A literature study of the factors that influence the communication interface between Research & development and manufacturing functions

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Master's Thesis in the field of Quality Technology
Written at Linköping University

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Abstract

Communication, coordination and cooperation are critical for a successful organization. This master’s thesis work presents a literature study of the factors that influence the interface between Research & development and manufacturing functions. Research & development and manufacturing functions rarely share information among each other and rarely combine their skills and knowledge to produce effective and efficient work within organization. This is due to lack of mutual understanding improper communication and coordination among members in the teams. In the late 1990’s, competition, Information Technology proliferation, increasing customer demands for better products at shorter lead times emphasized increased need for effective product development. Each function has its specialization and is effective in their domain. Each department has roles and responsibilities to complete given tasks. But they neglect the organizational and management issues and lack the focus where they are a part of a bigger process (i.e. delivering value to customer and making the company successful at the end of the day). The main focus of the thesis is to give deeper knowledge on communication and coordination between Research and Development and manufacturing. This is achieved by review of the articles, analysis and finally synthesis of literature to develop constructs and analysis models. This will help to understand the factors and its interaction. The factors identified are individual responsibilities, artefacts and system or domain understanding, communication idea, control and role distribution, teams, accessibility and arena for personal meetings and finally overall leadership.

Each factor has its own and unique contribution to success within the organization. These factors are interrelated and dependent on one another. Artefacts understanding deals with some actions and steps has to be taken in order to execute the given tasks, individual role plays an important role in what sense he/she will contribute to the team as well as to the organization. Even active responsibilities must understand the system or domain and quickly adjust to the environment and get practice on it. Teams are essential tool in any organization, working together creates creative problem solving, improves effective of communication, improves development skills and ability of an individual, mutual understanding and cooperation among group members all will constitute to the teams. Finally teams are the critical building blocks of an organization. The model developed needs further testing through empirical evidence to increase its validity.

Key words: Communication & Coordination, new product development, R&D and manufacturing interface, organizational behavior, communication process, active, domain, teams, leadership, artefact, role distribution and accessibility.
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Madhusudan Seegapalya Chikkagangaiah
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Abbreviations
PD-product development
IPD-integrated product development
NPD-new product development
CE-concurrent engineering
R&D-research and development
DMI-design-manufacturing involvement
EMI-early manufacturing involvement
DMR-design-manufacturing relationships
CAM-computer aided manufacturing
CAD-computer aided design
CAPP-computer aided process planning system
EFQM-european foundation of quality management
TQM-total quality management
QFD-quality function deployment
IR-interorganizational relations
SPS-social problem solving
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Chapter 1

Introduction

1.1 Background
In the fast growing world, designers and manufacturers in the companies must adopt new skills and gaining knowledge to compete in the booming field. In any organization we have seen that the problems rising in design field or in production line or in warehouse, coordination and collaboration between various departments was not effective. This is due to lack of communication and cooperation between departments within organization. In new product development, speed and flexibility of the development process has been manifested as an important factor contributing to the success. Many companies are facing problem in mastering the cross-functional interdependencies, which become pivotal as tasks from different functions are executed in parallel and the development cycle time is compressed. A design review team does not communicate with the manufacturing teams in terms of product development which leads to failure in the market and effects in organization growth. The design-manufacturing interface is perhaps the one of the most interesting challenge facing product innovators in the immediate future. The use of offshore and/or the contract manufacturing linkages problematic since many firms have only limited experience succeeding with intra-organizational interactions. Several various factors involves in breaking the communication and cooperation between research and development units and manufacturing units are conflicts, barriers to cooperation like organizational responsibilities, physical barriers, language, cultural thought worlds and personality etc., in order to overcome the above mentioned problem in the industries through proper way of communication and cooperation, there are few concepts and approaches, which provides strong foundations to learn the things effectively and efficiently. They are team approach, through conceptual and managerial lessons, organization top management involvement, training needed for all managers and other staff in the unit and finally moderator or through agent which acts like facilitator takes the risk from all the departments and assign the task for each and everyone, in order to complete the given task. Etc.

1.2 Purpose of the thesis
The background for this thesis work was the communication between research and development units and manufacturing units, and the purpose of work is to give deeper knowledge about the communication and cooperation between R&D and Manufacturing functions.
cooperation between Research and Development and manufacturing functions. A business unit must identify its customer’s needs, develop appropriate products to satisfy those needs and have a manufacturing system to make its product profitably. Three functional areas that support these activities of a business are marketing, manufacturing and design. To be competitive, each one of these areas needs to be managed strategically. This present research work is located at the helix research department idea development, entrepreneur and innovation. The role of company classification is important as an aid to identify the nature of the product development. Meaning that it is necessary to understand how the overall business strategy leads to particular types of product development strategies in different types of company (e.g., whether to develop completely new products, redesign existing products, customize on demands). Different companies approach this problem in a variety of ways which in turn can be associated with successful or unsuccessful outcomes. Successful outcome means it can be regarded as satisfy market demands in terms of increased sales, fewer customer complaints, reduced service costs, etc. where as unsuccessful companies experience contrary indications. Research and development and manufacturing departments are facing a problem in communication and coordination within department, they fail to capitalize the market segments because too much focus on product development and neglecting organization communication on behavior and also on management issues. This is the area where all organization should considered their organizational behavior on communication and structured be involved in all aspects of decisions and issues.

1.3 Statement of the problem

This study is on the integration between R & D and manufacturing. This was selected for the following reasons. First, the documented differences in the thought worlds suggest that an in-depth study on the interface would reveal a rich set of integration mechanisms. Second, prior studies that the R &D and manufacturing integration is of significant importance to successful new product development. In present scenario market situation and research is used to analyze the market and consumer or customer mind/trend. Hence market research is one of the R & D activities in an organization. One must say that the marketing has traditionally played an important role in business strategy. Because it is seen as being close to the customer, and manufacturing has played only a reactive role in the strategy formulation process. Now the strategic role of manufacturing is recognized and attempts are being made to put manufacturing strategy in its proper perspective. This is an inspiration to me, but my work is mainly depending on research and development and manufacturing units. How inter-organizational or intra-organizational companies are facing a big problems in the area of communication and co-ordination. There are not capitalizing in producing the product to customers with no defects. In the early design stage includes lot of new technologies and complexity in nature, which unable to understand by the production engineer during the product manufacturing stage. This
leads to product failure in the market and the company fails to compute with the neighboring companies. There are some more problems like interface between R&D and manufacturing backward of education in terms of proper procedure and plans. Individual functional plays a very important role in any firm, because they fail to attain the co-operation among the individual and in groups. If it is a smaller firm then they need to concentrate with in the firm with other department. Combining their work with other units in the firm, this leads to success in the market. If it is a huge company then they should merge their one of units with another company, develop the concepts and discuss the issue on face to face communication which reduces later design changes in the production before the product releases in the market.

Communication plays an important role in the Research and development and manufacturing unit, there are many barrier include personality and cultural differences, similarly language, organizational and physical barriers affects mainly on communication and cooperation with in the departments. My main idea is to use this factors like individual\active responsibilities, domain understanding, artefact understanding and teams in the R&D and manufacturing interface, brings the changes in the organizational structure. Each factor will have own contribution like how the individual or active responsible will adopt the situation, when the work assign to particular person in the department he\she should adapt new technologies to solve the problems this is an individual responsible one of the factors discussing in my thesis work.

1.4 Thesis structure
Thesis structure comprises the introduction in chapter1. Chapter 2 deals with the theory on communication in organization gives theoretical background on ontologies (concepts and terminology) for communication and cooperation in research and development and manufacturing unit. Chapter 3 is about the organizational communication this includes introduction about communication processes and some basic terminologies on communication. Chapter 4 is about the literature research involves the method adapted for the thesis work, presentation of each articles briefly and discussion on each factors. Chapter 5 is about results obtained from the articles will find in table format. Chapter 6 deals with discussion; some important contribution from the article, critiques has been discussed. Chapter 7 conclusion and future work. Flow chart below shows the pictorial view of thesis structure.
1.5 Methodology

First of all I would like to choose the methodology which fits to my thesis work, it’s been very hard to find the methodology which tells or deals smoothly on related topic of my work. I have divided the methodology into four parts namely literature based studying, collection of information through internet based source, analysis and finally critics on chosen methodology. In this case I have chosen the literature based reading
which is the most required and essential user of the two. Basically this work relates to helix research unit which was carried out at Linkoping University, I got an opportunity to work on this research base unit. In fact the topic is interesting and valuable to an organization. In the fast evidence shows that the companies are more focus on product design or in the manufacturing unit to reduce the setup times in operation and increase the production flows steadily. They neglect about the organizational behavior on communication. The only way to overcome the negotiation and conflicts in the industry is through means of communication and cooperation.

Next task is about the collection of information through our university databases. Here we have full text coverage of biology, chemistry, engineering, physics and theology, etc. my work is more related to engineering and management aspects, so the main focus was on academics search premier, business source premier, science direct, Google scholar and Scopus, the essential databases which I have to look in for the rest of my thesis. Third task of my thesis work is related to analysis; this analysis can be done through adopted method from it. Read the article, make some important notes on very key words and analyze the key words and finally make comments on the article. We have the background of helix research unit’s factors, how these factors will help in the companies to overcome the conflicts, barriers in an organization. The Final task of the methodology is about the critiques on chosen methodology,

1.6. Basic concepts on Conceptual framework
A conceptual framework which integrates the design activities along with manufacturing and also considering the market as equal partner to reinforce the overall organization mission and vision. Conceptual framework provides an effective interface between, designs, manufacturing and marketing functions. By considering or using the dimensions of competition as the integrating force. The competitive dimensions are: price, speed, flexibility, performance, feature, reliability, conformance, durability, serviceability, aesthetics and perceived quality. The next section will present the basic ideas of each division and finally ends up with an interface framework.

1.6.1. R&D and manufacturing
A business unit must point out the customer needs and expectations to develop the product that meets the customer needs and satisfy their expectation and also the company should be able to get the profit from the produced product. This involves the support from the three functional areas to achieve the activities of the business unit.
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Good R&D unit means research should be focused on developing new products. This can be achieved only if the organization has good R & D laboratory. When once R & D unit exists in an organization number of information will be available like journals, Tech. papers, books, periodicals and information regarding production, development, marketing etc. so that for reference, for experimentation and consultation other organizations / departments comes to the host organization. Production, marketing and logistics are all inter-related because logistics depends on market demand and its location and market demand depends on the type of product. Note that the production department in any good organization should have an R & D unit because new production processes should emerge from the R & D department. Factors to improve R & D are: Good experimental equipments, Good fabrication equipments, Well established R & D unit with engineers and scientists, Documentation of past research, R & D activities of the organization and Journals, conferences etc. and to improve production one should have dedicated human resource, sophisticated equipments and good manufacturing methods. In present situation market study and transportation research are used to analyze the market and peoples mind/trend. Hence market research is one of the R & D activities in an organization.

1.6.2. Integration of Design, Manufacturing

This framework supports a structured approach to collective decision makers to the design strategy with manufacturing and marketing. Figure1.6.2. Below gives the structured way (Terry Hill’s, 1989). Five basic steps are required to incorporate the design strategy with manufacturing and marketing.
Step 1. Defining corporate objectives and the business strategy- corporate objectives are different and it varies from organization to organization, it reflects the unique nature of the business and it’s strategic in a systematic plan of awareness and vision (Porter (1980)).

Step 2. Formulation of marketing strategy- the marketing strategy is the logic by which the business unit expects to achieve its marketing objectives. Marketing strategy consists of making decisions on corporate marketing expenditures, marketing mix, and marketing allocations in relation to expected environmental and competitive conditions (Kotler (1984)).

Step 3. Establishment of order-winners and qualifiers- the relevant dimensions of competition are defined as order winners and qualifiers by asking how a product competes in the market segment of interest (Hill (1989)).
Step 4. Formulation of a manufacturing strategy - the role of manufacturing strategy guides (Hill (1989)).

a. To provide a process technology edge and
b. To support the company’s market needs better than the manufacturing function of its competitors.

Step 5. Formulation of a design strategy

a. Positioning of the product design along the complexity and innovation dimensions, and
b. Identifying the appropriate design infrastructure to support the product design task for the targeted strategic positioning.

1.7. Trans organizational Development

Well in an organization we come across inter-organizational and intra-organization. According to porter value chain I will differentiate between this two in the next paragraph.

Inter-organizational can be defined as the focus between two firm’s, which starts from inbound logistics through outbound logistics followed by marketing and sales and other various department of HRM and technology development between two firms. Intra-organization deals only in an organization from various departments or in other words which deals with in organization. Here I would like to discuss in more detail on Trans organizational development.

Researchers spread their work in a broader way and move on more focus from organization and other environment relations to networks and populations of organizations (Hannan & Freeman, 1977; Aldrich & Whetten, 1981). In the similar way, practitioners have changed the planned way and go beyond the single organizations to the corporate performance of sets of organizations (Trist, 1979). This type of multi-
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organizational group can be referred to as trans organizational system (TS). A detailed explanation and the prelim of planning system have to change to do or compare with the system, called Trans organizational development (TD). The trans organizational system consist of organizations that have joined together to achieve the needed goals and mission of the organizations for the common purpose. They have been referred to as ‘action-sets’ (Aldrich and Whetten, 1981), ‘social action system’ (Van de ven, 1976), ‘interorganizational domains or systems’ (Trist, 1979), ‘consortiums’ (Brown, et al., 1974), ‘joint ventures’ (Aiken & Hage, 1968), ‘directed interorganizational system’ (Lawless, 1982), ‘community decision organizations’ (Warren, 1967), and ‘network organizations’ (Metcalf, 1976). Transorganizational development is emphasize the improving the effective of TS. It mainly focuses from the conceptual framework on the involving texture of organizational environments (Emery & Trist, 1965) and several endeavors to help organizations adjust with the environmental complexity and change (Trist, 1967; Emery & Trist, 1973).

As in mentioned in the above paragraph about the Trans organizational systems are the social corporate forms of organizations which have joined together for a common purpose. The two distinct flow or current patterns of research provides an insight into their processes and structure: interorganizational relations (IR) and social problem solving (SPS). IR relates with single organization and their relationships with their large task environment, including other organizations, mainly they have more focus on broaden or extend to interorganizational relationships within networks of organizations, congeries of organizations taken as social corporate or collectives. Similarly on the other hand, this evolves mainly from the consideration of the large related environment itself considered as a system. Both fields will provide the unique complementary approaches to understanding TS.

1.8. Summary

This introduction chapter covers the purpose and statement of the problem, followed by brief introduction to Research and development and manufacturing by using conceptual frame work and the integration of design and manufacturing. Figure 1.6.2 gives you clear idea of integration. In the next chapter i will discuss some basic theory and facts relates to organization deals on communication.
Chapter 2

Theory on communication in organization

In the previous chapter presents a detail work of my thesis, which consists of background, purpose and statement of the problem. Thesis structure diagram gives more information on how this thesis work is structured. So in this chapter 2 covers theories on communication in organization include the concepts of human relations, like early involvement relation to the work and also in the later human relations. Section 2.2 deals with the concepts of reconsidering the closeness of personal disclosure, non personal information, etc. Section 2.3 covers the contingency theory on communication. And finally in the section 2.4 describe the different views into two forms like an organizational view like the company wide concept and tools views.

2.1. Legacy of human relations

The idea of openness up lines of communication is a curing for organizational ills. It maps the development of the ideology of openness in organizational communication from its origins in the human relations movement.

2.1.1. Early human relations

The significance of the early human relations on open superior manner-subordinate communication grown out from an assumption about the need for unique goals among organizational members (Bendix, 1974). Mayo and Dickson have observed in their research at Harvard seen the open communication between manages and employees as an integrating mechanism (Mayo, 1945; Roethlisberger & Dickson, 1947). Two assumptions was setup first, carry employees to cover their feelings about their jobs and super ordinate, this can over come by talking would relieve the worker stress and gives a chance to management to observe the untapped sources of workers motivation (Perrow, 1986). Second, progressively relative contact between workers and management, the employee should focus on the work and also involved in achieving the company goal. This improves the team sprit and also improves the productivity. In order to achieve this, early human relations involved emphasize relative downward communication from superiors to progressively integration, shows an obedient interest in the employee (Bendix, 1974). Bring out communication upward on the part of the employee. Re-examinations of early human relation research shown that economic rewards, better discipline and the anxieties caused by the national depression constitute more towards the improved performance than did improved communication (Carey, 1967; Conrad, 1985. Franke & Kaul, 1978). According to Peter Drucker says early human relations is a kind of psychological manipulation in which the exploitation of ‘individual fears, anxieties, and personality needs are replaces by the old fear of being punished or of losing one’s job’ in controlling employees (Peter Drucker, p.243, 1974).
2.1.2. Later human relations

Human relations stress the mutual responsibilities of managers and employees to create ‘supportive relationships’ through open communication (Likert, 1967). It backup the research on openness communication in the communication field. Redding defined the meaning of open communication as relationship as one in which both parties perceive the other to be a willing and receptive listener, and refrain from responses which might be seen as negative or nonaccepting. From this statement, ideal managerial is category by supportive, empathy, participation, and trust, achieved in party by the candid disclose of feelings (Redding, 1972, p. 330). Wiio says that open communication leads to greater dissatisfaction with the job and to the organization. Dissatisfaction is not only the reason to be low open, conflict spawns via media or compromise and positive change, but this will not show the relationship between open communication and employee attitudes is not as simple as is sometimes presumed. Focus on the effect of openness on attitudes is moderated by the nature of the information that is shared and the extent to which revelations expose detail of significant disagreement (Wiio, citied in Goldhaber, 1983). Finally subordinates prefer open communication varies depending upon characteristics of their superiors.

2.2. Reconsidering Openness

In this section reconsidering openness can be categorized into three different ways. (1) Disclosure of personal information. This is due to early human relations movement, employee feelings and reliefs were important for effective coordinate relationships. (2) Disclosure of nonpersonal information. Openness is defined as supportiveness rather than unrestricted forthrightness. (3) One is overlapping the two and addresses the linguistic choices which include being more or less open. This is one of the most and important aspect in work on language and symbolism in the organizations (cf. Eisenberg & Riley, in press; Pondy, Frost, Morgan, &Dandridge, 1983).

