EFFECTIVE INTERNAL COMMUNICATION ISSUES IN CROSS-FUNCTIONAL DESIGN TEAMS: THE CASE OF A GRADUATE COURSE IN INDUSTRIAL DESIGN

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ABSTRACT

EFFECTIVE INTERNAL COMMUNICATION ISSUES IN CROSS-FUNCTIONAL DESIGN TEAMS: THE CASE OF A GRADUATE COURSE IN INDUSTRIAL DESIGN

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This thesis examines the factors in effective internal communication in cross-functional design teams. As a new product development model, the team concept in industrial organizations is investigated with respect to its necessity, types, and application, and internal communication is analysed as an important factor to reach high-performance in cross-functional design teams. The literature findings are cross-examined by a case study conducted in the context of a graduate course in industrial design which involved cross-functional design teams.

Keywords: New Product Development, Team, Cross-Functional Design Team, Internal Communication

ÖZ

ÇAPRAZ FONKSİYONLU TASARIM EKİPLERİNDE ETKİN İÇ İLETİŞİM FAKTÖRLERİ: BİR YÜKSEK LİSANS TASARIM DERSİ KAPSAMINDA ÇAPRAZ FONKSİYONLU TASARIM EKİPLERİ ÖRNEĞİ

Güneş, Serkan

Yüksek Lisans, Endüstri Ürünleri Tasarımı Bölümü
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Bu çalışma, çapraz fonksiyonlu tasarım ekiplerinde etkin iç iletişimi sağlayan etkenleri incelemektedir. Endüstriyel organizasyonlarda yeni ürün geliştirme modelleri arasında yer alan ekip çalışması olgusu, gerekliliği, çeşitleri ve uygulanışı açısından ele alınarak, çapraz fonksiyonlu tasarım ekiplerinde yüksek başarıma ulaşmada önemli bir etmen olan iç iletişim tartışılmaktadır. Çalışma dahilinde bir yüksek lisans dersi kapsamında çapraz fonksiyonlu tasarım ekipleri örneği incelenmekte, kütüphane araştırması bulguları ile örnek olay incelemesinde ulaşılan sonuçlar karşılaştırılmaktadır.

Anahtar Kelimeler: Yeni Ürün Geliştirme, Ekip, Çapraz Fonksiyonlu Tasarım Ekipleri, İç İletişim

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INTRODUCTION

1.1 SIGNIFICANCE OF THE SUBJECT

The new product develoment effort is getting complex and dynamic and includes a number of vital necessities. Because of increased changeabilty and complexity in the business environment, more rapid responses to change are needed and this requires getting more integrated and more communicating in industrial organization. It is widely acknowledged that the New Product Development process focuses on the relationship between functional departments. This situation forces the business to rely on team structures in their bodies because design was always have team character. Vogel et al. state that successful products require the involvement of a minimum of at last three core competences: engineering, industrial design and marketing (1998). This situation is higly related with the complexity of the product that the organization produce. The specific composition of product development process depends on the particular characteristics of the product. Few products are developed by single individual (Ulrich and Eppinger, 2000). Different sectors need different levels of team neccessity depending on the complexity of the product that they launch to the market and newness that they

attached to the product. The increase in the complexity of the products gives rise to more complex business relations and interdepartmental integration within an industrial organization. Teams have been so well studied, and that people at so many companies have worked on in teams for many years. All this research and experience has produced new insights into what distinguishes the successes from the failuries. Because work teams cluster at opposite ends of success continiuum. Many function beatifully; many others fail miserably (Hackman, 1998). Most of the teamwork resarchs on industrial design focused innovative companies who face intensive competition such as 3M, Kodak, HP, IBM, Motorola, Xerox, Boeing, GM, Apple, Polaroid and Sony. In this research, virtuous teamwork practices are exampled and departmental integration within the organization is promoted for new product development success. Numerous studies indicate that the use of cross-functional design teams improves the effectiveness of new product development process to strengthen the interaction and to overcome organizational limitations. Many factors have been suggested for success within cross-functional design teams, but communication factor arises as the most important issue. Although several empirical studies have specified the internal communication requirement in design teams as a precondition for success, there is no specific prescription for application due to organizational variations.

Teams must be trained in teamwork; members often need help in skills such as listening, communication with different kinds of people, and staying focused on the task. According to Vogel et. al., professionals needs to be exposed to

interdisciplinary experiences before their first employment. Design students need to develop effective communication skills, interpret costumer needs, and integrate issues of materials and production at university level (1998). On the other hand, educational practices in industrial design differ from professional practices to reflect real life conditions. This isolated context focuses on training, but mostly neglect organizational limitations that the students will face in future. However this restrictive practice enables students to improve their teamwork practices in more sheltered training ground without fatal errors.

1.2 STRUCTURE OF THE THESIS

In this study the relationship between effective internal communication and cross-functional design team performance is examined. In order to achieve this aim, in Chapter 2, the scope of team concept is discussed broadly by analyzing its vital role in new product development process in industrial organizations. To support this argument, the study begins with the models of new product development to locate team approach in this context, and to highlight the importance of teamwork in this process. To illustrate the subject matter, the literature of design management is investigated together with the new product development literature. The current literature shows that the industrial organizations who integrates new product development structure into their bodies focus on team approach because of the increasing competitive market conditions. This is perhaps why research on team approach has become such an important field of study.

In Chapter 3, various types of team formations are examined to indicate the differences between formation dynamics, their definition and benefits that are attributed to them. After this preliminary discussion the study focuses on the subject of cross-functional teams and the factors in their effectiveness.

As the central focus, in Chapter 4, internal communication in cross-functional teams is discussed as the most important factor for effectiveness. Through a variety of examples of literature, internal communications within cross-functional teams is analyzed by their types, structures, mechanisms and applications.

After the review of the literature a case study is introduced as part of the study in order to illustrate and to be compared with the findings in the literature review in Chapter 5. The conjecture of the case study is planned in the Graduate Program of the Department of the Industrial Design at the Middle East Technical University. The students of the Graduate Program are assumed to be the potential members of cross-functional team formation that is indicated in literature. This type of application caused several advantages and limitations for the study. Although the study did not reflected real life conditions, this situation led to observe social process of teamwork intensively. Detailed limitations are listed at the end of the case study. In the case study, first, factors that have impact on the performance of cross-functional teams are analyzed in an educational context. Second, the content of the case study is expanded in order to compare the differences between teamwork and individual work.

Lastly, the findings of the case study are discussed in conclusion. Case study findings are compared with literature findings and several recommendations are listed for the organizations that try to integrate teamwork in their bodies.

