facilitate. In general, CSCW tools are analyzed as following (Adelson 1999, Bossak 1998, Cormen, Leiserson and Rivest 1990)

Functional Analysis

This analysis categorize CSCW tools according to their function into:

1. Computer-Mediated Communication Systems: Focus on transport of information
2. Information Sharing Tools: The emphasis is on the ways in which the meaning of the information can be more effectively communicated
3. Computer Supported Meeting Environment: Support a range of professional meetings requirements, such as group decision-making, brainstorming, and so on.
4. Collaborative Writing Tools: Real time group editor
5. Shared Workspace Systems: Multiplex the input and output between a group of users

One of the main concerns organizations have about implementing CSCW–especially in a global environment–is the security of the system.

Interaction Analysis

CSCW tools provide the means for carrying out different types of the interactions, these interactions are classified according to the following dimensions:

1. Time: same, different
2. Location: same, different
3. Information Representation: text, picture, 2-D/3D models, audio, video
4. Information Flow: one way, two way, and broadcast (multi-direction)
5. Frequency of Information Flow: continuous, scheduled discrete, on-demand
6. Interaction Request: active, passive (who initiates, and who waits)
7. Documentation: permanent, temporary (store information, or just forward)

Resource Assignment Module

The resource assignment module attempts to allocate the most appropriate resources to the development tasks, while taking into consideration the organization policies with respect to resource management. Different organization may have different resource management strategies and these strategies should be incorporated in the assignment module. Following are the steps included in the assignment module:

Determine Assignment Goals

Usually the assignment goal is to allocate enough resources to effectively complete the development process.

Determine Assignment Constraints

Assignment constraints may include:

Cost constraints: The cost of using a certain resource

Availability constraints: When and for how long a certain resource might be available

Efficiency constraints: The probability that a certain resource will be able to perform the required task successfully

Assign Resource to Tasks

This step is where the actual assignment takes place. Several assignment algorithms or heuristics can be used such as linear programming, integer programming, AND/OR search algorithms, and set-covering. If complete assignment was achieved, the procedure stops. In case of incomplete assignment, the module highlights which tasks were not satisfied and what is the reason for that incomplete assignment. Three strategies could be used to handle the incomplete assignment:

Obtaining new resources: This can be done by allocating (or hiring) more resources

Re-sequence the development process: Change the sequence of the tasks so that resources could be available

Decouple or couple tasks: Decoupling is breaking the tasks into smaller tasks that can be performed by different resources, while coupling is merging similar tasks together so that they can be assigned to the same resource

Generate the Final Task-resource Assignment

Report the Results of the Assignment

Resources Interaction Needs Analysis Module

Actors working on tasks that have dependences associated with them will need to share information and coordinate their work accordingly. The relationship between actors and the nature of the interaction are analyzed to find what information is needed, when it is needed, and in what format it should

be presented. The analysis of the interaction between actors follows the same overall analysis that was used in the CSCW tools analysis module.

Interaction Tools Selection Module

The interaction tools selection module consists of tool-screening and tool-selection. The screening step focuses on identifying alternative tools capable of carrying out the interactions between actors. The question answered here is "which tools can serve as means to carry out this type of interaction?". The selection step evaluates and ranks the set of alternative tools leading to the selection of one or two tools to be used. The evaluation and ranking are based on a selection criteria and on the situation under study. The concept selection matrix (Eppen, Gould, Schmidet, Moore and Weatherford 1998) is completed using the following steps,

1. List all alternative tools in columns
2. List the selection criteria in the rows
3. Enter the importance weight for each criteria (total weights should be 1)
4. Rate the tools (1 to 5, 1: Worst and 5:best)
5. Rank the tools (multiply the weights by the rating)

The resulting matrix is shown in Figure 5.

CSCW system must incorporate security features that can reduce the threats to the systems.

CSCW Tools

		Tool 1		Tool 2				Tool N	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Criterion 1	0.5	5	2.5	1	0.5			5	2.5
Criterion 2	0.3	3	0.9	3	0.9			2	0.6
.									
Criterion J	0.2	3	0.6	3	0.6			3	0.6
Total Score		4		2				3.7	
Rank		1		4				3	
Rating		Worst 1		Bad 2		Neutral 3		Good 4	Best 5

Figure 5: Tools Selection Matrix

Case Study

The Collaboration Planning Framework (CPF) was tested using an experiment that was carried out in the Collaborative Engineering Laboratory at Wayne State University. The laboratory is equipped with several collaboration tools such as GroupSystems[1] (electronic meeting system), Logical Decisions for Groups[2] (group decisions tool), and several web based tools (email, white board, virtual chat, and discussion board). The test subjects were 14 graduate students in the Industrial and Manufacturing Engineering Department.

The case objective was to develop and implement a collaborative product development process to determine the initial product specifications (for a bicycle) based on customer requirements, i.e. the students were asked to investigate and determine customer requirements and then propose the product specifications to meet these requirements.

Experiment Setup

The test subjects (students) were divided into four geographically distributed multidisciplinary teams. Disciplines considered for the initial team formation were management, marketing, design, manufacture, and production. The four teams were asked to identify the initial product specifications for a "bicycle" that best meet customers' requirement. The four teams were required to use their collective knowledge in implementing the case study. The teams were required to develop a "product design and development" process to use, assign people to carry out the processes, select appropriate tools to use, and finally implement the process to generate the initial specifications.

Experiment Procedure

The experiment was carried out according to the modules in the CPF. The actions of the teams are summarized by module as following:

Module 1: Product Development Process Analysis Module

The development process was analyzed and the two phases were needed for development as in Figure 6:

		Phase	
		1	2
		Identify Customer Needs	Establish Initial Product Design Specifications
Step	1	Determine Customers	Prepare a list of Metrics
	2	Collect Raw Data	Benchmark Competitions
	3	Benchmark Competitive Products (Market)	Prioritize Metrics
	4	Translate Customer Data into Customer Needs	Assign Values to Metrics
	5	Prioritize Needs	Report Phase Results
	6	Report Phase Results	

Figure 6: Product Development Analysis

Next, the information needs between the development steps were identified and used in the DSM to re-sequence the process. The resulting DSM is shown in Figure 7.

	1.1	1.3	2.2	1.2	1.4	1.5	2.1	2.3	1.6	2.4	2.5
1.1	1.1										
1.3		1.3	1								
2.2		1	2.2								
1.2	1			1.2							
1.4				1	1.4			1			
1.5					1	1.5		1			
2.1							2.1	1			
2.3	1				1	1	1	2.3			
1.6	1	1		1	1	1			1.6		
2.4						1		1		2.4	
2.5			1				1	1		1	2.5

Figure 7: DSM Showing the Re-sequenced Development Process

[1]Group Systems is a registered trademark of Ventana Corp.
[2]Logical Decisions for Groups is a registered trademark of Logical Decisions

Notes:

1. Rows and columns represent the development steps (for example, 1.4 means phase 1 step 4)
2. A mark 1 in the cell means that an information precedence exists, and an empty cell means that there is no information needs

Finally, the skill requirement for each step was identified as in the following Figure,

Phase	Step	Skills A	B	C	D	E
1	1		1			
	2		1	1		
	3	1	1	1		
	4	1	1	1		
	5	1	1	1		
	6	1				
2	1		1	1	1	1
	2		1	1	1	1
	3	1	1	1	1	
	4	1		1	1	1
	5	1				

A : Management
B : Marketing
C : Design
D : Manufacture
E : Production

A mark "1" means that the skill is needed to carry out the step

Figure 8: Step-Skill Requirements

Module 2: Organization Analysis

The organization analysis was performed using questionnaires, and interviews as the means to collect data. The organization analysis resulted in identifying the skills for each actor and location of each actor within the organization as follows,

Although it is expected that the cost of CSCW systems will continue to decline as more systems and technologies become affordable, the benefits of CSCW should be presented in a way that justifies the cost.

	Team		Skills A	B	C	D	E
Actor	1	1	1	1			
		2			1		
		3	1			1	
		4			1		
	2	5	1			1	
		6	1			1	
		7				1	1
	3	8	1	1		1	1
		9	1		1	1	
		10				1	
	4	11				1	1
		12	1	1		1	
		13	1			1	1
		14	1			1	1

A : Management
B : Marketing
C : Design
D : Manufacture
E : Production

A mark "1" means that the actor has the skill

Figure 9: Actor–Skill Analysis

Team Information:

- Each team is located in a different place
- Members of teams 1 & 2 (A) can participate in synchronous meeting with each other
- Members of team 3 & 4 (B) can participate in synchronous meetings with each other
- Members of teams A & B can only meet asynchronously

Module 3: CSCW Tools Analysis Module

The tools were analyzed and classified according to:

- Time: same, different
- Location: same, different
- Information Representation: text, picture, 2-D/3D models, audio, video
- Information Flow: one way, two way, and broadcast
- Frequency of Information Flow: continuous, scheduled discrete, on-demand

Figure 10 shows the classified tools.

	Time		Location		Information Representation						Information Flow			Frequency		
	Same	Different	Same	Distributed	Text	Picture	2D Model	3D Model	Audio	Video	Uni-Directional	Bi-directional	Multi-directional	Continuous	Scheduled	On-Demand
Email	0	1	1	1	1	0	0	0	0	0	1	0	1	0	1	1
Categorizer	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0
Electronic Brainstorming	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	0
Group Outliner	1	1	1	1	1	0	0	0	0	0	1	1	1	1	1	1
Topic Commenter	1	1	1	1	1	0	0	0	0	0	1	1	0	1	1	1
Vote	1	1	1	1	1	0	0	0	0	0	1	0	0	0	1	1
Alternative Analysis	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	0
Survey	1	1	1	1	1	0	0	0	0	0	1	0	1	0	1	1
White Board	1	0	0	1	1	1	0	0	0	0	1	1	1	1	1	1
Virtual Chat	1	0	0	1	1	0	0	0	0	0	0	1	1	1	0	0
Discussion Board	0	1	0	1	1	0	0	0	0	0	1	0	1	0	1	1

Figure 10: CSCW Tools Classification

Note: 1 means that the tool satisfies the interaction requirement; 0: Otherwise

Module 4: Resource Assignment Module

The heuristic used for assigning actors to steps included several rules as following:

- All tasks must be satisfied with at least two actors per step
- An actor cannot be assigned to two parallel steps at the same time
- An actor cannot be assigned to more that one "interacting" step
- Obtain additional resources (actors) for any unassigned task

These rules resulted in the following assignment (an external actor had to be used "actor 15")

		Actor 1	2	4	5	7	8	9	12	15
Step	1.1	1					1			
	1.3							1	1	
	2.2		1			1				1
	1.2	1	1							
	1.4	1	1							
	1.5			1			1			
	2.1					1		1	1	
	2.4						1	1		
	2.3				1					1
	1.6	1								
	2.5	1								

Figure 11: Step-Actor Assignment

Module 5: Actor Interaction Needs Analysis Module

The interactions between actors were analyzed and classified according to the same criteria used for the CSCW tools analysis. Figure 12 shows the interaction analysis between actors (Adelson 1999, Bruno and Agrawal 1997, Chang, O'Neil and Herl 1999, Chen and Wei 1997, Cleland 1996) working collaboratively on steps 1.3 and 2.2.

Actors \ Criteria		Actor			
		Time		Location	
		Same	Different	Same	Distributed
2	7	1	0	0	1
	9	0	1	0	1
	12	0	1	0	1
	15	1	0	1	0
7	9	0	1	0	1
	12	0	1	0	1
	15	1	1	0	1
9	12	1	0	0	1
	15	0	1	0	1
12	15	1	1	0	1

Figure 12: Actor-Actor Interaction Analysis

Module 6: Interaction Tools Selection Module

This module consists of two steps. Step 1 [Figure 13] is the initial identi-fication of the alternative tools that could be used to carry out the interactions. Step 2 [Figure 14] is the evaluation of the alternative tools and the selection of the most appropriate one.

Computer Supported Collaborative Product Development (CSC-PD) is the set of all activities needed by people working in teams according to engineering methodologies and supported by technical tools to conceive, design, produce, and sell a product.

		Actors									
		2				7			9		12
		7	9	12	15	9	12	15	12	15	15
Tools	1										
	2	1	1	1	1	1	1	1	1	1	1
	3	1	1	1	1	1	1	1	1	1	1
	4	1	1	1	1	1	1	1	1	1	1
	5										
	6										
	7	1	1	1	1	1	1	1	1	1	1
	8										
	9	1							1		
	10										
	11										

Figure 13: Initial Interaction Tool Identification

Tools

		Tool 2		Tool 3		Tool 4		Tool 7	
Selection Criteria	Weight	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score	Rating	Weighted Score
Appli-cability	0.25	5	1.25	1	0.25	4	1	4	1
Cost	0.25	3	0.75	3	0.75	3	0.75	3	0.75
Speed of Computation	0.25	4	1	2	0.5	4	1	3	0.75
Data Trans-ferability	0.25	2	0.5	2	0.5	2	0.5	2	0.5
Total Score		3.5		2		3.25		3	
Rank		1		4		2		3	

Figure 14: Interaction Tools Selection Matrix

The tool selected to perform the interactions between the actors (Adelson 1999, Bruno 1997, Chang 1999, Chen 1997, Cleland 1996) working collaboratively (on steps 1.3 and 2.2) is tool number 2 (categorizer).

Discussion and Conclusion

The case study showed that the Collaboration Planning Framework (CPF) was able to analyze the interaction needs between product developers, and select the most appropriate CSCW tools. Also, the CPF provided the teams with clear procedures and guidelines which allowed them to organize their work and effectively collaborate with each other.

Overall, the CPF successfully assisted the team to plan and implement a computer supported collaborative system.

The Collaboration Planning Framework (CPF) is an analysis and planning tool that provides a systemic and organized method to build computer supported collaborative product development systems.

The CPF consists of six modules that provide the means to:

1. Analyze, model, and enhance current product development processes,
2. Analyze resources available in the organization(s) attempting to collaborate,
3. Analyze and categorize CSCW tools,
4. Assign resources to development processes,
5. Analyze the interaction needs between resources, and
6. Select the most appropriate CSCW tools to satisfy the interaction needs and thus build collaboration systems.

The modular nature of the CPF allows for independent or parallel implementation. For example, module 1 and 2 (PD process analysis, and Organization analysis consecutively) can be carried out simultaneously. In addition, module 3 (CSCW tools analysis) does not need to be carried out for each new project. That is, once it is implemented, it can be updated as new tools become available or as tools are phased out.

The CPF provide organizations with a flexible method to address their collaboration needs, and gain better insight into their development process. CPF allows organizations to evaluate several collaboration tools and select the most appropriate set of tools based on the organization collaboration needs.

Further Work

The modular structure of the CPF allows for independent and continuous improvement. Such planned improvements include building a "collaboration readiness assessment model" which is part of the organization analysis module. This proposed enhancement should provide a generic model to be used by different organizations to assess their

organizational capabilities to collaborate. Another proposed enhancement is in module 3 (resource assignment), the current module utilizes a heuristic that addresses skill and availability constraints, and there is a need to include other constraints such as cost and expertise. In addition, the assignment heuristic itself could be improved, or even replaced by a more efficient algorithm or assignment technique.

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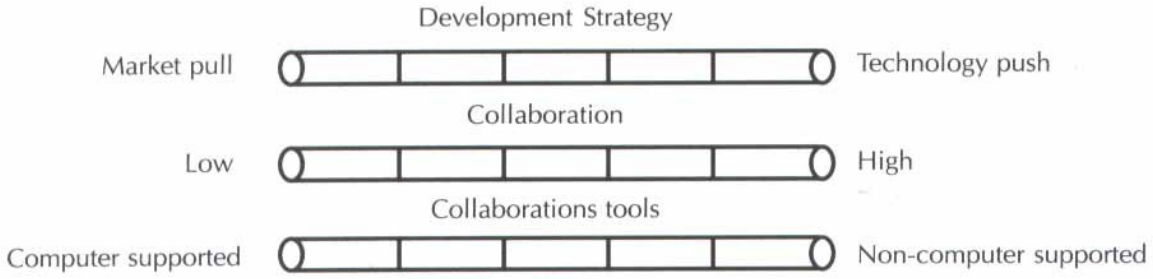
Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Collaborative Global Product Development"* on the following points:
   - Flexibility in terms of ***"options"***
   - Flexibility in terms of ***"change mechanisms"***
   - Flexbility in terms of ***"freedom of choice"*** to participating actors.
2. Identify and describe the types of flexibilities that are relevant for your own organizational collaborative product development? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational technological system on following on continua. (Please tick mark in the appropriate box(es)).



4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Collaborative Global Product Development"* relevant to your organization.

Reflecting Applicability in Real Life

1. Implement the various modules of collaborative product development, as illustrated in the case situation, in your own context.
2. Select an appropriate tool of collaborative product development as descried in this paper and try to implement it in a real life situation. Discuss your experience.

Empirical Study

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User Involvement and Flexibility in Strategic MIS Planning: A Path Analytic Study

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Abstract

This paper presents empirical findings on relationships between user involvement and flexibility variables in strategic planning of information systems. 'Flexibility' has been considered for organization, MIS, and usage. The proposed research model assumes organizational flexibility as a dependent variable, MIS and usage flexibility as intervening variables and user involvement in MIS strategic planning as an independent variable. Hypotheses are formulated based on the proposed research model and are tested empirically by questionnaire survey. The sample size was 296 comprising of users and planners from 42 organizations randomly selected from eight different sectors. The measures for flexibility variables are generated by idea engineering exercise. Scale tables explaining the dimensions of user involvement and flexibility were used to obtain the responses for each questionnaire item. A set of predefined criteria was used to ensure the relevance of the respondents' for this survey.

The univariate results of the research variables are presented for optimistic, most likely, and pessimistic scenarios. The dimension-wise values for user involvement and flexibility variables are given to gain more insight into each of the variable construct. The results of statistical analysis validate the relationship between user involvement and flexibility variables in strategic planning of MIS. Path analysis was carried out to predict organizational flexibility and usage flexibility. The causal explanations are given considering direct and indirect impacts of causal variables.

Keywords: MIS flexibility, MIS strategic planning, organizational flexibility, user involvement, usage flexibility

Introduction

A management information system (MIS) supports management decision making by providing information in the form of reports and responses to queries to managers at all levels of an organization (Nickerson, 2001). Increased investment in MIS, increasing strategic impact of MIS on the business (Boynton and Zmud, 1987) and evolving role of MIS in the organization (Nolan 1979, McFarlan et al. 1983) have brought forward the MIS planning process as an important issue among the organizational processes. Earl (1989) validates that different planning approaches will bring different likelihood of success to the organization. The three stages of MIS planning are strategic planning, deriving organizational information requirements and resources allocation (Blumenthal 1973, Bowman et al. 1983). Some of the major activities in strategic planning are assessing organizational objectives, appraising business strategies, setting MIS mission, objectives, policies, and linking the MIS plan with the business strategies.

The major dimensions of MIS planning are the quality of the planning process (means) and the planning effectiveness (ends) (Premkumar and King, 1994). The prominent actors involved in the planning process are user, planner, and top management (Moynihan 1990); and the key variables are user and top management involvement for planning effectiveness along with information inputs to planning (Premkumar 1992). Top management wants a more systematic planning process for MIS with better involvement of users (Brancheau and Wetherbe 1987, Hartog and Herbert 1986). Besides user involvement, other factors influencing the MIS planning process are quality of strategic business planning, resources allocated to planning, and management styles (Lederer and Sethi 1988, Raghunathan and Raghunathan 1988, 1989, 1991, Premkumar and King 1991). The major setbacks in the MIS planning practice are the lack of linkage between business and MIS (Lederer and Mendelow 1987, Galliers 1991) and the incapability of MIS to adopt and resonate with organizational information requirements (Pyburn 1983, Cash 1988).

Role of Users in MIS Planning

In the planning stage, users can give a more accurate and complete picture on the organizational information requirements (Robey and Farrow 1982); the capacity to handle any expected or unexpected changes in organizational

strategy can be built into MIS by the lead of user advice and suggestions. The MIS fluidity can be imparted from the user's working knowledge about the business operations at various levels. Moreover, as the planners are not having organizational expertise adequately, it is the responsibility of the users to provide expertise.

Importance of Organizational and MIS Flexibility

Today's business environments are often fast moving, turbulent, and unpredictable because of ever changing trends in technology, global competition, and electronic commerce. These changes make the long-term strategies obsolete, and to cope with these dynamically changing environments, organizations have to develop flexible strategies, resources, and business processes (Lee, 2001). Also, organizations look for flexibility to quickly adapt to environmental changes and thereby gain an advantage over their competitors (Leana and Barry, 2000). Though a good information system can support this to happen, many times it fails because of its rigidity and passiveness in handling new situations. The information systems need to adapt to new changes and challenges with minimum cost. For e-business applications, flexibility and adaptability are high priority areas in the list of requirements (Evans, 1999). So, information systems researchers and practitioners recently started recognizing the importance of information systems flexibility (Byrd and Turner 2000, Duncan 1995).

Based on conceptual inputs about flexibility, a group of twenty participants in a workshop on information systems planning, gave their feedback for importance of MIS flexibility. The participants were all senior level managers with more than ten years of information systems usage experience. According to them, flexibility in information system facilitates more effective, fast, efficient, user friendly and open communication system to meet the user's information needs; multiplies the ability to respond to organizational changes and business conditions both within and outside the organization. Flexible flow of information engenders creativity in performance by inhaling outside changes and increases organizational effectiveness.

Flexibility enables to alter the information systems strategies whenever organizational strategies are changing, reduces the built-in resistance for change, and eases the organizational strategic change process. Flexible MIS incorporates a federation of application systems to support competitive strategies, to analyze and solve organizational problems. Consequently, the information reports are to be designed and used in such a way that they give basic understanding of the business situation as well as provide guidelines to make decisions.