2.2.1. Openness as personal disclosure

According to Imberman (1979) says the frequent listening sessions will encourage employees to share their feelings this leads to better or lively labor management relations. More over managers would conduct leveling sessions in which they communicate openly with employees about their performance, skills, ability and feelings. Sincere and honesty plays a vital role and would have backfire as long as managers listened carefully, avoid emotionalism and look up those employees who have already left the organization as a result of leveling sessions takes to ‘removal of stress from the organization’ (Stangnaro, 1982). Sessions of this kind will backfire for both managers and employees. Disclosure is appropriate for under certain conditions, this approach can cause serious discomfort, confusion, emotional demands, and more stress than is relieved. Most
work relationships are non interpersonal. Close relationships results from mutual disclosure can complicate rather than simplify employees work lives (Conrad, 1985). Increased knowledge of another person may lead to an improved work relationship.

The idea on open communication is not good always, because it contradicts deeply held belief about human relationships. However the belief about communication differs from the actual behavior of organizations (Steele, 1975). Managers regularly use ‘manipulative persuasion’ to disguise self-interest, to distort information (Allen, Madison, Porter, Renwick, & Mayes, 1979). When communicating with superiors, subordinates deviate from openness to protect self-interests; messages directed upward in organizations are ‘largely edited and carefulness. (Krone, 1985, p.9).

2.2.2. Openness as disclosure of nonpersonal information
Nonpersonal information increases organizational effectiveness in certain conditions only. It may between labor and management, organization and public, etc. carefully team goals and individual can be advance to the disclosure of information. Research evidence says that the disclose will not lead to best settlements (Putnam & Jones, 1982). For example, in many organizations some informal rules which puts limits on some important topics discussion at the meetings, real differences are forge out at backstage (Steele, 1975). It depends on people sense of legitimacy for survival, which would result in blocking of communication about the technical activities so as to end or prevent internal conflicts, which can ultimately lead to bigger damage to the organization image. Directions of openness do little to help managers and adjust with such complex problems. More ever openness is like a free flow of exchange information; this brings power relationships and reduces the outcome of political behavior. Finally according to Conrad (1985) ‘the norms and political realities of organizations thus reward people for closed, not open communication’.

2.2.3. Openness as clear, unambiguous communication
Some of the managers have already tried with trust in increasing the clearness of communication between people, this situation will arise when there is a disagreement are essential and the things getting worse. Members from the organization they have to strict to strategic use of ambiguity. This is useful to use strategic ambiguity when dealing with several interactional goals joined with supervisory positions. Managers have the ability of carrying on performance appraisal with the use of strategically ambiguous statements and comments may results in improving the subordinate performance, this will allow or set him or her the ‘freedom and creativity to excel’(Goodall, Wilson, & Waagen, 1986, p-77). Explicit communication can affect task-related decisions and attributes about the character. Similarly managers who are explicit in the mission statement and
goals are at the risk. When the mission statement was not clear then the conflict will arise, these conflicts are unavoidable. So an ambiguous missions and goals show a path for having several directions interpretations to coexist and are more effective in groups to work together. This ambiguous gives the organizations a freedom to respond to environmental changes (Keesing, 1974). ‘Ambiguity in strategy, characteristic of many public organizations, therefore may be an asset’ (Ring & Perry, 1985, p.279).

2.3. Contingency perspective on organizational communication

it is valuable for the managers and the employee to have the benefits of empathic listening, creates an atmosphere of mutual respect and encourage for new and innovative ideas; share feelings and give respect to the sentiments when individuals so desire. The development of contingency perspective in which communication strategies will reflect the goals and mission statements and also characteristics proposed. There are four types of different contingencies are individual, relational, organizational and finally environmental.

2.3.1. Individual contingencies

Style, personal motives and preferences will affect the communicative choices. If some one is challenging shaping up his career, then his\her private life keep separate, work life and degree of openness can be explain with respect to this desire ends. Similarly a person’s communication style like shyness would affect the extent of communication with others.

2.3.2. Relational contingencies

Relates the closeness or shared history between communication members. Relational contingencies also suggest tact, politeness and the conservation of familiarity, one explanation for one’s degree of openness. More ever in this case the ease of sharing personal information of one employee with another employee is based on degree of trust and respect in the relationships.

2.3.3. Organizational contingencies

The constraints on the communication may be related to job, roles and responsibilities of individual employee in the organization. It’s very important that from the company point of view, the employee should not give company secrets to the public or other organizations about the job in hand; this will have a major impact on organizations.
2.3.4. Environmental contingencies

This includes the organizations internal and external communication. It is very important that the top management level like CEOs, managing director and the manager monitor their degree of openness with the public as a way of protecting their organizations from several threats to legitimacy or survival.

2.4. Different views and tools

In this section discussion on organizational view according to company wide view and the tools are general to my thesis work will be discussed in detail.

2.4.1. Organizational view

The three main organizational approaches are company wide range, improvement programme and finally toolbox. Figure 2.4.1. Gives more idea on how this will relate to an organization.

![Diagram of organizational approaches]

Figure 2.4.1. Three main organizational approaches

**Company-wide strategy:** The up most important risk in the beginning for the organizational members is to know about the company strategy, their product and processes, structure and patterns etc., after analyzing on these aspects, collect the information for the task to completion of the product, involves the data from the previous projects, feedback from others those involved in the recent work and prepare a statement in order to fulfill the required work. The most important is to get the top management support or involvement in the work in every aspect of whole product life cycle. Identify what the customer wants and their needs and expectations, this can be done through interview and among group members in the team in order to find out the needs and expectations of customers in present market situation.

**Improvement programme:** When we considered organizations, whether it’s an inter-organization or intra organizational implementation is an important term for the improvement programme. Implementation will be
effective to both large and small firms. Gives an exact solution to overcome the problem. This can be done based on the organization strategies and by considering the decision to implement the new programme to the existing one, this will bring more success to the firms. More ever when doing this new implementation, some firms are lagging behind of the new technologies, some kind of methodology and required tools are not able to achieve the ongoing work needs a guideline to complete the task and support from the organization.

**Toolbox:** This is more about learning the tools and techniques as an individual and from the organization benefit of view also. Methodologies like (DMAIC & DMADV) requires the commitment from the top to bottom management approach requires essential assistance from each and every one involved in work. An employee has to come forward and learn the new techniques in order to survive in the competition world, so it basically knows the tools and techniques for the completion of product life cycle. Use of six sigma approach is best suited as methodologies and also tools for general problem solving.

### 2.4.2. Tools view

Due to globalization of the market, the short life cycle or products, increased product diversity, similarly high demand of quality and short delivery times. More ever to be competitive in the market therefore must use new technologies for their product development; re-engineer their organizational structures and ability to make best decision through the whole development cycle. These new technology includes internet technology, CAD\CAM\CAPP integration technology, simulation based technology and knowledge based and optimization theory. Information system and management involves some programming in java based and visual basic script will enhance the system in better way. Technology has major impact on organizations. Technology is the leading stone of organizational activity various from equipment for mass production to final delivery products to the advanced digital processes. The new forms of communication and information technologies enhance (ex. E-mail, teleconferencing, computer conferencing, personal computer and local area network [LAN], interactive cable television, videotext and satellite communication), computer networks, computer-aided manufacturing (e.g. CAM; robotics), and computer-aided design (CAD) shifted from physically moving things to processing information.

### 2.5. Overall summary

Communication is a very broad term; in general it is a process of exchange of ideas and views either verbal or by written statements. It shows the path from the origin of components to the human relation movements. The significance of early human relations in open superior-subordinate way, then followed by the mutual responsibilities of senior managers and the employees to create strong relationship through open
communication. In the next section 2.2. Reconsidering openness can be categorized into three different ways first, openness as personal disclosure here encourages the employees to share their feelings to the management. So having a change of good relation with higher hierarchy. Second, openness as disclosure of nonpersonal information this disclosure will not leads to better settlements. Which puts some restrictions in the meetings, do not discuss those issues in the meetings makes more uncomfortable real differences are forge out at a backstage. Section 2.3. It creates a platform for the employees and managers for mutual understanding of each other, create innovative ideas, share feelings and respect one another. Section 2.4 Deals with the organizational and tools views. In the organizational view discuss on three approaches to the organization like company-wide strategy, improvement programme and finally toolbox have been discussed and also the tools which are very essential to know, how these tools can be used are discussed so far.
Chapter 3

Organizational communication

Well in the previous two chapters covers the background, purpose and thesis structure as well as the theories on communication with legacy human relation. Then reconsidering on openness with personal and non personal disclosure in details. In chapter 3 covers a brief introduction to communication, in section 3.2 to know more on basic components on communication with some essential elements description in details. Section 3.3 covers the organization identification and communication processes. And finally in the section 3.4 give on idea of properties on communication process and organizational identification.

3.1. Introduction to communication

Communication serves as a medium by means of which people’s thoughts, translated either into written and spoken form, (this can also referred to as messages and texts), conveyed by one person to another person for them to interpret and fit into the frame of reference. This concept some times called as transmission theory. Most of the work that people do in organizations requires some degree of active coordination, cooperation and communication with others. Even in individual members of groups need to communicate with each other to accomplish their R & D and manufacturing process, with in organizations, groups need to communicate with other groups. Informal communication is frequent in R & D and manufacturing functions, it aids organizational members to learning about each other and their work, and it supports R & D, manufacturing work and social function also. This provides a facility that cooperates and collaborates rely on the start joint work. Individual communicate with others in the organization enhance organizational commitment because this frequent communication leads to individual to feel that they are active participants in the organization (Huff et al. 1989). This active participants leads to greater control in the organizations.

3.2. Basic components of communication

Organization can not operate without communication. Communication can take various forms but all forms involve the transfer of information from one party to the other. In order for the transfer of information to qualify as communication, the recipient must understand the meaning of the information transferred to them. If the recipient does not understand the meaning of the information conveyed to them communication has not taken place. Communication is the life source of organization because organizations involve people. People cannot interact with each other with out communication. Figure3.2. gives an idea of components of communication process. Communication process includes seven key elements as illustrated in the diagram below.
Communication between two or more people and involves the transfer of information or message from one person to the others. The person transferring the information is called the sender or transmitter. The people receiving the message are known as receivers. The transmitter will need to send the information in a format that the receiver will understand. Converting the information into a format that the receivers will understand is known as encoding. Messages can be encoded into a variety of formats oral, written or visual. After encoding the message is transferred via a medium called a channel. After transference the information will need to be interpreted by the receiver. This process of interpretation is known as decoding. Finally the receiver will send a message back to the transmitter confirming whether the information sent has been understood. This back check is known as feedback. At each stage in the process encoding, transference, and decoding there is the possibility of interference which may hinder the communication process. This is known as noise. When information is transferred from the transmitter to the receiver not all of the information may be received by the receiver because called noise. Each of the noise may be affect the amount of information transferred. More noise decreases the amount of correct information received. Noise can take a variety of forms including language issues and cultural differences, environmental issues, channel issues, receiver attitude and behavior and transmission journey, etc.
3.3. Organizational identification and communication processes

Organizational members specify the self interest in relation to the organization (Turner, 1987). Which involves social and psychological bond relationship covers the employees and the organization. Research on identification, refers to the strength of an individual’s cognitive attachment to the organization (Dutton et al. 1994). This strength determines some critical beliefs and behaviors, like employees feelings of interpersonal trust, goal-setting processes, organizational norms and practices and able to adjust with the others members in the organization and finally gives an opportunities for organizational learning (Kogut and Zander, 1996). Identification is essential for virtual organizations, it facilitates critical organization functions these are challenges in virtual contexts a) coordination and control of dispersed organizational actors; b) work group functioning; c)encouragement of extra role helping behaviors; and d) retention of valuable employees.

Organization identification provides a connection between the organization and a work force, this identification motivates members to coordinate their efforts to achieve organizational goals by enhancing interpersonal trust and cooperation (Brewer, 1981; Kramer and Brewer 1984, 1986). Communication can enhance or strength members’ identification, it provides the solid foundation to the organization members sets a value for sharing perceptions of the organizations defining features like norms, values and culture. Communication helps to create shared meaning, it provides a social context cues. This shared meaning provides organization members with a clear sense of organization’s identity, this will strength member’s identification.

3.4. Properties of communication media and their effect on organizational identification

The link between communication and organizational identification is very important, individual virtual status plays a critical role which leads to different communication media. Appendix-I gives more information on comparison of communication media with respect to accessibility, formality, shared interpretive context and social context cues.

Face-to-Face communication is an important media available for the workers in the traditional office. For the virtual workers have less impact on face-to-face, because they heavily depend on e-mail and telephone as the media of necessity. Richness theory was proposed by (Daft et al. 1987). Says that communication media make more or less effective on several dimensions. For instance in face-to-face communication tends to convey social context cues are very strongly, effective in creating social presence and also a shared context among organization members. When compared to e-mail and telephone are not rich as face-to-face communication. So e-mail and telephone are less effective as a means of creating and maintaining the
organization identification. Past evidence suggest that the social context cues are considered in order to determine the impact of different communication media on individuals.

3.5. Overall summary

In the very beginning of this chapter it’s all about the introduction to communication and their process. Communication serves as a medium between two people. Again communication having both formal and informal communication. Informal communication helps organizations to learn new techniques and tools; it also helps R&D-manufacturing interface. Some terminology was explained in the followed section, some communication terms were given more information to understand the meaning of communication. Organization members show the self interest in relation to organization; this involves social and psychological relationships between employees and the organization. All this comes under the topic of organization identification and communication processes. Finally in the last session is about the communication media and their effects on organizational identification, face-to-face is one of the best in business these days. It’s an important media to communicate people in the office compared to telephone and e-mail. High intensity and high frequency for the face-to-face communication compared to telephone and e-mail process.
Chapter 4

Literature research

4.1. Adapted method for the thesis work

Basic introduction to the thesis work in chapter 1, includes the background of the thesis, statement of the problem and finally some comments on conceptual framework of R&D, manufacturing have been discussed in the introduction part, where as in chapter 2 is all about the basic theory on communication, involves human relations, early and later human relations on the processes, reconsidering openness in three different structured ways, contingency perspective model on organizational communication discussed in detail with four approaches of contingency, finally ends with organizational tools views have some comments on it. In chapter 3, is on the organizational communication which includes some basic terminology on communication, organizational identification and communication processes, their properties and effects on it have been discussed so far.

Here in this chapter i will discuss the adapted method for my thesis work in a structured way. This thesis work can be structured in two ways. First, present each article briefly whole summary then discussion in relation to those factors in terms of each factor separately for all the articles and finally make a summary on all the factors with respect to the articles stated, this is one way of doing my thesis work has been structured. Second, present each factor in details like general way of all the stated articles, then discussion on each factor in relation to those factors with respect to the stated articles and finally make a summary of all articles. These are the two methods which I have adapted to my thesis work. I personally rated first method is best for me, so I choose to work for the rest of my thesis work on selected method.

4.1.1. Factors discussion in details

There are eight factors has been used for my thesis work, right now the recent research work is carried away by the HELIX research group unit of people at Linköping universitet. There are about 14 factors which has been combined and reduced to eight factors adapted to my thesis work. These factors are individual\active responsibilities, artefact understanding, domain\system understanding, communication media\early communication about an idea, control and role distribution, teams, accessibility\arena for personnel meetings and finally overall leadership.

Individual\active responsibilities - individual refers to a person or to any specific object in a collection. The state of the world he acts in and the total awareness of those he may represent around him. The word active
means provides the space for self-realization, for making new contacts. So finally individual responsibilities to take up the task individually have the aim to achieve it.

**Artefact understanding** - A human-made object that is a prototype or standard of measurement. Prototype means a prototype is built to test the function and feel of the new design before starting production of a product.

**Domain\system understanding** - is a field of study. Gives the meaning of body of works and knowledge. The meaning of system says system have a structured by its parts and its processes more ever systems have functional and as well as structural relationships between each other.

**Communication idea\early communication about the idea** - Communication is a process that allows people to exchange information by several methods. Communication requires that all parties understand a common language that is exchanged with each other. More ever it is an activity of conveying and communicating information from one another.

**Control and role distribution** - a process implemented in an organization to help achieve specific goals. Activity of managing or exerting control over some thing. Role involves a function of a senior manager, first his role is to form a project leader and core team to work on particular project. Finally assign each role and responsibilities to them in order to complete the project.

**Teams** - individual who normally interact in completing tasks. Teams are the corporate units working together to pull something from their hands. Specific meaning coordinating groups of individuals working together even they are not in constant contact.

**Accessibility\arena for personnel meetings** - used to describe the degree to which a system is usable by as many people as possible. In other words, it is the degree of ease with which it is possible to reach a certain location from other locations. Accessibility can be seen as "ability to access" the functionality and other benefits.

**Overall leadership** - "the ability of an individual to influence, motivate, and enable others to contribute toward the effectiveness and success of the organizations of which they are members." Leadership is an ability of an
individual to provide some rules and regulations and lead the team in front. It’s an attitude that influences the environment around us.