CHAPTER 2

NEW PRODUCT DEVELOPMENT AND INDUSTRIAL DESIGN

2.1 INDUSTRIAL ORGANIZATIONS AND NEW PRODUCT DEVELOPMENT

The goal of industrial organizations is to make profit and to keep on growing. Industrial organizations acquire this profit through with the products they produce and the services they offer. The products have to obtain a share in the market in order to return as profit. For their long-term survival, industrial organizations have to enter the market place with superior products (Holland et al., 2000). High profit leads to industrial success which can be defined as organizations' overall new product success compared to their primary competitors (McDonough, 2000).

Products compete in the market place. The market share is affected by such factors such as price, quality, durability and reliability; but at the same time by the industrial design factors like appearance, variety and specifications, which exert strong influence on are highly effective on the preferences of consumers. The success of industrial design refers to an increase in profitability and commercial benefits (Oakley, 1990; Gorb, 1990).

Walsh et al. (1992) emphasize the strong connection between industrial design, and price and quality factors, which affects business success in an innovative company. They also stress the positive effects of success in industrial design on marketing strategy, innovation and manufacturing technologies. According to Hartly (1990) the best killer of profits is the bringing of a product late to the market and in poor quality. Otala (1991) claims "launching a premature product may cause considerable profit losses by killing existing viable products."

Design effort is related with overall strategy of industrial organizations. Porter defines three core competence factors: price, focus and differentiation. All these factors are related with design efforts. Industrial organizations try to reduce costs and compete on lower price. *Focus* is a market-based concept; industrial organizations are obliged to find out market niches and they try to satisfy consumer needs through design efforts. *Differentiation* is the divergence of products in the same market segment, and design is one of the product positioning tools adding various features like quality, durability, ease of use, distinctive aesthetics and price (Porter, 1980).

The market forces[1] created by the specific area of competition, the core competencies[2] created by the organizations' tacit knowledge, and the values[3],

[1] Market forces are the facts about the environment within which an organization functions or competes which, taken together, indicate a probable future state of affairs of relevance to an organization (Raynor, 1998).

taken together, lead to a mission[4] statement, and then to a vision[5] which directly affects corporate strategy (Raynor, 1998) (Figure 1).

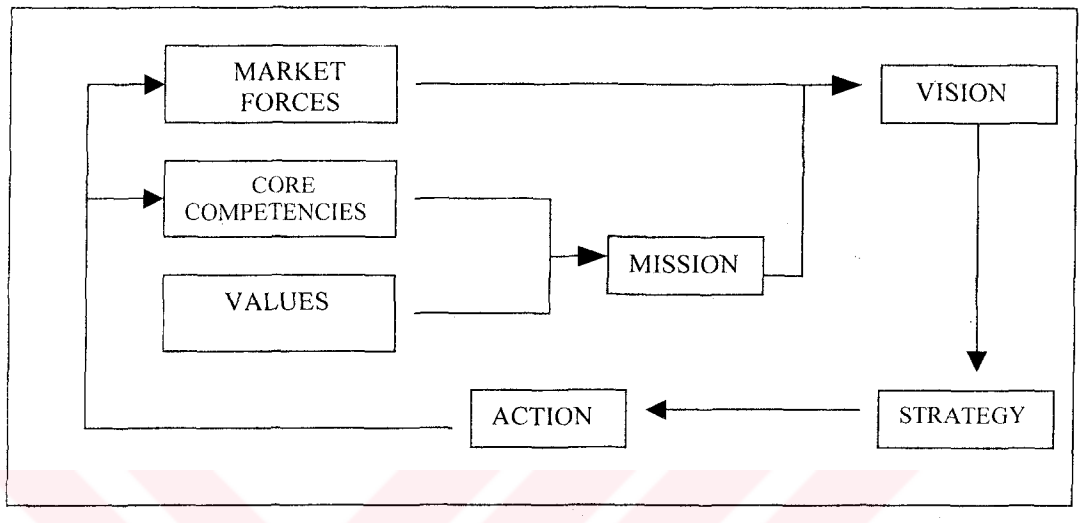

Figure 1. The framework for creating organizational strategy. The figure does not show the complete framework described by Raynor.

As mentioned before, industrial design is strongly linked with market forces and core competencies, and it can be defined as a strategic tool for an industrial organization.

[2] Core competencies are limited number of skills or technologies which, taken together, serve to differentiate a company from others in market place in such a way as to provide competitive advantage (Raynor, 1998).
[3] Values: Principles or concepts of intrinsic worth with which to align one's actions as an end in itself (Raynor, 1998).
[4] Mission: A concise statement of the customers and core competencies of the organization; in other words, the arena of competition for the organization and those characteristics of the profession that will allow it perform successfully in that arena (Raynor,1998).
[5] Vision: A statement of the desired future state of the organization within the arena of competition defined in the mission (Raynor, 1998).

The relevant literature locates industrial design within the new product development process. According to Trott (1998), new product development concerns the management of the disciplines involved in the development of new products. This comprehensive definition considers design as a sub-function of new product development (Figure 2).

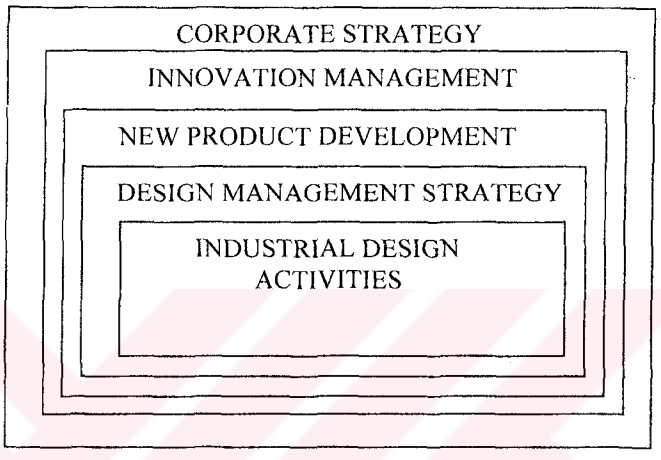

Figure 2:The place of industrial design in corporate strategy. The interpretation is based on Trott (1998).

Figure 2 does not illustrate the whole spectrum of corporate strategy, it is limited to the place of industrial design within corporate strategy. In accordance with their corporate strategy, industrial organizations form an innovation management system. Innovation management creates ideal conditions for creative activities. As a sub-activity of innovation management, new product development comes along with a set of activities such as marketing, industrial design, engineering, production and sales.