In the literature, user involvement studies were administered in MIS development phases, but rarely empirical studies are seen on user involvement in MIS strategic planning, though it has been emphasized as a necessity for implementation success (Premkumar 1992, Jarvanpaa and Ives 1990). Empirical studies on dimensions of user involvement are also lacking. Similarly, MIS adaptability to organizational strategies has been emphasized (Tozer 1986, Certo and Peter 1991, Drucker 1994), but rarely empirical studies are available (Bahrami 1992, Leeuw and Voberta 1996). How to incorporate flexibility in MIS as well as in organization is also left unanswered.

Model for User Involvement in MIS Strategic Planning Generating Flexibility in MIS, and Organization

Figure 1 shows the research model proposing organizational flexibility as the dependent variable (outcome), MIS flexibility and usage flexibility as the intervening variables, and user involvement in strategic planning of MIS as the independent variable. In other words, MIS flexibility and usage flexibility are proposed as antecedent variable, the 'means' to achieve organizational flexibility. Every organization wants to free themselves from environmental forces by responding to them rapidly. With flexibility in information systems, organizations are in a better position to adapt to the changing directions and business circumstances with increased ability to respond to changing forces. To achieve this, a strong alignment between organization and MIS is proposed in the research model. Adaptability of information systems reports for new situations is referred by usage flexibility. Involving users in MIS strategic planning process is proposed to increase MIS flexibility by this means to increase organizational flexibility.

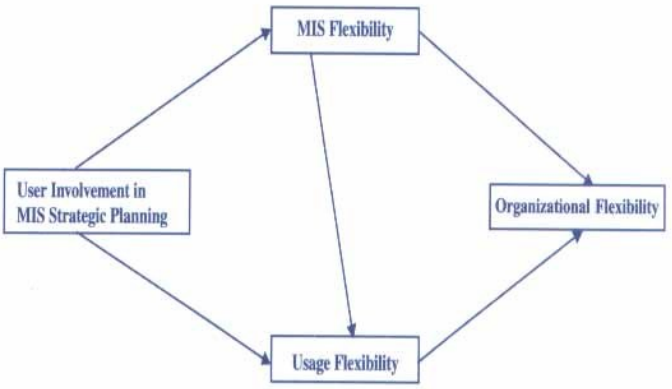


Figure 1: Research Model for User Involvement in MIS Strategic Planning to Generate Flexibility in MIS and Organization

User Involvement in MIS Strategic Planning

User Involvement

In the MIS context user involvement is a subjective psychological state of the individual user in terms of importance of the user attaches to a given system (Barki and Hartwick 1989, Jarvenpaa and Ives 1991). User influence (Schonberger 1980, Edstrom 1977), participation in the MIS process (Ives and Olson 1984, Barki and Hartwick 1989), systems analysis activities by the user (Baroudi et al. 1986, Doll and Torkzadeh 1989), user's role to attain the MIS goal (Swanson 1974) are also treated as user involvement in literature.

Dimensions of User Involvement

Users can be involved in strategic planning of MIS by inviting them for consultations (consultative), or by having user representatives in the MIS planning team or steering committee (representative) or arriving a user led consensus in the MIS planning decisions (Mumford, 1981). In no involvement situation users are unwilling or not invited to participate in MIS planning; in symbolic involvement user's input is requested but ignored in the MIS plan; in involvement by advice user's advice for MIS planning is solicited through interviews and questionnaires (Lucas, 1974); in involvement by weak control users have "sign off" responsibility for MIS plan; in involvement by doing user is a planning team member (King and Rodriquez, 1981); and in involvement by strong control users pay directly for new development in MIS plan.

Measures for User Involvement

Measurement can focus on specific activities or events to which the user can respond to strategic planning of MIS relatively objectively (Olson and Ives, 1981). User involvement in strategic planning of MIS could be explaining and clarifying information requirements for MIS strategic plan, detailing input/output, stating MIS objectives and asking questions and providing answers in the MIS planning process (Franz and Robey , 1986).

The research model proposes organizational flexibility as the dependent variable (outcome), MIS flexibility and usage flexibility as the intervening variables, and user involvement in strategic planning of MIS as the independent variable.

MIS Flexibility

Upton (1994) defines flexibility as "the ability to change or react with little penalty in time, effort, cost or performance;" flexibility is the ability of a system to take different forms (Easton and Rothschild, 1988). Flexibility is a multidimensional concept demanding agility and versatility; associated with change, innovation and novelty; coupled with robustness and resilience, implying stability, sustainable advantage and capabilities that may evolve over time (Bahrami, 1992). Sushil (1997) defines flexibility as "the exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive and innovative manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts."

The competitive forces have immediate impact on the profitability and growth potential of the organization. In order to transform these forces in favor of the organization, active support from MIS is required, especially in handling new situations. The organizational information system has to adapt to new changes and challenges quickly with minimum effort and cost to capitalize on the opportunities. Mensah (1989) defines MIS flexibility as "the ability to respond and adapt to changing business conditions both within and outside the organization." Duncan (1995) captured the flexibility of IT infrastructure with platform, network/telecommunication, data, and applications. Byrd and Turner (2000) measured IT infrastructure flexibility with such dimensions as IT connectivity, application functionality, IT compatibility, data transparency, technology management, business knowledge, management knowledge, and technical skills.

MIS flexibility is the capacity of the information system to change or to adapt and adjust in response to new conditions, demands, or circumstances from the organization. The change in information requirements from organization and environment should be encountered successfully without exorbitant changes in the system. In general, the objectives of MIS flexibility are satisfying information requirements, decision support, futuristic applications, operational support, and response to organizational strategies. MIS flexibility handles special situations in organizational functions or industry needs (Diebold, 1965) and adapt to regulatory or other environmental changes (Bruns and McFarlan, 1987) especially quick and accurate responses to crisis. Better-adapted MIS to the technological and economic variables with high degree of integration to the organization increases the possibility of implementation success (Ein-Dor and Segev, 1978). Perhaps MIS objectives must be flexible enough to permit adaptation to the changing directions and circumstances of the organization (Sethi and Levi, 1977). MIS flexibility in the innovative dimension will be an important contributing component. MIS planning should have the built-in flexibility (Raghunathan and Raghunathan, 1991), to allow adaptation of MIS processes to new opportunities.

Usage Flexibility

Different users have varying expectations and the usage pattern depends on their individual differences. The users aspire for individual packages for their own work processes. Users who are extroverts may demand detailed information and those who are introverts may demand information encapsulation. The study identifies the following major issues in usage flexibility: role of MIS reports, decision making and management level of the user.

Role of MIS Reports: The operational reports could be obtained for understanding the business situation and the decisions could be taken by user's intuition, knowledge, experience as well as guided by the information reports. So MIS reports are to be flexible enough to meet the requirements to accomplish the objectives. If the objective is 'cost reduction', then reports have to support this; and when the objective is changed to ' increase in market share' then accordingly the reports have to supply the details.

Decision Making: At one extreme, the decision maker can use intuition and experience supplemented by the information

reports; and at the other end the decisions are taken as instructed by the reports without any subjective opinion of the decision maker.

Management Level of the User: Facts and figures provided by MIS are to be used with a varying degree of freedom by different levels of management. At operational level, the degree of usage flexibility is less than that of the strategic level since rules and procedures mostly drive the operational usage. As strategic management demands faster visualization of future scenarios, usage flexibility is extremely high at the strategic level. So the degree of usage flexibility is related with the management level.

Organizational Flexibility

Organizational flexibility is its capacity to respond to environmental changes. Leeuw and Volberda (1996) says "organizational flexibility is the degree to which an organization possesses a variety of actual and potential procedures, and the rapidity by which it can implement these procedures, in order to increase the control capability of the management and improve the controllability of the organization and environment." In the functionalistic point of view, flexible organizations are open systems which can free themselves from environmental control (Burrel and Morgan, 1979). The environmental fluctuations are the challenges to the organization, which are disturbing the organization's equilibrium, to anchor the stability again (Bahrami and Evans, 1987). The organization has to respond and self organize (Goguen and Varela, 1979) with simple fluid structures (Peters and Waterman, 1982) for minimizing the fluctuations (Smith, 1984). In other words, the organization seeks freedom from environmental influence (Dill, 1958, Aharoni et al. 1978), in order to adapt to the environmental changes (De Leeuw, 1982). For this, flexible and agile organizational forms are necessary which can be able to accommodate novelty, innovation, and change (Bahrami, 1992). So a flexible firm is open to new ideas (Ramnarayan and Bhatnagar, 1993, Atkinson and Meager 1984, Atkinson 1985) and these open systems are having continuous exchange of inputs and outputs (Morgan, 1986). The speed with which the organization adapts to the environmental changes matters the success of the organization (Dumaine 1989, Hammer and Champy 1994).

Strategic Flexibility

Hart (1937) defines strategic flexibility as "the ability to do things differently or do something else when the need arises." It is viewed as the capability to change a firm's strategy to respond to environmental changes in a timely and appropriate manner (Das and Elango, 1995). Strategic management has been regarded as a flexible planning process to resonate with organization's environment (Certo and Peter, 1991). Need for flexible capacity in the organization and flexible strategies for organizational growth (Goold and Campbell, 1987) are emphasized for organization growth. Hamel and Prahalad (1989) in their study of global organizations identified successful organizations with clarity in strategic intent and the success has been achieved by flexible means. The need for linking flexibility, organizational strategy and environment is discussed by Krijnen (1979), Aaker(1984) and Quinn (1985). The art of balancing the control and inducting flexibility in the organization referred by Stacey (1993). Balancing is required in the global and local operations, big and small groups, centralization and decentralization (Taylor, 1991). A radical reshaping from the traditional organizational landscape becomes the need of the hour (Child, 1987). Especially at the strategic level, organization has to reposition and refocus quickly (Bahrami, 1992).

Research Hypotheses

Following hypotheses on user involvement in MIS strategic planning, MIS flexibility, usage flexibility and organizational flexibility are evolved from the proposed research model:

H1. User involvement in MIS Strategic planning increases the possibility of MIS flexibility.

H2. The more flexibility in MIS, greater the possibility for organizational flexibility.

H3. User involvement in MIS Strategic planning increases the possibility of usage flexibility.

H4. The more flexibility in MIS influences a higher possibility of usage flexibility.

H5. The more flexibility in usage increases the possibility of organizational flexibility.

H6. Usage flexibility mediates the relationship between MIS flexibility and organizational flexibility.

H7. MIS flexibility mediates the relationship between user involvement in MIS strategic planning and organizational flexibility.

H8. MIS flexibility mediates the relationship between user involvement in MIS strategic planning and usage flexibility.

Methodology

The proposed research model includes dynamic interactions among user, MIS, and organization that are complex systems with unpredictable behavior. The antecedent elements namely user involvement in MIS strategic planning and MIS flexibility may or may not influence the predicted behavior of organizational flexibility. Since the hypotheses are formulated to test this behavior, empirical data explaining the interactions are required. The people involved with the system are users, planners, and top management and users are distributed in all levels of management namely operational, tactical, and strategic. Therefore, a questionnaire instrument can be used to collect empirical data from them. Statistical analysis of data can reveal the results of hypotheses testing.

The research variables in the model are of qualitative nature, and to gain more insight into each of them the dimensions of involvement and flexibility can be used. To

handle the ambiguity in the interactions among the qualitative variables, fuzzy quantifiers are suggested. Since the standard measures for flexibility are not sufficiently addressed in the literature, filed generated measures are proposed. For this purpose, idea-engineering exercise is recommended as a tool.

Measures of User Involvement and Flexibility Variables

A construct is an abstract representation of a phenomenon of interest. User involvement in strategic planning of IS and flexibility variables are the construct of interest in this study. Churchill (1979) suggests a procedure to develop a better measure for the variables. The procedure includes specifying the domain of the construct, generating a sample of items to capture the specified domain, and statistically assessing the construct validity to purify the measure. Byrd and Turner (2000) followed this procedure to develop a construct for flexibility of information technology infrastructure. According to them, the domain of a construct is same as the definition of the concept and views of several authors about this concept. These views are synthesized into the construct definition and are characterized into dimensions of the construct. Reviewing the literature, the underlying dimensions of the construct were identified. A similar approach is followed to identify the dimensions of involvement and flexibility construct. Here dimensions refer various aspects of a construct. The dimensions and description of involvement and flexibility construct are given in the following sections.

This study differs from the traditional empirical studies in obtaining the responses for each item in the construct. Typically, dimensions are the various aspects of a construct and for each dimension the measurement items are developed. This study also assumes the dimensions as different aspects of a construct. The items to measure the construct were obtained empirically as explained in the subsequent section. For each item in the construct and for each dimension, the respondents were instructed to recollect from the mental database in terms of a possibility value. The respondents learned about the dimensions through an instruction sheet accompanied by the questionnaire. In some cases, the researchers conducted in-house workshops to explain the dimensions of involvement and flexibility. After recollecting from the mental database, the respondent arrives a fuzzy set of possibility values for each item in the construct. Comparing the fuzzy sets given in the instruction sheet, the respondent chooses a one, which is closer to the arrived fuzzy set. The qualitative value corresponding to the chosen fuzzy set in the scale table will be the final response to the item for the construct under consideration.

Measures for User Involvement in Strategic Planning of MIS

For user involvement in strategic planning of MIS, field generated measures are used besides standard measures. Fourteen MIS experts from industry and academia participated in this exercise to generate measures and they are given in Appendix I.

Measures for Flexibility Variables

The measures for flexibility variables were generated by using idea engineering exercise; twenty two senior managers from public and private sector organizations participated in this exercise. The responses were obtained with the worldview: 'User involvement generates a flexible MIS'. The determinants for organizational flexibility, MIS flexibility, and usage flexibility are identified. The determinants of organizational flexibility are: organizational skill upgradation, tuning the organization to face competition, technology absorption for upgradation, organizational strategies for flexibility and organizational climate for open communication. The determinants of MIS flexibility are: MIS focus, nature of application systems, information systems support, information availability for strategic change, and information systems model. The determinants of usage flexibility are: role of MIS reports, usage of reports, user level in the management hierarchy and the individual difference. Based on the above determinants the measures for flexibility variables are generated and shown in Appendix I.

Dimensions of User Involvement

The dimensions of user involvement considered in the study are control, responsibility, advice, and symbolic (Mumford and Henshall, 1983). When the users perceive certain application systems are critical for their job enrichment, they go to the extent of developing them out of their own budgets. Here the users show high level of commitment for MIS planning; the deviations of MIS plan from user expectations are controlled by the users themselves. MIS planning committee could involve user representatives from functional areas; each user representative takes sign off responsibility at each step of the MIS planning process. Though some of the information systems do not directly affect the job routine of each individual user, for the benefit of the organization, the user takes responsibility in explaining the information links between the different functional areas.

The determinants of organizational flexibility are: organizational skill upgradation, tuning the organization to face competition, technology absorption for upgradation, organizational strategies for flexibility and organizational climate for open communication.

User views on MIS policies, guidelines, rules, procedures are solicited through questionnaires and interviews. Here users play advisory role in planning information systems. In some cases, interactive involvement may not be there, but one time inputs are obtained in the form of advice and views. Symbolic Involvement of users is shown if the users are not able to assess their information requirements. Lack of expertise from the users or unwillingness may disqualify them from the MIS planning process. In these situations, users are involved tangentially; and their inputs are requested for the planning process and at the same time irrelevant inputs may be ignored.

Dimensions of Flexibility

Sushil (1994) gave the dimensions of flexibility as innovative, integrative, interactive, and intelligence. These dimensions are applied in the organizational and information systems context. "Innovation" dimension in information systems refer to creative problem solving and decision making; "Innovation" in organizations refer to making effective organizational changes to gain an edge over the competitors. The innovative organizations are able to survive and grow in the turbulently changing environment. "Interactive" dimension in information systems facilitates a more user friendly way of obtaining user inputs. In organizational context, 'interactive' dimension refers to different functional systems working together to make rapid response to the environmental changes.

"Integration" dimension of information systems speaks about combining all the islands of application systems in a more holistic manner by providing a total solution to the organizational requirements. "Integration" dimension for organization is about combining various expertises from several functional areas to accomplish the business objectives.

"Intelligence" dimension of information systems brings the organizational knowledge in the form of information and data into the system. Organizational knowledge is driving the effective problem solving and decision making; and knowledge driven managerial processes is another dimension of organizational flexibility.

Weights for the Dimensions

The weights for the dimensions of user involvement and flexibility were obtained from twenty respondents who participated in a workshop on "Flexibility in Information Systems". The respondents were senior level MIS executives from Industry.

The weights for the dimensions of user involvement in a scale of 0–1 are as follows:

Responsibility	-	0.4
Control	-	0.25
Advice	-	0.25
Symbolic Involvement	-	0.1

The weights for the dimensions of flexibility in a scale of 0-1 are as follows:

Innovation	-	0.3
Intelligence	-	0.3
Interactiveness	-	0.2
Integration	-	0.2

Need for a Scale Table

To answer a question, a respondent may recollect only a limited knowledge base and may give a qualitative judgement in little time. Another respondent may take more time to recollect a larger part of the mental database, to analyze different aspects of a construct and to synthesize the final response. It will be more convenient if the dimensions and quantitative conversions of qualitative judgements are given to the respondent before hand. For instance, giving the dimensions of flexibility and user involvement facilitate the respondent to recollect and to synthesize the response on a standardized scale. Before giving the qualitative judgement about an item in the questionnaire, the respondent is required to think in two steps. In the first step, the dimensions of the construct are to be kept in mind and obtain the response on each dimension. In the second step, the responses are to be aggregated to arrive at the final qualitative judgement.

For example, the selected dimensions of involvement for this study are responsibility, control , advice and symbolic. For the item "user involvement level in explaining the business mission and the business strategies", user recollects from the mental database about his/her experience in each dimension of involvement. To what extent the user took corrective steps to set right the deviated MIS plan will be the response for control dimension; to what extent the user took sign off responsibility at each stage of MIS planning will be the response in responsibility dimension; the extent the user played advisory role in clarifying policies, major guidelines and procedures pertaining to business strategies will be the involvement in advisory dimension; and lastly the extent to which user tangentially involved to assess the information requirements to MIS plan will be in symbolic dimension.

Multidimensional Scaling and Fuzzy Sets

The scale matrix used in the study is the combination of multidimensional scaling and fuzzy set scaling. Multidimensional scaling (MDS) is a useful tool that enables the analysis of data in areas where organized concepts and underlying dimensions are not well developed (Chen et al. 2002), and concerns with similarity and dissimilarity between pair of objects (Oh and Raftery, 2001). Though multidimensional scaling has root in psychology, recently the interest has increased because of its usefulness especially in the field of information retrieval for the Web and other document databases (Schutze and Silverstein, 1997).

The basic component of fuzzy set theory is its rating of membership in terms of possibility values. Simply put, in classical logic a crisp set has true or false membership whereas in fuzzy logic a set is noncrisp (or fuzzy) with a membership ranging between null and full and its possibility value varying between 0 and 1. Responding to qualitative variables in a crisp way is subject to risk, because reference points are confounded by various characteristics of the respondents (Gaba and Viscusi, 1998). Even some times the qualitative judgements about a construct could be biased, because the process of triggering that response often varies from person to person. Gaba and Viscusi (1998) suggest to include quantitative judgments when people differ in their qualitative characterization. If such quantitative scale is not available, they propose to use a benchmark qualitative judgement accompanied by an appropriate quantitative counterpart. Accordingly, the study proposes a scale table,

which includes qualitative judgments ranging from "Very High' to 'Almost Nil" accompanied by its quantitative counterpart in terms of fuzzy sets.

User involvement in MIS strategic planning and flexibility variables are of qualitative nature, which can be captured by fuzzy quantifiers. The interplay between user, MIS, and organization is more complex; fuzzy quantifiers can capture the ambiguities and impreciseness in the interplay. Moreover, achieving flexibility through user involvement is non-predictable and the fuzzy sets are useful to predict the outcomes. The individual differences in the MIS planning team lead into some coercive and pluralistic views in the planning process; these pluralistic views can be better quantified by possibility values. The fuzzy set operations will be useful to reduce the unstructuredness in involving users in the MIS planning process. As MIS planning is required for the entire organization, fuzzification of ambiguities in all levels of the organization can be better represented by possibility values. Types of user involvement and flexibility are characterized by their dimensions; and the degree of involvement and flexibility are represented by possibility values.

Field Generated Fuzzy Sets

The inputs for the scale tables were obtained from a group of nine MIS executives from public and private sector organizations. The dimensions of involvement and flexibility variables were explained to them and their opinion was solicited on the qualitative scale of 'Very High' to 'Almost Nil'. For example, user involvement is 'Very High' means users show a very high involvement in control, responsibility, advice, and symbolic. The rating for each dimension was obtained in a scale of 0-1 resulting into a fuzzy set for 'Very High' user involvement. Similarly the fuzzy sets for other qualitative scales namely 'High', 'Moderate', 'Low', 'Very Low', and 'Almost Nil' were obtained as shown in Appendix II a. The field generated fuzzy sets for flexibility is shown in Appendix II b.

The dimensions of user involvement considered in the study are control, responsibility, advice, and symbolic.

Pilot Testing

The questionnaire items and instructions to use the scale table were tested with thirty five MIS practitioners from the field and academia. As a result, some items in the questionnaire were rephrased and more technical words were removed; instructions to use the scale matrix were simplified; duplicate and double-barreled questions were removed. The scale table construction including the dimensions of the research variables and fuzzy sets were avoided.

Validation Scheme

The validation scheme for the entire study includes validation on structure, behavior, and policy implications. The structure validation is testing for the objectives; behavior validation is for testing the behavior (results) generated by the survey, and policy implications are for validating the recommendations made by the survey (Sushil, 1993).

Structure Validation

Questionnaire Construction: The questionnaire items, the scale matrix and the dimensions of research variables were validated from field experts at the level of Directors and Deputy Directors of MIS. The measures for flexibility variables were developed through Idea engineering exercise in which twenty two senior level user managers from public and private sector organizations participated. Field generated measures add more confidence to the construct validity of the questionnaire. The sixteen items instrument was pilot tested with twenty five MIS practitioners who had more than five years experience in MIS usage.