4.1.2. Present each article briefly

In this section will describe each article in briefly, after describing each article in briefly, next section is all about the discussion on those articles related to the factors and this chapter will ends with the over all summary of each articles. Appendix-II Gives the details of all the referred articles to my thesis work.

| Title: A WWW-based integrated product development platform for sheet metal parts intelligent concurrent design and manufacturing. |
| Author: S. Q. XIE, P. L. TU, D. AITCHISON, R. DUNLOP and Z. D. ZHOU. |
| Key words: world wide web, integration framework and design\manufacturing knowledge base module. |

**Article 01:** Individual role must be adapted very quickly in order to survive in the departments, because lots of competition in and around the organization. Learn the latest and most innovate ideas and integrated tools like CAM\CAD design related tools, individual contribution to team is very important in the organization point of view. This will improve self confidence, morale, lift team spirit and also along with subordinates having better communication and coordination. Where as the artefacts it’s a man made tool need to understand quickly. Design repositories it’s a like a warehouse where we can store materials and can be retrieve at any time when there is a need. This concept is very essential in the early stage of product development concept. Network agent as having a dual role, some times they act as a resource provider to some projects and can retrieve the needed data at any time. Having the responsibilities of handling very difficult tasks in the team members, this can be done through proper coordination and cooperation among the group members in the team. A team needs a support from every one in the organization and it’s widely distributed in the organization. Every organization needs a common platform where the company ongoing operations can be seen and can interact at any time among the members of the organization, so a common platform like www-based integrated product development is the one which provides all necessary information of the ongoing work related to the company.

| Title: A distributed multi-agent environment for product design and manufacturing planning. |
| Author: J. SUN, Y. F. ZHANG and A. Y. C. NEE. |
| Key words: process and manufacturing planning, concurrent engineering, multi agent, facilitator. |

**Article 02:** A modern tool like DFX which means design for everything includes assembly, manufacturing, serviceability, reliability, etc. best suited for all operation from R&D and manufacturing functions, this helps
in understanding the design and manufacturing process to select the required tools for the particular operation each one can have a individual role and aims to achieve the required task. Best way to achieve to coordinate among others in the department for constant and smooth flow of work. A federated approach is one which acts like a system is an entity that maintains its existence through the proper mutual interaction among others in the organization. Knowing more on software tools and its better to interact with others and discuss the work and proceed further. One way of communication is through by interacting agent in the organization, this agent act as coordinator between departments transfer information from one division to another division, assistance and guidelines to all the members of the teams, so it’s better to have a common agent in the unit.

| Title: Integrating R&D and Marketing: a review and analysis of the literature. |
| Author: Abbie Griffin and John R. Hauser. |
| Key words: R&D, cross-functional teams, new product development functional integration. |

**Article 03:** Sharing knowledge is one of the main contributions to the department, improves your confidence and takes up the new challenges to work on it. Provides a gate way for finding the new opportunity for next generation of product development. Knowing customer needs in today’s present situation plays a significant role in the individual part. Too much involvement with the other members in the organization will affect the nature of work and sets a base for complicated issues. So try to be close but keep in mind that will not affect the system. Open communication will improves inside as well as outside of the organization and brings a change in the organization.

| Title: An Evaluation of Research on Integrated Product Development. |
| Author: Donald Gerwin Nicholas J. Barrowman. |
| Key words: integrated product development, cross-functional teams, new product development functional integration, concurrent engineering. |

**Article 04:** Every system has some set of goals and tasks in order to fulfill the given system requirements. Each having a different type of goals, having a proper stage or plan to execute the tasks. So each place a vital role in their part. Cross functional is one of the main integrated product development characteristics. Achievement needs support from teams as well as from their subsystem.

| Title: Antecedents and Consequences of Cross-Functional Cooperation: A Comparison of R&D, Manufacturing, and Marketing Perspectives. |
| Author: X. Michael Song, Mitzi M. Montoya-Weiss, and Jeffrey B. Schmidt. |
| Key words: integrated product development, cross-functional teams, and new product development functional integration, R&D, manufacturing and marketing. |
**Article 05:** Concurrent engineering, QFD and both internal and external factors are very essential to understand the how system can be reached with these new techniques. Like the external factors which are uncontrollable in the firm where as internal factors have direct impact on operating environment. Further more both are hypothesized to impact cross-functional cooperation. Similarly the concept of cross-functional communication in new product development firms is adopted in simulating, facilitating and maintaining the cooperation between various functional areas. Finally some organizational characteristics support also needed from top to bottom approach system, this will impact directly an indirectly through cross-functional cooperation.

<table>
<thead>
<tr>
<th>Title:</th>
<th>Cross functional teams in product development accommodating the structure to the process.</th>
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<tbody>
<tr>
<td>Author:</td>
<td>Anne Donnellon.</td>
</tr>
<tr>
<td>Key words:</td>
<td>product development teams, organizational outcomes team approach groups.</td>
</tr>
</tbody>
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**Article 06:** Team approach needs knowledge from different specialization area from different functional unit, mutual understanding or adjustment are belongs to team approach. It’s good to know about the organization strategies first, observe the ongoing sequence of operation, body language and culture etc. achievement can be obtained through hard work and performs well in the specific operation, needs patience and practices to work and freedom of choice for creative ideas. Teams are the logical way to engage the considerable skills and knowledge and groups are the building blocks of organizations, gives a better problem solutions, generate creative ideas, make better decision, etc.,

<table>
<thead>
<tr>
<th>Title:</th>
<th>Design Strategy and Its Interface with Manufacturing and Marketing: A Conceptual Framework.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author:</td>
<td>JAMES A. FITZSIMMONS, PANAGIOTIS KOUVELIS, DEBASISH N. MALLICK.</td>
</tr>
<tr>
<td>Key words:</td>
<td>cross-functional teams, new product development functional integration, R&amp;D, manufacturing and marketing, product design, complexity and innovation.</td>
</tr>
</tbody>
</table>

**Article 07:** It’s important to know the dimensions of competition, because the level of design effort will depend on this competition like price, speed, flexibility, quality. Complexity and innovation are the design variables in the system to know, how this will affect the system. Teams must adopt some approaches like sequential and team approach best to use on high level of complexity and innovation; teams play critical factors in this aspects.
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

| Title: Design-Manufacturing Integration as a Mediator of Antecedents to New Product Design Quality. |
| Author: Morgan L. Swink and Roger Calantone. |
| Key words: new product development, design-manufacturing integration. |

**Article 08:** When we produce some product, we must keep in mind that the produced product is free from defects, cheaply and easily available to customers in the market. Must adopt new kind of techniques like design-manufacturing integration says that the technology novelty has the direct influence on design quality, whereas the project organization complexity will have less impact on design quality. Design-manufacturing integration acts like a bridge between this to terminologies provides a solid platform to the design quality.

| Title: Early Manufacturing Involvement in New Product Development. |
| Author: John E. Ettlie. |
| Key words: product development, design-manufacturing integration. |

**Article 09:** Early manufacturing involvement is an important concept to discuss in the beginning of any product development. This makes the final product more comfortable with the early involvement between two departments working on this. It reduces lot of development cost, improves product development life cycle and efficiency. One important thing to notice that the early involvement between R&D and manufacturing functions, makes a product with less design changes at the time of production, this less design changes improves product life cycle more and stay in the turbulent market.

| Title: Engineering design and product development and its relationship to manufacturing: A programme of case study research in British companies. |
| Author: P.M. Braiden”, N. Alderman and A.T. Thwaites. |
| Key words: product development process, design and manufacturing. |

**Article 10:** It’s a social science methodology has being applied to both research and development and manufacturing functions. Creating an interdisciplinary approach sets a base for both the research and development and manufacturing to share the values and ideas, find out the technical problems and their social and economic environment to operate on it. And the non-competitive benchmarking gets feedback from the previous experiments knowledge and applies directly on to the competitors.

| Title: R&D-Production in the early phases of new product development projects. |
| Author: Jukka Nihtilä. |
| Key words: cross-functional integration, coordination, early project phases, new product development. |
Articles 11: In this article is all about the coordination, means as an activity to ensure concerted action in a situation of interdependency (Thompson, 1967. p.55). Teams’ managerial qualities, the integration mechanism is largely dependent on the type and size of the organization. Informal contacts, formal meetings, liaison personnel acting as an agent or facilitator represents or in-charge for the particular operations. Through job-rotation can be used to develop cross-functional skills.

| Title: Integrating Design and Manufacturing to Deploy Advanced Manufacturing Technology.  
| Author: STACY A. REIFEIS and John E. Ettlie.  
| Key words: computer aided design, design for manufacture, design-manufacturing integration. |

Article 12: The CAD/CAM technologies again plays an important role in active responsibilities, with the help of this technologies both the research and development and manufacturing department can achieve better integration and cooperation. Erase the old system and adopt the new way of success. Must practice with new roles and practices and procedures, management policies etc.

| Title: Interdepartmental Interdependence and Coordination: the case of the Design/Manufacturing Interface.  
| Author: Paul S. Adler.  
| Key words: design-manufacturing relationships, functional coordination, product development process, design, manufacturing, novelty, analyzability, uncertainty. |

Article 13: Both the uncertainty and equivocality can be managed by face-to-face communication, share more information and through richer communication. Engineering changes is a form of mutual adaptation in the manufacturing phase. Design manufacturing relationships will encourage the firms to reconsider their DMR. When the firms moves aggressively on CAD/CAM technologies, there is a change to attain a better communication and coordination among departments. Transitions teams, in this approach the design engineer has the chance to work in the manufacturing unit and vice-versa. They move on temporary basis to complete the given task until the product has released in the market. Some times they will work on full time basis or part time basis it depends on the nature of the work.

| Title: Knowledge sharing in integrated product development.  
| Author: Paul Hong, William J. Doll, Abraham Y. Nahm and Xiao Li.  
| Key words: innovation, knowledge management, product development, performance measurement (quality). |

Article 14: Identifying customer needs and matching with the design and manufacturing process a big problem in this arena. But this can be achieved through mutual understanding among group members, proper
way of communication and coordination. Individual as having main role in order to constitute the smooth flow of pattern of work. Process performance measures the effectiveness of the product development process itself. Shared knowledge is viewed as an understanding and appreciation among different functions. The concept of development productivity is the effectiveness of developing the new products from product concept to manufacturing (Cooper, 1999; Cooper and Klein Schmidt, 1995).

### Article 15: Managing the design/manufacturing interface across firms

**Title:** Managing the design/manufacturing interface across firms.  
**Author:** David Twigg.  
**Key words:** coordination, design, integration product development, manufacturing, suppliers.

Coordination requires a combination of skills, culture and other technical systems. Each having many different roles and strategies and it all comes under product development. Organizational aspects includes skills, depth of organization culture, are the variables to coordinating new product development. And finally technical and organizational factors are the main area influences the coordination of activities (Winch et al. 1991).

### Article 16: Organizing for concurrent engineering: an integration mechanism framework

**Title:** Organizing for concurrent engineering: an integration mechanism framework.  
**Author:** Victor Paashuis and Harry Bore.  
**Key words:** concurrent engineering, new product development, integration by process, technology, cross-functional cooperation and communication.

Concurrent engineering is a systematic approach towards the design of products. This involves the strategic process, technological and organizational mechanisms, main aim is to collaborate, with more frequent communication between two departments, through this quality can be improved and deliver the product on time. Communication is a process in which information generates in one section and is transferred to another section. With the help of meetings, teleconferencing, exchange of documentations is possible to achieve better communication.

### Article 17: Role of design-philosophies in interfacing manufacturing with marketing

**Title:** Role of design-philosophies in interfacing manufacturing with marketing.  
**Author:** Balakrishnan, Amiya K. Chakravarty, Sanjoy Ghose.  
**Key words:** engineering design, manufacturing-marketing interface

Design philosophy would guide the product designer towards specific manufacturing attributes values would be the most appropriate for a product once he'she gets input about its desired marketing attributes values.
Article 18: The concept of template approach have improved coordination, communication, sets a solid platform for all the three departments. Template approach defines the proper tools and techniques in order to require assessing and balancing from the customer identification to the concept generation and also to the concept selection process. Technical balance needs a disciplined engineering organization and system, competing with product development cycle, this technical balance will be referred to have building critical skills.

Article 19: The degree of interdependence and the nature of interactions among the functional specialist will be influenced by the nature of the collective task they seek to accomplish. It needs a support from the development team in order to achieve the high level of new product manufacturing.

Article 20: Contingency model- with the help of specialist in the department is it possible to improve the new product development activities. Team spirit and coordination among the members in the organization leads to team success. More ever the joint involvement focus on a two units at a time rather than focusing on all departments at a time this will set a failure in the product development, and to know the deeper knowledge of integration NPD activities, its better have the joint involvement together by using a stage-specific approach.

4.1.3. Discussion in relation to factors
This part is one of the most important to my thesis work. In this section i will discuss each article in detail with respect to all factors. Results will be presented in the next chapter of all articles in table format. Figure 4.1.3a. Below gives an idea of factor influences. Figure also gives you a clear indication on how this factors
will influence on articles, before I took this thesis the initial result will shown in first figure, later applying those factors to my thesis work. The results obtained will be shown in second figure will be seen at the end of discussion of this section.

**Figure 4.1.3a. Preliminary results of research factors**

Results obtained from the preliminary result from the Helix Research and development division unit at Linkoping Universitet.

**Article 01: Individual\Active responsibility**- An essential improvement step in the early design phase and as well as in the later manufacturing phase makes the product and process success, must adopt or revise their organizational structure and make use of new technologies to produce the achieve the desired outcomes. Most important decision is to make correct steps in the beginning leads to more success in the later stage. **Artefact understanding**- A facility where things can be storage or retrieve the data for the smooth completion of the task. It’s a people involvement to execute the work in a proper manner and also it guides you in the design stage. **Communication idea\early communication about the idea**- Network agent has having the dual role, means ability to work and manage the things in both design and manufacturing area. These network agents are having all the information or a resource which is useful for the project completion. Having the responsibility to provide required assistance to another team or group to help them for the constant flow of work in the unit. **Teams**- Nothing but a coordination and communication between teams that are widely distributed in a network. **Accessibility\Arena for personnel meetings**- This platform is built on WWW
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

environment, which can be accessed from anywhere inside or outside the company through intranets and internets.

**Article 02: Individual\Active responsibility**- Design for assembly, manufacturing, serviceability, etc role was vital, because the agent has known some background of both the fields and according to situation can adopt the suitable condition needed for particular operations in each area. Rather than forming more active roles, make it single component. **Artefact understanding**- System can be defined as ‘system is an entity that maintains its existence through the mutual interaction of its parts’. Or in other words interrelated interacting artifacts designed to work as a coherent entity. With the help of software tools it is possible to interact with others. Developments in the so called distributed approach to concurrent engineering, including heterogeneous multi-agent system. **Communication idea\ early communication about the idea**- The facilitator manages interactions and conflict resolution in the agent community, which avoids communication bottlenecks problems, reduces communication cost and implementation complexity, and ensures scalability of agents.

**Article 03: Individual\Active responsibility**- The role of project leader in the team represents an active responsibility; his role is to assign the task to his colleague in the group those who are working under him. Not only assign some task to his team but also as a project leader should know some roles and responsibility. This is very effective in the beginning and also in the ending stage of the product development. **Communication idea\ early communication about the idea**- The name itself says that harmony means congruity of parts with one another and with the whole. Cooperation and communication are parts with one another and together with the whole as interfunctional harmony. **Control and role distribution**- Identifying the customer needs and expectations is the most difficult thing in the world, because every time the customer is looking innovative products, which is not available in the market. Even though the companies are trying to fulfill the customer needs with new products, and also they are trying to get their feedback about the product and other stuff like that. It needs patience and hard work. Developer should know what is going to do and how can we fulfill those needs to achieve or satisfy the customers expectations. **Teams**- Try with different forms and layouts, which increase communication with team co-location. Give an opportunity to move freely and in friendly environment. Informal meeting places, discussion forum in the working place and free coffee, which is located at every place in the building. Improves communication in the team. **Accessibility\ Arena for personnel meetings**- Developing informal reduces the language, thought world and physical barrier, etc., capable of producing better communication, increases coordination and also better way of decision making. **Overall leadership**- Harmonious- discuss important issues; resolve conflicts early, work together.
Formalization-clear performance standards and responsibilities, also well defined guidelines. Decentralization-issues resolved quickly by common knowledge. Innovativeness-accept failure, support new ideas. Value cooperation-able to take opportunities and also to exchange views and perspectives. Joint reward system-joint involvement from all three department; do not blame others for failures.

**Article 04: Domain\system understanding** - Every project has definite beginning and ending activities, starts with mission statement, goals and visions, roles and responsibilities also takes place in it. **Teams**- With the help of new technologies like CAD\CAM\CAPP develop new forms of products and release in the market. Need a strong coordination between departments as well as companies, if they are working jointly. Workers have to get some rewards and incentives for their effort to complete the product and for success. **Overall leadership**- Get involved in work as important, has knowing other members in the team or in the department also important. Maintain a good and healthy relationship with their neighboring department improves not only communication but also a good coordination and cooperation.

**Article 05: Artefact understanding** - The external factors are the uncontrollable action in the firm operating environment; where as internal facilitators are direct control of the firm. Both are hypothesized to impact cross-functional cooperation. **Domain\system understanding** - This is a major decision area, combining three units at a time is a real big problem. Some times leads to failure of the project because it involves too many people from all the three units, which makes uncomfortable with the working environment. But by the use of cross-functional communication in the effective and efficient manner brings a lot of improvement in it. It over comes the misunderstanding between various department in the firm. **Control and role distribution**- This are the barriers need to take precaution, should plan in such a way that this barrier will not affect the cross-functional cooperation. Control action has to be taken before it gets worse. **Teams**- It’s a mutual relationship with another department in the organization. Dependent on one another for the smooth flow of work in the domain. Sharing knowledge is also an important concept, which sets a solid base or platform to execute the given task with the help of communication and coordination with another group or team in the unit. **Overall leadership**- These are some of the organizational characteristics in the firm. For any kind of kickoff need a support from the top management and also from the middle management also. Once they process was get success, should appropriate there work in the form of incentives and reward system.

**Article 06: Domain\system understanding** - Specialized knowledge means that the knowledge in one field should be specialized; this contributes a steady focus on particular task to complete the required work. Its very important to know the about the company status and their strategies, what they are looking for in terms
of structure, culture, etc., team involvement in the work provides a strong base for team approach. **Control and role distribution**- If you took up a project work, then end result is to achieve in best way. It consists of hard work and doing well. Hard work comes from how much you involved in the work and also how you observe or analyze the things for the improvement. Patience and planning and time are very most aspects. **Teams**- Senior manager in the company have the rights to form a teams. Have the rights to pick for the right kind of job and assign the roles. So in the team consists of 4 to 5 members having different background and skills and knowledge. They must quickly adapt to the situation and work together as a team through share information and discuss each other for some kind of difficulty tasks. Finally once you followed the goals and values of the project, leads to success in it. **Overall leadership**- As the name suggests group’s building blocks of organizations. Consists of different people for a specific job, when we considered through a group having more problem-solving techniques, creative ideas, helps in making better decisions but as an individual cannot be achieved this. Some task has to be done on group through mutual cooperation and communication, sharing information and discussion with other members in the teams. Freely move and have the freedom to create own ideas, be friendly with others.