2.2 DESIGN MANAGEMENT

The importance of new product development is frequently emphasized in the relevant literature. According to Trott (1998) the percentages of new products in total sales are increasing, the causes of which are mostly market dependent. Swink et al. (1996) group these causes as market and technology driven. Shorter product life cycles and higher quality requirements are mentioned as market driven trends whereas complexity of products, new materials and process technologies are examined under the technology driven factors. According to Otala (1991) these requirements are contradictory and impossible to be reconciled unless traditional methods of managing product development are radically altered.

Walsh et al. (1992) define industrial design as the core point of new product development, and design management plays an important role in the connection between new product development and industrial design activities. The content of this connection can be found in the definitions of design management. The definitions of design management show some differences in accordance with the function and role of industrial design activity in an industrial organization. Gorb (1990) expresses his definition of design management as "the effective activation of available design resources by operational directions within an organization to help it achieve its aims". Walsh et al. (1992) define design management as "the planning and coordinating activity necessary to create, make and launch a new product on to the market." According to Blaich and Blaich (1993) on the other hand, design management is "the implementation of design as a formal program

of activity within a corporation by communicating the relevance of design to long-term corporate goals and coordinating design resources at all levels of corporate activity to achieve the objectives of the corporation". Finally Hetzel (1997) defines design management as the awareness of managerial staff.

These various definitions of design management indicate a rather wide scope of tasks. Blaich and Blaich list the major tasks involved in design management as follows:

1- Contributing to corporate strategic goals,

2- Managing the design resources,

3- Managing the design process,

4- Cultivating an information and idea network.

To overcome the scope and complexity of these tasks involved, industrial organizations create new product development models.

2.3 NEW PRODUCT DEVELOPMENT MODELS

The differences in new product development models derive from various organizational conditions, and requirements of the market that the industrial organizations act in. The structure of an industrial organization directly affects and shapes the new product development model it chooses. Size of the organization, general management style, types of products that it produces, level of technology, organization's history, and unique abilities of individuals are listed

as the structural reasons that affect the choice of new product development models (Walsh et al., 1992). The relevant management literature indicates that there is a need for flexible new product development models in response to rapid changing market conditions and competition such as shorter product life cycles and changing consumer trends (Holland et al., 2000; Hyvönnen, 1991).

The design management literature examines the models of new product development from structural, managerial and effectual perspectives. In *structural perspective*, studies focus on physical arrangement of individuals. *Managerial perspective* indicates the management style and leadership issues. The productivity and effectiveness of the model is examined under the *effectual perspective*. The case and field studies conducted from these perspectives focus on three major coordination issues: a) coordination within in-house resources, b) coordination with the out-sourced support (such as consultant firms and specialists), or c) coordination between internal and external resources.

In the related literature, several types of new product development models are mentioned. The major difference between these types seems to emerge from the inter-functional communication issues involved in the models. The whole spectrum of new product development models, from the very traditional ones to the very experimental ones, is going to be discussed in the following sections.

2.3.1 DEPARTMENTAL-STAGE MODEL

The departmental-stage model has a linear structure which is also called "Relay Race" by Walsh et al. As illustrated in Figure 3, each function is responsible for fulfilling a certain task and the project moves in linear fashion from one function to another. Because of this structure, Trott, who sees functional borders as walls, also calls the model "On the Wall Model". The process in this model is slow because of "reworking[6]".

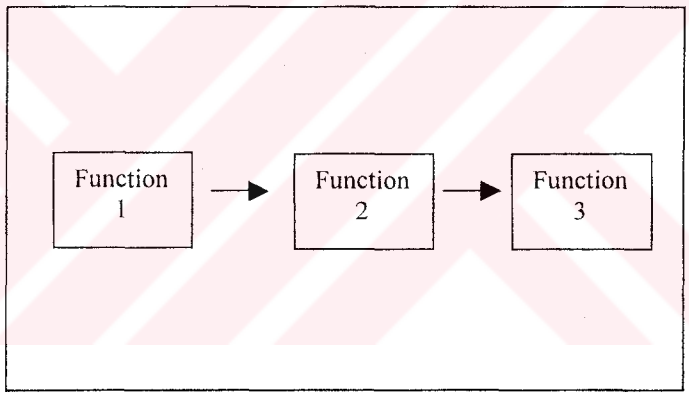

Figure 3. Departmental-Stage Model.

According to Walsh et al. (1992), since communication is limited in this model, it will not be able to fulfill the requirement of the rapid product development, limited budget and product quality. Another major problem with this model is the

[6] Reworking expresses the idea of reciprocal transition of a project between the functions of an industrial organization.

lack of a formally appointed administrator or facilitator; the project management changes from one function to another during the process.

2.3.2 ACTIVITY-STAGE MODEL

In the activity-stage model, as a solution to the limited communication problem in the departmental-stage model, limited feedback loops are offered (Figure 4). Walsh et al. (1992) describe this model as a volleyball game in which projects go back and forth between departments before moving to the next stage. Trott mentions a similarity between concurrent engineering[7] and activity-stage model (1998). Although concurrent engineering does not fully support teamwork, in some sources it is also mentioned as simultaneous engineering approach, since the efforts are project driven. According to Hartly, concurrent engineering is an effective method, supporting a system in which all the members are equal (1990). Unlike the activity-stage model, the place of individuals in the hierarchy, their careers and experiences are important inputs in the departmental-stage model (Walsh et al., 1992). Because of the limited feedback loops, the activity-stage model is superior than the departmental-stage model; however it requires fundamental changes in the general philosophy of an organization (Trott, 1998).

[7] Concurrent engineering (CE): The systematic method to focus attention on the project as a whole rather than the individual stages, primarily by involving all functions from the outset of the project. Although Trott mentions CE under the activity-stage model, Hartly sees CE as teamwork. The difference between these ideas is based on structural and functional analysis of the CE. CE seems to have an appropriate basis for teamwork conceptually, but it remains insufficient to break the functional borders in reality.

Cost, adaptation problems, instability of hierarchical levels, and time constraints may prevent organizations from using the activity-stage model.

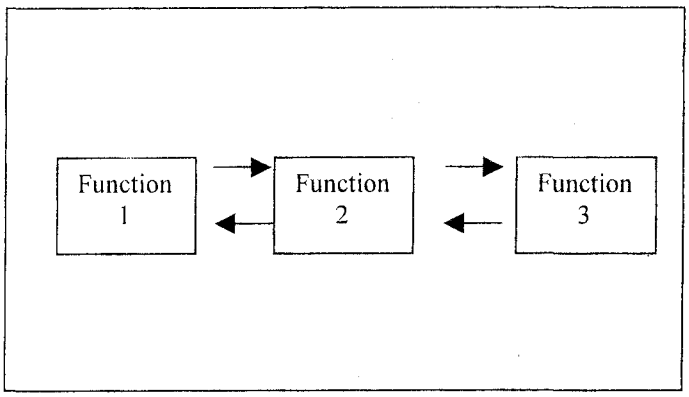

Figure 4. Activity-Stage Model.