Respondent's Relevance: The respondent's relevance for this study was ensured by a set of predefined criteria; the inputs of irrelevant respondents were ignored. By this data filtering process, higher confidence was assured on the data part.

Behaviour Validation

To ensure more confidence in the data analysis and results, the most extreme cases of data values were omitted from analysis; for this 2.5% on either side of the data distribution was excluded from analysis. For univariate and bivariate analysis, optimistic, most likely, and pessimistic data values were considered to obtain different scenarios.

Hypotheses testing: The hypotheses are validated by chi-square values with 0.0001 level of significance, this gives more confidence in the results of hypotheses testing. The degree of association between the pair of variables was obtained by Pearson's correlation coefficient with 1 tailed level of significance at 0.01 and 0.001 level. The extreme values of data viz. optimistic and pessimistic values were also used to confirm the hypotheses by chi-square and correlation values. A hypothesis is accepted only if it is true in all the three different scenarios: optimistic, most likely, and pessimistic.

Policy implications: Management intervention points and recommendations suggested by the study were validated with field experts. Different policies for involving users in strategic planning of MIS and organizational flexibility were identified; the feasibility to implement these policies was cross-checked with experts through interviews.

Data Collection

Sample Design

The respondents for the survey were randomly chosen from users and planners population. The sample is random and purposive since the respondents were selected at random with a purpose of obtaining their views on involvement and flexibility. Forty two public and private organizations were selected at random from eight different sectors including service, information consultancy, engineering, automobile, consumer goods, consumer durable, high technology and

Government. To diminish the skewness on data from the same geographical region and to get views from widely scattered population, the survey was conducted in three major cities of India: New Delhi, Chennai, and Bangalore. The sixteen items questionnaire instrument was personally administered to 296 respondents from 42 organizations. The respondent's profile with number of respondents in each sector is given in Table 1.

Table 1: Respondent's Profile

Industry	No. of Respondents
Service	70
Information Consultancy	86
Engineering	35
Automobile	22
Consumer Goods	23
Consumer Durable	15
High Technology	36
Government	9
Total : 42 Organizations	
Respondents :	**296**

Respondent's Relevance

User respondents were selected from strategic, tactical, and operational level of management. The managerial level of respondents and distribution of organizations based on annual sales turnover are given in Table 2. The relevance of the respondent was ensured by the following criteria: functional expertise of the user, managerial level of the user and number of years of experience in MIS usage.

A hypothesis is accepted only if it is true in all the three different scenarios: optimistic, most likely, and pessimistic.

Table 2: Managerial Level of the Respondents and Distribution of Organizations

Respondents by Position	No. of Respondents	Distribution of Organizations	No. of Respondents
Managerial Level		Annual Turnover (Rs. in Crores)	
Strategic	38	Less than 100 Crores	115
Tactical	153	101 - 200	39
Operational	85	201 - 300	7
		301 - 400	18
		501 - 1000	14
		1000 - 2000	6
		2001 - 3000	10
		3001 - 4000	21
		4001 - 5000	32
		5000 - 7000	14

Functional expertise of the user: When a user is specializing in the same function for a number of years, explaining the functional strategies and linking them with the MIS plan will be much easier. Detailing the inputs for MIS flexibility in the functional area will be much better.

Managerial level of user: Since the MIS planning horizon and focus vary for each managerial level, including users from operational, tactical, and strategic level will be appropriate for the study.

Experience in MIS usage: MIS usage experience enables the users to have more exposure to MIS planning activities. The usage flexibility in reports will be much clear for experienced users than novice users.

Relevance Score for the Sample

The relevance score for each respondent was computed based on the criteria; the individual score for relevance ranges from 0.4 to 1. The most likely aggregated score for the sample is 0.76 indicating a fairly high relevance. Optimistic and pessimistic scores are 0.95 and 0.45 respectively, and 95% of the total respondents' relevance score falls between this range.

State-of-the-art Analysis: Univariate Analysis

Conversion of Responses to Fuzzy Sets

In the survey, the final responses were obtained in a qualitative scale ranging from 'Very High' to 'Almost Nil'. A respondent arrives a qualitative judgement for an item after synthesizing the responses in all four dimensions of the variable construct. To get back the response in each dimension, the qualitative responses were reconverted into fuzzy sets. This was done with reference to the standardized scale table. For example, if a respondent's response was "Moderate" for an item on user involvement then with reference to the scale table, the fuzzy set conversion will be {0.6, 0.4, 0.5, 0.4}. These elements are the possibility values for the given item in user involvement dimensions namely responsibility, control, advice, and symbolic respectively. For convenience, these possibility values were multiplied by 10 to get the possibility values in a 0–10 interval scale. Thus qualitative response "Moderate" is equivalent to the fuzzy set {6, 4, 5, 4}. The aggregated value for the item is the weighted average of these scores and in this case, it is 5.05. In this way, the aggregated values for each item to the entire sample of 296 were obtained.

Reasons for Three Values for Each Item

From the data distribution of aggregate values, optimistic, most likely, and pessimistic values for each item were identified and based on the content of each questionnaire item, important theme was identified and shown in Appendix III. To obtain a more realistic value for each item "Most likely" value could be used. Though 'Optimistic' value is some what difficult to achieve by all organizations, but helps

to set a target for the desired state of involvement and flexibility; and "Pessimistic" indicates the undesired state. The three point values for each item can be used by other studies as better estimates and in any simulation to draw different scenarios. Optimistic values may be true in case of a favorable organizational context such as positive organizational culture for MIS planning, high level of maturity and sophistication in information systems growth in an organization, top management support and so on. The causes to achieve optimistic values could be explored further to generate the best-case scenarios in an organization and to avoid the worst-case scenarios. The optimistic, most likely, and pessimistic values for each item in the questionnaire are shown in Appendix III.

Optimistic, Most Likely and Pessimistic Values for the Dimensions

In this study, a variable construct is measured by four items, and each item measures the four dimensions of the construct. So for each variable, sixteen scores are obtained. The arbitrary fuzzy set for four items representing a variable is as follows:

$\{S_{i11}, S_{i12}, S_{i13}, S_{i14}, S_{i21}, S_{i22}, S_{i23}, S_{i24}, S_{i31}, S_{i32}, S_{i33}, S_{i34}, S_{i41}, S_{i42}, S_{i43}, S_{i44}\}$

where Sijk is the respondent's score for Ith variable, Jth item in the Kth dimension. The variable 'i' is measured by four items. As the scores for each dimension is in the interval scale of 0–10, the arithmetic mean is used to find the most likely values. In other words, simple average of $\{S_{i11}, S_{i21}, S_{i31}, S_{i41}\}$ gives the 'most likely' response of a respondent in the first dimension of the variable. The 'most likely' values for each dimension of the variable for the sample of 296 respondents were plotted as a frequency distribution. The least value has been chosen as the pessimistic value and the maximum as the optimistic one for the entire sample. In doing so the extreme values in the frequency distribution were omitted as they were having a single digit frequency. For calculation purpose, the cutoff point was 2.5 % on both sides of the frequency distribution.

Optimistic, most likely and pessimistic values for responsibility, control, advice and symbolic dimensions of user involvement are shown in Figure 2(a). Optimistic, most likely and pessimistic values for innovation, intelligence, integration and interaction dimensions of MIS flexibility, usage flexibility and organizational flexibility are given in Figures 2(b), 2(c), and 2(d) respectively.

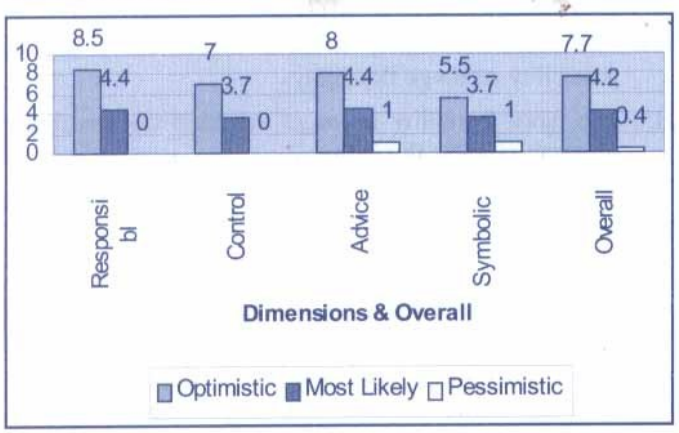


Fig. 2 (a) User Involvement in Strategic Planning of MIS

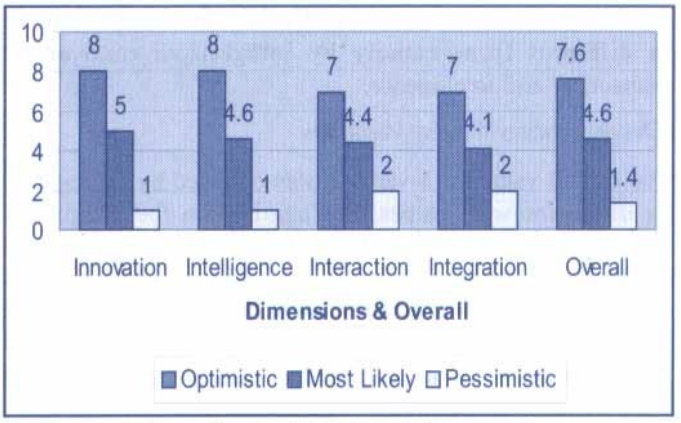


Fig. 2 (b) MIS Flexibility

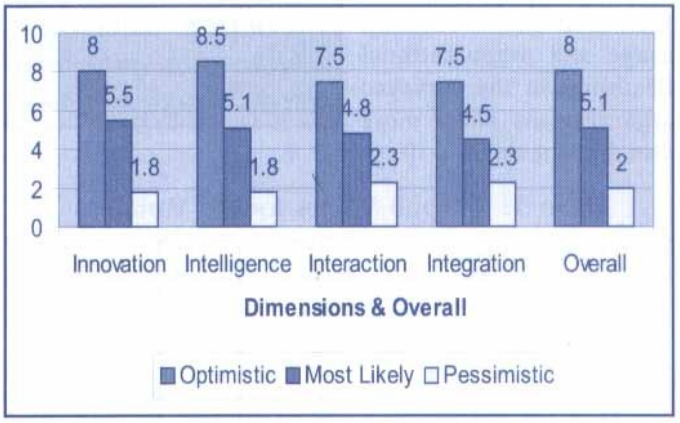


Fig. 2 (c) Usage Flexibility

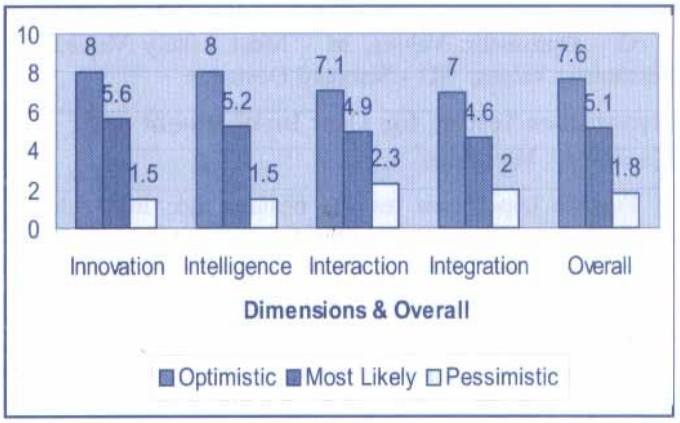


Fig. 2 (d) Organizational Flexibility

The dimension–wise values are useful to get more insight into each dimension of a construct. For instance, dimension-wise values for user involvement help to know the degree of involvement by responsibility, control, advice, and symbolic. These values are useful to identify and diagnose the causes in case of low involvement. If the involvement is less in any front, the importance can be understood by the weights and accordingly the management can take corrective action. For

example, if less responsibility is shown by the users in MIS planning exercise, management need to mediate to involve them for more responsibility. Also the dimension-wise values and the weights are useful to assign priorities for management intervention. Similarly, the dimension wise values for flexibility variables are useful to diagnose the flexibility status in different front namely by integration, innovation, interactive, and intelligence.

Overall Values for the Variables

The overall value for a variable was obtained by aggregating its dimension-wise values. For aggregation the weights of the respective dimensions had been used. For instance, to obtain the aggregate value for user involvement the weights (0.4, 0.25, 0.25, 0.1) were used. The overall standard deviation was computed based on the weighted average of four dimensions of the respondents. The overall values for each variable in optimistic, most likely and pessimistic scenarios are reported in Table 3. It can be seen that usage and organizational flexibility in the surveyed organizations show more than 5 in a scale of 0–10.

Forty two public and private organizations were selected at random from eight different sectors including service, information consultancy, engineering, automobile, consumer goods, consumer durable, high technology and Government.

Table 3: Overall Values for the Variables

No.	Variable Name	O	M	P	S.D.
1.	User Involvement in strategic planning of MIS	7.7	4.15	0.35	2.06
2.	MIS Flexibility	7.6	4.55	1.4	1.7
3.	Usage Flexibility	7.95	5.06	2	1.65
4.	Organizational Flexibility	7.6	5.13	1.76	1.49

O - Optimistic Values, M - Most Likely Values, P-Pessimistic Values, SD - Standard Deviation

Hypotheses Testing for User Involvement and Flexibility Variables

For the hypotheses testing, besides the "most likely" values from the data distribution, the extreme values of data namely optimistic and pessimistic values were considered. Testing the hypotheses with the extreme values of empirical data gives more confidence in accepting or rejecting them. This is because a hypothesis that is true with most-likely value set, may fail to stand in an extreme scenario. In those cases, the hypotheses are to be accepted subject to certain extreme conditions and to be cautious in interpreting the results in the vicinity of data distribution. For unconditional acceptance, the hypotheses are to be tested in all cases including the extreme scenarios and thereby any uncertainty in the conclusion will be reduced.

The scale table has both fuzzy sets of possibility values and the ordinal scale. The possibility values are in interval scale (in an interval of 0-1). The qualitative values from 'Very High' to 'Almost Nil' are in ordinal scale. Also the scale table facilitates to convert interval to ordinal data by converting the fuzzy sets to qualitative values. Therefore, the sample data can be viewed in interval mode of data by considering the fuzzy sets of possibility values and by omitting the qualitative values. On the other hand, the qualitative values, which are the defuzzified fuzzy sets, will result into ordinal scale.

To test the relatedness of two variables, (i) when the data for them is in interval scale, Pearson correlation coefficient is an appropriate statistic and (ii) when the data is in ordinal scale chi-square would be an appropriate statistic (Motulsky, 1995). Since the data collected in this study could be viewed in both interval and ordinal through the scale table, for statistical testing purposes both the modes of data were considered. Accordingly, for each mode, an appropriate statistic was used namely Chi-square test for ordinal form of data and Pearson correlation co-efficient for interval form of data.

The Chi square test of independence examines the association between two qualitative or categorical variables and Pearson correlation coefficient quantifies the degree of association between them. The chi-square test discloses whether scores on the two variables are independent or related; of course with an assumption that the sample is random and the sample data is nominal or ordinal. Hence the Chi-square test of independence authenticates the relatedness of two variables. SPSS package was used to compute the statistical values and results of hypotheses testing are summarized in Appendix IV.

Chi square and correlation values shown in Appendix IV support the following hypotheses at 0.001 level of significance:

H1. User involvement in MIS Strategic planning increases the possibility of MIS flexibility.

H2. The more flexibility in MIS, greater the possibility for organizational flexibility.

H3. User involvement in MIS Strategic planning increases the possibility of usage flexibility.

H4. The more flexibility in MIS influences a higher possibility of usage flexibility.

H5. The more flexibility in usage increases the possibility of organizational flexibility.

User Involvement in MIS Strategic Planning and MIS Flexibility

The results in Appendix IV show a significant Chi-square value for user involvement in MIS strategic planning and MIS flexibility and validate that the two are related in the optimistic, most likely, and pessimistic data values. The degree of association between them is positive (r=.2562) at 0.001 level of significance.

MIS Flexibility and Organizational Flexibility

The Chi-square value in Appendix IV shows that MIS flexibility and organizational flexibility are not independent and validate that the two are related on optimistic, most likely, and pessimistic data values. The results on correlation co-efficient show a high positive association (r=0.5479) at 0.001 level of significance.

User Involvement in MIS Strategic Planning and Usage Flexibility

Appendix IV shows a significant Chi-square for user involvement in MIS strategic planning and usage flexibility and validate that the two are not independent on the optimistic, most likely and pessimistic data values; the association between the two is positive (R = 0.3496) at 0.001 level of significance.

MIS Flexibility and Usage Flexibility

Chi-square value in Appendix IV shows that MIS flexibility and usage flexibility are not independent and validate that the two are related on optimistic, most likely, and pessimistic data values. The correlation coefficient shows a positive association (R=0.3820) at 0.001 level of significance.

Usage Flexibility and Organizational Flexibility

Appendix IV shows a significant Chi-square for usage flexibility and organizational flexibility and validates that the two are not independent on the optimistic, most likely and pessimistic data values. The association between them is positive (R = 0.2774) at 0.001 level of significance.

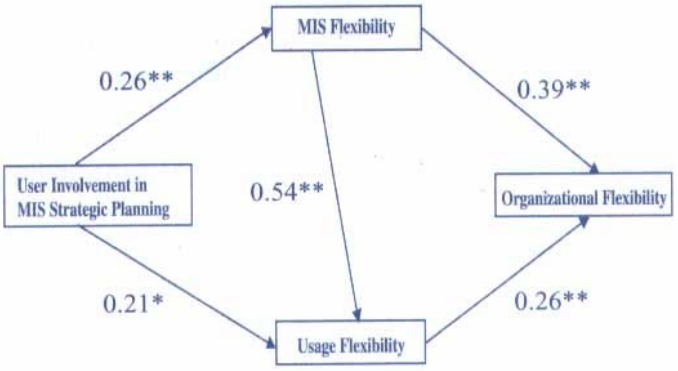
Path Analysis

Path analysis was carried out to study the direct and indirect effects of causal variables. Path analysis is a method for discovering causes and the analysis was carried out with the intention of testing the theoretical considerations in the hypotheses H6, H7, and H8. Examining the amount of causal impacts gives more confidence in making statements about the actions to be taken to produce desired changes in the dependent variable viz. organizational flexibility.

Total effect on organizational flexibility from user involvement in MIS strategic planning is 0.19. This can be used to predict the organizational flexibility from user involvement in MIS strategic planning.

A causal model consisting of user involvement in MIS strategic planning, MIS flexibility, usage flexibility and organizational flexibility is shown in Figure 1. The exogenous variable in this model is user involvement in MIS strategic planning whose variability is assumed to be determined by causes outside the causal model. The other variables are endogenous variables whose variation is explained by exogenous variables or endogenous variable in the system.

When the variables are expressed in standardized form (z scores), the path coefficients turn out to be standardized regression coefficients obtained in the ordinary regression analysis (Tukey 1977, Pedhazur 1982). So stepwise regression analysis was carried out at each stage of the path diagram and the standardized regression coefficients (the beta values of the regression analysis) were used as the path coefficients. The results of path analysis are shown in Figure 3.



** Statistically significant at 0.001 level
* Statistically significant at 0.01 level

Figure 3. Results of Path Analysis Showing Path Coefficients (Standardized Regression Coefficients)

Hypotheses Testing for the Causal Model

For the causal model, bivariate regression was carried out for each pair of variables. The path coefficients with the significant level for each pair are shown in Figure 3. The effect of MIS flexibility on usage flexibility is significant (P<0.001) and the effect is 0.54; effect of usage flexibility on organizational flexibility is also significant (P<0.001) and the effect is 0.26. So hypothesis H6 is accepted namely the usage flexibility mediates the relationship between MIS flexibility and organizational flexibility.

The effect of user involvement in MIS strategic planning on MIS flexibility is significant (P< 0.001) and the effect is 0.26; effect of MIS flexibility on organizational flexibility is also significant (P<0.001) and the effect is 0.39. So hypothesis H7 is accepted that the MIS flexibility mediates the relationship between user involvement in MIS strategic planning and organizational flexibility.

The effect of user involvement in MIS strategic planning on MIS flexibility is significant (P<0.01) and the effect is 0.26; effect of MIS flexibility on usage flexibility is also significant (P<0.001) and the effect is 0.54. So hypothesis H8 is accepted that the MIS flexibility mediates the relationship between user involvement in MIS strategic planning and usage flexibility.

Causal Impacts for Organizational Flexibility

The direct and indirect impacts on organizational flexibility are shown in Table 4. The direct effect of an exogenous variable is shown by the path coefficients and the indirect effect is generated by the intervening variables. The indirect

effect is measured by the product of the path coefficients in each cause effect link of the route under consideration. In case of more than one indirect path, total indirect effect is the sum of all possible routes leading to the endogenous variable. The total impact on the endogenous variable is the sum of direct and indirect effect. The result on the causal impact for organizational flexibility from MIS flexibility is shown in Table 4. For organizational flexibility the direct effect from MIS flexibility is 0.39 and the indirect effect is 0.14, which is through usage flexibility. As a result the total effect on organizational flexibility from MIS flexibility is 0.53.

The results on the causal impact for organizational flexibility from user involvement in MIS strategic planning are also shown in Table 4. This is in support of hypothesis H7. For the endogenous variable organizational flexibility, the direct impact from user involvement in MIS strategic planning is nil; the indirect impact is 0.19 through three routes; first is through MIS flexibility, second is through usage flexibility and the third is through MIS and usage flexibility together. As a result total effect on organizational flexibility from user involvement in MIS strategic planning is 0.19. This can be used to predict the organizational flexibility from user involvement in MIS strategic planning.

To increase the flexibility at the strategic level, more decision supporting systems are required and at the operational level more decision–making systems are required.