**Article 07: Individual\Active responsibility**- Design effort is required to analyzing and understanding all the strategic alternatives can pursue to gain a competitive advantage in product market segment and also to identify the new product-market segment. **Artefact understanding**- Basically when a component has build, it consists of lot of subcomponents in it. This is very complex in nature to assemble and also takes more time to fix it. Interaction is also an important concept in combining the part manufactured in one unit, then again to join or add supporting part to it. It’s easy to build a simple components with fewer parts when compare with large parts. When it consists of large parts to assemble then complexity will starts. **Domain\system understanding**- Companies are missing an opportunity to recognize there product design as a strategic element in the business strategy, which puts the company in the backward seat. More ever should think in this way, design is a business function and also a source of competitive strength.

**Article 08: Individual\Active responsibility**- This can achieve or attain through the integration of three primary sets of functional activities in product design and development. They are marketing, product design and production process design. **Artefact understanding**- Design-manufacturing integration (DMI), with the new technologies offers the potential to improve the design quality. **Domain\system understanding**- The dimension of competitiveness must match with the customer choice, so it’s very important to marketing and design people should know about more strategic framework of design, manufacturing and marketing.
Article 09: Artefact understanding- The primary role in the product development is design; whereas manufacturing part will be the secondary. Representatives of manufacturing are placed on teams to help design products and processes together.

Article 10: Artefact understanding- Researchers and engineers got an opportunity to work together by understanding the available resources in the company. Control and role distribution- Get the previous knowledge from the company and try to experiment with the directly with their competitors.


Article 12: Artefact understanding- With the help of newly technologies like CAM\CAD\CAPP brings a new scope in the R&D and production interface. It’s very important that representative from each division should work together and finally shown up there work as a team work, there by improving communication and coordination. It also helps in removing all barriers. With the use of computer integrated manufacturing system, capability to manage both manufacturing and research unit’s work. This can be done with the help of CAM\CAD. Domain\system understanding- When we look up to some mature firms, problems are existing because the Research and development team they had a plan to improve from present form to the most effective form through innovative new product to customers and meets their needs and expectations. Control and role distribution- Any form of work, which starts from the basic planning and having a proper structure. Some new management policies and philosophies to communicate and coordinate between design and manufacturing.

Article 13: Individual\Active responsibility- Coordination is very essential in any organization when we looked up in the departments. Because a product development work will depend on the set of rules and responsibilities, which includes planning structure as well as schedules. More importantly the mutual coordination and cooperation plays a vital role. Equivocality can be reduced by face-to-face dialogue, analyzability is reduced by creation of new information through the development of artefacts-design drawings, technical specifications, and manufactured products are richer in information context. Artefact
understanding- A task related to engineering work, where the design team can make a drawing and sends to manufacturing for further process in the product development. If the manufacturing needs some changes in the existing design drawing one, then they will send it back to design to modify the drawings or sketches. Engineering changes are very important in the organizational point of view, because it brings an implementation to the present process and also a strong coordination and cooperation. Domain\system understanding- An important thing to notice here, the organization should consider or choose the coordination mechanism that will minimizes the cost of producibility while insure an acceptable level of producibility. Design-manufacturing relationship is encouraging the firm to reconsider their organizational structure. This will automatically upgrades the tools and techniques which involves design and manufacturing work. It improves barrier in the department and brings better way of communication in the division. It’s a very interesting challenging task need to take up and establish a platform for future use as well. Control and role distribution- In any product development, pre work, actual work and post work are consisted. Pre work is the beginning to the project or it’s a kickoff or foundation for the next stage. Where as actual work means need to define the specific roles and destination. And finally the post work goes to the actual testing area according to the definition of actual work defined in their activity. Teams- Transition team is been very effective, because people like having the background of design and also having a better knowledge in the manufacturing helps a lot in identifying the problems in the early stages of product development. This transition team will reduce development cost of the project and reduces the budget in terms of redesign the product for one more time.

Article 14: Artefact understanding- The basic understanding of needs and their expectations is a complex task for the engineer and manufacturers. Different customer wants different set of products with new features, which is complex in nature and more costs. When the engineers and manufacturers considered the customer invoice in the design stage, find a difficult way of sorting out the more complex work to simple things. Which involves a time consuming and also there is no guarantee of the product in the market. But team members in the product development are working out hard in order to bring the most complex design to simple one with the help of proper communication and coordination between departments in the unit. Domain\system understanding- Shared knowledge of customers- for the product development members it’s very important to know the current needs and future requirements of the products for the customers. Those who are having a higher level of contact with are have more degrees of understanding of the changing customer needs, value-to customers and also level of customer satisfaction with their products. Shared knowledge of suppliers-shared understanding (i.e. know-why) of supplier’s design and manufacturing capabilities among product development team members. Since the suppliers are highly involved in the success of IPD, play a critical role
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

in for timely and cost-effective decision making in IPD. Allows PD members to improve their processes means communication and coordination among design and manufacturing engineers, enhance customer values. Shared knowledge of internal capabilities are usually resides among design and manufacturing team members. A very important task is to know how many different functional specialists are aware of the strengths and weaknesses in terms of design and manufacturing processes and other capabilities.

**Communication idea\ early communication about the idea**- Shared knowledge is important in product development process. Because it involves stages in PD are concept development, system design, detail design, testing and refinement and manufacturing production activities etc. so knowing the situation and understanding the concepts and later translates this concepts with the other team members in the team helps a lot in product development processes. These are also critical resources to the PD. Now a day’s most of the firms are increasingly this shared knowledge and make use of available resources to the required task completion. **Teams**- Take up a task and try to come up with new innovative ideas in the initial stage of product development as an individual, then form a group and share your ideas and concepts to other members of the group members. This influences several factors like creative problem solving, effective communication and also good coordination of activities in the team members. In the planning stage it’s very important that the financial department has some future prediction on the product, which includes the manufacturing cost, design cost, resource cost and labor costs included in producing the product. The budget should not exceed the available estimation of the beginning plan. The product is effective when the available budget should not exceed the limitations of the project.

**Article 15: Artefact understanding**- The primary objective is to develop understanding of how established design and manufacturing departments coordinate their activities. More importantly how these departments should coordinate to manage efficiently their interdependence? **Domain\system understanding**- The successful completion of the project needs a combination from all the area like the skills and knowledge from the individual, must have a good sense of humor. Proper standards and procedure and some plans to do the work. **Communication idea\ early communication about the idea**- Today’s competitive world, product and process engineer must have a very highly or additional skills for team working, good creative problem solving techniques. This day’s organization wants to work as a joint involvement between design and manufacturing brings new changes in the organizational structure. Organization culture plays a major role on to outcome of the project completion. Usually organization will have a common language which will understand by everyone in the company. Different people have different languages, so it’s good to have a common language platform to every one. **Control and role distribution**- Both technological and organizational factors have a major impact on the coordination of activities. Because new advanced technologies like CAM\CAD\CAPP
brings lot of changes in the drawing and helps the designer to work in effective manner and having the proper guidelines to manage the things. Similarly the organization structure has the same impact on people behavior as an individual and as a team member also. Good culture proves you as a discipline etc. Teams-Coordinating between two departments at a time is best, rather than combining the three departments. It involves a lot of misunderstanding between team members working in together for the project, time consuming and delay in producing the final product. Rotating the staff in departments is also improves the team to work in an effective way.

**Article 16: Artefact understanding**- This systematic approach is the best one, which encompasses the design task and the way it applicable to the manufacturing sector and logistics department. This aims to reach the product designs in terms of both external demands and also to the internal demands, by considering the price, delivery time and cost for producing the product and lead time. Concurrent engineering covers the wide range of strategic process; innovative technology changes the organizational structure in an effective and efficient manner. It involves close cooperation between all the departments in the organization. When having proper communication with others in the department, there is a chance for improving manufacturability, reduces the need for the re-design having the caption like ‘first-time right’. The delivery time of producing the product can be reduced and better quality can be achieved. **Communication idea\ early communication about the idea**- Co-operation collaboration creates synergy in different individuals’ activities by creating and using a common knowledge base. Collaboration involves work effort from team work and having good understanding with others in the team, they must have vision what is doing to do, common platform language to speak and talk. Communication is the process in which information originating in one function (sender) is transferred to and put to use by another function (receiver). Information comprises knowledge and know-how, ideas, concepts, data, results, analyses and plans.

**Article 17: Artefact understanding**- Design philosophy would guide the product designer towards specific manufacturing attribute values would be most appropriate for a product once he/she gets input about its desired marketing attributes values. **Domain\system understanding**- In the manufacturing unit, some part processes which are invisible to the customer like cooking system capacity and oil capacity which can’t be seen by naked eye. For example the in the design stage with the help CATIA or Pro-E, the programming part is behind the screen which is not visible to the designer when they created some drawings.

**Article 18: Individual\Active responsibility**- The role of engineer is to update the existing system and also the upcoming task with new technologies like CAD\CAM system. Make use of right resource at the proper
time and push with advanced technology rather than trying with old approaches. Artefact understanding- This approach is very essential in order to select the right tools and right techniques for the required operation for specific task in the production area. A value added in technically best in programming part of product development and also the corrective needs will choose for the particular task completion. It means focusing on the fundamentals of design and manufacturing, such as not counting defects but eliminating their causes.

It’s a joint venture; find the most critical region or part in the project that affect the process in design stage. Domain\system understanding- A technically balanced approach, therefore, requires that engineers and managers at all levels understand the technical and industrial processes involved in designing, developing, and manufacturing new products. Control and role distribution- Both design phase and manufacturing phase should be integrated, keep in mind that in order to survive in the booming market they have to produce with good quality. This can be done with the help of new technologies; the system is being able to change the structure with the market demands. Innovative ideas in the design phase helps in the manufacturing phase to produce a desired product for the customer at the right time and at the right place, which plays a very crucial role in product and process fit.

Article 19: Artefact understanding- Integration with in departments and the situational dimension or behavior, among the highly skilled and knowledgeable employee will take the task and complete with success without any failures. With the help of development team integration it is possible to achieve the high new product manufacturing. Teams- Cross functional integration has great influence on product development on NPD success. The initial design process involvement with the other department produces greater success, with the help removal of communication barriers in a work group. Better integration leads to working together and have an access to one another in the department freely and easily accessible the necessary resources needed for the work. It is very important from the managers’ point of view, that the given task he/she has to explain in a clear manner without any conflicts or any communication barrier that will affect the team working group. It needs involvement from the top management level in the organization to support for the project with all necessary requirements will satisfy the basic needs for the projects. This kind of support will boost the specialist to concentrate harder and take the risks on in his own. Provides an excellent platform to work in such an environment in order to achieve best NPM. Overall leadership- This collaborative environment helps the team behaviors and easy access for project personnel. This will provide the basic needs for the projects to begin, easy flow of access from all the functional departments in the organization. The product development cycle time can be improved with effective team efforts, moreover the market criteria and other performance can be achieved.
Article 20: Artefact understanding - With the help of functional specialist in the department is it possible to improve the new product development activities. Working together leads to a team success; this brings the effectiveness and efficiently the work flow in the organization. Domain/system understanding - Means that joint involvement is very much essential in this approach. Instead of considering all three units at a time, focus on any of the two units and see the changes in it. Communication idea/early communication about the idea - Focal functions means that in the planning stage manufacturing can be called as the focal function, similarly in the development stage R&D called as the focal function and in the pretesting stage marketing called as focal function. So the manufacturing, R&D and marketing playing the central role in cross-functional information transfer and cooperation in product planning, development and testing activities, etc. Control and role distribution - For the customer identification need a joint involvement between Research and Development and marketing department. Where as for the production process need a joint involvement between Research and Development and manufacturing. Each stage, functions and their roles has to define properly; this will not affect the integration process.

![Analysis of Factors Results Obtained](image)

**Figure 4.1.3.b. Analyses results of research factors**

4.2. Overall summary

In the section 4.1 give an idea about adapt method for my thesis work, there are two approaches are available in that i choose first method is the best one. Detail discussion on factors used in my thesis work in section 4.1.2. Section 4.1.3. Briefly explains the each article, this procedure follows are all the remaining articles. In the next section discussion on each factors in details from the articles and i have presented in the above paragraph.
Chapter 5

Results

5.1. Presenting each table

After presenting each article briefly in the previous chapter with discussion on related factors. Now in this section presenting the table format results of each article, followed by detail analysis of most important contribution from the article, author opinion on different factors and finally conclude this section with summary. Figure 5.1. Below shows the factors are inter-related and depends on one another for the entire process.

![Figure 5.1. Schematic diagram of all factors](image)

This is actual work of my thesis; the above diagram is constructed based on the results obtained from the articles. As you can see in the above diagram each factors are inter-related and dependent on each other factors. Based on my review and knowledge is started to build this model, in the beginning we need a know the process, so artefact understanding will match all the criteria. Then continued with control and role distribution here the given task has to control in an effective manner, it needs a person capable of handling and managing the system and should have responsibilities to manage the entire flow of process. When the individual active responsibility comes to role distribution played an important role knowing the individual task and roles for this understanding the system is very important. For all this process needs an execution through the communication. So all four factors are mutually and inter-related on each other. Again the communication process constitutes the three more factors in the like the teams, teams or groups are the critical building blocks of organization so needs an capable person to manage and also to encourage the team to work.
in an friendly environmental status needs a leadership. And finally in order to execute the above process through the common platform of all the information should be published in www based integrated platform, where all the necessary information and also the ongoing the organization operation will be displayed.

**Article 01:** A WWW-based integrated product development platform for sheet metal parts intelligent concurrent design and manufacturing.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Influence</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Designers and manufacturers in the department must adopt new technologies for their new product developments re-engineer their organizational structures and enhance their ability to make decisions correctly through the whole PD cycle, particularly at the early design stages. Active interest in learning the new technologies with the help of guidelines and manuals. Knowledge gaining, sharing and coordinates with others brings you more energetic and enthusiasm in the work.</td>
<td>An essential improvement step in the early design phase and as well as in the later manufacturing phase makes the product and process success, must adopt or revise their organizational structure and make use of new technologies to produce the achieve the desired outcomes. Most important decision is to make correct steps in the beginning leads to more success in the later stage.</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Design Repositories- (Szykman et al. [2000]). To support the integrated and concurrent design process. More over it provides a comprehensive knowledge representation during the design stage. It’s as an information framework using an object-oriented artefact representation language that provides high-level division into form, function and behavior. New technologies like internet technology (Chui and Wright 1996), CAD/CAPP/CAM integration technology (Xie et al. 2001), and computer simulation technology (Bartolotta et al. 1998), knowledge-based and optimization theory (Dowlatshahi 1992).</td>
<td>A facility where things can be storage or retrieve the data for the smooth completion of the task. It’s a people involvement to execute the work in a proper manner and also it guides you in the design stage.</td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>4. Communication idea/early communication about the idea</td>
<td>By interacting with network agents in the knowledge interchange format (KIF) language (Gruber et al. 1992), designers could communicate and transfer knowledge among different knowledge bases as well as request information and services from each other. Pact(Palo alto collaborative test) (Cutkosky et al. 1993) acknowledged that</td>
<td>Network agent has having the dual role, means ability to work and manage the things in both design and manufacturing area. These network agents are having all the information or a resource which is useful for the project completion. Having the responsibility to provide required assistance to another team or group to help them for the constant flow of</td>
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A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

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<thead>
<tr>
<th>Factors</th>
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<th>Description</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>In the multi-agent paradigm, those isolated and distributed DFX (design for manufacturing, assembly, etc) systems can be integrated by encapsulating them as interacting agents.</td>
<td>Design for assembly, manufacturing, serviceability, etc role was vital, because the agent has known some background of both the fields and according to situation can adopt the suitable condition needed for particular operations in each area. Rather than forming more active roles, make it single component.</td>
</tr>
<tr>
<td>2. Artefact understanding</td>
<td>A federated approach is adopted to ensure the openness of the system. Users can freely add or remove agents without having to halt or to re-initialize the work in progress. The implementation methodology also provides an effective way of wrapping heterogeneous methodology also provides an effective way of wrapping heterogeneous legacy software tools in to java-based agents, such that these tools are capable of interacting with others.</td>
<td>System can be defined as ‘system is an entity that maintains its existence through the mutual interaction of its parts’. Or in other words interrelated interacting artifacts designed to work as a coherent entity. With the help of software tools it is possible to interact with others. Developments in the so called distributed approach to concurrent engineering, including heterogeneous multi-agent system. Examples in distributed collaborative and concurrent engineering are SHADE (McGuire et al. 1993), PACT (Cutkosky et al. 1993),</td>
</tr>
</tbody>
</table>
## 3. Domain's System Understanding

| SHARE (Toye et al. 1993), FIRST-LINK (Park et al. 1994), and NEXT-LINK (Petrie et al. 1994) and ABCDE (Balasubramanian and Norrie 1995). |


| Agents communicate via a mutually understood communication language and exchange information to solve problems in a collaborative manner. They may interact directly with each other. But a federated style is preferred, i.e. a facilitator acts as a gateway between agents and coordinates the communication and collaboration between them. A federated style is preferred, in which agents do not communicate directly with one another. Instead, they communicate only through a system program called facilitators. The agents form a federation in which they surrender their autonomy to their facilitator and the facilitator takes the responsibility for fulfilling their needs. |

The facilitator manages interactions and conflict resolution in the agent community, which avoids communication bottlenecks problems, reduces communication cost and implementation complexity, and ensures scalability of agents.