2.3.3 GROUP APPROACH

In the last thirty years, there has been an increasing emphasis on group work in industrial organizations (Donnellon, 1996). The basic reason for the existence of the workplace groups is to facilitate the interaction and communication among the various functions concerning the new product development activities in an industrial organization. As Hyvönen (1989) states:

> Industrial design works with the research and development resources of its client, creating a triad which is capable of realizing products that will be both of benefit to the consumer and a reflection of company's full potential. This is true of all industrially produced products, but is especially true for mass produced products which make extensive use of high technology. In such cases, the industrial designer alone can never solves all the problems that arise during the product development process. The need for an interactive, interdisciplinary approach by everyone involved is quickly becoming obvious.

Although there are different kinds of group and team structures, their general structure reflects the metaphor of a "Rugby Team" suggested by Walsh et al. In this structure, the barriers between functions are demolished and this cooperation lasts from the beginning till the end of a project (Figure 5). As mentioned by Trott (1998), in order to benefit from the group approach the firms need a fundamental change in their organizational structure and most of the firms are not prepared for this fundamental modification. Because of these difficulties most of the firms apply informal grouping methods in order to solve the problems mentioned by Trott. On the other hand, in the literature of management and design management there is an emphasis on the strategically planned and applied formal groups and teams. These workplace teams such as multi-departmental teams, development committees, inter-disciplinary teams, project teams, multi-disciplinary teams and cross-functional teams are going to be examined separately in the next chapter with particular emphasis on cross-functional design teams.

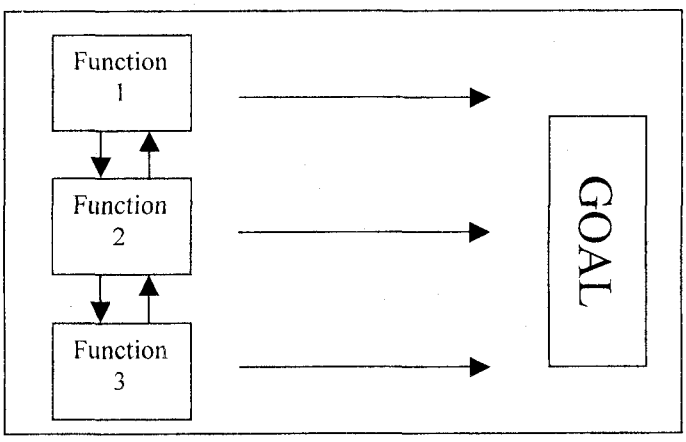

Figure 5. Group Approach.

2.3.4 NEW APPROACHES IN NEW PRODUCT DEVELOPMENT MODELS

Apart from these three models (activity-stage model, departmental-stage model and group approach), there are also various case studies and some newly developing models. For example, network models aim to get more feedback from all stakeholders including suppliers, distributors and customers throughout the product development process. This model is based on Nokana and Takeuchi's researches and it forms a "rich knowledge pool" which includes both internal and external inputs. It can be seen that linear new product development models with limited communication form an opposition to the present market conditions and to the design process activities inside the firm (Nokana and Takeuchi, 1995).

Even though all the models mentioned have some strengths and weaknesses, in new product development models there are a shift from an orthodox structure to a more organic structure. The cross-functional team approach confirms this view and forms the basis of this research.

2.4 THE IMPORTANCE OF TEAMWORK IN NEW PRODUCT DEVELOPMENT

Team approach in new product development process is a series of linked activities, and it is not under the monopoly of any single department in the organization. Although multi-functional structures pose challenges, according to

Trott, success in new product development only can be achieved with the participation of the personnel from different functions in the organization (1998).

There are two basic team structures adopted by firms concerning new product development: functional and matrix structures. According to the structure adopted by the firm, the participation of functions in organizations shows some differences. The functional structure provides both functional-based and production-based structures; the *matrix structure* is mainly project-based, and full-time and part-time personnel form business teams. These business teams may be "ad hoc" or formal. For example in the matrix structure used by Nokia Mobile Phones Ltd. (Pitkonen, 1989), design variations are shown to a project management group which represents marketing, R&D, production development directors and managers. This project management group, whose membership varies from time to time, is responsible for the design decisions along with the designer in accordance with the company's design management approach.

The relevant literature emphasizes participation in teams strongly. According to Ettue and Stoll (1990), participation is part of integration and plays a key role in reaching total integration. The total integration, here, refers to the participation of all functions related with the new product development process. According to Rassam (1995), a good product design is related with teamwork. Lawrence (1987) also states that the participation of internal functions to the process as a team is the basis of the idea of design management. Baxter (1995) also maintains

that the development process is a process that no one can achieve alone and teamwork has to be used in the innovative processes. The complexity of design process is also mentioned by Walsh et al. who formulated the "4 Cs" theory[8], where each "C" expresses one of the complex requirements of design activity .

Weiss (1993) has listed a few managerial reasons for the need for teamwork. First, teamwork is necessary to improve the outcome of the work, to solve problems, to make decisions and to determine the priorities; secondly, teamwork organizes the personal relations in a group, enhances creativity by surviving the group members from close supervision, and improves the quality of business life; and finally, the performance of a team is higher than the performance of an individual or a group of individuals working separately. From the marketing point of view Donnellon (1996) claims that most managers who try to cope with the intensive competition pressure support the teamwork approach. According to Oakley (1990), teams are tools that enable a shift from a mechanistic structure (formal, hierarchical, bureaucratic and inflexible) to an organic structure (informal, based on teams, and highly flexible).

Apart from these organizational benefits, team members have also advantages. Successful teamwork increases the dependence[9] of individuals on the organization

[8] While describing the design activity from various perspectives they mention four essential characteristics: Creativity, Complexity, Compromise, Choice.
[9] Dependence: The key point here is that the team members need to work with each other to succeed. The concept covers two sub-topics: Inter-dependence and Exterior-dependence.

and other members, which in turn, increases the work satisfaction and the feeling of responsibility (Donnellon, 1996). There are various approaches in the literature dealing with the benefits of teamwork from the team members' point of view. In one of these approaches, teamwork is examined from an individual's career point of view (Weiss, 1993; Trott, 1998). Another approach is the psychological approach focusing on the psychology of the team members at the beginning and the end of the process (Oakley, 1996; Donnellon, 1996); team members feel themselves as part of the team and the feeling of being a group grow in themselves (Walsh et al., 1992).