Table 4: Total Effects for Organizational Flexibility

Hypotheses	Variable from	Direct	Net Indirect (Intermediate path)	Total (Direct + Indirect)
H6	MIS flexibility	0.39	Via. Usage flexibility 0.14 (0.54*0.26)	0.53
H7	User involvement in MIS strategic planning	Nil	Via. MIS flexibility 0.101 (0.26*0.39) Via. Usage flexibility 0.055 (0.21*0.26) Via. MIS, Usage flexibility 0.037 (0.26*0.54*0.26)	0.19

Causal Impacts for MIS Usage Flexibility

The result on the causal impact for usage flexibility from user involvement in MIS strategic planing is shown in Table 5. This is in support of hypothesis H8. For the endogenous variable usage flexibility, the direct impact from user involvement in MIS strategic planning is 0.21, the indirect impact is 0.14 through MIS flexibility. The total effect on usage flexibility from user involvement in MIS strategic planning is 0.35. This can be used to predict the usage flexibility from user involvement in MIS strategic planning.

Table 5: Total Effect of User Involvement on Usage Flexibility

Hypotheses	Variable from	Direct	Net Indirect (Intermediate path)	Total (Direct + Indirect)
H6	User involvement in MIS strategic planning	0.21	Via. MIS flexibility 0.14 (0.54*0.26)	0.35

Discussion

MIS Flexibility and Organizational Flexibility

Agile companies depend heavily on information technology to support and manage business processes, while providing the information processing capability to treat masses of customers as individuals (O' Brien, 1999). Organizational flexibility allows a company to harmonize with other companies even with competitors; agile organizations leverage the impact of its information systems to bring new and innovative products to market as rapidly and cost effectively as possible. To upgrade and expand the organizational skill for more flexibility, information should be available to identify the required organizational skills. Customers expect the best technology and performance from the products and services; accordingly organizational technology is to be upgraded. The emerging technologies could be outsourced and the matured technologies could be developed indigenously to provide total solution and convenience to the customers.

In order to orchestrate with the organizational flexibility information systems need to be developed to support operational, tactical and strategic levels of management in a balanced manner. Application systems to support and implement organization's competitive strategies are to be incorporated in MIS planning. For example, if the competitive strategies are cost leadership, differentiation and growth then MIS should facilitate to implement these strategies. To achieve this, MIS with Extranet technology can be used to lower the cost to customers. Products and services are to be differentiated with innovative features such as on-line tracking of customer orders. Organizational growth is achieved by providing information support to regional and global business operations with technologies like global telecommunication network.

MIS Flexibility and Usage Flexibility

Information Systems applications development should focus on individual as well as group usage. To cater to the individual, the features of MIS and Decision Support Systems can be combined to feed the strategic information needs. For a group, information systems can provide interactive support to managers for their decision-making processes. Managers must be able to use the information systems to create scenarios by doing 'what if' kind of analysis as

well as must be able to use the reports for routine decision making.

Information reports generated from operational and strategic systems should enable the managers to manipulate large amount of detailed and consolidated data from many perspectives. To increase the flexibility at the strategic level, more decision supporting systems are required and at the operational level more decision making systems are required. Provisions are to be given to make decision maker's own insight and judgement in the decisions. MIS should provide more aggregate and consolidation reports as well as detailed and drilling-down reports. For example sales data can be rolled up to districts, and districts can be rolled up for regions to have more aggregate reports. Similarly detailed reports such as sales by individual products or by sales reps should be also provided for more usage flexibility.

User Involvement in MIS Strategic Planning and MIS Flexibility

Though in general all the users are equal stockholders in MIS planning, perhaps due to their routine commitments all of them might not be involved, but user representatives from the key departments can participate. The users can explain the strategies and future changes in their own business departments, accordingly provisions are to be made in MIS to react to such new situations. To balance the application development at operational and strategic level, user from both levels are to be involved to get inputs to the MIS planning process. Users can explain in what way the information systems can respond rapidly for strategic changes. User inputs are important from planning to screen implementation of an application system.

MIS planning working group including user representatives can conceptualize different modules linking with business strategies at the corporate and operational level to support and implement organization's strategies. Users play a key role in translating the business mission and objectives into MIS mission and objectives. Thus the business development plans can be linked with the MIS plans. In analyzing IT trends and its impact, users should be exposed to various sophisticated systems and new packages. In detailing the strategies and directions of information systems development, the departmental nominees at the working committee can interact with the MIS staff to lay down policies on MIS prioritization and budgeting for the prior areas of applications.

User Involvement in MIS Strategic Planning and Usage Flexibility

By allowing the users to have more hands on experimentation with information systems prototypes, suggestions for usage flexibility can be obtained. Users can detail the information systems modules, which are to be independent and homogeneous and at the same time should be capable of being utilized for the future. The information reports generated by different modules should benefit the users for creative thinking and scenario building rather than simple menu driven. In the planning process, users can classify the required information for usage based on the user type and functional area. For instance production information for top management may be reported in the on-line mode whereas commercial information for purchases can be in off-line mode.

The information reports are to be designed for user's current needs and likely needs. As each user's needs are liable to change, by involving them, visualization of future requirements could be addressed. User nominees from the functional areas can explain the different reports and queries needed to the planners. The users can better see the contents of aggregate information reports and detailed information reports.

Usage Flexibility and Organizational Flexibility

For better customer service, organizations are preparing to renew the skills in traditional and advanced areas. Consequently organizational processes are to be upgraded with the state-of-the-art technology. To implement the strategic business processes, management has to be well informed about all possible alternatives. By using information systems, managers must be able to manipulate the databases to generate scenarios to understand the given situation. Besides, usage flexibility enables the managers to react quickly to market pressures.

Information reports usage should trigger the decision-makers for creative thinking so that innovations could be incorporated in the organization's renewal process. Organizational decision making process is facilitated by using both decision making and decision supporting systems. For the strategic level business processes, aggregate and critical information is required and at the same time operational level requires detailed reports; one can achieve this with more usage flexibility. As the MIS usage flexibility increases organizational flexibility increases. Flexible flow of information in all functional areas enables the organizations for cheaper and quality products with reduced lead-time.

Concluding Remarks

When there is flexibility without any intent then the identity will be lost. So some outline is required within which flexibility could be achieved. Flexibility in information systems can be achieved with reference to organizational goals and objectives. The further development and expansion of applications can be done within this boundary. Flexibility should be incorporated in the entire communication process between the sender and receiver avoiding any possible noise factors or controversies. The work culture in the organizational set up has to be changed for more information driven management.

Instead of restricting the users to specify their information requirements alone, they can be involved in a distributed manner in various stages like planning, design, development and implementation of information systems. Identifying the people who are directly related to information systems usage and involving them as stake holders in the MIS planning

team is a crucial task for success. Top management commitment will facilitate a successful planning process. Creating an opportunity to the users to have discussions with their counterparts in bench marking organizations can generate willingness for their involvement. User's knowledge about IT and education to plan, build, and use MIS can facilitate for more involvement. Also, experience in earlier interaction with MIS planning team could pressure the users for meaningful involvement.

To gain more insight into user involvement and flexibility, dimensions have been considered and the priorities are obtained from the field to reduce the researcher's bias. For further research, relationships between the dimensions of involvement and flexibility can be studied to explore how the users could be involved for more MIS flexibility and how MIS flexibility can be increased to achieve more organizational flexibility.

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APPENDIX I. Measures for User Involvement and Flexibility Variables

User Involvement in MIS Strategic Planning

User involvement level in explaining the business mission and the business strategies
User involvement level in detailing the strategies or direction for information system development
User involvement level in analyzing the IT trends and their effect on the organization
User involvement level in linking the IS plan with business strategies

MIS Flexibility

Information Systems provide support for
Operational/ Strategic Management
Information Systems support for organization's strategic changes
Passive/ Active
Information Systems application development is for
Individual/ Group
Nature of information available for strategic changes
Proactive/ Reactive

Usage Flexibility

Information systems reports are used for
understanding the situation (informative)/making decisions
Information systems reports are used for
creative thinking/conservative thinking
Information systems used to obtain more
aggregated information/detailed information (drilling down) from the reports
Information systems reports are used to
Make decisions/support decisions

Organizational Flexibility

Organizational skill upgradation occurs in
Traditional/Advanced areas
Organization respond for competition in a more
Reactive/Proactive way
Organizational strategies are more focused on organization's
Stability/Growth.
Technology upgradation in the organization is done by
Technology import/Indigenous development

APPENDIX II

(a) Fuzzy Sets for Scaling User Involvement

Qualitative Values	Respon-sibility	Control	Advice	Symbolic
Very High	0.9	0.8	0.9	0.2
High	0.8	0.6	0.7	0.3
Moderate	0.6	0.6	0.4	0.4
Low	0.2	0.3	0.3	0.5
Very Low	0	0.1	0.2	0.6
Almost Nil	0	0	0.1	0.1

APPENDIX II

(b) Fuzzy Sets for Scaling Flexibility

Qualitative Values	Respon-sibility	Control	Advice	Symbolic
Very High	0.8	0.9	0.9	0.8
High	0.8	0.7	0.6	0.6
Moderate	0.6	0.5	0.5	0.4
Low	0.3	0.3	0.3	0.3
Very Low	0.1	0.1	0.2	0.2
Almost Nil	0	0	0.1	0.1

Appendix III: Item-wise Analysis (Question-wise Analysis)

ITEM NAME (Qn. No.)	Optimistic	Most Likely	Pessimistic	S.D.
Q1. User explaining the mission and strategies	8.45	4.03	0.35	2.51
Q2. User setting the MIS direction	8.45	4.42	0	2.34
Q3. Analyzing the IT trend	8.45	4.14	0.35	2.44
Q4. Clarifying the IT linkage with business	8.45	4.06	0.35	2.41
Q5. Organizational skill upgradation	8.3	4.93	1.4	2.27
Q6. Response to competition	8.3	4.73	1.4	2.29
Q7. Strategy orientation	8.3	5.7	1.4	2.43
Q8 Technology upgradation	8.3	5.29	0.4	2.36
Q9 MIS support for operational and strategic	8.3	5.07	1.4	2.37
Q10 Support for strategic changes	8.3	4.34	1	2.3
Q11 MIS development for individual and group	8.3	4.58	0.4	2.45
Q12 Support for strategies	8.3	4.49	0.4	2.39
Q13 MIS reports for informative and decision support	8.3	5.37	1.4	2.45
Q14 Reports for creative and conservative	8.3	4.6	0.4	2.41
Q15 Prefer to use brief and detailed reports	8.3	5.19	1.4	2.46
Q16 Reports for making and supporting decisions	8.3	5.28	1.4	2.33

Appendix IV: Results of Hypotheses Testing: User Involvement and Flexibility variables

Hypotheses	Variable 1	Variable 2	Results
H1	User involvement in MIS strategic planning	MIS Flexibility	80.55a 25[b] .0000[c] .2562** R[O] R[M] R[P]
H2	MIS Flexibility	Organizational Flexibility	139.68[a] 25[b] .0000[c] 5479** R[O] R[M] R[P]
H3	User involvement in MIS strategic planning	Usage Flexibility	60.39[a] 25[b] .00009[c] .3496** R[O] R[M] R[P]
H4	MIS Flexibility	Usage Flexibility	32.19[a] 15[b] .0004[c] .3820** R[O] R[M] R[P]
H5	Usage Flexibility	Organizational Flexibility	56.56[a] 25[b] .0003[c] .2774** R[O] R[M] R[P]

[a] Pearson's Chi-square Value, b Degrees of Freedom, c Significance level
* Pearson's Correlation coefficient 1 tailed significance ($p<.01$)
** Pearson's Correlation coefficient 1 tailed significance ($p<.001$)
[O] - Optimistic,M - Most Likely,P - Pessimistic
[R] - Related

Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Strategic MIS Planning"* on the following points:
   - Flexibility in terms of "options"
   - Flexibility in terms of "change mechanisms"
   - Flexbility in terms of "freedom of choice" to participating actors.
2. Identify and describe the types of flexibilities in strategic MIS planning that are relevant for your own organizational collaborative product development? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational technological system on following on continua. (Please tick mark in the appropriate box(es)).

User Involvement

Control ☐ ☐ ☐ ☐ ☐ Symbolic

Information system support

Passive ☐ ☐ ☐ ☐ ☐ Active

Organizational Response

Reactive ☐ ☐ ☐ ☐ ☐ Proactive

IS Reports for

Conservative thinking ☐ ☐ ☐ ☐ ☐ Creative thinking

4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Strategic MIS Planning"* relevant to your organization.

Reflecting Applicability in Real Life

1. Map the various types of flexibilities discussed in this paper for your organization and discuss their relationship with user involvement in MIS planning.
2. To what extent the findings of this paper are relevant in the strategic MIS planning of your organization? discuss.

Empirical and Case Study

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Flexibility and Competitiveness : Case of Software/Services Firms in India

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Abstract

Software industry has emerged as a powerful engine of economic growth. India, with its comparative factor advantages, has excessively high hopes on the industry. These hopes were partly fueled by more than fifty percent growth rates the industry experienced over the last decade. The new century demands new paradigm to succeed. Recent slow down in the U.S. and its adverse impacts hints at the weaknesses in the business model and managerial approaches used by many Indian firms to compete. Flexibility, a common theme among many evolving managerial approaches, will be critical for success of the software firms in their competitiveness journey. Attempts have been made in this paper to understand the role of flexibility in competitiveness taking the case of software industry. Correlation among criteria of flexibility and specific factors of competitive performance has been explored. The findings are reinforced through case study of a leading Indian organization that has sustained its competitiveness.

Keywords: competitiveness, flexibility, information technology (IT), software industry

Introduction

Software and related service industries are major growth drivers and India is keen to make its mark in such industry. Software industry has created enormous expectations in taking India into high growth territory. The average growth rate for the industry has been more than fifty percent in the last decade of the twentieth century. Its share of the Indian exports has been also increasing continuously (Table 1). However, the sustained competitiveness and growth prospects of the industry are increasingly questioned in wake of rapidly changing global scenario.

Table 1 : Share of electronics, Computer software & services in India's total exports (1992-93 to 1999-2000)

Year	Percent share	Growth rate (%)*
1992-93	3.6	
1993-94	3.6	26.72
1994-95	4.7	44.51
1995-96	6.0	66.37
1996-97	7.3	46.51
1997-98	9.0	
1998-99	11.4	
1999-2000	14.1	

Source: Electronics & Computer Software Export Promotion Council of India (ESC, 2000); * Export growth.

Competitiveness is the foundation on which such growth can be achieved. The long-term competitiveness of a firm can be judged from its sustained growth rate over years. One such indication is total shareholders return (TSR). A study done by Boston Consulting Group gives a list of best performing companies over the last few years that have created value to its shareholders consistently (BCG, 2000). In following table, the world's top performers according to the TSR value are given (Table 2). The return in industries like information/ communication and telecommunication (IC&T) and media are very high.

Table 2 : World's Top Performers and Value Creators

Company	Sector	Average annual TSR (1995-99) (%)
Infosys	IC&T	170
Wipro	IC&T	164
Dell Computer*	IC&T	153
Zee Telefilms	Media	151
America Online*	Media	143
Satyam Computer	IC&T	141
SAP*	IC&T	91
NIIT	IC&T	90

Source: Corporate Dossier, The Economic Times, New Delhi, 12-18 May 2000. * TSR for 1994-98.

Sustaining competitiveness in rapidly changing market dynamics demands flexibility, particularly on part of enterprises. Companies are trying to introduce different flexibility measures to improve and enhance their competitiveness in rapidly changing business environment. The relationship between flexibility and competitiveness has been visualized for quite some time, but it's rare that these relationships have been quantified (Sushil ed. 2000 b). This research is an attempt in this direction to explore the role of flexibility in competitiveness in context of software/ service industry.

Concepts of Flexibility and Competitiveness

Flexibility can be defined as '*the ability to change or react with little penalty in time, effort, cost or performance*' (Sushil, 2000 & 2000a). Flexibility is a multi-faceted concept with different connotations, paradigms, foundations and dimensions. Strategic, Organizational, Financial, Information Systems and Manufacturing flexibility have been identified as cornerstones of enterprise flexibility (Sushil, 2000). Flexibility is not shifting to extremes, but to dynamically balance them. There are many connotations of flexibility like agility, adaptiveness, responsiveness, versatility, etc. One popular view of flexibility can emerge by mapping it on to functional structure (Sushil ed., 2000):

- Strategic Flexibility
- Manufacturing Flexibility
- Human Resources Flexibility
- Financial Flexibility
- Technology Management Flexibility
- Marketing Flexibility
- Organizational Flexibility
- IT/ IS Flexibility

Concept of competitiveness is becoming very important in today's world, as scores of Indian firms and industries face unparalleled competition and survival crisis. Continuous downward slide of rupee is just one reflection of declining competitiveness of the nation as also visible in rankings by World Competitiveness Yearbook (WCY) (Table 3). Ongoing research about competitiveness of Indian industries by benchmarking with Japan, Korea, U.S. etc. have identified specific weaknesses of Indian industries and challenges ahead (Momaya, 2001). In context of competitiveness, many frameworks and models are available. Asset-Process-Performance (APP) framework provides interesting opportunities for focus on different factors of assets and processes to enhance competitiveness on specific variables related to a firm's performance (Momaya, 1996).

Competitiveness can be defined at three levels: nation, industry/ sector and company/ firm level. There are many different definitions of the comprehensive concept of competitiveness. The functional definitions of competitiveness at three levels as given by D'Cruz are (D'Cruz, 1992):

Table 3 : World Competitiveness Yearbook Ranking of Select countries, April 2001

Country	2001	200	1999	1998	1997
USA	1	1	1	1	1
Singapore	2	2	2	2	2
Canada	9	8	10	8	6
Japan	26	24	24	20	17
Korea	28	28	41	36	30
Malaysia	29	27	28	19	14
China	33	30	29	21	27
Thailand	38	35	36	41	31
Philippines	40	37	31	32	29
India	**41**	**39**	**42**	**38**	**41**
Russia	45	47	46	43	46

Source: World Competitiveness Year Book, WCY (2001).

- Country Competitiveness: Extent to which a national environment is conducive or detrimental to business.
- Industry/ Sector Competitiveness: Extent to which an industry or a business sector offers potential for growth and attractive return on investment. The concept can also be defined as the collective ability of firms in the sector to compete internationally.
- Firm/ Company Competitiveness: Ability to design, produce and / or market products or services superior to those offered by competitors, considering the price and non-price qualities.

The average growth rate for the industry has been more than fifty percent in the last decade of the twentieth century.

According the strategy guru, Prof. Porter, competitiveness is directly related to the prosperity of a nation. In international markets, its' the firms, not nations, that compete among themselves. (Porter, 1998). The Asset - Process - Performance framework (APP Framework) can be used to capture importance of different factors of competitiveness. The framework can help identify action areas, if correlation among different criteria can be accurately established for a firm or an industry (Momaya, 2000). In this paper, this framework has been used. Competitive performance by a firm is obtained through its competitive processes using competitive assets. The performance of a firm can be measured by many criteria such as return on investment (RoI), economic value addition (EVA), profitability, trade balance (exports minus imports), etc. Similarly competitive processes include, among many others, strategy of the firm, human resources management, technological processes, financial management processes, knowledge management processes, etc. The assets include hardware, software, human resources, etc. Management of technology was identified as the key to competitiveness and wealth creation (Khalil, 2000). Hence, technological perspective was given more importance while selecting criteria to evaluate the relationship between flexibility and competitiveness.

Problem Definition

Indian software services industry has remarkable achievements, but faces major challenges particularly in wake of recent slowdown in technology industries in the USA. Countries like China have also focused seriously on the development of their software industry. China has shown it can surge ahead in sectors like manufacturing in the global arena in short time. It's planning to improve its competitiveness in industries like software and become global player sensing the opportunity in this industry. It can easily beat India in software competitiveness at this pace of growth. Chinese software industry already has significant competitive edge in most of the Orient. Orient is growing at very high rate and is one of the largest markets in the world. A very significant aspect of China's competitiveness is perhaps the mindset with which they conduct business (Rao, 2001).

Apart from consistent high growth over the last decade, the software industry has remarkable achievements in terms of quality, technological breadth, exports and employment (Ajitabh, 2000). However, it has some problems as well as challenges. A glimpse of major problems and challenges are given below:

Sustaining competitiveness in rapidly changing market dynamics demands flexibility, particularly on part of enterprises. Companies are trying to introduce different flexibility measures to improve and enhance their competitiveness in rapidly changing business environment.

- Low market share in the global market (less than two percent of total global market)
- Most of the firms are at the bottom of the IT/ Software/ Consulting value pyramid with quite low productivity
- Low productivity growth
- Products, branding and related industries such as IT hardware, communications
- India has a large pool of English speaking scientific professionals which is the basis of low cost comparative advantage for most of the IT/ Software firms, but this comparative advantage can't be sustained if not converted into long term competitive advantage.

Excessive dependence on a single market, and that too with low cost as unique selling proposition (USP), has hurt many companies as well as individuals. As indicated earlier, countries such as China have also focused seriously on the software industry. With experience and track record of global successes in manufacturing and flexible strategy, it will not be surprising to see China surge ahead of India in short time.

Research Methodology

The study is based on primary as well as secondary data. The primary data were collected through questionnaire survey from 104 companies in the IT and software industry. The primary and secondary data consisted of pilot study, information from various annual reports of the companies, information from web, discussions from professionals, case studies, etc. An Indian company was selected for case study from list of companies having long-term sustainable performance. The interplay of flexibility and competitiveness was observed closely in the case study of the firm to identify various practical facets of flexibility. Systematic methodology involving mix of secondary data analysis and case approach was evolved to understand the link between flexibility and competitiveness. Based of pilot questionnaire and discussions, following hypotheses were evolved:

- Flexibility is positively correlated with competitive performance.
- Flexibility in processes have more important role than flexibility in assets.

(By process, it is meant that from the three facets of competitiveness, viz., asset, process and performance, flexibility in processes have more important role than flexibility than others).