## 5. Control and Role Distribution

| Nil |

## 6. Teams

| Nil |

## 7. Assessability/Arena for Personnel Meetings

| Nil |

## 8. Overall Leadership

| Nil |

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### Article 03: Integrating R&D and Marketing: a review and analysis of the literature

<table>
<thead>
<tr>
<th>Factors</th>
<th>Influence</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Individual/Active Responsibility</td>
<td>There are some common responsibilities as an individual in the department to understand some facts. Share responsibilities for setting new product goals, identifying opportunities for the next generation of product improvement, resolving engineering design and customer-need tradeoffs, and understanding customer needs.</td>
<td>The role of project leader in the team represents an active responsibility; his role is to assign the task to his colleague in the group those who are working under him. Not only assign some task to his team but also as a project leader should know some roles and responsibility. This is very effective in the beginning and also in the ending stage of the product development.</td>
</tr>
</tbody>
</table>
These responsibilities require cooperation throughout the entire task and the combined enterprise of both functional groups.

2. Artefacts understanding

| Nil |
| Nil |

3. Domain's system understanding

| Nil |
| Nil |

4. Communication idea/early communication about the idea

Interfunctional harmony means communication and cooperation, not just the communication (Souder, William E. 1988).

The name itself says that harmony means congruity of parts with one another and with the whole. Cooperation and communication are parts with one another and together with the whole as interfunctional harmony.

5. Control and role distribution

- Establishing development goals and priorities
- Analyzing customer needs
- Designing user and service manuals
- Information sharing about competitor strategies and reactions
- Generating and screening new ideas
- Developing new products according to the marketing needs
- Reviewing test market results (Parry et al [1992], Gupta et al [1985]).

Identifying the customer needs and expectations is the most difficult thing in the world, because every time the customer is looking innovative products, which is not available in the market. Even though the companies are trying to fulfill the customer needs with new products, and also they are trying to get their feedback about the product and other stuff like that. It needs patience and hard work. Developer should know what is going to do and how can we achieve this needs which satisfy the customers?

6. Teams

Too much integration may not be the answer if this integration means that team members lose their functional skills over time or if the team members focus too much on integration and lose sight of their other goals. Communication drops off rapidly with distance; one solution is to relocate people to reduce the distance between marketing, R&D and manufacturing (Lutz, Robert A. [1994]). Some firms have changed their physical facilities and co-located cross functional development groups to promote the level of communication by reducing the physical separation barrier. This provides the opportunity for, but does not by itself generate. Coordinate or communication.

Try with different forms and layouts, which increase communication with team co-location. Give an opportunity to move freely and friendly environment. Informal meeting places, discussion forum in the working place and free coffee, which is located at every place in the building. Enhance communication.

7. Accessibility

Informal social networks encourage open communication and provide contact both

Developing informal reduces the language, thought world and physical barrier, etc.,
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

8. Overall leadership

<table>
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<tr>
<th>Factors</th>
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<tbody>
<tr>
<td>1. Individual accountability</td>
<td>Nil</td>
<td>© Nil</td>
</tr>
<tr>
<td>2. Artefact understanding</td>
<td>Nil</td>
<td>© Nil</td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>Conceptualize coordination in terms of two subsystems that separately align conflicts over, and differing interpretations of, goals and tasks.</td>
<td>© Every project has definite beginning and ending activities, starts with mission statement, goals and visions, roles and responsibilities also takes place in it.</td>
</tr>
<tr>
<td>4. Communication idea/early communication about the idea</td>
<td>Nil</td>
<td>© Nil</td>
</tr>
<tr>
<td>5. Control and role distribution</td>
<td>Nil</td>
<td>© Nil</td>
</tr>
</tbody>
</table>
| 6. Teams | Cross-functional teams one of the IPD’s main characteristics (Clausing 1994, Fleischer and Liker 1997). IPD must achieve not only coordination between different departments in the same company, but also between companies. | With the help of new technologies like CAD/CAM/CAPP develop new forms of products and release in the market. Need a strong coordination between departments as well as companies, if they are working jointly. Workers have to get some rewards and
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

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<tr>
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<tbody>
<tr>
<td>1. Individual responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefact understanding</td>
<td>Concurrent engineering (CE) and QFD, external forces and internal facilitators.</td>
<td>The external factors are the uncontrollable action in the firm operating environment; whereas internal facilitators are direct control of the firm. Both are hypothesized to impact cross-functional cooperation.</td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>Cross-functional communication in NPD-firms has become increasingly interested in stimulating, facilitating, and maintaining cooperation between the various functional areas. Which inherently cross-functional, involving people from R&amp;D, manufacturing</td>
<td>This is a major decision area, combining three units at a time is a real big problem. Some times leads to failure of the project because it involves too many people from all the three units, which makes uncomfortable with the working environment. But by the use of cross-</td>
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4. Communication idea

<table>
<thead>
<tr>
<th>Pain Points</th>
<th>Solutions</th>
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<tr>
<td>Nil</td>
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</table>

5. Control and role distribution

Some potential barrier to cross-functional cooperation are
1. Personality differences between functions (between technical and marketing people)
2. Cultural differences or thought-worlds
3. Language or jargon unique to each area.
4. Organizational responsibilities and reward system.
5. Physical barrier, such as between distance between the departments.

This are the barriers need to take precaution, should plan in such a way that this barrier will not affect the cross-functional cooperation. Control action has to be taken before it gets worse.

6. Teams

Cross-functional integration, cooperation is defined as coordination of behavior.

Cross-functional cooperation refers to interdependency and information sharing between the various organizational units.

It’s a mutual relationship with another department in the organization. Dependent on one another for the smooth flow of work in the domain. Sharing knowledge is also an important concept, which sets a solid base or platform to execute the given task with the help of communication and coordination with another group or team in the unit.

7. Accessibility for personnel meetings

Nil

Nil

8. Overall leadership

Organizational characteristics (e.g., top management support, evaluation and reward system) impact new product performance both directly and indirectly through cross-functional cooperation

These are some of the organizational characteristics in the firm. For any kind of kickoff need a support from the top management and also from the middle management also. Once they process was get success, should appropriate there work in the form of incentives and reward system.
### Article 06: Cross functional teams in product development accommodating the structure to the process

<table>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefact understanding</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>The task of product development-requiring the integration of different specialized knowledge and benefiting significantly from the constant, mutual adjustment of that knowledge-seems particularly well suited to a team approach.</td>
<td>Specialized knowledge means that the knowledge in one field should be specialized; this contributes a steady focus on particular task to complete the required work. Its very important to know the about the company status and their strategies, what they are looking for in terms of structure, culture, etc., team involvement in the work provides a strong base for team approach.</td>
</tr>
<tr>
<td>4. Communication idea\ early communication about the idea</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>5. Control and role distribution</td>
<td>Achievement means working hard and performing well, but with a sense of meaning and authenticity; and direct and undelayed recognition for excellence and quality, but with freedom from constraints on initiative and creativity (Labier, D. Modern [1986]).</td>
<td>If you took up a project work, then end result is to achieve in best way. It consists of hard work and doing well. Hard work comes from how much you involved in the work and also how you observe or analyze the things for the improvement. Patience and planning and time are very most aspects.</td>
</tr>
<tr>
<td>6. Teams</td>
<td>Teams are the logical way to engage the considerable knowledge and skills of the new careerists because they demand ‘knowledge and skill of the business, its goals and values, and skills in interpersonal relations’ (Labier, D. Modern [1986]). This also provides the sense of community and mutual responsibility.</td>
<td>Senior manager in the company have the rights to form a teams. Have the rights to pick for the right kind of job and assign the roles. So in the team consists of 4 to 5 members having different background and skills and knowledge. They must quickly adapt to the situation and work together as a team through share information and discuss each other for some kind of difficulty tasks. Finally once you followed the goals and values of the project, leads to success in it.</td>
</tr>
</tbody>
</table>
7. Accessibility: arena for personnel meetings  
Accommodations to team work included training all team members in this new way of working, assembling teams by skills rather than by position, giving professional’s choice over team management, and allowing team to establish their own goals. Overtime, many other accommodations were made: training was expanded to include all managers and executives, managerial roles were clarified, and the managerial orientation to control was reduced.

8. Overall leadership  
Groups are the critical building blocks of organizations. They produce more creative solutions (Osborn, A.F [1957]), make better decisions (Davis, J.H. [1973]), improve the implementation of decisions and increase commitment. Work teams have been also identified as one of several mechanisms for integrating that are likely to develop as a function of specialization within a firm (Lawrence, P.R, and Lorsch, J.W. [1967]).

As the name itself says that groups is the building blocks of organizations. Consists of different people for a specific job, when we considered through a group having more problem-solving techniques, creative ideas, helps in making better decisions but as an individual cannot be achieved this.

Some task has to be done on group through mutual cooperation and communication, sharing information and discussion with other members in the teams. Freely move and have the freedom to create own ideas, be friendly with others.

---

**Article 07:** Design Strategy and Its Interface with Manufacturing and Marketing: A conceptual framework

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<tr>
<th>Factors</th>
<th>Influence</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>In order to manage design strategically, we need to understand what level of design effort is needed to achieve a particular position along these dimensions of competition are cost, quality, reliability, flexibility, service and speed of delivery.</td>
<td>Design effort is required to analyzing and understanding all the strategic alternatives can pursue to gain a competitive advantage in product market segment and also to identify the new product-market segment.</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Complexity and innovation are the basic design variables. Complexity of a system is defined by the number of elements in that system and by the level of interactions among these elements (Cooper, Sinha and Sullivan (1990)).</td>
<td>Basically when a component has build, it consists of lot of subcomponents in it. This is very complex in nature to assemble and also takes more time to fix it. Interaction is also an important concept in combining the part manufactured in one unit, then again to join or add supporting part to it. It’s easy to build a simple components with fewer parts when...</td>
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</table>
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

### Innovation

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<tbody>
<tr>
<td>Innovation is defined as the incorporation of new ideas and technology (Foster 1986).</td>
<td>compare with large parts. When it consists of large parts to assemble then complexity will starts.</td>
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### Domain's understanding

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<th>Factors</th>
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<tbody>
<tr>
<td>Design should also be recognized for its own unique contribution to competitiveness. This is because design introduces new competitive priorities such as product development, timely introduction of new products from conception to market delivery, and the invention of attractive secondary features for an existing product.</td>
<td>Companies are missing an opportunity to recognize there product design as a strategic element in the business strategy, which puts the company in the backward seat. More ever should think in this way, design is a business function and also a source of competitive strength.</td>
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### Communication

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<th>Factors</th>
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### Control and role distribution

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<th>Factors</th>
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<td>Nil</td>
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### Teams

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<th>Factors</th>
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<tbody>
<tr>
<td>Several approaches to support the design team: Sequential approach, concurrent approach, team approach.</td>
<td>Sequential approach relates to functional organization and also manages to deal with high level of complexity. Team approach relates to matrix organization and connected to high level of innovation.</td>
<td></td>
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### Accessibility

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<tr>
<th>Factors</th>
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<tr>
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### Overall leadership

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<td>Nil</td>
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**Article 08: Design-Manufacturing Integration as a Mediator of Antecedents to New Product Design Quality**

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<tr>
<th>Factors</th>
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<th>Description</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>'fitness for customer use’. In order for a product to be fit for the customer needs or use (Garvin.D.A [1987]). • It must address the particular needs or desires of customers. • It must perform adequately along these particular dimensions. • It must be free of defects.</td>
<td>This can achieve or attain through the integration of three primary sets of functional activities in product design and development. They are marketing, product design and production process design.</td>
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3. Domain's system understanding

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<th>Factors</th>
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<th>Description</th>
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<tbody>
<tr>
<td>1. Integration of marketing and design engineering knowledge insures that customer’s needs are known and addressed. 2. Integration of design engineering and manufacturing process knowledge insures that the product will be produced efficiently and without defects, thus improving product reliability.</td>
<td>Nil</td>
<td>The dimension of competitiveness must match with the customer choice, so it’s very important to marketing choice, so it’s very important to marketing and design people should know about more strategic framework of design, manufacturing and marketing.</td>
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4. Communication idea/early communication about the idea

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<th>Factors</th>
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<tbody>
<tr>
<td>Nil</td>
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5. Control and role distribution

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<tr>
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<th>Description</th>
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<tbody>
<tr>
<td>Nil</td>
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6. Teams

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<th>Factors</th>
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<tbody>
<tr>
<td>Nil</td>
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7. Accessibility/area for personnel meetings

<table>
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<tr>
<th>Factors</th>
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<tbody>
<tr>
<td>Nil</td>
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8. Overall leadership

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<tr>
<th>Factors</th>
<th>Influence</th>
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<tbody>
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<td>Nil</td>
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Article 09: Early Manufacturing Involvement in New Product Development

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<thead>
<tr>
<th>Factors</th>
<th>Influence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Individual's active responsibility</td>
<td>Nil</td>
<td>Nil</td>
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<th>Factors</th>
<th>Influence</th>
<th>Description</th>
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<tbody>
<tr>
<td>2. Are facts understanding</td>
<td>Early manufacturing involvement (EMI)</td>
<td>The primary role in the product development is design; where as manufacturing part will be the secondary. Representatives of manufacturing are placed on teams to help design products and processes together.</td>
</tr>
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<th>Factors</th>
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<tbody>
<tr>
<td>3. Domain understanding</td>
<td>Nil</td>
<td>Nil</td>
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<th>Factors</th>
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<tr>
<td>4. Communication idea/early communication about the idea</td>
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<td>Nil</td>
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<th>Factors</th>
<th>Influence</th>
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<tbody>
<tr>
<td>5. Control and role</td>
<td>Nil</td>
<td>Nil</td>
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</table>
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

### Article 10: Engineering design and product development and its relationship to manufacturing: A programme of case study research in British companies

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<thead>
<tr>
<th>Factors</th>
<th>Influence</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Interdisciplinary approach</td>
<td>Researchers and engineers got an opportunity to work together by understanding the available resources in the company.</td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>4. Communication idea\ early communication about the idea</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>5. Control and role distribution</td>
<td>Non-competitive benchmarking</td>
<td>Get the previous knowledge from the company and try to experiment with the directly with their competitors.</td>
</tr>
<tr>
<td>6. Teams</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>7. Accessibility\arena for personnel meetings</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>8. Overall leadership</td>
<td>Nil</td>
<td>Nil</td>
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### Article 11. R&D-Production in the early phases of new product development projects

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<thead>
<tr>
<th>Factors</th>
<th>Influence</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
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A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

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<tbody>
<tr>
<td>2. Artefacts understanding</td>
<td>Nil</td>
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<tr>
<td>3. Domain's system understanding</td>
<td>Nil</td>
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<tr>
<td>4. Communication idea/early communication about the idea</td>
<td>Nil</td>
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<tr>
<td>5. Control and role distribution</td>
<td>Nil</td>
</tr>
<tr>
<td>6. Teams</td>
<td>Dean and Susman (1989) identified four organizational approaches to integrate design and manufacturing functions in new product development. Manufacturing sign-off, integrators, third a cross-functional team and fourth one-department. Manufacturing sign-off prohibits unproducible designs from reaching the manufacturing stage. Integrators can be used to act as liaisons toward the manufacturing function working together with designers on producibility issues. Third, a cross-functional team consisting of representatives from different functional disciplines is effective but more resource consuming approach to integrate the two functions. Fourth one-department, approach makes producibility an integral part of new product development.</td>
</tr>
<tr>
<td>7. Accessibility/arena for personnel meetings</td>
<td>Nil</td>
</tr>
<tr>
<td>8. Overall leadership</td>
<td>Gupta and Wilemon (1990) identified the mechanisms to enhance the early involvement of functional groups. Job rotation, regular joint reviews, seminars and joint customer visits, social interaction and physical collocation. Job rotation can be used to develop cross-functional skills, regular joint reviews to ensure early problem identification. Seminars and joint customer visits to change the mindset of the personnel and social interactions as well as physical collocation to enhance informal communication between the different functional groups.</td>
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**Article 12: Integrating Design and Manufacturing to Deploy Advanced Manufacturing Technology**

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<th>Factors</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
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</tbody>
</table>
2. Artefacts understanding

| A. CAM\CAD technologies. With the use of these technologies at the engineering level, manufacturing engineering and design engineering are required to work together as a ‘coordinated team’. A belief in the integration of design and manufacturing has developed, and the old sequential operations are replaces with new technologies in the firm.  
B. The CAM\CAD system is being implemented with the system and a growing trend to create a new position of computer-integrated manufacturing (CIM) czar who rules over both manufacturing engineering and information functions. |
|---|
| With the help of highly technologies like CAM\CAD\CAPP, brings a new scope in the R&D and production interface. It’s very important that representative from each division should work together and finally shown up there work as a team work, there by improving communication and coordination. It also helps in removing all barriers.  
| With the use of computer integrated manufacturing system, capability to manage both manufacturing and research unit’s work. This can be done with the help of CAM\CAD. |

3. Domain\system understanding

| R&D-Production interface, problems at this interface contribute substantially to the underutilization of computer-aided design and manufacturing systems (Flynn [1985]).  
So here it is very important that computerization of the design and manufacturing functions in organizational brings existing communication and coordination problems to light and exacerbates this chronic difficulties. |
<table>
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<tbody>
<tr>
<td>When we look up to some mature firms, problems are existing because the Research and development team they had a plan to improve from present form to the most effective form through innovative new product to customers and meets their needs and expectations.</td>
</tr>
</tbody>
</table>

4. Communication idea\early communication about the idea

| Nil |
| Nil |

5. Control and role distribution

| Adopting administrative innovations- new policies, practices and structures, new management philosophies or practices were adopted explicitly to coordinate design and manufacturing.  
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<tbody>
<tr>
<td>Any form of work which starts from the basic planning and having a proper structure. Some new management policies and philosophies to communicate and coordinate between design and manufacturing.</td>
</tr>
</tbody>
</table>

6. Teams

| Nil |
| Nil |

7. Accessibility\arena for personnel meetings

| Nil |
| Nil |

8. Overall leadership

| Nil |
| Nil |
### Article 13: Interdepartmental Interdependence and Coordination: the case of the Design/Manufacturing Interface