Throughout the chapter, new product development models are examined as strategic tools. In comparison to other models, the group approach has various advantages. The next chapter will look at the scope of team concept and cross-functional teams in detail, and examine the internal communication in cross-functional teams as a critical and vital factor in overall team performance.

CHAPTER 3

CROSS-FUNCTIONAL TEAMS

3.1 WORKING GROUPS AND TEAMS

Before defining the cross-functional teams, the extent of team concept and the differences among various group formations need to be examined. All teams are group of individuals, but not any group of individuals is a team. Katzenbach and Smith (1993) cross-examine different types of team formations and working groups in *The Wisdom of Teams*.

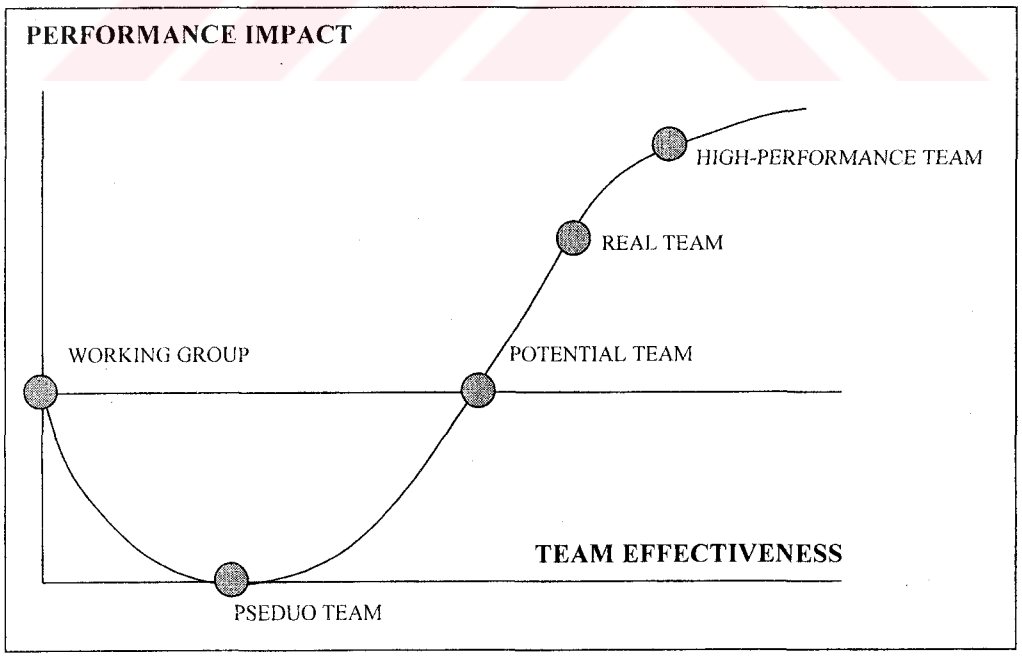

Figure 6. The overall framework of team concept by Katzenbach and Smith, 1993.

The authors discuss various groups of individuals from the performance and effectiveness points of view (Figure 6).

Working groups are structured in accordance by traditional organizational roles where members interact primarily to share information, best practices or perspectives, and make decisions to help each other perform more effectively within each member's individual area of responsibility. In working groups, individual efforts are combined to create an output, however individuals do not always work toward group goals and tasks commonly. The group performance is based on individual contributions, and the effectiveness is achieved through individual responsibility. In this individual-responsibility-based (as opposed to collective-responsibility-based) structure, members do not take responsibility for the results other than their own, and the overall performance is based on the abilities of individuals to accomplish the task. Sometimes working groups are preferred because teams are seen as 'risky', 'disruptive' and 'elusive'. In fact, the teams that are seen as "risky", "disruptive" and "elusive" are defined as *pseudo teams* in which the members call themselves a "team" but has no clear sense of direction or purpose, joint goals or accountability. From a managerial point of view, members are chosen, schedules are kept, meetings are done, and reports are prepared however in pseudo teams, on the other hand,:

- Conflicts arise,
- Innovative solutions are hindered,
- Functional divergences and beliefs are repeated,

- Trust and interdependence do not occur,
- Motivation disappears,
- Negative individual divergences increase.

As a result, the conditions become worse than they were at the initial state. Most of the industrial organizations resist to team structure because of their negative past experiences with *pseudo teams*.

In *pseudo teams* one of the critical questions for members is the personal benefit from the teamwork process. An alternative solution developed by Sears is "self-directed work teams" (1998). In this approach the authority is distributed among team members and they exercise limited rights to take decisions concerning the reward system[10].

Working groups in organizations should be supported primarily because they can build an infrastructure for the real team processes in many ways. That is working groups:

- Can be formed easily,
- Can establish the basis for the preconditions[11] of a real team,
- Can help members develop professional and communicative skills,
- Can facilitate a smooth transition from a vertical, hierarchical structure to a more horizontal structure (especially for top management),

[10] Reward system: In this case, reward system is limited to raises in salaries and future career opportunities.
[11] Small size, complementary skill set, and mutual accountability (Katzenbach and Smith, 1993).

- Can be an alternative structure to pseudo teams.

Similar to Katzenbach and Smith, Sears (1998) compares working groups and teams in terms of several criteria (Table 1):

Table 1. The comparison between work groups and teams. Source; Sears, 1998.

	Working Groups	Teams
Leadership	Strong leader	Shared leadership
Size	Team size or larger	Small (typically less than twenty)
Accountability	Individual	Individual and mutual
Purpose	Same as organization mission Goal attainment	Team purpose devised by team with board management decision Goal attainment and alignment
Skills	Functional, established, may be complementary	Complementary, and sometimes under development
Work products	Individual	Collective
Basis for productivity	Sum of individual "bests"	More than sum of its parts
Effectiveness measure	Indirect influence (e.g., impact on business financial performance	Direct evaluation of collective work product
Interactions	Structured, efficient meetings with agendas and reports	Open-ended discussions, problem-solving

In Figure 6, working groups have the same performance impact as *potential teams* but they differ in terms of team effectiveness. *Potential teams*, which meet team conditions adequately, are transitional groups to real team structures. In real teams, the teams are well established and have team experience (Sears, 1998).