Methodology of data collection

The primary data was done using questionnaire survey. The questionnaire was designed keeping in mind both qualitative and quantitative aspects of competitiveness of IT firm. The qualitative data were collected on a 5-point Likert scale, 1 being the strongly disagree and 5 being the strongly agree. The quantitative data were collected either in an absolute term or in ratios and subsequently converted into Likert scale. For example, lets look at following companies, their performance on productivity and corresponding value on the Likert scale (Table 4).

Table 4 : An Example of Conversion of Quantitative Data to Likert Scale

Company	Productivity (Sales, $'000 / employee)	Value on Likert Scale (From 1 to 5)
A	43	3
B	23	2
C	16	1
D	86	5
E	69	4

Note: for scores less than equal to 20, the value on likert scale was 1 (minimum), for 21-40, it was 2, and so on upto value 81-100, for which likert scale value assigned was 5 (maximum).

The questionnaire was designed and categorized under three facets of competitiveness: Competitive assets; competitive processes; and competitive performance. Some criteria/items, under each of the above said factors, were recognized and the questions were developed on each criterion/item. Approximately 85 questions were developed in the questionnaire (Himanshu, 2000). Generic criteria were

obtained from the asset - processes – performance (APP) framework (Momaya, 2000). Sub-criteria that were industry specific were obtained through preliminary pilot questionnaire survey and discussions.

The sampling was done on the basis of the non-probabilistic and judgment sampling. As indicated, the selection of the list of the companies were done considering the fact that the availability of data in public domain, easy access for questionnaire survey, listed companies and of course good performance for last few years (minimum 3 yrs). *Company/ firm* being the unit of analysis, the sample broadly covers the IT companies operating in software development and services, IT education and training, networking and communication technology in India. A total of 250 IT companies were selected from the database of Software Technology Park (STP), Noida, NASSCOM Report (1999), and Dataquest magazines. The questionnaires were dispatched to companies spread all over India, such as New Delhi, Noida, Gurgaon, Mumbai, Hyderabad, Bangalore and Bhubaneswar either by courier service, e-mail or by hand delivery wherever possible. The persons responding to the questionnaire were mostly members of the senior management such as directors, general managers, managers of human resource department and the proprietor of company. Financial aspects and other questions, based on data available from web or annual reports, were quantified. The respondents profile is given in Appendix II.

Continuous downward slide of rupee is just one reflection of declining competitiveness of the nation as also visible in rankings by World Competitiveness Yearbook

Secondary data was collected from various published sources. These included the annual report of companies, web resources, magazines newspapers, etc. Infosys Technologies Ltd. (ITL) was selected from among top Indian listed companies for case study. Infosys ranked high in many parameters like compounded annual growth rate, CAGR (1996-2000) – an indicator of long term competitiveness of companies, it had high return on capital employed (RoCE) and high Economic Value Addition (EVA). The selected firm was mapped using SAP model (Sushil, 2000).

Table 5 : Indian Software Companies - A comparison

Organization*	Sales (Rs. crore) 2001	Sales (Rs. crore) 2001	EVA (Rs. cr.), 2000	RoCE (%)	5 yr. CAGR (%) 1996-2000
Infosys	1900	884	106	46.4	53.4
TCS	2870	2115			36.5
Wipro	3054	2372	117	54.1	22.4
HCL Tech.	1127	400	5	18.4	27.9
NIIT		745	75	45.5	44.5

Source: Indian Software Report, ISR (2001), Indiainfoline.com
Note: The selected organization is among the top 10 companies in the sector as per revenue.

Case Study: Infosys Technologies Ltd.

Infosys Technologies Ltd. (ITL) Infosys was established in July 2, 1982, by a group of professionals. From a very modest start, today Infosys is a global brand and one of the leading in IT services company from India. It has its headquarters in Bangalore. It is India's top-ranked software company and undisputed leader in the industry in terms of the quality of its people, its technological prowess, the quality of most of its projects and its client list. The company has a high quality of management that, apart from giving the company the right strategic direction, has set high standards of corporate governance along with transparency of operations.

Infosys has adopted high quality standards for its software development process and is one of the few companies in the world to get the SEI-CMM Level 5 certification along with other quality certifications like ISP and TickIT. The company also has a very high quality of employees due to its strong personnel policies. This is a significant competitive advantage in an industry where the key resource is manpower.

Infosys offers its clients services in the area of software development, maintenance and reengineering services and e-commerce and Internet / Intranet consulting. The company also operates dedicated offshore development centres for some of its clients. The company offers clients both onsite and offshore services. In the domestic market it operates in the domain of banking where it has three products Bancs 2000, BankAway and FINACLE (launched in FY01). This makes a very small part of its revenues with the bulk of its revenues coming from export revenues. The company utilizes an extensive non-US based (offshore) infrastructure to provide software solutions to clients worldwide. 194 out of 500 *Fortune 500* companies are clients of Infosys. It has a *robust and resilient business model* (PSPD Model i.e. Profitable, Sustainable, Predictable and De-risking) that helps it to meet challenges thrown-up by changing market situations both in growing and recessionary period. Inherent built-in flexibility helps the company to meet the changing business scenario. One of the many examples of this is that the company's revenue from European operations have gone up to 20.5 percent, a remarkable shift from traditional American market, in short time i.e. in last quarter of last financial year (2000). The company plans and deploys its ingredients of growth in place – infrastructure, people, processes and systems – to meet changing global business conditions (Nandan, 2001).

Infosys has a very effective business and growth strategy. It has always used proactive approach for enhancing its performance and long-term competitiveness. The company's business strategy includes having world-class operating model, investing heavily in human resources, having financial flexibility using ESOPs (started in 1994), focus on managed software solutions, capitalizing on well-established offshore development model, maintaining disciplined focus on business

& client mix, etc. The growth strategy for the company includes, among many others, broadening service offerings, increasing business with existing clients, developing new clients, increasing revenue productivity (per IT professional), pursuing selective strategic acquisitions, etc. SAP Analysis of Information case is given in Appendix II.

Research Findings

First, we will give the results from the factor analysis of primary data and then we will discuss results from the case study. Using the APP framework, the analysis was done to find correlation between Performance criteria and Asset/ Processes criteria. Strong correlation between performance criteria like 'customer satisfaction' and 'attracting IT professionals' emerged from primary data analysis (Table 6). Some of the criteria, in asset and processes, like 'knowledge management processes', 'professional teamwork/ group work', 'employee job flexibility', 'talent management processes', 'employee stock option' are highly correlated with the two main criteria of 'customer satisfaction' and 'attracting IT professionals'.

Competitive performance by a firm is obtained through its competitive processes using competitive assets. The performance of a firm can be measured by many criteria such as return on investment (RoI), economic value addition (EVA), profitability, trade balance (exports minus imports), etc.

Table 6 : Correlation of performance criteria with Asset and Process criteria

Performance criteria ---→ Asets/Process criteria (below)	Customer satisfaction	Trade balance (Export-Import)	Attracting IT professional	Compounded annual growth rate (CAGR)	Return on capital employed (ROCE)
Professional team work/group work	0.425**	-	0.377**	-	-
Employee job flexibility	0.414**	-	0.287**	-	-
Adaptive to internal change	0.260**	-	0.403**	-	-
Adaptive to external change	0.195**	-	0.350**	-	-
HRD process	0.323**	0.200*	0.309**	-	-
Employee Stock Option	-	-	0.314**	0.401**	0.332*
Integrated project management	0.302**	-	0.328**	0.309**	-
Knowledge Management Processes	0.349**	-	0.519**	-	-
Talent mgmt. processes	0.416**	0.289**	0.415**	-	-

Note: * denotes correlation is significant at 0.05 level (2 tailed) and
** denotes correlation is significant at 0.01 level (2 tailed) for a sample of 104 software and services companies.

From the case study of Infosys, it can be said that the company has leveraged flexibility to scale new heights rapidly. The *strategic flexibility* provides maximum leverage to enhance competitiveness. *Openness* and *adaptability* to change has been the key for the success of the company in both growth and recessionary period (CII, 2001). Ability of the company to grow rapidly, even in face of changed circumstances indicates the soundness of its strategic management. Infosys utilizes its flexible business models and project management ability to manage the changes in terms of business segments, geographical segments, clients, technologies, products and services.

Table 7 : Drivers of flexibility in Infosys

Strategic Flexibility	Financial Flexibility	HR Flexibility	Operational Flexibility	IS Flexibility
▪ Speed ▪ Agility ▪ Choice ▪Client ▪ Project ▪ Technology	▪ ESOPs ▪ De-risking ▪ Multiple source financing	▪ Teamwork ▪ Openness ▪ Politics-free culture ▪ Individual growth-oriented culture ▪ Training	▪ Scalability ▪ Project Mgmt. Capability	▪ Project Mgmt. ▪ Knowledge Mgmt. ▪ Maturity-CMM

Note: ESOPs – Employee Stock Option Plan, CMM – Capability Maturity Model, HR – Human Resources, IS – Information Systems

Infosys sees its employees as greatest asset. It has unique human resource practice for its employees and innovative flexible working approaches that have strengthened its internal operations and helped in enhancing its effectiveness. All these show that the company has *human resources flexibility*. The company has a series of training programmes to help employees better themselves. The competitive firm shows some other flexibility as depicted in Table 7. The slogan coined by the company, *'Learn Once, Use Anywhere'* insists on having a common core strategy and using it with slight and appropriate additions and deletions for different projects wherever possible, is yet another example of flexible approach used by the company. To counter the uncertainty posed by the software industry worldwide, Infosys has a very concise and effective strategy, which lies in its project management skills; it can deliver any project from concept to completion within 18 months. This is because of its agile and effective project dis - integration and integration (offshore plus onshore) form its offices across the world.

Conclusion

Software/ services firms in India have been feeling the pressures from the slowing down of the global economy. Today, the growth plans, billing rates, bottom and top lines are adversely affected in these firms. Most of these firms have been trying hard to sustain their revenue, growth and competitiveness in this recessionary period. To compete in the global market, the firms have been using various management approaches including flexibility concept. Attempt has been done through this study to understand the

relationship between flexibility and competitiveness of firms. From the data analysis, relevant criteria has been selected and their correlation have been established. The major criteria that have strong correlation amongst various criteria are customer satisfaction and attracting information technology professionals. It is evident that flexibilities like strategic and human resources flexibility are more important for firms in the industry. Openness and adaptability to change has been the key for the success of the company in both growth and recessionary period. This paper is one of the first papers in identifying the relationship between flexibility and competitiveness at firm level. There is still considerable scope for exploring and understanding the dynamics of flexibility and competitiveness for the industry. Some of the areas of further research include identification and selection of more relevant criteria, establishing their correlation, development mechanism of these criteria for enhancing competitiveness through flexibility.

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Appendix I : SAP Analysis for Infosys

SAP Model (Situation-Actor-Processes Model) has been used to understands the various flexibility dimensions that the company uses to enhance its competitiveness. As we know the external corporate environment is shifting from stable environment to highly turbulent and its is becoming more and more complex for the companies to formulate their strategies. The internal environment in the companies is also shifting from formal and traditional working environment to informal, creative and innovative environment. The control is shifting to a de-centralization from a centralized authoritative culture. In the changed environment, the roles of actors are also changing. Today can't afford to have only individualistic role; rather role of team is emphasized. Companies have to be more proactive rather than reactive and the thinking has been shifting from convergent to divergent and more open to enter into new markets where the challenges are high and the culture is different. The process for delivery has also been changing. Earlier due to relatively stable business environment, the processes were more or less programmed, now it has to be more creative, as the environment is becoming more and more ambiguous and requires participative rather than autocratic approach. The companies encourage entrepreneurial skill sin it. The time to respond to customer and deliver more value is decreasing making organizations agile. There is less of hierarchical organizational structure and more of networked structure that incorporates both local as well as global contents. The selection process of the employees is also shifting from only 'academic qualification' to a mix of both 'qualification' as well as 'ability to learn' criteria.

Graphical Representation

Situation

External Environment

Stability [I] Turbulence

Simple [I] Complex

Internal Environment

Formal [I] Informal

Traditional [I] Innovative

Centralized [I] De-centralized

Actors

Individualistic [I] Group/ Team

Reactive [I] Proactive

Thinking

Convergent [I] Divergent

Process

Programmed [I] Creative

Precise [I] Ambiguous

Autocratic [I] Participate

Culture

[I] Entrepreneurial

Slow [I] Agile

Organisation structure

Local Global

Hierarchical [I] Networked

Debt/Equity ration

Debt Equity

[I] (Zero debt)

Employee selection

Academic qualification Ability to learn

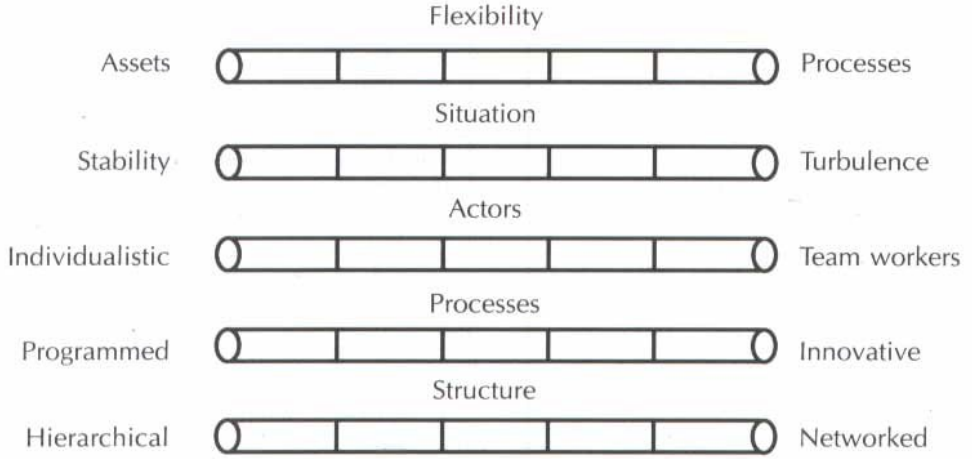
Note : [I] stands for Infosys.

Appendix II : Statistics of the Respondent-Firms and Sector-Wise Distribution

1.	**Number of employees**	**Respondent firms (%)**
	1. <100	12 (11.88)
	2. 100 -500	44 (43.56)
	3. 500 - 1000	17 (16.83)
	4. 1000 - 3000	17 (16.83)
	5. 3000 – 5000	6 (5.95)
	6. >5000	5 (4.95)
	Total	**101 (100)**
2	**Sales Turnover in Million US $ (Rs Million)**	Respondent firms (%)
	1. < 2.12 (<100)	23 (22.9)
	2. 2.12-4.25 (101-200)	02 (1.90)
	3. 4.25 – 10.6 (201-500)	18 (17.9)
	4. 10.6 – 21.2 (501-1000)	13 (12.8)
	5. 21.2 – 42.55 (1001-3000)	20 (19.9)
	6. 42.55-106.4 (3001-5000)	12 (11.8)
	7. >106.4 (>5000)	13 (12.8)
	Total	**101 (100)**
3	**Exports (% of total sales)**	Respondent firms (%)
	1. < 5%	40 (39.60)
	2. 5-10 %	4 (3.96)
	3. 10-30%	9 (8.91)
	4. 30-50%	11(10.89)
	5. 50-70%	9 (8.91)
	6. >70%	28 (27.73)
	Total	**101 (100)**
4	**Geographical spread**	Respondent firms (%)
	1. Bangalore	09 (8.92)
	2. Bhubaneswar	02 (1.98)
	3. Bombay	08 (7.92)
	4. Gurgaon	08 (7.92)
	5. Hyderabad	05 (4.95)
	6. New Delhi	35 (34.65)
	7. Noida	34 (33.66)
	Total	**101 (100)**
5	**Industry sector**	Respondent firms (%)
	1. Packages software, services and projects	
	2. Hardware	86 (85.15)
	3. IT Education and Training	08 (7.92)
	4. Dot com firms	04 (3.96)
	Total	**03 (2.97)** **101(100)**

Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Enhancing Competitiveness"* on the following points:
   - Flexibility in terms of "options"
   - Flexibility in terms of "change mechanisms"
   - Flexbility in terms of "freedom of choice" to participating actors.
2. Identify and describe the types of flexibilities in strategic MIS planning that are relevant for your own organizational Competitiveness ? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational technological system on following on continua. (Please tick mark in the appropriate box(es)).



4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Competitiveness"* relevant to your organization.

Reflecting Applicability in Real Life

1. How do you find the case study presented in this paper relevant to your organization ? Critically examine and use the relevant issues.
2. Based on the learnings from this paper, develop strategies to enhance the competitiveness of your organization/ industry.

Empirical Study

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Flexible Management of New Technology

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Abstract

Technology and its management are today matters of global primacy. Technology is being developed, improved, combined, refined, bought, sold and traded around the world at unprecedented levels. As technology is crucial to the development of a country, the management of such an important resource, both at national and enterprise levels, is vital. The technology and its management cannot be left to the forces of chance. As an important resource it has to be properly planned, cultivated and developed. Flexibility means being agile and the ability to be versatile. It also refers to qualities such as 'robustness' or 'resilience' that enables an enterprise to endure when negatively affected by changes. To have competitive advantage, flexibility needs to be introduced at various steps of technology management. An empirical study conducted has proved that there exists a strong relationship between flexibility and technology management, which calls for flexible management of new technology for strategic success.

Keywords: competitive advantage, flexibility, flexible management, new technology, strategic success

Introduction

Flexible management of new technology means providing freedom of choice to the technology manager and giving him different options to exercise his free will to manage the industrial situation through a flexibly evolved self-organizing management process, incorporating various change mechanisms. The technology manager understands the ambiguous situation through deep involvement, thinking of general qualitative patterns through reasoning by analogy. He exercises the freedom of choice to flexibly and systemically evolve a management process on the continuum in an interactive and innovative manner for generating an organic order in its own reality. The technology management process is a flexible and self-organizing that is to be evolved by him using his internal and external flexibility for managing situation in ambiguous and dynamic reality.

In the modern age, technology is perhaps the most important resource to any nation. To maintain their competitive edge, companies are increasingly looking outside. They adopt and assimilate new technology, improve and refine existing technology and combine both in their quest for success in world markets (Rastogi, 1993). Forces within the firm for technological solutions are harnessed, organised and encouraged. Problems needing technological solutions are identified, alternative solutions are generated, analyzed and evaluated.

Flexibility

Flexibility is the speed at which a system can react to and accommodate changes. Upton (1994) defines flexibility as the ability to change or react with little penalty in time, effort, cost, or performance. He proposes a framework for management of flexibility that asks a manager to identify dimensions, time horizon, and elements of flexibility for effectively managing flexibility.

The concept of flexibility, in an organisational context, refers to the ability to precipitate intentional changes, to continuously respond to unanticipated changes, and to adjust to the unexpected consequences of predictable changes (Bahrami, 1992). He states that flexibility is the ability to do things differently or do something else, should the need arise. He stresses that pioneering companies are experimenting with novel organizational structures and management processes. The impetus is towards flexible organizational forms, which can accommodate novelty, innovation, and change. Other developments include de-layering, team-based network, alliances and partnerships and a new employer-employee covenant.

Sushil (1997) advocates the concept of systemic flexibility, which is defined as "exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive manner, capturing the ambiguity in systems, and expanding the continuum with minimum time and effort."

Need of Flexibility

Many enterprises are in the midst of fundamental changes in organizational design and management practices. A shift towards greater flexibility generates challenges for management. The primary challenge posed by new flexible

technologies is their higher 'knowledge intensity' and the management of knowledge has become the central task of the firms wanting to survive in a world of rapidly evolving technological possibilities (Adler, 1988). Nemetz and Fry (1988) confirm that flexible manufacturing technology organizations will have the capability to be flexible in their response to unique customer demands.

Flexibility is a multi-dimensional concept, demanding agility and versatility; associated with change, innovation and novelty; coupled with robustness and resilience, implying stability, sustainable advantage and capabilities that may evolve over time (Bahrami, 1992). Confusion and ambiguity about flexibility severely inhibits its effective management. It is necessary for the management to know the dimensions of nature of change, time horizon and elements of flexibility (Upton, 1994).

Flexible Systems Management

Sushil (1997) has discussed an evolving paradigm of flexible system management, which revolves around the concepts of continuum and freedom of choice. It contemplates the dynamic interplay on the continuum by exercising freedom of choice exhibiting 'systemic flexibility'. Flexible system management has three components–situation, actor and process. A situation is to be managed by an actor through a flexibly evolved self-organizing management process. The actor understands the situation and exercises the freedom of choice to flexibly and systemically evolve a management process. The process is flexible and a self-organizing system of management is to be evolved by actor using its flexibility for managing situation.

The concept of flexibility, in an organizational context, refers to the ability to precipitate intentional changes, to continuously respond to unanticipated changes, and to adjust to the unexpected consequences of predictable changes.

Technology

Technology is defined as the practical knowledge, know-how, skill and artefacts that can be used to develop a new product or service and/or a new production/delivery system (Moriarity et al, 1990). Also, technology is the knowledge, tools, equipment and work techniques used by an organisation in delivering its products or services (Palaniswami and Bisho, 1992). It is the application of knowledge, scientifically derived or otherwise to the creation or modification of things and processes. Technology depends on (cannot exist without) knowledge of how to apply other knowledge to create or modify useful things or processes where knowledge has been derived scientifically or otherwise (Aldridge, 1990).

Technology is also defined as 'a body of knowledge, tools and techniques, derived from both science and practical experience, that is used in the development, design, production and application of products, processes, systems, and services' (Steensma, 1996). Technology refers to a system of components that act on or change an object from one state to another. The components include hardware, software and programs to transform materials or information from one state to another (Goodman and Griffith, 1991).

New Technology

New technology is a product or process that a company has not previously used in their operation. The technology from research and development laboratories that have yet not been piloted or commercialized even once is termed as new technology. It impacts organizations, people, product/services and the training functions that support them. Technology is quickly becoming a critical resource to drive and support human performance; therefore, it will have to be integrated with work. The existing infrastructure may put a premium on the compatibility of the two families of technologies, the new and the old. Also, technical capability requires the synergy of people and technology (Sharif, 1986).