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<th>Factors</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Four generic coordination approaches: standardization or rules, plans and schedules, and mutual adjustment (Thompson’s 1967) and teams (Van de Ven et al, 1976).</td>
<td>Coordination is very essential in any organization when we looked up in the departments. Because a product development work will depend on the set of rules and responsibilities, which includes planning structure as well as schedules. More importantly the mutual coordination and cooperation plays a vital role.</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Engineering changes (ECs)-represents a common form of mutual adaptation in the manufacturing phase: like design ‘draws the drawings over the wall’ to manufacturing. And in the subsequent months manufacturing sends back a minor change in the required to ensure producibility.</td>
<td>A task related to engineering work, where the design team can make a drawing and sends to manufacturing for further process in the product development. If the manufacturing needs some changes in the existing design drawing one, then they will send it back to design to modify the drawings or sketches. Engineering changes are very important in the organizational point of view, because it brings an implementation to the present process and also a strong coordination and cooperation.</td>
</tr>
</tbody>
</table>
| 3. Domain's system understanding | - Key output of the pre-project phase is a set of design and manufacturing capabilities: skills procedures, technologies, structures.  
- The output of the design phase is a set of product and process specifications, mostly in the form of drawings.  
- The output of the manufacturing phase is shippable product or to the hands of the customers or retailers or distributors.  
‘Cost of producibility’ (COP), According to Crosby defines the cost of quality (Crosby 1979): the total costs of preventing, assessing and correcting producibility problems. The key costs are:  
- Costs in redesigning the product or process, and cancelling or reordering components and equipments.  
- Organizational costs in the time required to coordinate between the functions (Krubasik 1988). | An important thing to notice here, the organization should consider or choose the coordination mechanism that will minimizes the cost of producibility while insure an acceptable level of producibility. |
Design/manufacturing relationship (DMR)- CAM/CAD was encouraging firms to reconsider their DMR. CAM/CAD has multifarious effects on the developments process, because it changes the tasks and the technologies of design, of manufacturing, and of the communications between these departments. So the firms’ moves aggressively into CAM/CAD often find that their established approaches to design/manufacturing coordination are challenged (Adler 1989). It’s a very interesting challenging task need to take up and establish a platform for future use as well.

| 4. Communication idea/early communication about the idea | Nil | Nil |
| 5. Control and role distribution | Temporal phases of product development activity:  
- Pre-project coordination during the activities that precede the initiation of a given development project.  
- Design-phase coordination during the phase required for the product and process definition.  
- Manufacturing-phase coordination after the release to manufacturing operations of the product and process specifications. Pre-project coordination-design and manufacturing can sometimes satisfy much of their overall coordination requirement prior to any specific product development project. The new product development projects should be able to draw on a set of proven and compatible product and process technologies, rather than having to await the invention of the technologies required to realize its project objectives.  
- CAM/CAD technologies provide a very best example.  
- Other key projects activities include formulating functional strategies for the design and manufacturing | In any product development, pre work, actual work and post work are consisted. Pre work is the beginning to the project or it’s a kickoff or foundation for the next stage. Where as actual work means need to define the specific roles and destination. And finally the post work goes to the actual testing area according to the definition of actual work defined in their activity. |
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

- Transition teams’ in this approach. Some design engineers moved with the design into manufacturing on temporary assignment, so as to make they available on a full-time basis for whatever design revisions were required.

This innovations deal with a common problem: design personnel move on to the next product design project after the last one is released to manufacturing; this rotation was also seen as a way of developing design engineers understanding of manufacturing.

Transition team is been very effective, because people like having the background of design and also having a better knowledge in the manufacturing helps a lot in identifying the problems in the early stages of product development. This transition team will reduce development cost of the project and reduces the budget in terms of redesign the product for one more time.

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<th>Article 14: Knowledge sharing in integrated product development</th>
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<tr>
<td>1. Individual active responsibility</td>
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<tr>
<td>2. Artefacts understanding</td>
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</table>
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

But team members in the product development are working out hard in order to bring the most complex design to simple one with the help of proper communication and coordination between departments in the unit.

| 3. Domain's understanding | Types of shared knowledge:  
|                          | - Shared knowledge of customers (Calantone et al. 1996; Narver and Slater, 1990).  
|                          | - Shared knowledge of suppliers (Hahn et al. 1990).  
|                          | - Shared knowledge of internal capabilities (Clark and Wheelwright, 1993).  

Shared knowledge of customers- for the product development members it’s very important to know the current needs and future requirements of the products for the customers. Those who are having a higher level of contact with are have more degrees of understanding of the changing customer needs, value-to customers and also level of customer satisfaction with their products.

Shared knowledge of suppliers-shared understanding (i.e. know-why) of supplier’s design and manufacturing capabilities among product development team members. Since the suppliers are highly involved in the success of IPD, play a critical role in for timely and cost-effective decision making in IPD.

Allows PD members to improve their processes means communication and coordination among design and manufacturing engineers), enhance customer values.

Shared knowledge of internal capabilities- same as shared knowledge of suppliers but this will applicable to firms. Internal capabilities usually resides among design and manufacturing team members.

A very important task is to know how many different functional specialists are aware of the strengths and weaknesses in terms of design and manufacturing processes and other capabilities.

| 4. Communication idea/early communication about the idea | Shared knowledge is one of the unique, valuable, and critical resources (Nonaka and Takeuchi 1995; Prahalad and Hamel, 1990). Firms increasingly rely on building and creating a shared knowledge base as an important resource capability (Huber, 1991, 1996; Nonaka, 1994).  
|                                                        | Shared knowledge is important in product development process. Because it involves stages in PD are concept development, system design, detail design, testing and refinement and manufacturing production activities etc. so knowing the situation and understanding the concepts and later translates this concepts.
On the project level, team share knowledge of individuals in order to solve problems and find innovative solutions (Davenport et al. 1996; Drucker, 1991; Kogut and Zander, 1992).

- Shared knowledge is viewed as an understanding and appreciation among different functions, and effective shared knowledge is regarded as a synergy between team members (Hoopes and Postrel, 1999).

This day’s most of the firms are increasingly this shared knowledge and make use of available resources to the required task completion.

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<tr>
<th>Control and role distribution</th>
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| Teams | Team work- to the degree of collaborative behavior among product development team members. Indicators of high level of team work are:  
2. Effective decision implementation (Mabert et al. 1992).  
3. Creative problem solving (Gustafson, 1994).  
4. Effective communication (Brown and Eisenhardt, 1995).  
5. Good coordination of activities (Brown and Eisenhardt, 1995).  
6. Defining later stage problems (e.g. manufacturing and design problems) is an indication of high level of team work (Clark and Fujimoto, 1991).  
Development productivity to the effectiveness of developing new products from product concept to manufacturing (Cooper, 1999: Cooper and KleinSchmidt, 1995).  
1. About the total costs incurred in all activities of the product development.  
2. Measured by the overall technical and team performance in terms of efficiency, budget, schedule and innovation.  
Take up a task and try to come up with new innovative ideas in the initial stage of product development as an individual, then form a group and share your ideas and concepts to other members of the group members.  
This influences several factors like creative problem solving, effective communication and also good coordination of activities in the team members.  
In the planning stage it’s very important that the financial department has some future prediction on the product, which includes the manufacturing cost, design cost, resource cost and labor costs included in producing the product. The budget should not exceed the available estimation of the beginning plan.  
The product is effective when the available budget should not exceed the limitations of the project. |  |
| Accessibility | Nil | Nil |
for personnel meetings

8. Overall leadership  Nil  Nil

**Article 15:** Managing the design/manufacturing interface across firms

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<tr>
<th>Factors</th>
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<th>Description</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Inter-firm coordination (Alder, 1988, 1995)</td>
<td>The primary objective is to develop understanding of how established design and manufacturing departments coordinate their activities. More importantly how these departments should coordinate to manage efficiently their interdependence?</td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>The coordination of product development activities thus requires a combination of available skills, prevalent culture, strategies, procedures, structure and technological systems. Each plays a role through the many phases of the development programme.</td>
<td>The successful completion of the project needs a combination from all the area like the skills and knowledge from the individual, must have a good sense of humor. Proper standards and procedure and some plans to do the work.</td>
</tr>
<tr>
<td>4. Communication idea/early communication about the idea</td>
<td>Organizational aspects of coordinating new product development, five variables of importance: skills, procedures, structure, strategy and culture (Alder, 1988). 1. Skills-skills are frequently viewed as a person’s accumulated capabilities through their long working experience. However today’s product and process engineer needs an additional skills for team working, problem solving, leadership and negotiation. 2. Organizations may also seek to improve coordination through procedures and structure, such as joint product/process design teams, design for manufacturing and assembly, and the early release of design information to manufacturing. 3. The depth of organization culture impacts upon projects outcomes. Some differences in core values, norms, attitudes, and sometimes</td>
<td>Today’s competitive world, product and process engineer must have a very highly or additional skills for team working, good creative problem solving techniques. This day’s organization wants to work as a joint involvement between design and manufacturing brings new changes in the organizational structure. Organization culture plays a major role on to outcome of the project completion. Usually organization will have a common language which will understand by everyone in the company. Different people have different languages, so it’s good to have a common language platform to every one.</td>
</tr>
</tbody>
</table>
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

| 5. Control and role distribution | Two critical influences on the coordination of these activities (Winch et al. (1991):
1. Technological factors-material tools, tools and advanced manufacturing technologies.
2. Organizational factors-culture, structure, and people. | Both technological and organizational factors have a major impact on the coordination of activities. Because new advanced technologies like CAM\CAD\CAPP brings lot of changes in the drawing and helps the designer to work in effective manner and having the proper guidelines to manage the things.
Similarly the organization structure has the same impact on people behavior as an individual and as a team member also. Good culture proves you as a discipline etc., |

| 6. Teams | In order to improving product and process engineering integration. Three important steps need to be considered by companies (Soderberg, (1989)):
- Collocating the two functions
- Rotating staff between functions
- Reducing the disparity between career paths, incentives, pay and job specifications. | Coordinating between two departments at a time is best, rather than combining the three departments. It involves a lot of misunderstanding between team members working in together for the project, time consuming and delay in producing the final product. Rotating the staff in departments is also improves the team to work in an effective way. |

| 7. Accessibility\arena for personnel meetings | Nil | Nil |

| 8. Overall leadership | Nil | Nil |

**Article 16: Organizing for concurrent engineering: an integration mechanism framework**

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<tr>
<th>Factors</th>
<th>Influence</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Individual responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Concurrent engineering (CE)- “a systematic approach towards the design of products and the way they are manufactured, assembled, stocked, transported, distributed and recycled, which aims to optimize product designs in terms of both external demands (e.g. price, quality, delivery time, delivery reliability, range, recyclability) and internal demands (e.g. cost, lead time, quality, delivery time and cost for producing the product and lead time.</td>
<td>This systematic approach is the best one, which encompasses the design task and the way it applicable to the manufacturing sector and logistics department. This aims to reach the product designs in terms of both external demands and also to the internal demands, by considering the price, delivery time and cost for producing the product and lead time.</td>
</tr>
</tbody>
</table>

CE encompasses a wide range of strategic, process, technological and organizational integration mechanism (Boer, H [1994]), aimed at closer collaboration, earlier and more frequent communication between the functions involved in the design, manufacturing and marketing of new products (Clark, K.B. and Fujimoto, [1991], Paashuis et al [1994]).

- Enables an as early as possible start of new product-related activities.
- Reduces the need for re-design (“first-time right” design).
- Results in reduced costs, improved manufacturability and assemblability, reduced design and manufacturing lead time, and other predominantly internal advantages related to the development of new products.

In turn, these advantages would contribute to external advantages such as improved quality, and reduced price, delivery time and, possibly even, time-to-market of new products.

Concurrent engineering covers the wide range of strategic process; innovative technology changes the organizational structure in an effective and efficient manner.

It involves close cooperation between all the departments in the organization. When having proper communication with others in the department, there is a chance for improving manufacturability, reduces the need for the re-design having the caption like ‘first-time right’.

The delivery time of producing the product can be reduced and better quality can be achieved.

### Table

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<tr>
<th>Domain/system understanding</th>
<th>Nil</th>
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<tr>
<th>Communication idea/early communication about the idea</th>
<th>Nil</th>
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</table>

Integration is cross functional co-operation: Co-operation is a process in which several people with different, possibly complementary, skills work together, in this case, to create new product designs (Kahn, K.B, [1994], Schrage, M [1990]).

Among the mechanisms facilitating collaboration are:
- Teamwork;
- A mutual understanding;
- A common vision, frame of reference and language; shared resources;
- Collective goals.

Co-operation collaboration creates synergy in different individuals’ activities by creating and using a common knowledge base.

Collaboration involves work effort from team work and having good understanding with others in the team, they must have vision what is doing to do, common platform language to speak and talk.

Communication is the process in which
Integration is interfunctional Communication:
Considering that designing new products essentially is an information processing activity, the importance of interfunctional communication, i.e. information exchange between design and the other functions involved in the NPD (Moenaert, R.K. and Souder[1990])

Mechanisms to achieve communication include committee meetings, teleconferencing, conference calls, memorandums, and exchange of documentation.

Information originating in one function (sender) is transferred to and put to use by another function (receiver).

Information comprises knowledge and know-how, ideas, concepts, data, results, analyses and plans (Moenaert, R.K et al [1992]).

5. Control and role distribution
Facilitating integration-There are four categories of mechanisms enabling or facilitating collaboration, communication and overlap, namely: integration by strategic, process, technological and organizational integration.

Integration of strategy- goals and strategies serve several purposes. Process- mechanism of improving the NPD performance is re-designing the design process itself. Technological- includes knowledge, skills, methods, experience, techniques and tools. Use to perform their task. Organization integration- makes use of suitable organizational arrangements.

6. Teams
Nil

7. Accessibility arena for personnel meetings
Nil

8. Overall leadership
Nil

**Article 17: Role of design-philosophies in interfacing manufacturing with marketing**

<table>
<thead>
<tr>
<th>Factors</th>
<th>Influence</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Nil</td>
<td>Design philosophy would guide the product designer towards specific manufacturing attribute values would be most appropriate for a product once he/she gets input about its desired marketing attributes values.</td>
</tr>
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</table>

Division of Quality Technology and Management
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

| 3. Domain's system understanding | Marketing attributes- as product features (e.g., ground clearance, turning cycle, etc). Manufacturing attributes-according to this, are those product features that are less visible to the customer (e.g., cooling system capacity, oil capacity, maximum power output, etc.). | In the manufacturing unit, some part processes which are invisible to the customer like cooking system capacity and oil capacity which can’t be seen by naked eye. For example the in the design stage with the help of CATIA OR Pro-E, the programming part is behind the screen which is not visible to the designer when they created some drawings. |
| 4. Communication idea-early communication about the idea | Nil | Nil |
| 5. Control and role distribution | Nil | Nil |
| 6. Teams | Nil | Nil |
| 7. Accessibility
distribution for personnel meetings | Nil | Nil |
| 8. Overall leadership | Nil | Nil |

**Article 18:** A Survey of Educational and Training Needs for Transition of a Product from Development to Manufacturing

<table>
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<tr>
<th>Factors</th>
<th>Influence</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Engineer- must be encouraged to keep up to date and know what is going on in technology development and the engineering community so that when the time is right, they can pull new technology rather than oppose the unfamiliar being pushed on them (Ralph Gomory [1989]).</td>
<td>The role of engineer is to update the existing system and also the upcoming task with new technologies like CAD/CAM system. Make use of right resource at the proper time and push with advanced technology rather than trying with old approaches.</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Template approach- The term “template” is used to define the proper tools and techniques required to assess and balance the technical adequacy of a product transitioning from development to production. This type of approach can provide a very valuable framework in structuring technically sound product.</td>
<td>This approach is very essential in order to select the right tools and right techniques for the required operation for specific task in the production area. A value added in technically best in programming part of product development and also the corrective needs will choose for</td>
</tr>
</tbody>
</table>
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

| Development programs, determining their risk, and identifying areas that need corrective action (Bodensteiner and Priest [1988]). |
| The value of the technical and engineering concepts that are the basis of the “template approach,” and these concepts are the basic building blocks of: |
| • Improved planning and transition from development to |
| • Improved quality and producibility of products. |
| • Lowered long-term life-cycle costs. |
| • Improved teamwork, coordination and understanding between |
| • Design, production, and management of functions (concurrent or simultaneous engineering). |
| 2. The template approach and concepts have improved coordination, teamwork, and understanding/ cooperation between engineering, manufacturing, and management. |
| Managers and researchers recognize that today the key to improving the design and manufacturing process is the ability to bring technical balance to the engineering and management process (W. J. Willough, [1987], C. G. Bell [1989]). It means structuring an organization to bring technical balance to the process through flexible organic mechanisms, such as the team approach in concurrent engineering and management (C. F. Vogt, [1991], S. G. Soderberg [1989]). It means the ability to change attitudes and corporate culture, to emphasize rapid technological innovation, to hasten the application of new technologies to manufacturing, and to foster organizational learning by including technical risk and an integrated team assessment into management decisions (P. S. Adler, may [1989], aug [1989]). |
| “Transition From Development To Production,” was promulgated in 1985 in a the particular task completion. |
| “Transition From Development To Production,” was promulgated in 1985 in a |
| It means focusing on the fundamentals of design and manufacturing, such as not counting defects but eliminating their causes. |
| It’s a joint venture; find the most critical region or part in the project that affect the process in design stage. |
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

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<tr>
<th>3. Domain's Understanding</th>
<th>Technical balance means:</th>
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<tr>
<td></td>
<td>• A disciplined engineering and management approach. Soderberg refers to this as a disciplined engineering organization and system (S. G. Soderberg [1989]).</td>
</tr>
<tr>
<td></td>
<td>• An approach that does not foster adversarial attitudes between functional areas and between functional and support areas. Gomory calls this competing with the product development cycle (R. E. Gomory, [1989]).</td>
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<tr>
<td></td>
<td>• An approach that does not contribute to serial thinking in the design process, manufacturing process, and marketing process. Hunt describes this as “mechatronics”, using fully integrated teams of product designers, and manufacturing, purchasing, and marketing personnel acting in concert with each other to design both the product and the manufacturing system (V. D. Hunt, [1988]).</td>
</tr>
<tr>
<td></td>
<td>• An approach that does not inhibit cross-functional communication and teamwork. The National Research Council refers to this as building critical skills (Nat. Res. Council, Washington, DC [1991]).</td>
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</table>

| 4. Commun | Nil | A technically balanced approach, therefore, requires that engineers and managers at all levels understand the technical and industrial processes involved in designing, developing, and manufacturing new products. | Nil |
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

5. Control and role distribution

“World-class manufacturers” - the path to restoring that competitive edge had to begin with an understanding of technological innovation, emphasizing an integration and balance between product innovation and process innovation. This results in a focus on both design and manufacturing as an integrated process.