High-performance teams consist of experienced team members with *successful* past experience in teamwork. Figure 6 also shows the typical stages of team formation process within an industrial organization. The main question here is why most of the industrial organizations still refuse to use teams. The answer can partially be found in negative pseudo team experiences. Furthermore *real* team formations have to overcome organizational difficulties and they require critical changes in the organizational structure (Trott, 1998; Donnellon, 1996). Team experiences reflect and effect the organizational structure (Baltaş, 2000). According to Peter Drucker (1992) this organizational change should occur suddenly; it may have a traumatic effect but the main idea is to break away from past organizational beliefs and structure[12]. Donnellon formulates this transition process as reaching a balance between organizational interest and individual self-interest. Similar to Drucker, she also mentions the tension between team structure and the organizational structure. She claims that successful team structures can only be attained when the organization passes over these paradoxical difficulties within its structure. The paradoxical issues in teams can be grouped under four topics: Individualism, identity, inter-dependence, and trust. Each team member or a nominee for a team, experiences an inner-evaluation process when he faces these paradoxical issues (Table 2).

[12] Past organizational beliefs and structures comprise of hierarchical privileges, functional based cooperation and defense, individual bias and responsibility and self-interest and report system (Drucker, 1992).

Table 2. Paradoxical structure between working alone and working as a team member. Source: Donnellon, 1996.

Individual Work	Paradoxical Structure	Teamwork
Individual	Individualism	Team member
Functional group	Identity	Team
Independent	Inter-dependence	Dependent
Lack of confidence	Trust	Trust

After this analysis, Donnellon also compares pseudo teams with real teams in terms of teamwork process (Table 3).

Table 3. Differences between pseudo teams and real teams. Source: Donnellon, 1996.

Pseudo Teams	Criteria	Real team
Functional group	Identity	Team
Independent	Inter-dependence	Inter-dependent
Much	Hierarchy	Less
Far	Social Structure	Near
Compulsion Concordanance Avoidance	Working Strategy	Confrontation Collaboration
Win-lose	Agreement process	Win-win

Donnellon emphasizes the agreement process as the most important aspect of teams and this process covers all the paradoxical dilemmas. In pseudo teams (as well as in working groups) the agreement process is formulated as a win-lose process, whereas in real teams it is a win-win process. In pseudo teams each member compromises on a more personal basis; in real teams, on the other hand, members compromise for the benefit of the whole team. Unlike Katzenbach and Smith, Donnellon uses different categories of team formations within organizations:

- Cooperation Based Teams,
- New Born Teams,
- Rival Teams,
- Pseudo Teams
- Unsuccessful Teams.

These five categories of team formations are examined under the criteria that reflect the team process (Figure 7).

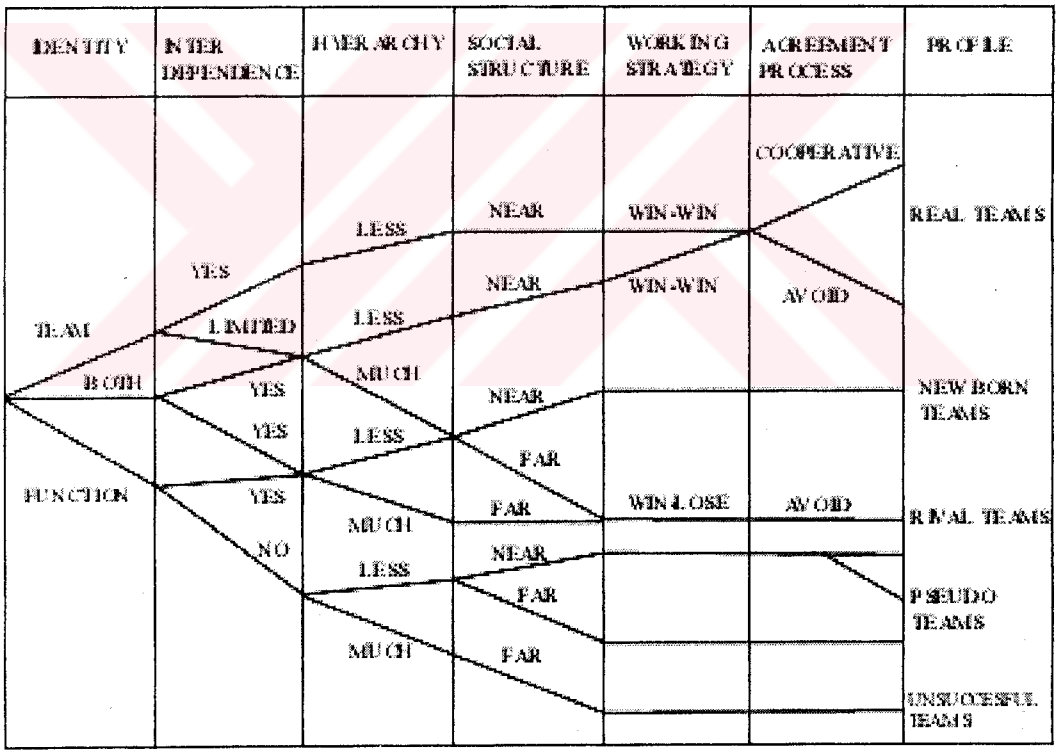

Figure 7. Five categories of team formations in accordance with the team criteria. Source; Donnellon, 1996.

After this broad examination of teams in general, the next focus will be cross-functional teams.

3.2 CROSS-FUNCTIONAL TEAMS

3.2.1 Interdepartmental integration

The concept of interdepartmental integration[13] is a key concept for the cross-functional team idea (Jasawalla and Sashittal 1998). According to Kahn (1996), interdepartmental integration originates from interaction and collaboration (Figure 8). Interaction defines formal and transactional communication whereas collaboration defines informal, cooperative relationships that build a shared vision (Figure 8).