There are many factors that affect the competition namely technology innovation, design and process flexibility, quality, productivity, cost, speed to market, service mix and so forth. This new set of factors dictating global competition has been radically changing the role of new technology. Technology is not only regarded as something coming along with new products and processes, but is taken as the means and results of the communication process between different functions like R&D, production and marketing. Thus technology has an important bearing on corporate performance and growth (Nandi, 1995).

Management of New Technology

Managing new technology means to use new technology to create competitive advantages (Betz, 1987). Management of technology links engineering, science and management disciplines to plan, develop and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization' (National Research Council, 1987).

In both the cases the words *managing* and *management* have compatible meanings. In the first case *managing* means 'to create competitive advantages'. In the second case, *management* means 'to shape and accomplish the strategic and operational objectives of an organization' (Aldridge, 1990). 'Management of Technology links engineering, science, marketing, operations, human resources and other management disciplines to formulate strategy, develop technological capabilities, and use them to achieve strategic objectives' (Price, 1996).

According to Soloman (1990), technology management is the capacity of a firm, a group or society to master the management of the factors that condition technical change so as to improve its economic, social and cultural environment and wealth, whereas, according to Pavitt (1990), the

successful management of technology requires the capacity to orchestrate and integrate functional and specialist groups for the implementation of innovations, continuous questioning of the appropriateness of exploitation of existing technology and a willingness to take a long view of technological accumulation within the firm.

Sethi and Hickey (1985), have proposed a methodology for introducing the strategic approach for technology management function into overall business planning process. A framework for incorporating technological issues into business strategy has been proposed by Frohman (1985) which consists of four steps, that are 'identifying the organization's distinctive technological competence(s), identifying technology that contributes or will contribute to business success, coordinating business goals and technological implications, and aligning systems for implementation'.

Phases of Technology Management

The process of technology management has assumed great proportions demanding its division into various phases. Popper and Buskirk (1993) have discussed technology life cycles in industrial markets with an analogy of product life cycles. They have divided the technology life cycle into six basic phases, i.e. cutting edge, state-of-the-art, advanced, mainstream, and mature and decline. In this study, the overall process of technology management has been divided into following phases.

Technology is defined as the practical knowledge, know-how, skill and artefacts that can be used to develop a new product or service and/or a new production/delivery system.

Technology Forecasting

Technological forecast is a prediction of future characteristics of useful machines, products, processes, procedures and techniques. It is also defined as 'the seeking of or anticipation of technological innovation' and is an important management function. Technology forecast serves as an input to the process of making plans and decisions for future expansion or new business or even to remain competitive in market. Some of the forecasting techniques commonly used are: brainstorming, Delphi technique, trend extrapolation, technology monitoring, growth curves etc. However, the forecaster has to judiciously select a technique or combination of techniques depending upon the methodology and end objective in views (Sareen, 1991).

Technology Planning

Planning is crucial for quick and timely commercialization of technologies. If technology planning is not done effectively, then no amount of investment in technology can yield results (Koerner, 1989).

Technology Development

Technology development means to develop technologies, i.e. translate R&D efforts to marketable products, processes, or services. Invention and innovation are the key requirements of technology development. Invention involves development of new technology by basic or applied research whereas innovation is the product of an organization accomplished through idea generation, collection, evaluation, experimentation and construction. Innovation represents the birth of the new product, material or process from R&D activities. In R&D laboratories new ideas are generated by 'need pull' and 'knowledge push' factors.

Successful innovations help obtaining marketing and customer expertise and generate sound financial foundations for subsequent innovations (Theis, 1996). The various technology development modes include in-house R&D, cooperative R&D, contract research, R&D collaboration, research societies and research companies.

Technology Acquisition

Technology acquisition can be viewed as a means of supplementing firm's internal innovative processes, allowing an organization to circumvent various phases of technology life cycle. By externally acquiring a technology, the organization may be able to access technology within the mature phase and forego previous developmental phases (Kumar, 1994).

Technology Transfer

Transfer of technology means transfer of knowledge generally through purchase of technology for use. In other words, technology transfer is defined as the process by which the embodied as well as disembodied knowledge contained within one organization is acquired by another (Kirkland, 1996).

This transfer can take place via publications, patent disclosures, and the interaction of personnel, joint ventures, turnkey projects, R&D companies, consultants and research companies. Transfer, unlike its common one-way movement of relocation often represents a two way of multilateral learning process (Dearing, 1993). Technology transfer can be a device to strengthen local production system, provide information and training, serve as a stimulant for further development, facilitate a more competitive position in international market place and assist in closing the gap between developed and developing nations.

Technology transfer can take place within the organization, within a group, within an industry, between industries, between governments, between industry and government or between industry and university. Based on the above transfer levels, we can classify transfer of technology into two main groups; horizontal and vertical technology transfer.

Horizontal technology transfer implies transfer of technology from one firm to another, generally located in different countries, mainly due to reasons of competition or near maturity of technologies. Vertical technology transfer means transfer of technology from an R&D organisation to a firm. Such transfers are mostly within the country and the

technologies are new, and may often require further efforts in terms of establishing commercial viability (Yilmaz, 1996).

Technology Adoption and Adaptation

Adoption and adaptation of technology are concerned with putting to use the new technology and its smooth acceptance and utilization. Adoption calls for adopting competitive technology at the right time. In this case, factors like customer needs, time of adoption, and similarity of new technology with the existing, changes for establishing production are all very important. Adaptation should be in the nature of technology transplantation, starting from the stage of design and detailed engineering itself up to replication of improved prototypes and indigenisation of tooling etc. Government policies, manpower planning, production processes and changes made in it for adaptation are important considerations (Singh et al, 1996).

Technology Diffusion and Substitution

Diffusion refers to the process by which technology is extended to other parts of the organization or across organizations. As new technology spreads throughout the organization, a social environment is created for the emergence of normative and value consensus (Griffith, 1991). The widespread introduction of a new technology within an organization, signals the legitimacy of the technology and it helps institutionalize the technology in the social environment.

Management of technology links engineering, science and management disciplines to plan, develop and implement technological capabilities to shape and accomplish the strategic and operational objectives of an organization.

The study of diffusion of new technologies can be categorized into three categories as intra-firm diffusion, inter-firm diffusion and economy-wide diffusion. Intra-firm diffusion is diffusion in different parts of the same organization. Inter-firm diffusion is diffusion in between different organizations. Economy-wide diffusion is diffusion of technology from higher economic organization to lower economic organization (Vij et al, 1992).

Technology substitution in the life span of technology represents the decline in the use and eventual extension of a technology due to replacement by another technology. Many technical and non-technical factors influence the rate of substitution. The time taken in the substitution stage depends on the market dynamics.

Technology Utilization

Industries all over the world are acquiring new technologies. However, it is seen in some cases that expensive machinery and equipment is generally not put to use in a manner in which it was planned in the beginning. The acquired technology should be utilized fully to improve the production facilities to meet the growing demand for higher quality, less cost, large variety, customer oriented products and services. Companies should not acquire technology merely for image enhancement (Hartano, 1994)

Technology Phasing-out

It occurs when the technology has reached the point of virtually universal applicability. License agreements have probably expired and technology will be of little commercial value for direct use. It is called obsolescence stage. Depending upon the industry's traits and nature of competition, the strategies vary from an immediate exit to increased investment. In this phase, new technology displaces the declined technology and firm survives only by pricing itself substantially below the new technology. However, some old technologies may still have a market value to the third-world nations (under-developed nations) that wish to employ surplus labor in the substitution projects (Madan Mohan, 1994).

Need of the Day

Flexibility needs to be introduced at all the phases of technology management to ensure its smooth assimilation in the existing systems. It is required to take up a detailed study which analyze all the areas and issues related with management of new technologies, the effects of each area and issue on the whole productive system and work out a systematic plan to manage the new technology introducing flexibility at every stage of the management process.

Correlation between Flexibility and Technology Management

A detailed survey has been conducted in various manufacturing enterprises in the northern region of India. The objective of the survey has been to determine the status of technology management in these organizations; flexibility incorporated in the management process; changing need of technology; effect of introducing flexibility in various phases of technology life cycle; attitude of top management, middle management, staff and workers towards change; financial resources available for incorporating flexibility in managing the new technology; and costs and benefits associated with various phases of technology management.

Methodology

For conducting the survey, the first task has been to design a questionnaire, which seeks information on status of technology management and incorporating flexibility in it. The questions have been designed on various phases of technology management starting from technology forecasting to phasing-out. Every phase carries questions pertaining to present level of flexibility in managing new technology in an organization. Questions pertaining to technical, economic, social and environmental aspects of managing technology are also included in every phase.

The questionnaire has been pre-tested and a survey carried out by mail and also by undertaking personal visits to the organizations. The response has been compiled and analysed to find out the information regarding status of new technology

in general, status in various phases of technology management, present level of flexibility, changing need of technology, effect of introducing flexibility in technology management and attitude of the management towards change.

The correlation between flexibility and technology management has been found out.

Industries Covered

The manufacturing industry in the northern region of India has been surveyed. The manufacturing industry produces a wide range of products like tractors, cars, bicycles, pistons, piston rings, diesel locomotives, filters for automobiles, harvesting combines, automobile engines, light commercial vehicles, motor cycles, scooters, shock absorbers, steel wires, casting of engine housings, manufacturing of refrigerators, air-conditioners, televisions, pressure cookers, telephones, automobile parts, cotton and synthetic yarn, industrial pumps, and a large number of other industrial goods and consumer durables.

A list of engineering industrial firms in the region was prepared by referring to the PHD Chamber of Commerce and industry directory of members, and Thapar directory of industries. A total of 186 industrial enterprises were selected.

Conducting the Survey

Initially, the questionnaire was mailed to all the 186 firms along with a covering letter stating the objectives of the study with a request to send an early reply. Subsequently, reminders were sent to all the firms to expedite the matter. Information from some of the organizations was received in this way. Most of the information, however, has been collected by making personal visits to the organizations and by having discussions with the executives at the senior levels.

Response from the Industry

A lot of efforts were made to get the maximum response from the industry. A total of 47 industrial enterprises out of 186 responded to the questionnaire. Out of these 186 firms, 144 were large-scale firms and 42 medium scales. Out of the responding firms, 38 were from large scale and 09 were from medium scale industrial units. The response of the industry is presented in Table 1 and depicted in Figure 1.

Adoption and adaptation of technology are concerned with putting to use the new technology and its smooth acceptance and utilization. Adoption calls for adopting competitive technology at the right time.

Table 1 : Response of the Industry

Classification	Questionnaire Sent to	Response	
	Number of Companies	In numbers	In percent
All firms	186	47	25%
With collaboration	90	18	20%
Without collaboration	96	29	30%
Large scale	144	38	26%
Medium Scale	42	09	21%

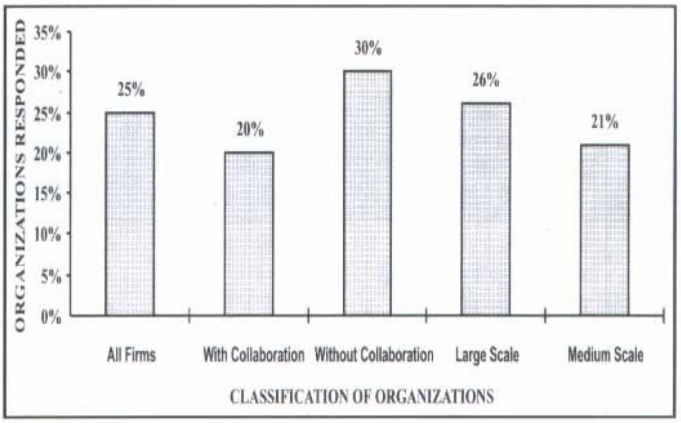

Figure 1 : Response of the Organizations

1. The sector-wise and scale-wise response as percentage of total response is given in Table 2.

Table 2 : Response of the Industry as Percentage of the Total Response

Classification	Number	Percentage of Total
Total	47	100%
Large firms	38	80%
Medium Scale	9	20%
Automobile Manufacturing firms	17	36%
Auto-Parts Manufacturing Firms	14	30%
House-hold Appliances	10	21%
Others	6	13%

Managing New Technology

It is observed from Appendix BI that the score in various phases of technology management is quite encouraging. Based on this score in all the 47 organizations, the average value *'x'* for each phase and its standard deviation *'a'* has been calculated. With the help of average value and standard deviation, the performance of the company has been rated as follows:

$> x + a$	V. Good
$> x$ to $x + a$	Good
$> x - a$ to x	Fair
$< x - a$	Poor

Table 3 shows these values and the percentage of companies getting it. From this table, it is clear that the status of technology management is fair to good in about 96% of the companies whereas only 2% are in very good range and 2% in poor. The bar chart in Figure 2 helps in comparing the status at a glance.

Table 3 : Status of Organizations in Technology Management

S. No	Phases of Technology Management	Percentage of Organisations under			
		V. Good	Good	Fair	Poor
0	Status	2	53	43	2
1	Technology Forecasting	4	58	38	—
2	Technology Planning	17	30	40	13
3	Technology Development	6	56	32	6
4	Technology Acquisition	13	41	23	23
5	Technology Transfer	13	40	36	11
6	Technology Adoption & Adaptation	17	26	38	19
7	Technology Diffusion and Substitution	13	36	45	6
8	Technology Utilisation	15	36	30	19
9	Technology Phasing-out	15	38	32	15
	Average of 1 to 9	**12.55**	**40.12**	**34.88**	**12.45**

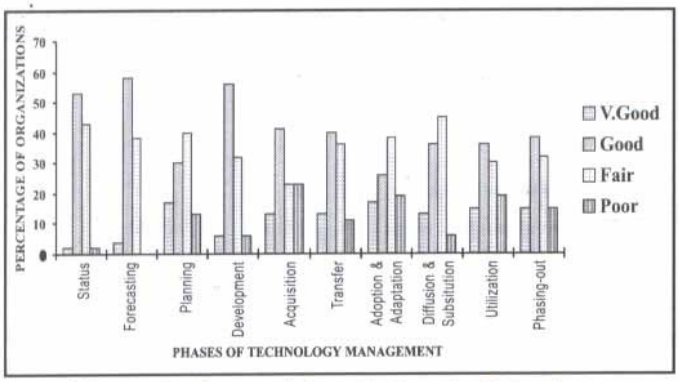

Figure 2 : Status of Organizations in Technology Management

Technology Forecasting

In technology forecasting phase of technology management, again 96% of the organizations are in the range of fair to good, which shows that the forecasted technology doesn't prove to be excellent, but at the same time not bad also. The overall technology forecasting exercise in India is good with an average score of 0.78 depicted in Figure 3. 58% of the organizations are in 'good' bracket, and only 4% are in top which means that only few organizations could predict the right technology for their future ventures and could achieve their objectives of market leadership with world-class quality.

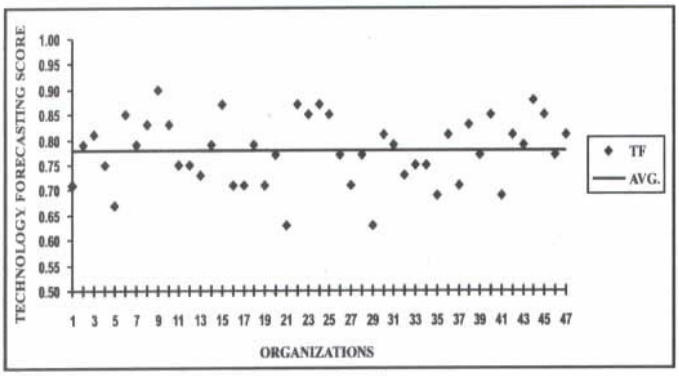

Figure 3 : Level of Technology Forecasting in Different Organizations

Technology Planning

In technology planning phase, the scene is slightly better. 17% of the companies, being in 'very good' bracket show that there are certain companies who could plan for new technology and its introduction in their plants for technology upgradation exercise and were the beneficiaries. 70% of the organizations are just average technology planners. 40% of the organization are in 'fair' bracket and 13% are in 'poor' which is an alarming figure for manufacturing industry. This may be one of the barriers in global competitiveness. This picture is very clear from the graphical representation shown in Figure 4. The average score for this phase again is good with a value of 0.75.

Technology Development

Technology development exercise in India, of course is poor, but the figures show that 62% of the organizations have concentrated on developmental activities and only 6% are having poor development efforts. The figures in this section are encouraging as 94% of the organizations are doing fairly well. On an average, this effort in India is quite encouraging as the average score in this case is 0.76, but if the graph shown in Figure 5 is analysed carefully, then there are some organisations in which the score is much lower than the average value. Those organisations should also concentrate on the indigenous development activities.

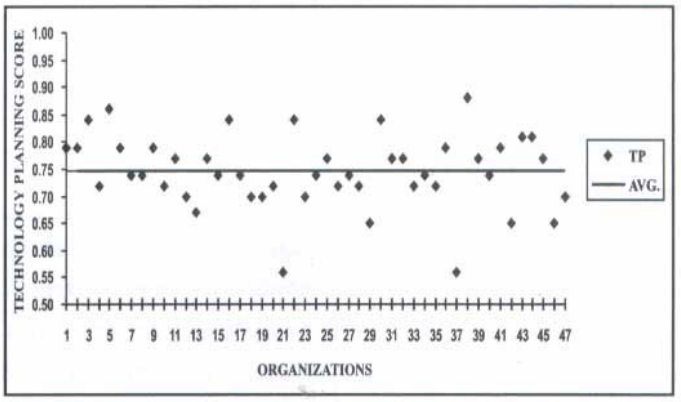

Figure 4 : Level of Technology Planning in Different Organizations

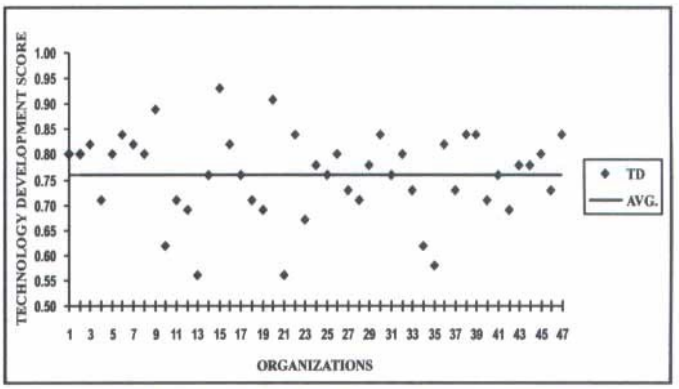

Figure 5 : Level of Technology Development in Different Organizations

Technology Acquisition

Contrary to this, technology acquisition is still a preferred option in India as compared to technology development. The acquisition is generally from the advance and developed countries. 13% of the organisations have scored 'very good' position that shows that they have considered the economic, technical, social and environmental effects of the technology fully. They have also gone in for the technical feasibility, and social adaptability of new technology. 41% of the organisations are in 'good', 23% in fair, and 23% in poor bracket. The poor bracket indicates that while acquiring new technology, some of the organisations get fascinated by the pump and show of the donor companies and do not go in for the detailed analysis of the technology being acquired. But overall performance of the manufacturing industry in this phase of technology management is good with an average score of 0.77. There are few organisations in which the score of this phase is considerably less than the average score, as is clear from the graph shown in Figure 6.

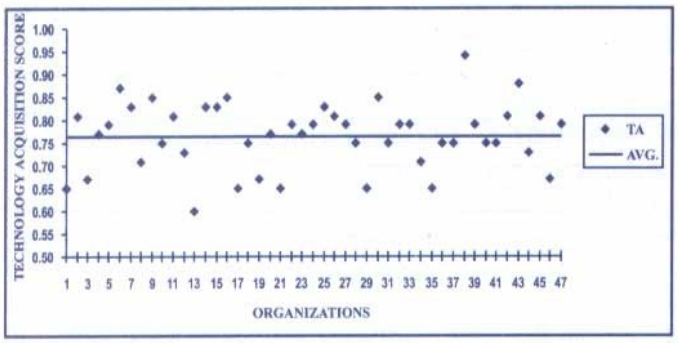

Figure 6 : Level of Technology Acquisition in Different Organizations

Technology Transfer

The percent score of technology transfer shows that 13% of the organizations being in very good bracket, have gone in for detailed analysis before getting the new technology transferred from the advanced nations. They have thoroughly studied the technical advantage, organisational flexibility required, economic, social and environmental impacts of new technology and the benefits expected. 76% of the organizations lie in the 'fair' to 'good' range, which is very comfortable position. But 11% of the organisations are still in the poor range that may be a cause of concern. The average score in this phase being 0.75, and most of the organisations lying very near to this value (Figure 7), the situation is encouraging one. Indian manufacturing industry on the whole is very cautious while getting the new technology transferred from advanced nations.

Figure 7 : Level of Technology Transfer in Different Organizations

Technology Adoption and Adaptation

Technology transferred from advance countries certainly need adoption and then adaptation to make it user friendly. The transferred technology may not be fulfilling all the requirements of the user and certain alterations /modification may help in getting desired results. In that case the donor organisation may have to impart training at its own place or at the receiver's end. On the other hand, the receiving firm may have to devise new methods, tooling etc. to satisfy the need of the new technology. Technology content is an important factor in this case which ease out the adaptive efforts of the organisation.

17% of the organisations being in very good bracket indicate that they could easily adopt and adapt the new technology whereas on the other extreme, 19% of the organisations faced a lot of difficulty to adopt it and hence they are in the poor bracket. This indicates that, transferred technology do have some negative factors associated with it which make the adaptation difficult in certain cases. Only 26% of the components are in 'good' and 38% in fair classes. These figures depict that this phase has a great importance in Indian context and is demanding more care. It is clear from Figure 8 that the average score in this phase is just 0.66 which is much below the average score for the other phases of technology management discussed earlier. Adaptive efforts have to be strengthened to make the acquired/developed technology user friendly to yield higher results.