- Manufacturing firms in the world today have found that success in product development results from an integrated company approach, with the commitment of management (from top to bottom) to a balanced system between technical performance in design/manufacturing processes, and the traditional focus on cost and schedule/milestone performance (W. Skinner, [1985], H. R. Hayes and S.C. Wheelwright [1984], R. E. Wheeler,[1986], R. E. Gomory, [1989]).

- Today’s successful firms focus on tying the design system to the manufacturing and marketing systems. It also requires a coordinated-team approach with improved cross-functional and concurrent integration, interaction, and communication.

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<th>Factors</th>
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<tr>
<td>Article 19: Threats to new product manufacturability and the effects of development team integration processes</td>
<td>Both in the design phase and manufacturing phase should be integrated, keep in mind that in order to survive in the booming market they have to produce with good quality, with the help of new technologies the system is being able to change the structure with the market demands. Innovative ideas in the design phase helps in the manufacturing phase to produce a desired product for the customer at the right time and at the right place, which Plays a very crucial role in product and process fit.</td>
<td></td>
</tr>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
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</table>
| 2. Artefacts understanding | Dependency theory - This theory states that the degree of interdependence and the nature of interactions among functional specialists within an organization are influenced by the nature of the collective task they seek to accomplish. Product design and development involves many different specialists. Each is highly dependent on others for information necessary to complete his/her individual tasks (Pfeffer and Salancik, 1978).  
  - Dependency theory would suggest that NPD project characteristics affect the nature and timing of functional interactions required for high NPM.  
  - Dependency theory findings suggest that development team integration processes are useful as means for resolving dependencies among components of product and process designs. | Integration with in departments and the situational dimension or behavior, among the highly skilled and knowledgeable employee will take the task and complete with success without any failures.  
With the help of development team integration it is possible to achieve the high new product manufacturing. |
| 3. Domain's system understanding | Nil | Nil |
| 4. Communication idea/early communication about the idea | Nil | Nil |
| 5. Control and role distribution | Nil | Nil |
| 6. Teams | Cross-functional integration of personnel in product development has produced paramount positive effects on NPD performance in many firms (Swink, 1998). It says that collaborative, concurrent design processing promotes greater integration of various functional concerns. For many firms, successful integration requires the removal of communication barriers that prevent personnel from effectively | Cross functional integration has great influence on product development on NPD success. The initial design process involvement with the other department produces greater success, with the help removal of communication barriers in a work group. Better integration leads to working together and have an access to one another in the department freely and easily accessible the necessary resources needed for the work. |

- Communication barriers result from physical, organizational and cultural divisions in a work group.
- Better integration results when development personnel have easy access to one another and when functional groups work well together.
- When product development personnel are accessible and team-oriented, they are presumably more proficient at intense information processing, making the organization more responsive to the interplay of design decisions affecting various product and process functions (Cooper, 1998; Suman and Dean, 1992).
- Capabilities and requirements are better understood and problems are solved earlier.

Development team integration processes often require project personnel to behave in non-traditional ways. Consequently, it is vital for managers to convey a sense of priority that encourages team members to overcome barriers formed by the corporate culture and functional norms.

- Development personnel who detect a high level of management commitment and priority are more likely to become more interested in the project, to take greater ownership and to be more willing to take risks.
- A high level champion for the project provides energy and enthusiasm, and committed top level managers are more willing to fight for resources needed for the project. Furthermore, high priority projects are likely to include more management safeguards and controls designed to address product–process design dependencies, thereby ensuring a

It is very important from the managers’ point of view, that the given task he/she has to explain in a clear manner without any conflicts or any communication barrier that will affect the team working group.

It needs involvement from the top management level in the organization to support for the project with all necessary requirements will satisfy the basic needs for the projects. This kind of support will boost the specialist to concentrate harder and take the risks on in his own.

Provides an excellent platform to work in such an environment in order to achieve best NPM.
### Development Team Integration Processes

Development team integration processes provided most of the explained variance in NPM, suggesting that NPM is highly manageable.

Development team integration tactics are efforts to elevate the voices of downstream stakeholders in product development. Better NPM results are achieved when manufacturing and supplier personnel get more closely involved in NPD.

<table>
<thead>
<tr>
<th>7. Accessibility\arena for personnel meetings</th>
<th>Nil</th>
<th>Nil</th>
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</table>

| 8. Overall leadership | A collaborative NPD environment is clearly indicated as an important influence on NPM. This supporting the need for team behaviors, and easy access among project personnel. This will linked to collaborative environment characteristics to improved time, market and financial performance (Rothwell et al., 1974; Maidique and Zirger, 1984; Cooper and Klein Schmidt, 1987; Souder, 1987; Ettile, 1995, 1997). Top management support has been associated with reduced NPD lead time, especially in dynamic, uncertain markets (Eisenhardt and Tabrizi, 1995; Swink et al., 1996a). This study suggests that management support also exerts considerable influences on NPM. Greater management commitment and resource availability may motivate and enable project personnel to better handle unforeseen problems, including those affecting manufacturability outcomes. Management support also appears to be particularly important when |
|----------------------|---------------------------------------------|-------------------------------------------------|
|                      | This collaborative environment helps the team behaviors and easy access for project personnel. This will provide the basic needs for the projects to begin, easy flow of access from all the functional departments in the organization. The product development cycle time can be improved with effective team efforts, moreover the market criteria and other performance can be achieved. |
A Literature study of the Factors that influence Communication interface between R&D and Manufacturing functions

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<tr>
<th>Factors</th>
<th>Influence</th>
<th>Description</th>
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<tbody>
<tr>
<td>1. Individual active responsibility</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>2. Artefacts understanding</td>
<td>Contingency model- is gaining attention in the research on cross-functional integration. Under some conditions, NPD activities may be performed more effectively and efficiently by personnel within departments without requiring cross-functional involvement (Olson et al, [1995], Wheelwright et al, [1992]). One important task in managing the cross-functional interface is to identify the conditions under which the benefits of cross-functional integration out-weigh the costs. With the help of functional specialist in the department is it possible to improve the new product development activities. Working together leads to a team success; this brings the effectiveness and efficiently the work flow in the organization.</td>
<td></td>
</tr>
<tr>
<td>3. Domain's system understanding</td>
<td>To gain a deeper understanding of the dynamics of integration in NPD process, it is important to study the joint involvement in a three-functional setting using a stage-specific approach (Griffin.A et al, [1993], [1992], Song et al, [1997]). Means that joint involvement is very much essential in this approach. Instead of considering all three units at a time, focus on any of the two units and see the changes in it.</td>
<td></td>
</tr>
<tr>
<td>4. Communication idea/early communication about the idea</td>
<td>Communication hub suggest that effective implementation of cross-functional integration requires attention to paired communication between focal and nonfocal functions. When we consider in the development stage, both manufacturing and marketing should concentrate on providing information to R&amp;D and on participating in Focal functions means that in the planning stage manufacturing can be called as the focal function, similarly in the development stage R&amp;D called as the focal function and in the pretesting stage marketing called as focal function. So the manufacturing, R&amp;D and marketing playing the central role in cross-functional information transfer and</td>
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</table>
the product design activities. As the focal function at this stage, R&D can facilitate the involvement of manufacturing and marketing in designing new product features, determining specifications, and approving the final design. Information sharing and coordination between nonfocal functional can be implanted indirectly through the communication hub.

<table>
<thead>
<tr>
<th>5. Control and role distribution</th>
<th>Managerial implications- First, firms need to enhance their understanding of the integration patterns that lead to effective and efficient NPD performance across stages and focus their efforts on the right types of joint involvement at each stage. Second, the importance of a given function in integration depends on the stage and three major functions need a clear understanding of their roles as cross-functional integration participants in different stages. Third, joint involvement between pairs of departments is generally more beneficial than that among all three departments. This indicates that innovations do not benefit substantially from improved communication and interaction when all three functions are involved in the same activities. Instead, pairs work together more efficiently, leading to a higher net gain from cross-functional integration.</th>
<th>For the customer identification need a joint involvement between Research and Development and marketing department. Where as for the production process need a joint involvement between Research and Development and manufacturing. Each stage, functions and their roles has to define properly; this will not affect the integration process. Joint involvement is essential at a time focus on two departments once, rather than considering all at a time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Teams</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>7. Accessibility for personnel meetings</td>
<td>Nil</td>
<td>Nil</td>
</tr>
<tr>
<td>8. Overall leadership</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>
5.2. Summary

In the previous section, I have described the each article in briefly and then discussion on each factors. Where as in this section I presented all the articles in the table format. Gives an idea of how these factors will influences on each article, and also detailed description of all the related factors stated with respect to each factors. Schematic diagram gives an idea on how these factors are related and interlink on one another. Each factor has own contribution to the success of the organization in Research and Development and manufacturing. Some factors have direct influences on other factors, where as others factors are no influences. This existing model needs empirical validity in the future research. This figure was constructed based on the result obtained from the articles, in which the factors stated on related factors or not. Make a quick noted down on this, detailed analysis table format result will be seen in the appendix-III at the end of the report.
Chapter 6

Discussion

6.1. Discussing each factor its importance, different opinion & did they agree

In the previous section, I have presented in detail structure of the article and also the description on each factors with respect to articles in table format. Now my task is to explain on how each factor will influence the decision, do they agree and also the different opinion on related articles by other authors. I have divided the discussion with respect to factors related to each articles stated, first of all explanation on one factor in detail influence from the article and finally add opinion and comments on it etc. Appendix-III Gives you review of all articles with respect to factors with some key terms.

1. Individual/Active responsibility

Must adopt new technologies for their new product development, reconsider their organizational structure and make corrective decision, Try to adopt new tools and techniques and pull out the old sequential methods. This will improve the entire product development life cycle and also the individual performance, improves the individual self confidence etc. Active interest in learning new techniques and tools is essential. This can be achieved through proper training to research and development and manufacturing employees from the higher hierarchy; also by user manuals this brings a change to the organization in an effective way of improvement. From individual perspective as well as company point of view leads to beneficial to both of them in the organization. Sharing responsibilities provides a base for individual, gets freedom to choose the method for the work. Creates a goals and mission of the work and also easy to identify the customer needs and having the opportunity to build new generation of products.

Other author from one article says that with the help of DFX stands for design for everything like assembly, manufacturing, serviceability and reliability etc. The DFX methods will suits for all kinds of operation. Here active members in the division as the freedom of choice to choose the most appropriate tools for the particular operation. They referred to as interacting agents with the selected tools.

Another author pointed out that the responsibilities require cooperation throughout the entire product development cycle, and also combined effort from functional groups to complete the given task.

Another author says as active roles means, first find out the organization strategy, structure and patterns of the company. Second, the dimensions of competition like price, quality, speed and flexibility etc. How this
dimension can fit to the organization structure, in what way this competitive edge leads to success of customer needs and expectations.

**Conclusion:** active involvement in the department and takes the responsibilities will increase the self confidence of an individual. Sharing information among members in the department, understanding new system procedure and able to adapt quickly to the existing system. Etc.,

**2. Artefact understanding**

As the name itself says it’s a man-made object. It’s an information framework using an object-orientated artefact representation. Provides a comprehensive knowledge during early stages in the product development. This can be achieved with the help of new internet technology, new CAD\CAM\CAPP, computer simulation etc. high level of uncertainty always puts firms under pressure to provide a better quality of products, in such a way that meets or exceeds customer expectations. Technological novelty is the degree to which new products employ’s product or production process technologies those are new to the developing firms. Where as the project organization complexities are indicated by the number of different occupational specialist contains in the organization. So finally design-manufacturing integration in new product development projects mediates the relationship of technological novelty and project organization complexity aims to achieve the product design quality. Concurrent engineering and engineering changes are very important in the organization point of view, brings a implementation to the existing process and provides a strong coordination, cooperation etc. concurrent engineering would contribute to external advantages like improved quality, reduce price. The concept of template approach is same as conceptual framework, define the proper tools and techniques to access and to balance technical adequacy of the product. This approach provides better coordination, supports team work and understanding’s cooperation between design, manufacturing and management.

One author says that avoid complexity and innovation in design and manufacturing process. Instead of making more complex products, try to make a simple one should be economical, effective in nature and also efficient performance. The author argues that the interaction is an essential asset to work together, lifts team spirit and cooperates to work in a friendly environment.

Both concurrent and engineering changes as having a wide range of strategic processes. This involves a close cooperation in the organization with the help of this the delivery time of producing product time can be reduced and achieve better quality.
Another author pointed out that the primary role of product development is design, whereas manufacturing plays a secondary role. If the design and manufacturing team work together in the initial stage of product development, this will make fewer or lesser design changes in the later stage of production process. So finally this process improves product development cycle time, reduces the extra cost and time.

**Conclusion:** Comprehensive knowledge can be gained through understanding the new technology like CAD\CAM\CAPP. This will help to know the behavior and nature of the system in which you are working. Nowadays lots of new technology in the form of internet\intranet, knowledge based simulation and optimization theory plays an important role in the artefact understand.

### 3. Domain\System understanding

Cross-functional communication in new product development firms become interested in simulating, facilitating and cooperation between other functional areas. Quality function deployment and simultaneous engineering are some of the techniques to enhance cross-functional communication. Make the R&D\manufacturing functions interface into computerization, so that the design and manufacturing functions in the organization brings communication and cooperation. Skills, leadership and organizational culture and languages, procedures and practices are aspects of coordinating new product development.

One author says specialization in one particular field makes a more knowledge and in-depth grip to the work, these brings changes to the organization and establish coordination from one department to another department through specialist in the each unit. This needs a mutual adjustment to the work is essential equipment for constant flow of communication and coordination. Encourage firms to consider the design-manufacturing relationship in a broader way.

Another author says that nowadays most of the companies are in backward seat, because they are fail to recognizes the design as a business function and it’s a competitive strength to the organization. So focus on design as a business function.

**Conclusion:** This domain understanding as a vital role in Research and Development and manufacturing functions, because the specialization is an important concept. Here system analyst should have wide and broader knowledge in particular field, helps in managing the domain in an effective and efficient manner. In
every department the specialist in single operation, later they can combine their skills and knowledge to work in an efficient manner.

4. Communication idea: Early communication about an idea

With the help of network agents, designers can communicate and transfer knowledge among different knowledge bases, provides better services and access information. Agents can mutually understood communication they can directly interact each other. But the federated style is appropriate because in this style they don’t interaction each other directly, they will use a facilitator. The act of facilitator gateway between agents and coordinates communication and collaboration between them. Facilitator takes the responsibilities to fulfill their needs. An agent uses facilitators to manage interactions and avoids conflicts in the agents, some common communication problems can be avoided, including the communication bottlenecks problems also. Communication and cooperation are part of one another and together constitute the whole as interfunctional harmony.

One author talks about the shared knowledge is an important step in product development process. Shared knowledge is one of the unique, valuable and critical resources. Most of the firms these days are adapting this shared knowledge techniques.

**Conclusion:** Communication is a process, exchange of information from one person to another. If a process is to complete in particular period or in allocated time, then we need a tool like communication. Every process begins with communication and ends with communication. Like agents and facilitators acts like as a mediator in between two departments, provide necessary information to the required process to complete on time.

5. Control and role distribution

Product development involves a structured planning in the beginning, identify the customer needs and expectations, then set goals and mission of the work. Bear in mind that developing new products according to the market needs. Brain storming is a special kind of technique; issues can be sorted out easily with a group of 5 to 6 members in the team. Barrier to communication is a main problem to the organization. Especially personality, cultural thought worlds, languages, physical separation and organizational barrier. Achievement is not easy terms with the above barrier has to over takes means needs a hard work and perform well, this is the only way to over come the above mentioned barriers. Here both technological and organizational factors will influences the coordination of activities.
One author concludes that adopting administrative innovation brings changes to the existing system through management philosophies, proper structure and practices and policies. This is an effective way of coordinating R&D and manufacturing functions.

Well another author argues the same issue as stated above. Understanding the technological innovation, emphasize an integration and balance between product and process innovation. Results in a better focus on both design and manufacturing as an integrated process.

**Conclusion:** Identifying the customer needs and expectations in the market is a difficult job. When you start doing this, need a control division means that developing a product according to customer needs rather than just focusing on company survival in the turbulent market. Individual roles of taking risks, when the product is not able to satisfy the required needs of customer. More ever should not blame for others to reach the required target, find out the problem and fix it soon further it damages the system. So control and role distribution is an important tool in the organization to consider as a most and essential factor.

6. Teams
To support the collaborative work between teams, the area should be geographically distributed. Teams are the logical way to operate the knowledge and skills, knowledge constitute the goals and values where as skills related to interpersonal relations. Transition teams as having a dual character, these team members will work in design and manufacturing department. They will work full-time and temporary as well it depends on the nature of work and product also. Transition team will gain knowledge and skills in both field improves personal values and also the firm values. Job rotation with in the unit brings more changes to new system; gaining knowledge in different fields helps a lot in the other purpose. Effective team members are able to provide creative problem solving methods, effective communication also and good coordination among the team members in the activities involved.

One author talks on too much integration means team members will lose their functional skills over times, and even if the team focus on to much on integration then there is a chance of lose sight of their other goals. So finally communication will drastically affect.

Another author says that through the sequential and team approaches, possible to deal with high level of complexity and innovation with respect to functional and matrix organization.
Conclusion: Teams are the logical way of thinking and solving the most complicated problems. Team consists of 5 to 6 members, each one will share their thoughts and information for the particular product. Combine their work in the brain storming process, it’s a platform can improves communication, encourages ideas and managerial skills.