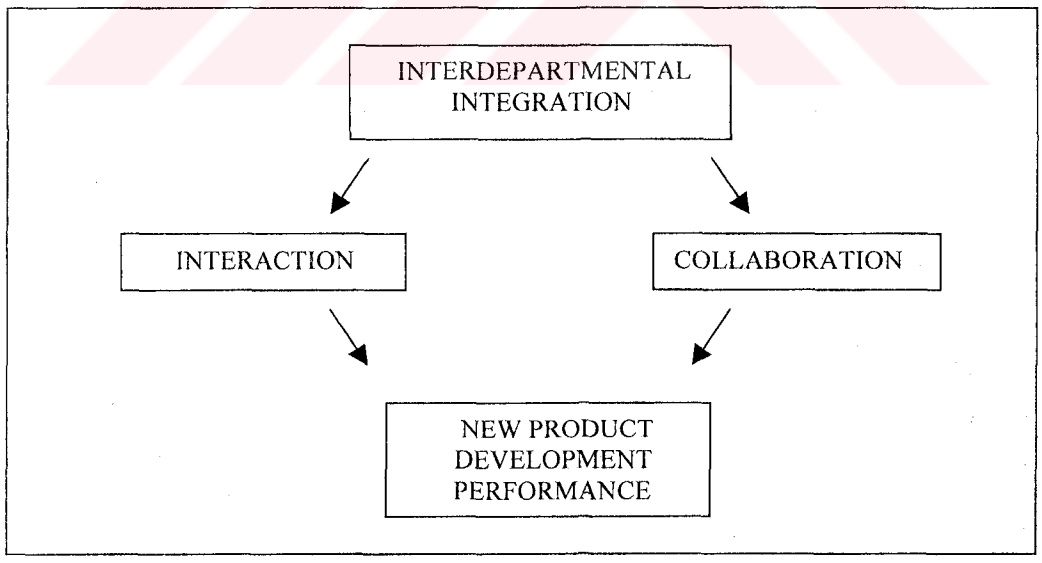

Figure 8. Conceptual framework for interdepartmental integration introduced by Kahn (1996).

Holland and et al. (1998) consider meetings, committees, telephone calls, e-mail transfer, standard forms, memos and reports and fax usage as *interaction activities,* and collective goals, mutual understanding, informal activity, shared resources, common vision and *esprit de corps*[14] as *collaboration activities.*

Jasawalla and Sashittal draw attention to the inadequacy of this framework and add cross-functional linkages between interdepartmental integration and new product development process (Figure 9). According to them, interaction and collaboration are not sufficient for new product development performance and several team conditions should be met concerning cross-functional linkages.

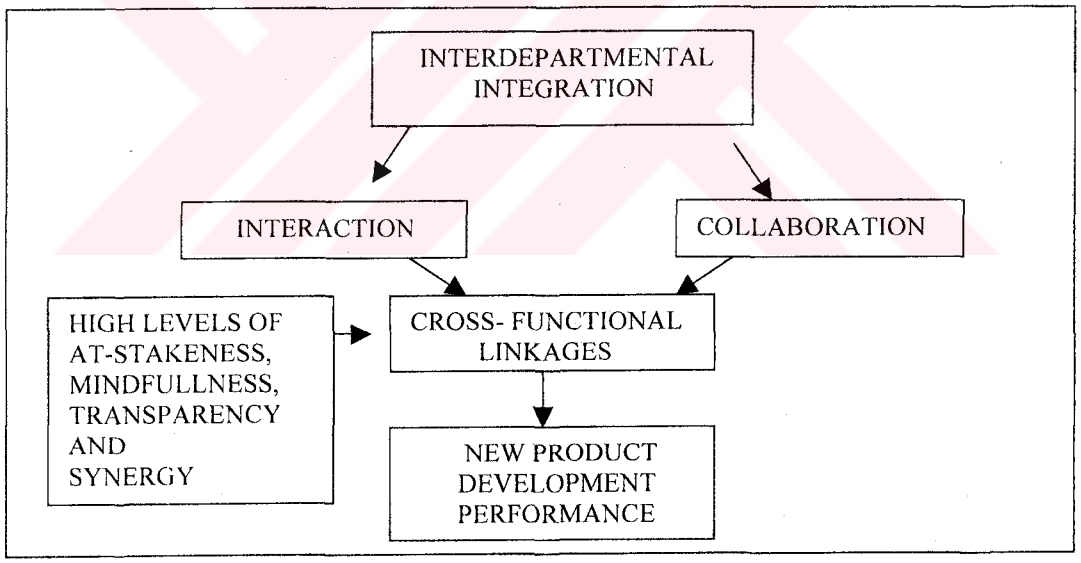

Figure 9. Jasawalla and Sahsittal's interpretation of interdepartmental integration (1998).

[13] Inter-departmental Integration Concept: High levels of interaction, coordination of activities and cooperation and development of shared vision.
[14] *Esprit de Corps* is best described as a sense of pride in belonging to a unit. It is built on the foundations of morale and discipline.

Cross-functional linkages are shaped by four conditions mainly: at-stakeness, mindfulness, transparency and synergy. However, for the success of cross-functional linkages the conditions should be performed at high levels.

Jasawalla and Sashittal describe at-stakeness as a condition where participants have equitable interests in implementing jointly developed agendas and feel equal stake in new product development related outcomes, which leads to common goals for team members. These goals are personal, and/or for the benefit of the organization and its strategy.

Transparency defines a condition of high awareness achieved by intense communication - which requires exchange of hard-data that increases motivation and makes the agenda and conditions explicit for all participants. Hard-data refers to information that people with opposing orientations and points of view can accept as valid descriptions of situations and events (Jasawalla and Sahsittal, 1998). These descriptions are divided into two groups: a) formal and technical data for the organizational task, and b) communication of participants to express their ideas and acceptances.

Transparency has a strong relation with *mindfulness* where new product development decisions and participants' actions reflect an integrated understanding of the extent and often-divergent motivations, agendas and constraints that exist all the time (Jasawalla and Sashittal, 1998). This condition has also an impact on the effectiveness of agreement process where all ideas

should be taken into account and evaluated equally. *Synergy*[15] concept involves the idea that the total outcome of a collective work is more than individual efforts.

3.2.2 Dynamics of cross-functional linkages

Cross-functional linkages are shaped by environmental forces which can be examined under two sub-topics: Macro-environmental forces and micro-environmental forces (Jasawalla and Sashittal, 1998).

Macro-environmental forces involve the impact of the organization. According to Jasawalla and Sahsittal (a) priority of new product development within the organization, (b) decentralization of new product decisions, and (c) nature of leadership have great impact on macro-environmental forces. Donnellon groups these three items as "organization design" and adds culture of the organization, training system, report system, and reward system to macro-environmental forces.

In terms of micro-environmental forces, both authors study the impact of participants: Propensity to change, propensity to cooperate, level of trust and managerial initiatives are listed as the forces that shape the structure of cross-functional linkages.

[15] A Latin originated word with the combination of *syn* (with, together)+ *ergon* (working).

According the Jasawalla and Sashittal, both macro and micro forces affect the selection of any structural mechanism (such as team, functional diversity) that fits the organization. Donnellon, on the other hand, focuses on the effects of these forces on selected structural mechanisms. She claims that these forces do not only effect selection but also have direct impact on team dynamics.

Cross-functional teams are offered as one of the structural mechanisms in this context. The definitions of cross-functional teams reflect the effects of both macro and micro forces in team formation.