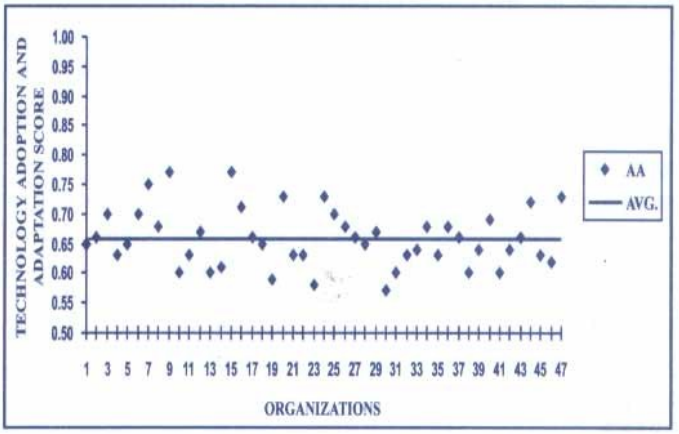

Figure 8 : Level of Technology Adoption and Adaptation in Different Organizations

Technology Diffusion and Substitution

The new technology has to be diffused in the organisation first and then the inter-firm diffusion is also required to substitute the old technology. The overall picture in this case is good as 81% of the organisations are in fair to good range and 13% in top bracket. Only 6% are in poor bracket which is not so high. But the average score of 0.68 indicates that there is ample opportunity for improvement.

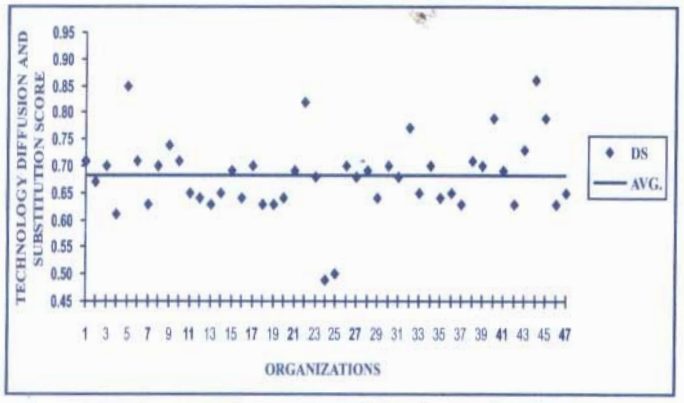

Figure 9 : Level of Technology Diffusion and Substitution in Different Organizations

From the graph shown in Figure 9, it is clear that the overall diffusion and substitution of newly developed/acquired technology is satisfactory in Indian manufacturing industry.

Technology Utilization

Acquisition/development of new technology to meet the national/international competition is the need of the hour. No country can survive in this global competition without the newly developed technologies. Mere possessing of new technology does not give an organisation a competitive advantage. To be globally competent, the optimum utilization of new technology is needed.

The status of technology management is fair to good in about 96% of the companies whereas only 2% are in very good range and 2% in poor.

The scores in this section shows that 15% of the companies are in 'very good' bracket whereas 19% are in the 'poor' bracket which means that 19% of the organizations have very poor utilization of the newly developed/acquired technology. This is certainly a matter of concern for these organizations and for India as such. Only 66% of the organizations are in comfortable zone. The average value in this phase is 0.79, which is really encouraging. This means that overall utilization of new technology in Indian manufacturing industry is good. The graph shown in Figure 10 indicate that those organizations with their score much less than the average, must concentrate on this phase to enhance the production and overall productivity of their organizations. This phase certainly needs investigation to make an optimal utilization of new technology.

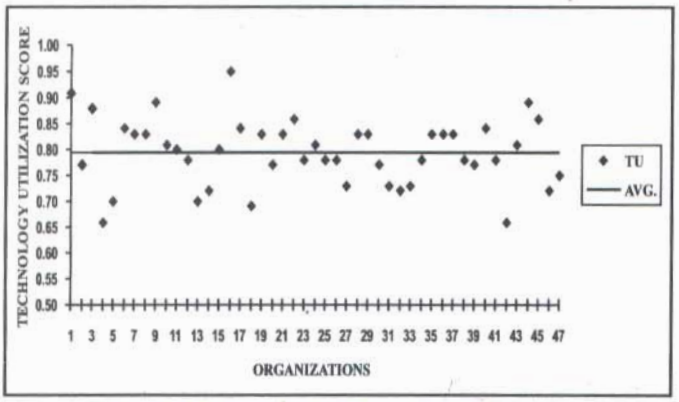

Figure 10 : Level of Technology Utilization in Different Organizations

Technology Phasing-out

When the present technology is not fulfilling the demand of quality, quantity and timely deliveries, it needs replacement. In that case the present technology is to be phased out and the latest technology in that area needs introduction. For phasing-out the old technology, it may be sold to under-developed countries/organizations or can be upgraded. But the decision for phasing-out the present technology has to be very carefully and judiciously taken after considering all related factors. The resulting technical, economic, social & environmental aspects are also to be taken care of. Organizations that accomplish this task successfully are really the market leaders.

The analysis of this phase shows that 15% of the companies are in the top bracket and 15% in the bottom one. Although 70% are in the comfortable zone but the bottom 15% figure is of concern. It happens in most of the cases in India, that the organizations have to simply scrap the old technology at very low salvage value, which certainly is a loss to the organization. Those organizations that can phase-out their old technology smoothly are really gainers in the long run. But the old technology has to be phased-out one day. The average score of 0.67 in this case is certainly not encouraging. India still can concentrate on this area to find alternative approaches of phasing-out. As is clear from Figure 11, the highest score of 0.76 achieved by a few organizations is also not very encouraging.

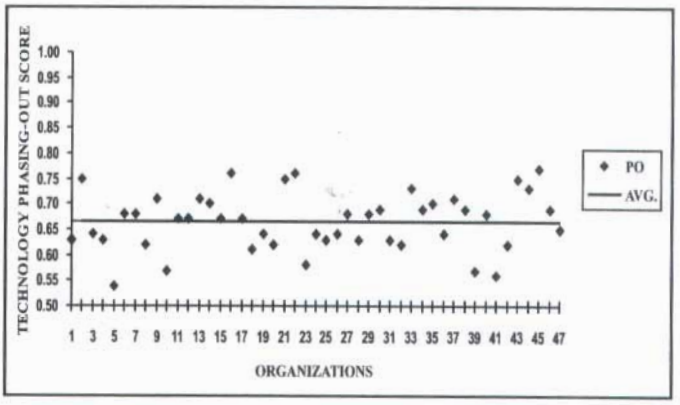

Figure 11 : Level of Technology Phasing-out in Different Organizations

Overall Technology Management

The overall technology management process in Indian manufacturing industry is more than satisfactory. The average score of 0.73 is in a comfortable zone and can still be improved by concentrating on individual phases. The graphical representation in Figure 12 explains the same.

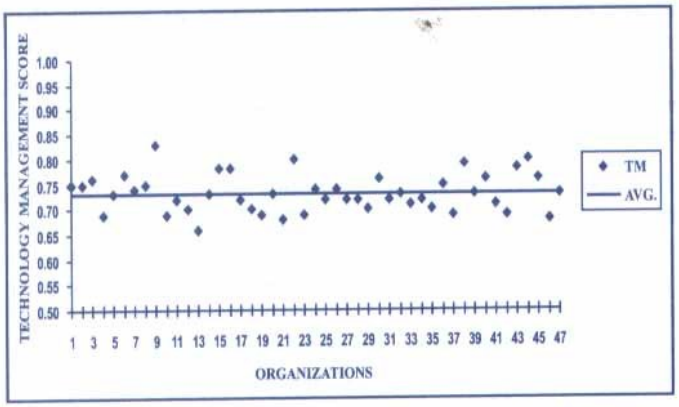

Figure 12 : Level of Technology Management in Different Organisations

The management of new technology in manufacturing industry emphasizes that the various phases of technology management should be closely monitored in the given organizations to get the final success in this exercise. Accordingly, the questions related to these phases were designed in the questionnaire covering the technical, economic, social, environmental, organizational and cultural aspects. Level of flexibility introduced in these phases and its resulting impact has also been questioned. Attitude of the management, supervision and work force also forms an essential part of these phases of technology and its management.

The information received in this format has been tabulated in Appendix I under the different heads. The abbreviation used for different phases of technology management is given in Table 4.

Table 4 : Abbreviations used for Different Phases of Technology Management

S. No.	Phase	Score
1	Technology Forecasting	TF
2.	Technology Planning	TP
3.	Technology Development	TD
4.	Technology Acquisition	TA
5.	Technology Transfer	TTR
6.	Adoption and Adaptation	AA
7.	Diffusion and Substitution	DS
8.	Technology Utilization	TU
9.	Planning- out	Po

The scores of all the phases after converting them to factors (dividing by 100) have been used to calculate one value for the total technology management exercise. This has been calculated by taking an average value of these scores that is

$$TM = \frac{TF+TP+TD+TA+TTR+AA+DS+TU+Po}{9\ (100)}$$

This value of TM for all the 47 organizations is given in Appendix I.

Flexible Management of New Technology

It was discussed that introduction of flexibility in the management process of technology shall certainly show encouraging results. These results shall be derived from the survey scores in particular questions related to flexibility in technology management and other questions related indirectly to the flexible management process. The average value of flexibility in Indian manufacturing industry has been calculated as 0.72, which definitely is encouraging. The graph shown in Figure 13 depicts that majority of the organisations are very near to this average score. Hence the required flexibility in their technology management approach is there. But an increase in the average value shall certainly be having a positive impact on the performance of the organisations.

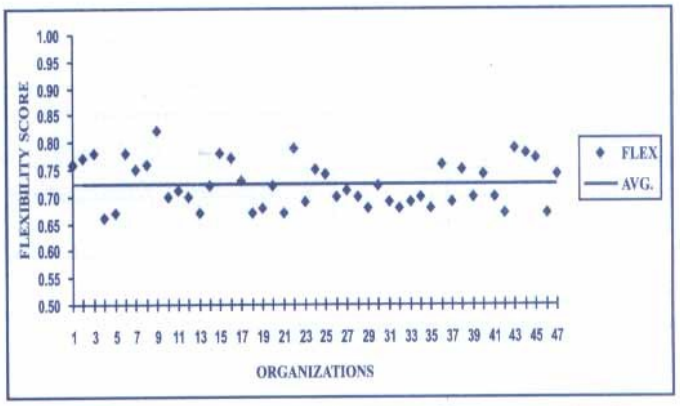

Figure 13 : Level of Flexibility in Different Organizations

Correlation between Flexibility and Technology Management

A correlation matrix has been generated (Table 5) which shows correlation between flexibility, technology management function as a whole and various phases of technology management.

Table 5 : Correlation Matrix

	FLEX	TF	TP	TD	TA	TTR	AA	DS	TU	PO	TM
FLEX	1										
TF	0.621	1									
TP	0.601	0.363	1								
TD	0.65	0.411	0.549	1							
TA	0.429	0.488	0.496	0.559	1						
TTR	0.339	0.298	0.385	0.167	-0.06	1					
AA	0.559	0.318	0.073	0.508	0.19	0.197	1				
DS	0.28	0.122	0.418	0.207	0.076	0.401	-0.076	1			
TU	0.663	0.145	0.248	0.229	-0.063	0.25	0.36	0.253	1		
PO	0.401	0.075	-0.011	-0.012	0.098	-0.175	0.129	0.098	0.371	1	
TM	0.899	0.582	0.736	0.733	0.564	0.44	0.484	0.486	0.548	0.337	1

From this correlation matrix, it is quite clear that there is a significant relationship between flexibility and technology management. This has also been presented in the form of bar chart in Figure 14. Even the correlation between

flexibility and various phases of technology management, starting from technology forecasting to technology phasing-out, is quite strong. The relationship between flexibility and technology phasing out is not so significant, as is shown by the matrix. The reason for this is that in developing countries, there are only few options with the companies while phasing-out their old technologies, whereas the developed countries generally sell their old technologies to developing countries without any difficulty.

In developing countries like India, the companies have either to transfer these old technologies to their own ancillaries, sister concerns or have to scrap them. So, there being very little flexibility in phasing-out decisions, the correlation between flexibility and phasing-out phase of technology management doesn't seem to be significant.

Similarly in technology transfer phase, the relationship between flexibility and this phase is again not significant. The reason being that the countries like India generally get the new technology transferred from the developed countries. There are hardly few cases, where the technology transfers from universities to industry and from industry to industry (Indian) or within the organizations there. Again there are only few options with the organizations while thinking of technology transfer. Most of the time it is from other nations. There is hardly any flexibility between different options.

The correlation between flexibility and various phases of technology management, starting from technology forecasting to technology phasing-out, is quite strong.

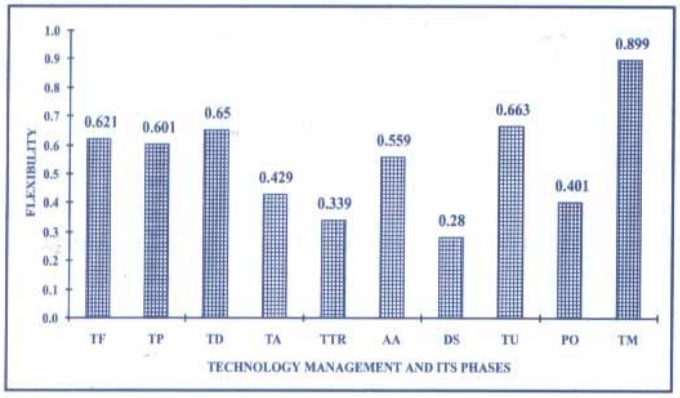

Figure 14 : Correlation of Flexibility with Technology Management and its Phases

The correlation between flexibility, and diffusion and substitution phase of technology management is also not significant (as shown by the correlation matrix). The reason is that in developing countries, it takes very long time to diffuse the new technology in the market because of the mental roadblocks of the customers and hence the substitution process is comparatively slow. The options available with the organization for intra-firm diffusion, inter-firm diffusion, nation-wise diffusion and international diffusion are few. The organizations cannot afford to have so many changes on the shop floor, in the organizational structure, in the market set-up and in the customer's perspective. It takes some time to accept the new technology by the society as a whole that ensures diffusion of the new technology and substituting the old one. Hence, the correlation does not seem to be significant, but there is certainly a correlation between these two factors.

Figure 15 shows the correlation between technology management and its various phases. It is clear from this bar chart that technology planning and technology development have stronger relationship with technology management as compared to the other phases. It means that planning is crucial to the overall management of technology and pays a lot. On the other hand, it is a fact that the indigenous developments contribute a lot in technical, economic, social, and environmental aspects of technology management. It brings pride to the nation also. The other major contributing phases are technology forecasting, technology acquisition, and technology utilization. If these areas get neglected somehow, the results may be very discouraging.

Next comes the contribution of technology diffusion and substitution, technology adoption and adaptation, and technology transfer. These areas are more demanding. It is certainly an exhaustive exercise to tackle the problems of these three phases. The contribution of the last phase, that is technology phasing-out is the lowest one. The reason is that for India, there are only a few options to phase-out the old technology. If India is able to sell the phased out technology to some needy and under-developed nation, then the importance and contribution of this phase to overall technology management function shall increase.

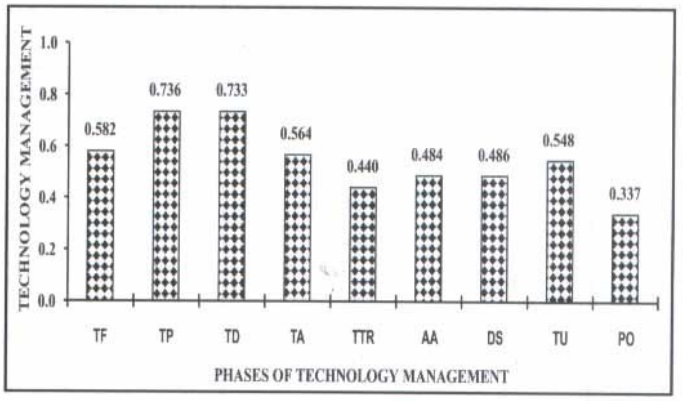

Figure 15 : Correlation between Technology Management and its Phases

Conclusion

It is clear from the earlier discussion that there exists a significant relationship between flexibility, technology management, and various phases of technology management. Hence the manufacturing industry of India should try to incorporate flexibility in managing new technology for meeting their global objectives. This flexibility has to be introduced in all the phases of technology life cycle to take care of the resulting technical, social, economic and

environmental effects of new technology. Flexible management of new technology shall enable the organizations to be strategically successful.

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Appendix : 1 Average Score For Different Phases of Technology Management

S. No	FLE	TF	TP	TD	TA	TTR	AA	DS	TU	PO	TM
1	0.76	0.71	0.79	0.8	0.65	0.85	0.65	0.71	0.91	0.63	0.75
2	0.77	0.79	0.79	0.8	0.81	0.69	0.66	0.67	0.77	0.75	0.75
3	0.78	0.81	0.84	0.82	0.67	0.8	0.7	0.7	0.88	0.64	0.76
4	0.66	0.75	0.72	0.71	0.77	0.7	0.63	0.61	0.66	0.63	0.69
5	0.67	0.67	0.86	0.8	0.79	0.77	0.65	0.85	0.7	0.54	0.73
6	0.78	0.85	0.79	0.84	0.87	0.73	0.7	0.71	0.84	0.68	0.77
7	0.75	0.79	0.74	0.82	0.83	0.69	0.75	0.63	0.83	0.68	0.74
8	0.76	0.83	0.74	0.8	0.71	0.77	0.68	0.7	0.83	0.62	0.75
9	0.82	0.9	0.79	0.89	0.85	0.91	0.77	0.74	0.89	0.71	0.83
10	0.7	0.83	0.72	0.62	0.75	0.77	0.6	0.71	0.81	0.57	0.69
11	0.71	0.75	0.77	0.71	0.81	0.75	0.63	0.65	0.8	0.67	0.72
12	0.7	0.75	0.7	0.69	0.73	0.81	0.67	0.64	0.78	0.67	0.7
13	0.67	0.73	0.67	0.56	0.6	0.73	0.6	0.63	0.7	0.71	0.66
14	0.72	0.79	0.77	0.76	0.83	0.7	0.61	0.65	0.72	0.7	0.73
15	0.78	0.87	0.74	0.93	0.83	0.78	0.77	0.69	0.8	0.67	0.78
16	0.77	0.71	0.84	0.82	0.85	0.69	0.71	0.64	0.95	0.76	0.78
17	0.73	0.71	0.74	0.76	0.65	0.83	0.66	0.7	0.84	0.67	0.72
18	0.67	0.79	0.7	0.71	0.75	0.83	0.65	0.63	0.69	0.61	0.7
19	0.68	0.71	0.7	0.69	0.67	0.72	0.59	0.63	0.83	0.64	0.69
20	0.72	0.77	0.72	0.91	0.77	0.73	0.73	0.64	0.77	0.62	0.73
21	0.67	0.63	0.56	0.56	0.65	0.72	0.63	0.69	0.83	0.75	0.68
22	0.79	0.87	0.84	0.84	0.79	0.78	0.63	0.82	0.86	0.76	0.8
23	0.69	0.85	0.7	0.67	0.77	0.7	0.58	0.68	0.78	0.58	0.69
24	0.75	0.87	0.74	0.78	0.79	0.77	0.73	0.49	0.81	0.64	0.74
25	0.74	0.85	0.77	0.76	0.83	0.68	0.7	0.5	0.78	0.63	0.72
26	0.7	0.77	0.72	0.8	0.81	0.72	0.68	0.7	0.78	0.64	0.74
27	0.71	0.71	0.74	0.73	0.79	0.78	0.66	0.68	0.73	0.68	0.72
28	0.7	0.77	0.72	0.71	0.75	0.76	0.65	0.69	0.83	0.63	0.72
29	0.68	0.63	0.65	0.78	0.65	0.68	0.67	0.64	0.83	0.68	0.7
30	0.72	0.81	0.84	0.84	0.85	0.75	0.57	0.7	0.77	0.69	0.76
31	0.69	0.79	0.77	0.76	0.75	0.72	0.6	0.68	0.73	0.63	0.72
32	0.68	0.73	0.77	0.8	0.79	0.73	0.63	0.77	0.72	0.62	0.73
33	0.69	0.75	0.72	0.73	0.79	0.69	0.64	0.65	0.73	0.73	0.71
34	0.7	0.75	0.74	0.62	0.71	0.73	0.68	0.7	0.78	0.69	0.72
35	0.68	0.69	0.72	0.58	0.65	0.75	0.63	0.64	0.83	0.7	0.7
36	0.76	0.81	0.79	0.82	0.75	0.76	0.68	0.65	0.83	0.64	0.75
37	0.69	0.71	0.56	0.73	0.75	0.64	0.66	0.63	0.83	0.71	0.69
38	0.75	0.83	0.88	0.84	0.94	0.8	0.6	0.71	0.78	0.69	0.79
39	0.7	0.77	0.77	0.84	0.79	0.8	0.64	0.7	0.77	0.57	0.73
40	0.74	0.85	0.74	0.71	0.75	0.8	0.69	0.79	0.84	0.68	0.76
41	0.7	0.69	0.79	0.76	0.75	0.76	0.6	0.69	0.78	0.56	0.71
42	0.67	0.81	0.65	0.69	0.81	0.76	0.64	0.63	0.66	0.62	0.69
43	0.79	0.79	0.81	0.78	0.88	0.74	0.66	0.73	0.81	0.75	0.78
44	0.78	0.88	0.81	0.78	0.73	0.88	0.72	0.86	0.89	0.73	0.8
45	0.77	0.85	0.77	0.8	0.81	0.68	0.63	0.79	0.86	0.77	0.76
46	0.67	0.77	0.65	0.73	0.67	0.7	0.62	0.63	0.72	0.69	0.68
47	0.74	0.81	0.7	0.84	0.79	0.68	0.73	0.65	0.75	0.65	0.73
AVG.	0.72	0.78	0.75	0.76	0.77	0.75	0.66	0.68	0.79	0.67	0.73

Flexibility Mapping : Practitioner's Perspective

1. What types of flexibilities you see in the practical situation of *"Management of New Technology"* on the following points:
   - Flexibility in terms of "options"
   - Flexibility in terms of "change mechanisms"
   - Flexbility in terms of "freedom of choice" to participating actors.
2. Identify and describe the types of flexibilities in strategic MIS planning that are relevant for management of technology in your own organizational Competitiveness ? On which dimensions, flexibility should be enhanced ?
3. Try to map your own organizational technological system on following on continua. (Please tick mark in the appropriate box(es)).