7. Accessibility\Arena for personnel meetings
With the use of www-based integrated platform product development, companies need to update the database to the internet, so the employees in the organization are able to access those information, meeting and discussion can be easily recorded to the system and they can interact also. People can access those information from anywhere in the company from inside and outside through internets and intranets. Gives an opportunity to work in an integrated friendly based environment. Harmonious operation involves discussion on most important issues first, resolve the conflicts very quickly this can be achieved through working together in a team. Special training needed to employees in the organization, when they working on new technologies involve complex tasks in it. Proper guidelines and assistance from the top management boost the self morale and also team spirit.

Conclusion: It’s better to provide the ongoing information to all the employees in the organization through www-based integrated platform. So every one in the organization will have the opportunity to contribute or share their opinion through this platform. It encourages individual morality and also self confidence of an individual. Provide incentives to the employees, reward system for their work, etc.

8. Overall leadership
Leaders are the capable to handle any kind of situation in the organization. Having more responsible than other members in the organization. His role is to explain the given task and take measurable steps to avoid conflicts. More ever not only between team members need to achieve coordination but also representatives in the team. Organizational characteristics will surely impact new product performance either directly or indirectly through cross-functional cooperation. Groups are the critical building blocks of organizations. They produce creative solutions, make better decisions. Informal contacts and personnel meetings bring new changes to the organization. And finally strong management leadership and support is needed to motivate and to reward these new behaviors.
**Conclusion:** Leadership is a main factor in an organization. Needs strong guidelines to all the subordinates and encourage them in an effective manner to work. In today’s organization life can be seen as groups are the critical building blocks of the organization.

**6.2. Summary**

First of all present the results obtained from the articles and represent in table format, this procedure follows for the remaining all articles. I presented in table format of all the articles results first in the chapter 5. Then in this section explains the individual factors with their importance, do they author agrees on the decision made in the articles and finally different opinion on other articles. Because each concept explained in different ways by different authors like the transition teams, this concept explained by other name called cross-functional teams. Both are dealt with same topic but in different ways.
Chapter 7

Conclusion and future work

7.1. Conclusion

Coordination and communication in the department is a main problem in every organization. Each is willing to work in his own way and not following the proper procedure and methods and even they are not cooperating among other members in the department all this issues leads to an organizational failure. During research and development stage only design engineers are involved in the process and then they will push the process to manufacturing section, here in the manufacturing unit they didn’t know the actual method of handling the sequence or operations. If the market needs a change to the existing design then the manufacturing unit is in deep trouble, not in a position to change the system or process. This sets a major drawback to the organization.

Factors like individual\'active responsibilities each member in the department must take the individual responsible and active involvement in the work, this will improve the individual performance and also the helps the organization to overcome the problems that are facing in the departments. Learning the new technologies quickly and actively involved in work and aims for organization success is one of the method and roles of an individual.

Teams plays an important role in every organization, teams are the building blocks of organization. Cross-functional integration has great influence on product development on new product development success. Better integration results when development personnel have easy access to one another and when functional groups work well together. Rotating the present staff between functions and also reducing the disparity between career paths, incentives, pay and job specifications. All this aspects will influence the team structure to work in a friendly environment.

For all this process needs a proper and better communication and coordination. More and better communications between design and manufacturing leads to better insights into the other functions role, thought worlds, language, goals, needs, wishes and limits (cf. Souder, 1977, 1987). More ever it increases the mutual understanding between the functions and helps the group members to put their own roles into perspective. Should support other’s contribution to the organization and also the trust strengthens the people relationships and better information utilization. Personal, language and physical barriers are reduced and the designers better consider the manufacturing requirements and possibilities during the design phase.
Communication enhances the each individual behavior and knowledge base and inter-functional expertise. The information exchange among others in the department permits an early detection of problems which means that problems can be finding when it is small, easier and needs less time to solve the problem. I can say on other word, better and regular design and manufacturing communication reduces later design changes and improves the development cycle time, reduces the extra cost and time.

7.2. Future Work

1. The European Foundation of Quality Management (EFQM) creates based on the membership. Found on 1988 by fourteen leading European businesses and the mission of EFQM is to driving force for sustainable Excellence in Europe and a vision of a world in which European organizations excel. EFQM establish the European quality award in 1991 and in the year 1997 the model’s name changed to ‘The European Model’.

The E.F.Q.M. model consists by 9 criteria, which are divided to two main categories. The first one is the so called Enablers criteria, and the second one, is the Results criteria. The existed relationship between them is close, and we can claim that these two categories overlap each other and are highly connected with the success of each organization. This success can be expressed in many ways, depending on the size of the company, the industry in which it operates, the (geographical) area in which is positioned etc. Thus, in some organization the efforts and the interest of its employees regardless of their position in the organizational chart is mainly focused on the achievement of the highly possible Net Income after taxes, in other organization the efforts are focused on the highly possible increase of the market share, in others on the maximization of the value that the customer perceives, while in others is focused on the reduction of the negative effects that the company’s operations have both at the local society and at the environment generally. The structure of the model is a non-prescriptive framework based on the nine criteria. Five of these are enablers and four are results can be seen from the figure 7.2a below.
The Enablers criteria of the model, represent all these actions that a organization has to do (actions which of course will differ from organization to organization and that’s why we can’t argue that there are some specific rules or guidelines which every organization should follow) in order to become able to achieve and implement its goals and objectives, which certainly are specific, individual and related to the organization which set these goals. Saying it in a different way, the Enablers criteria depict of the sum of all these activities and actions that running through an organization, it is what an organization does, in order to get some very good results which may concern the Human Resources (People Results), the Customers (Customer Results), the society including both its narrow and broad definition- (Society Results) or maybe results concerning the actual performance of a company (Key Performance Results). So, Results criteria are the “result”, the consequence of the Enablers Criteria.

The main philosophy behind the E.F.Q.M. model is a right-to-left one, but, if we use the E.F.Q.M. model and its components as a tool for Self Assessment, then, we can say that this philosophy transforms into a left-to-right one.

Six management control approaches will be adopted as a conceptual multidimensional framework for analyzing the European excellence model.

1. Bureaucratic and mechanic view of control- formal mechanisms in terms of objectives, rules, procedures, policies, reward systems and standardization in management control.
2. Cybernetic view of control- every process of control, i.e. activities for planning, budgeting and performance evaluation etc. are information processing view and the main idea of the system is self-regulating able system based on feed back and forward loops.

3. Agency view of control-relates principals and agents in organizations. Contractual relationships between principals and agents and focus on commonality of interests.

4. Human resource view of control-underlying assumptions in human resources field.


6. Cultural view of control-this are socially constructed organizations and social energy as driving force of organizational activities. Even deals with cultural aspects on individual and social actions within organizations.

One of the Leadership statements is that leaders should recognize and reward the organization employees for the excellent work which they do. This improvement will be implemented in the organization processes, through the establishment of a monthly/yearly special award. The implementation of such a measure, will contribute to an improvement at the levels of Employee satisfaction (People Results).

The reason is that, the employees of the organization will feel that their efforts are not “invisible” or meaningless for the organization management, but the organization, as an evidence of recognition of the efforts, decides to give them a special award during an appropriate ceremony. It is then logical, that the increase of employees’ satisfaction levels will automatically lead to an increase at the customer satisfaction, because the greater an employee is satisfied with his/her job, the more willing he or she will be to satisfy the customer.

One of the Policy and Strategy’s criterions is that the organization should develop a customer-focused philosophy or, to bring the customer to the centre of its activities and its interests, in order to be able to fully satisfy every single need or expectation that they will have. The implementation of this statement happens through the Processes of the organization, by implementing and using market research, by organizing focus groups, by sending to its customer’s appropriate structured questionnaires in order to be able to continuously be informed about their new needs, their new expectations and desires. This improvement will have a positive effect to the company’s Results and especially at those which concern the level of customer satisfaction. This will happen, because the customer will feel that the company tries to continuously be informed and accomplish all their needs.
This statement, is also being implemented through another one statement which belong to the Processes and specifically, through the need for developing a very solid relationship with the customer, not just during the buying process but also and mainly during the before and the after buying period of time. Furthermore, what is more important, is not just the implementation of such a philosophy but the systematic way of this implementation and by saying this, we mean that it is certainly important for the customer to feel that his relationship with the organization doesn’t exhaust in just a buying relationship, but it is something more than that. The key theme for the organization is to understand that this relationship should not be maintained for typical reasons but, the customer needs to feel that the organization is really interested about him, about his needs and expectations.

A consequence of the customers’ satisfaction will be a significant improvement at the Key Performance Results and especially the amount of sales and the market share.

One of the statements of the People criterion highlights that the organization should identify the competencies of its employees at the same time that also identifies the needs of each position, in order to be able to place the right person at the right position. This statement is being implemented through the Processes, with the establishment of equal hiring and promotion methods. This improvement, will lead to an improvement to the People satisfaction, especially because they will feel that the organization recognizes their competencies and skills and so, rewards them by offering the best suitable position for them and also, that the sole criterion related to their promotion opportunity will be their skills and their hard work.

On of the statements of the Partnerships and Resources criterion refers to the need of the appropriate choice of suppliers and also, to the need of establishing a long-term relationship with the most valuable ones. This improvement is being implemented through the Processes of the organization and specifically, through the development and implementation of new technologies but also through the continuous improvement of its products, improvement which can revitalize the organization competitive advantage and bring her one step ahead of the competition. Certainly, this improvement will lead to an improvement to Customer Results and that’s because the customers will be absolutely satisfied by the more advanced and quality superior products of the organization, but the positive consequences are expanded and cover also the Key Performance Results and especially lead to a market share increase and to an increase at the value of the shares.

Furthermore, a significant improvement to the organization Results related to the level of employee satisfaction will be generated through one more improvement happening at the People criterion and
specifically through the continuous improvement of the employees’ abilities and skills. For this reason, continuous training is demanded. This demand, is also identified at one of the Leadership statements and specifically the one, which is related with the commitment of the management to the philosophy and the principles of TQM, of continuous and step by step improvement (KAIZEN) and is being implemented at the Processes of the organization through the establishment of regular and repetitive training programs, seminars etc. This improvement will lead to an improvement of the People Results and this is because they will feel that the organization in which they work for, really cares about their future and their personal improvement and development and so, this improvement will automatically be translated to an improvement at the Key Performance Results and the reason is the highest productivity levels, the reduction of the absence levels and so on.

One of the Leadership’s statements emphasizes that the leaders of our organization should develop, implement and communicate an organizational culture, based on a network of system values, which will represent the principles and the beliefs upon which the organization is supposed to “travel”. This improvement is reflected at almost all the other Enablers criteria -it concerns the equal hiring and promoting system(People), the implementation of new and more friendly against the environment technology(Processes) and establishes close relationships with the schools and Universities but also the local society (Partnerships & Resources) etc.

All these, definitely have a strong effect at the Society Results (mainly), but also at the customers and the level of their satisfaction especially because the customers will understand the sole goal and target of the organization is not just the profit, but will also have a positive effect at the employees of the organization because they will feel that they work for a organization with strong values and principles, above of which is nothing, even the profit. So, improvements will also arise and at the Key Performance Results and especially to what concerns the market share and the external image of the organization and thus, the value of its share.

The principles of this philosophy should be communicated throughout the organization and need to be fully understood by the totality of the employees. That’s the only way in order to successfully implement this new management model. Certainly, the TQM philosophy is not the only one which can be adopted a complementary to this; many others can also be adopted, such as the 6-σ methodology, or ISO-9000 standard. The main characteristic of all these philosophies is actually the need for having a fully satisfied customer. The people have also a very important role to play. As already mentioned, people have to be inspired in order to accept and work for the change but this is not enough. People also need to be trained to the demands of the
new philosophies and so, specific and well organized training programmes, which should be intensive at the beginning but which will also never stop exist and the reason is that employees need always to be aware of everything new related to their work, it’s again the need for the so called continuous improvement.

2. University education and the corporate training process- engineering methodologies should be included in their university education and receive more attention in the area of computer-aided design, design for testing, design process, software design, technical risk assessment, design requirements and analysis and finally computer-aided manufacturing. University education should be thought in depth knowledge on each field for the students in the university with practical experience. The latest application of drawing CAD/CAM are the area deals the concepts and this are integral parts of both product and process innovation and the design process also, requires more attention for university education should emphasis this field to improve in an effective and efficient manner.

3. Suggestion for the future research in cross-functional involvement across NPD stages and by function. Appendix-IV gives an idea of joint involvement by stage and by function (paired joint involvement). And in figure 7.2b. Patterns of cross-functional joint involvement presents in clear and well structured manner.
Figure 7.2b. Patterns of cross-functional joint involvement

In the above figure, R&D and marketing joint involvement appears to be productive in the market opportunity analysis stage, because it facilitates market uncertainty reduction, increases developing new product with high demand and also competitive advantage. In the planning stage R&D and manufacturing joint involvement is important. New product design often needs a significant amount of process development in order to create the required design capabilities. The joint involvement between manufacturing and marketing is also critical in
the planning stage because manufacturing and marketing often have conflicting goals. Marketing mainly focus on satisfying consumer’s needs, while manufacturing focus on production efficiency. Maximizing the satisfaction of consumers needs may require excessive product modification. In the development stage, R&D has having a dual role of multifunctional network. R&D and manufacturing provides opportunities for interaction between design choices and process capabilities. While in R&D and marketing provides or transfers important marketing information and perspectives into product design. In the pretesting stage, R&D and marketing integration helps marketing to know the product’s technical specifications, attributes, usage, and required maintenance. Enables marketing to communicate more effectively with the customer about unique features. And finally in the launch stage, R&D and manufacturing is positively related to both new product development effectiveness and efficiency.
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Paashuis, V.J.B.J. and de Weerd-Nederhof, P.C., “Organizing the product creation process for integration; degree of integration, integration mechanisms and contingencies in product development and process design”, in McDonough E.F. III, and Tomkovick, C. (Eds), Bridging the Gap from Concept to Commercialization, Product Development and Management Association, Indianapolis, IN, 1994, pp. 163-77. 5 Ettlie, J.E., “


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WORKMAN, JOHN, Marketing’s limited role in new product development in our computer systems firm. Journal of Marketing Research 30: 405-421 (November 1993).


‘Key issues in organizational communication’: edited by Dennis Tourish and Owen Harige. Publication by Routledge taylor & francis group, London and New York.
Appendix-I Comparison b/w communication media and their effect on organizational identification

| Table 1 | Comparison of Communication Media with Respect to Accessibility, Formality, Shared Interpretive Context, and Social Context Cues (Derived from Previous Research) |
|-----------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|
| Accessibility/  | Face-to-Face | Document | Telephone | Electronic Mail |
| Synchronicity   | Synchronous with respect to time and place | Asynchronous with respect to time and place | Synchronous with respect to time; asynchronous with respect to place | Asynchronous with respect to time and place |
| Formality       | Dependent upon communicators | Highly formal | Dependent upon communicators | Highly informal |
| Shared Interpretive Context | Facilitates creation of interpretive context | Not explicitly considered | Not explicitly considered | Facilitates communication within established interpretive context. |
| Social Context Cues | Strong | Moderate | Moderate | Weak |

**Appendix-II Details of all articles name, author name, publication, volume and year**

<table>
<thead>
<tr>
<th>Article</th>
<th>Title</th>
<th>Authors</th>
<th>Publication Details</th>
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<tr>
<td><strong>6.</strong></td>
<td>Cross functional teams in product development accommodating the structure to the process</td>
<td>Anne Donnellon.</td>
<td>PROD INNOV MANAG 1993; 10:377-392.</td>
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<td><strong>8.</strong></td>
<td>Design-Manufacturing Integration as a Mediator of Antecedents to New Product Design</td>
<td>Morgan L. Swink, Roger Calantone, Member, IEEE.</td>
<td>IEEE TRANSACTIONS ON ENGINEERING MANAGEMENT, VOL. 51, NO. 4, NOVEMBER 2004.</td>
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<td><strong>9.</strong></td>
<td>Early Manufacturing Involvement in New Product Development</td>
<td>John E. Ettlie.</td>
<td>'95 ENGINEERING MANAGEMENT CONFERENCE.</td>
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<td><strong>12.</strong></td>
<td>Integrating Design and Manufacturing to Deploy Advanced Manufacturing Technology</td>
<td>STACY A. REIFEIS and John E. Ettlie.</td>
<td>INTERFACES 17: 6 November-December 1987 (pp. 63-74).</td>
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<td><strong>14.</strong></td>
<td>Knowledge sharing in integrated product development</td>
<td>Paul Hong, William J. Doll, Abraham Y. Nahm and Xiao Li.</td>
<td>European Journal of Innovation Management Volume 7 Number 2 · 2004 · pp. 102-112.</td>
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<td><strong>15.</strong></td>
<td>Managing the design/manufacturing interface across firms</td>
<td>David Twigg.</td>
<td>Integrated management system 13/4 [2002], 212-221.</td>
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<td><strong>17.</strong></td>
<td>Role of design-philosophies in interfacing manufacturing with marketing</td>
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### Appendix-III Analyses of all articles in table format

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<td>Article 1</td>
<td>Interest in learning new technologies</td>
<td>Design rep Ositories</td>
<td>Nil</td>
<td>Interacting network agents</td>
<td>Nil</td>
<td>Geographically distributed</td>
<td>Through www-based integrated PD platform</td>
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<td>Article 3</td>
<td>Active responsibilities</td>
<td>Nil</td>
<td>Nil</td>
<td>Inter functional harmony</td>
<td>Task required needs</td>
<td>No social movements affects communication</td>
<td>Informal communication</td>
<td>Leadership qualities, capabilities</td>
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<td>Goals-need to achieve, tasks to complete</td>
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<td>Cross functional teams</td>
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<td>Logical way of engage the teams</td>
<td>Accommodations, luxury life to teams</td>
<td>Groups are building blocks</td>
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<td>Adjusting system environment</td>
<td>Complexity &amp; innovation</td>
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Appendix-IV Patterns of joint involvement by stage and function process

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<th>Joint Involvement to Avoid</th>
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<td>R&amp;D-Manufacturing</td>
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<td>Development</td>
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<td>Launch</td>
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