Importance

Technology planning ☐☐☐☐☐ Technology implementation

Technology Provisioning

Development ☐☐☐☐☐ Acquisition

Technology transfer

Mature technology ☐☐☐☐☐ New technology

4. Develop a SAP-LAP (Situation Actor Process-Learning Action Performance) model of *"Managemet of New Technology"* relevant to your organization.

Reflecting Applicability in Real Life

1. To what extent the findings to this study in terms of relationship of flexibility and technology management phases are relevant for your organization. Critically examine.
2. Determine the strengths and weaknesses of different phases of technology management for your organization.

Learning Lessons on Flexible Systems Management L5

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Enterprise Flexibility

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Introduction

The enterprise is continuously under increasing pressure from various stakeholders as well as competitors

The requirements of various stakeholders external to the enterprise are changing over time. For example, the customers are becoming more aware and demand more variety, service and value from the enterprise. The shareholders' priorities of return and risk continuously shift as per the situation, however, their expectations of gaining value from the enterprise are enhancing. The financiers want more security. The society at large has higher expectations from the enterprise to fulfil its needs in terms of innovative products/services, cleaner and hygienic environment, ethical practices, upholding of moral values, and so on. Thus, the enterprise is continuously under increasing pressure from various stakeholders as well as competitors. In sum total, the enterprise is facing a more challenging situation. This is creating turbulence and chaos in the environment, with higher uncertainty, ambiguity and dynamism leading to higher rate of change and surfacing of new paradoxes and conflicts. The compounding complexity and change perspectives are fuelled by the political, economic, social, and technological shifts towards liberalization and globalization.

All components of the enterprise will have to adapt and respond to the changing requirements, be more open, agile and resilient to lead to such a transformation

The performance of the enterprise is dependent upon the value provided and thereby satisfaction and delight of all its stakeholders. The growing demand for the value by all the stakeholders need a total transformation of the business enterprise in terms of all its internal stakeholders or actors responsible for its operation, its business processes and systems, structure, strategies, and culture. All these components of the enterprise will have to adapt and respond to the changing requirements, be more open, agile and resilient to lead to such a transformation of the enterprise, i.e. creation of higher levels of enterprise flexibility to resonate with the environmental changes.

Defining Enterprise Flexibility

The three seminal questions are 'Why', 'What', and 'How' about enterprise flexibility

The three seminal questions to be answered are 'Why', 'What' and 'How' about enterprise flexibility. The first question, i.e. "why enterprise flexibility" has already been touched in the introductory section of this learning lesson. The changing requirements of various stakeholders, competitors, and the nature of the environment demand higher level of flexibility in the business enterprises. In this section the remaining two questions will be approached, i.e. firstly a conceptual framework of "what is enterprise flexibility" will be provided, and then it will be discussed, "how to create it".

The concept of systemic flexibility is:

"Flexibility is the exercise of free will or freedom of choice on the continuum to synthesize the dynamic interplay of thesis and antithesis in an interactive and innovative manner, capturing the ambiguity in systems and expanding the continuum with minimum time and efforts."

This includes three key words, i.e. continuum or options, dynamic interplay or change, and freedom of choice.

Accordingly, the enterprise flexibility can be defined as:

Enterprise flexibility means creating options at various levels, developing ways and means of change across the range of options, and providing freedom of choice to various actors

"Enterprise flexibility means creating options at various levels in the enterprise, developing ways and means of change across the range of options, and providing freedom of choice to various actors in the enterprise to make this change happen with minimum time and efforts."

This systemic concept of the enterprise flexibility can explain its various connotations such as adaptiveness, openness, responsiveness, change, freedom, agility, resilience, customization, and so on.

Some examples of options are contigency plans, cross-functional teams and multiple skills

On the one hand, the creation of more 'options' will enhance the openness in the enterprise, whereas on the other hand enhancing the openness in the enterprise will expose it to more avenues and will create more options for managing it. For example, at the strategic level contingency plans may be created, at the organizational level cross-functional teams may be created, and at individual level multiple skills may be provided. This will lead towards cultural diversity, innovation and creativity in the organization so as to generate new ideas and provide ground for experimentation. Openness is the start point of creating flexibility in the enterprise. If the enterprise acts as a closed system and the actors are close minded, they will not be able to sense the changing requirements and certainly the enterprise cannot prepare itself for coping with the situation. However, if the enterprise works as an open system and the actors are open-minded, they will continuously receive the environmental inputs and will work towards creating more options so as to suit the new demands that are likely to fall on the enterprise.

MTNL created telemarts and Maruti developed more models to create options

- For example, Mahanagar Telephone Nigam Limited (MTNL) has shown customer orientation to provide the best service and convenience to its customers. One innovation has been opening of Telemarts at various locations. These telecom shops cater to all needs of a new customer. At Telemart, one can make opening payment, choose telephone, and even choose the telephone number one want to have from the available list. They want to make the purchase of a new connection at Telemart, whether of Internet or telephone an experience for the customer. It has also now come with flexible schemes such paying only half the initial amount for the new connection immediately and rest deferred payment. It gives a free telephone connection with an Internet connection (payments of connection can be made later).
- Another example is the options created by Maruti Udyog Limited (MUL) to withstand the competitive pressures so far, as given below:
  - 10 models with almost 82 variants aimed at both the domestic and the export markets.
  - Product variants to suit the needs of customer groups.
  - Product range covers a broad spectrum of market segments starting from economy to luxury segment.
  - Continuous upgradation of products to offer "Value for Money" to the customers.

An enterprise with more options and having systems and processes that can 'change' from one option to another can easily adapt to the environmental changes. An open system will be able to learn about the expected changes in the environment and be proactive in adjusting itself accordingly. Thus, the options and change mechanisms will help the enterprise to be more adaptive and responsive. Such a flexible enterprise will be able to manage the change more effectively.

TCS is a good example of adapting to changing lines of business

- A significant example of adapting to changing lines of business is that of TCS. During 1980s body shopping was prevalent in US. TCS utilized this opportunity and trained and sent thousands of Indian professionals to work on projects in US. This resulted in widespread awareness about TCS apart from the huge revenue earnings. TCS was also quick in recognizing new opportunities like Y2K and Euro currency and worked in the direction of building new markets. It was quick to invest in sprawling, high tech, Y2K factory with an infrastructure of 1000 workstations and three IBM mainframes.

The third major aspect of enterprise flexibility is 'freedom of choice'. This would imply more freedom and empowerment to all actors. This is the source of all other connotations of enterprise flexibility. The freedom of choice will bring localness in the governance of the enterprise making it more agile and resilient. This will unfold the creativity of all the actors so as to create more options, systems of change across the options, and learning in the enterprise.

Telco has provided freedom of choice to both in house and external actors

- The crucial make or buy decisions have been made by Telco keeping in mind various aspects.
  - Global shopping has brought off the shelf products without a premium for customization.
  - Changes can be made by using Telco's in -house capabilities.
  - Telco sourced design from Italy (IDEA), engine from France (Institut Francais de Petrol) and integrated them using its engineering skills.
  - The assembly line was imported from Nissan, Australia (second hand) and modified to suit local requirements.
  - Target costing was employed to contain component costs.
  - Innovative logistic management techniques (optimum container size to hub, daily delivery to factory) are being used.

Thus, creating more options and dynamically interplaying across these options by exercising the freedom of choice will generate more enterprise flexibility enabling the enterprise to transform naturally and act spontaneously to respond to various changing requirements.

Creating Enterprise Flexibility

Some important actions to create enterprise flexibility on different dimensions are shown in the options field in Exhibit 1.

Exhibit 1: Options Field for Enterprise Flexibility

Strategy	Structure	Systems	People
• Shared vision • Entrepreneurial strategies • Dynamic balancing of paired opposites • SAP-LAP (Situation-Actor -Process- Learning-Action-Performance) Paradigm • Open environment • Paradoxical Strategies	• Fluid and Flexible structure • Flatter and networked organization • Informal organization • Localness and collective organization • Open communication	• Process oriented systems • Knowledge based learning systems • Customer oriented systems • Self-organizing teams • Systems balancing paradoxes • Systems thinking	• Learning environment • Multiskilling • Empowerment • Cultural diversity • Innovation culture • Creative tension

Samtel created flexibiltiy by leveraging technology and competencies

- The case of Samtel shows leveraging technology and competencies. It shows it is flexible in its means which is proven by its numerous technology transfer agreements, technology acquisitions, joint venture and being open to advise from experts from across the globe in its existing area of operation.

  Total employee involvement has been practiced towards customer satisfaction. It provides flexibility in terms of individual creativity and development of an innovative culture and risk taking ability.

GE has used its learning culture to create competitive advantage

- GE is a very large multi-business company with a learning culture that has transformed the diversity of its business and its size—from what is sometimes perceived as a handicap—into a tremendous competitive advantage. GE is a widely diverse array of 250 business segments, a dozen or so of the Fortune 500 size.

  What sets it apart is a culture that uses this wide diversity as a limitless source of learning opportunities, a store houses of ideas whose breadth and richness is unmatched in world business. At the heart of this culture is an understanding that an organization's ability to learn, and translate that learning into action rapidly, is the ultimate competitive business advantage.

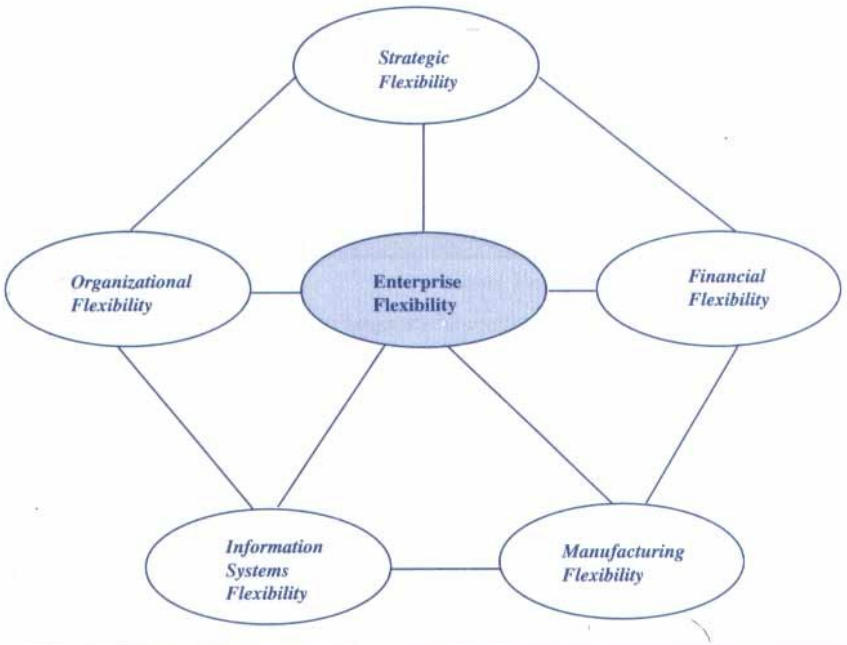
This appetite for ideas, this lust for learning was born in the '80s in a simple ritual called "Work-Out" was nothing more complicated than bringing people of all ranks and functions-managers, secretaries, engineers, line workers, sometimes customers and suppliers—together into a room to focus on a problem or an opportunity. It then acted rapidly and decisively on the best ideas developed, regardless of their source. The operative assumption is that someone, somewhere, has a better idea; and the operative compulsion is to find who has that better idea, learn it, and put it into action-quickly.

Cornerstones of Enterprise Flexibility

The cornerstones of enterprise flexibility are strategic, organizational, financial, information systems and manufacturing flexibilities

The various types of flexibilities in an enterprise are: strategic flexibility linked with the strategy dimension; organizational flexibility linked with structure and people dimensions; and flexibility of various types of systems, such as financial, information, manufacturing, marketing, technology management, and so on. The five cornerstones of enterprise flexibility considered in this learning lesson are shown in Exhibit 2.

Exhibit 2: Cornerstones of Enterprise Flexibility



Strategic flexibility provides openness, focus, change and resilience in the strategy formulation and implementation

The strategic flexibility provides transformational capability in terms of perpetual renewal of the enterprise as well as dynamic balancing of the paradoxical strategic options. This provides openness, focus, change, and resilience in the strategy formulation and implementation.

- Hero displayed strategic flexibility in making earnest attempt to give real time fast response to changing environment (Customers' needs an competitors' moves) and there was continuous interaction between environmental turbulence and strategy formulation and Hero's responsiveness to environmental change. It also required reframing of strategies at several stages, which are mentioned as under:

– Hero hived off the engine making unit of Hero Motors to another joint venture Hero Briggs and Stratton. This resulted in conversion of fixed costs to variable costs, which has reduced break even point of Hero Motors, which would in turn given boost to bottomlines. This strategy can be called organizational restructuring.

– It established exclusive dealerships in the south, the biggest moped market and one where Hero had negligible presence. This strategy aimed at increasing marketing efforts in new territory to follow the leader - TVS Suzuki.

- Hero planed to go beyond mere consolidation. Hero tied up with BMW to sell high -end bikes. It was radical experiment. A company, which was operating in high volume, low value markets wanted to venture in a high value, low volume business. This is clear evidence of adaptability and flexibility of Hero to move to diagonally opposite ends of product and market matrix.
- For starting new venture of scooters, the logic was that moped market was crowded with several players, but scooters market has an overwhelming presence of only two players- Bajaj and LML, along with TVS- Suzuki's Spectra. This strategy implies charting into new market with now product having some synergy with existing product lines - Motorcycles and Mopeds.

Organizational flexibility is the change making capability of the organization in its structure, processes, people and culture

The organizational flexibility is the change making capability of the organization in its structure, processes, people, and culture, so as to carry more than one option on the same continua at the same time and to dynamically interplay across the organizational options.

- With the integration of its Management Consultancy (MC) and IT division, TCS now has more flexibility in terms of designing project structures. They have a wider talent pool, which enables easy design of cross-functional teams, which are necessary for projects involving end-to-end consulting solutions. Earlier MC and IT were separate divisions; thus forming a cross-functional team was a difficult task. The main mechanism of its flexibility in its planning model, where each of the division initiate its planning target and implementation scheme with the help of a Central Planning Team. This team assists each of the unit in scanning environment, identifying the upcoming opportunities and accordingly set their targets which then become the basis of capital allocation. The flexibility is, thus, imported through a Centralized Co-ordination Department although the initiation of planning process is bottom up. However, the mechanism of flexibility is conditioned by a strong control from the Headquarter and practically speaking, its organizational response to change is rather traditional and strongly guided by its past experiences.

Financial flexibility deals with evoluation of the financial processes with versatility, adaptiveness and transparency

The financial flexibility can be defined as exercise of freedom of choice within the framework of Government monetary and fiscal policy, capital market regulations, investors risk-return preferences and corporate strategy to evolve the financial processes with versatility, adaptiveness and transparency so as to have better resonance with the business environment.

- A good example is of Reliance that prepares itself meticulously for the world that does not exist today. For example, even though Reliance may have no intention of raising finance from the international market, it would always be sitting on a prospectus ready right down to the last full stop with only spaces kept blank for the dates. Logic: the day scenario turns favourable, Reliance should be the fastest to raise capital. Timing is the key to why the Reliance has been successful. Before January 1997, the company loaded as much of dollar debt, as it could get. When interest costs dropped within the country, Reliance moved aggressively into Rupee loans. Today, Dollar debt is not available because of Asian crises and Rupee debt has become more expensive, Reliance is sitting pretty.

Information systems flexibility is the capacity of information systems to change or to adapt or adjust in response to new demands

The information system flexibility is the capacity of the information systems to change or to adapt and adjust in response to new conditions, demands or circumstances both within and outside the enterprise. It is composed of both systemic flexibility (flexible for organization requirements), and usage flexibility (flexible for usage).

Manufacturing flexibility is the ability to change or adapt to both external and internal conditions of manufacturing

The manufacturing flexibility is the ability of the manufacturing systems to change or adapt to both external and internal conditions with minimum time and efforts.

- Hero adopted flexible manufacturing techniques and practices, which facilitated quick change in processes catering to changing market requirement. Hero also adopted flexibility by introducing almost 2 new models every year. As a measure of product flexibility, it consolidated its position in mopeds (majestic auto), branched into 150 CC Scooters and developed 4 stroke engine technology to meet emission norms.

Reflection

Flexibility in the enterprise should be created in a manner so that controllability also in creases

Enterprise flexibility is desired in order to cope with the fast pace of change in business environment. Flexibility in the enterprise should be created in a manner so that controllability also increases. A highly open system with lack of controls may lead to a chaotic enterprise. Thus, flexibility in various domains such as strategy, structure, systems and people should be created in a manner so that it provides adaptiveness and responsiveness without loosing controllability. The options that are created within the domain of the enterprise create internal flexibility, whereas the options outside the enterprise in the rest of the value network create external flexibility. A right balance of external and internal flexibility is to be maintained for a high performing enterprise.

Self Assessment and Reflection with Reality

- Identify various options, change mechanisms and freedom of choice in the context of a real life enterprise and define the various types of flexibilities present.
- In what way the strategic, organizational, financial, information system and manufacturing flexibilities can be enhanced? Discuss with reference to a real life enterprise.

Event Diary

This section will contain events related to flexibility. Only highlights and important dates are provided. For more details, please visit the web page or contact the organizers. If you are planning any major flexibility related event (global conference/workshop/seminar), please submit the details (Event title, Dates, Place, Theme, Deadlines, Contact Info, Email, Web page, etc.) to Dr. K. Momaya at email momaya@dms.iitd.ernet.in with Subject: giftjourn@l, Event Submission.

Event	:	**The Thirteenth Annual Conference On American Society For Competitiveness (Asc)**
Theme	:	Competition in a Turbulent World
Dates	:	OCTOBER 10-12, 2002
Place	:	Washington, D.C. Area
Submission of Paper	:	June 15,2002
Contact	:	Prashanth B. Nagendra PO Box 1658, Indiana, PA 15705 Phone: (724) 357-4880 Fax: (724) 357-7768 Nagendra@iup.edu Elizabeth Fitzgerald Department of Management Kennesaw State University 1000 Chastain Road, Kennesaw, GA 30144-5591 Phone: (770) 423-6588 Fax: (770) 423-6606
Conference Web Site	:	http://ecobweb.ecob.iup.edu/asc/Call2002.htm
Event	:	**The Second International Conference On Electronic Business (ICEB 2002)**
Theme	:	Global E-Business In Knowledge-Based Economy: Management, Practice, And Opportunities
Dates	:	December 10-13, 2002 Place: Grand Hotel, Taipei, Taiwan
Deadline for Submitting Papers or Extended Abstracts	:	July 15, 2002 Notification of Acceptance: September 15, 2002 Camera-ready Papers: October 15, 2002 Ms. Susan Chen, Secretary of ICEB 2002 / Professor Chi-Chun Lo Institute of Information Management National Chiao Tung University, Hsinchu, Taiwan Tel: 886-3-5712301, Fax: 886-3-5723792 Email: iceb02@iim.nctu.edu.tw
Conference Web-site	:	http://www.iim.nctu.edu.tw/iceb2002
Event	:	**Fourth International Conference On Practical Aspects Of Knowledge Management**
Date	:	2-3 December, 2002
Venue	:	Vienna, Austria
Important dates	:	Submission of papers by August, 4, 2002 Acceptance notices mailed by September, 22, 2002 Final, camera-ready papers due by October, 28, 2002
Main contact for further information	:	Dimitris Karagiannis University of Vienna Department of Knowledge Engineering Brünner Str. 72, A-1210 Vienna, Austria Tel.: +43-1-4277-38481; Fax: +43-1-4277-38484 Email: dk@dke.univie.ac.at website: http://www.dke.univie.ac.at/pakm 2002

Call for Papers

Special issue of Global Journal of Flexible Systems Management

on

Flexible Supply Chains

This special issue of the *Global Journal of Flexible Systems Management* will be devoted to flexible supply chains. Since the early 1980s, when efforts to address the integration of suppliers and production led to the realization that effective supply chain management offered immense potential for improved inventory management, better purchasing practices, and increased quality, interest in supply chains has been growing. Twenty years later, new technologies are driving much of the growth and change in perceptions of supply chain management. Supply chains encompass the flows of materials, production, and information from the basic raw materials through delivery to the final customer. Flexible supply chains exhibit characteristics of flexible manufacturing - the ability to minimize costs while adapting rapidly to fluctuations in demand and changes in consumer preferences.

Contributions should examine issues and/or factors relevant to flexible supply chains. These might include, but are not limited to, the following:

- The distillation of massive amounts of information into useful knowledge to enable flexible supply chains to adapt quickly to changes in consumers' tastes
- The effective use of flexible supply chains to improve the efficiency of mass customization
- Consumer-based definitions of quality and the flexible supply chain's impact upon operation's ability to deliver quality products
- The impact of outsourcing on the flexibility of supply chains
- Meaningful metrics to monitor flexibility and quality in supply chains
- The importance of coordination in to supply chain flexibility
- Technology and flexible supply chains
- The impact of product and/or process design on the flexibility of supply chains
- B2B exchanges in flexible supply chains
- Cost reduction in flexible supply chains
- Matching degrees of flexibility in supply chains with product type

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