3.2.3 Definitions of cross-functional teams

The definitions of cross-functional teams are usually similar in terms of cross-functional linkages but they differ in terms of application and expectations.

According to Ancona and Caldwell (1992) "cross-functional teams consist of members of different departments and disciplines who are brought together under one manner and given the charge to make development decisions and enlist support for them throughout the organization." This definition emphasizes the support from managerial staff and the temporary nature of the cross-functional teams.

Holland et al. (1998) define a cross-functional team "as a group of people who apply different skills, with high degree of interdependence, to ensure the effective

delivery of a common organizational objective." Holland et al. do not only limit the variety of participants to their disciplines or functions but also to their skills. The term "interdependence" is mentioned as a critical point in team formation.

According to Wheelright and Clark (1992), the variety of participants is defined as "the extent in the talents of everyone from design engineers to salesmen on the development, manufacture and marketing of a new product." Smart (2000) emphasizes not only different backgrounds but also different levels of expertise, experiences, and participants' views in the participation process, and describes this fruitful combination as the superiority of cross-functional teams in comparison over other teams.

Kahn and McDonoughs' view focuses on interaction, information exchange, and co-location base (1997). Although this view does not cover the characteristics of team participants, it draws attention to the importance of communication and co-location in cross-functional teams. Co-location involves the physical separation (e.g. a separate operation room for the team) of team members from their original functional location.

Song et al. (1998) understand cross-functional teams as joint involvement of R&D, manufacturing, and marketing personnel who increase the quality, the manufacturability, and the marketability of the final product.

According to Horton (2000), a cross-functional team "is a team that produces goods, services or bodies of knowledge that are more valuable than those that could be produced if they worked alone." Horton mentions the *synergy* and *value* as the final output. In his view, the value is economic and cultural, and cultural value can help organizational learning to create synergy.

Katzenbach and Smith (1993) offer a general definition of teams, which also affects the definition of cross-functional teams. A team:

- Is small enough in number (usually less than 20),
- Has adequate levels of complementary skills,
- Has truly meaningful team purpose,
- Has a specific goal and goals,
- Has a clear working approach.

However cross-functional teams are different from conventional teams. According to Donnellon, variety and interdependence are the main factors that make cross-functional teams unique. Holland et al. (2000) define properties of cross-functional teams as follows:

> Firstly, cross-functional team members usually have competing social identities and loyalties. Since teams generate their own identities and loyalties, this can create conflicts for team members. Secondly, cross-functional teams are often temporary task teams undergoing significant

pressure and conflict. Thirdly, such teams often face high performance expectations, with aspirational goals of compressing development items, creating knowledge and enhancing organizational learning.

These properties can be seen as advantageous but there are some obstacles for cross-functional teams. Conflicting team goals and functional priorities are the basic reasons underlying the following obstacles:

- Lack of time,
- No clear definition of authority,
- Lack of cooperation,
- No clear direction or priorities,
- Conflicting personal goals,
- Overlapping responsibilities,
- Competing for resources,
- Conflicting organizational goals.

3.3 BENEFITS ATTRIBUTED TO CROSS-FUNCTIONAL TEAMS

Although many difficulties are faced in practice in industrial organizations, various benefits of cross-functional teams have been shown by the empirical studies. These benefits can be grouped under eight headings:

1. Cross-Functional Teams Increase Speed

Cross-functional team members share the same physical environment, which leads to intense interaction and healthy feedback loops. According to Trott, this shortens the process time (1998). Cross-functional teams are preferred since they provide a more faster process than traditional models (Whellright and Clark, 1992). Cross-functional teams need time for formation and becoming ripe, but this should not be perceived as a loss of time. Spending this time in an efficient way turns out to be an advantage for "real" teamwork.

2. Cross-Functional Teams Improve Ability to Handle Complexity

The emphasis on cross-functional teams reflects the growing complexity of today's work; no single individual or job function can process sufficient knowledge or skill for developing or maintaining innovative products or services (Smart, 2000). For example cross-functional teams are used to overcome the complexity in Japanese products (Whellright and Clark, 1992). According to Song et al. (1998), cross-functional team structures are particularly recommended as an effective way to improve complex new product development processes. Donnellon emphasizes that interdependency –which is one of the critical aspects of cross-functional teams– is necessary to overcome the difficulties in complex product design. The concept of synergy further supports the relevance of cross-functional teams in complex product development.

3. Cross-Functional Teams Foster an Entrepreneurial Culture

The work atmosphere created by cross-functional teams supports an entrepreneurial culture. Since cross-functional teams are less hierarchical, they enhance the entrepreneurial culture.

4. Cross-Functional Teams Allow the Integration of Customer Focus into the Process

The structure of cross-functional teams supports the variety of the members. Besides the members of an organization, people from outside the organization (e.g. suppliers, distributors, and customers) can also join the team. As an example, Motorola successfully used outside members while developing the Bravo Pager (Whellright and Clark, 1992).

5. Cross-Functional Teams Enhance Product Quality and Creativity

Cross-functional teams increase the *quality of new products*[16] in organizations which adopt the structure of cross-functional teams (Katzenbach and Smith, 1993; Cordero et all, 1998).

[16] "The establishment and specification of the necessary cost-quality, performance-quality, safety-quality and reliability-quality for the product required for the intended customer satisfaction, including the elimination or location of possible sources of quality troubles before the start of production"(Walsh et al., 1992).

Truly innovative teams have to be formed outside the corporate hierarchy and cross-functional team structure supports this approach. For example, in order to create an environment away from bureaucracy and to enhance creativity, the managerial hierarchy has not been imported to cross-functional teams working at General Motors (Wheelright and Clark, 1992).

In the literature, there are some conflicting results concerning cross-functional teams and new product development performance. According to McDonough (2000), conflicting results may stem from the organizational context within which cross-functional teams operate, including the size of the firm and the industry, or they may stem from the internal structure of the firm using cross-functional teams.

6. Cross-Functional Teams Enhance Employee Motivation

Cross-functional teams enhance responsibility and commitment for the team members; productivity increases due to high levels of involvement, commitment, motivation and subsequent accountability among participants (Smart, 2000). According to Donnellon (1996) these factors are related with job satisfaction. Empirical studies also show that co-location is correlated with job satisfaction; cross-functional teamwork is positively linked to the quality of work life[17] : *job outcomes* which means job growth, job security, membership in successful teams,

[17] Quality of work life: Perception of well-being at work.

and *job demand* which eliminates time pressure and coordinated effort (Kahn, 1996).

7. Cross-Functional Teams Enhance Quality of Communication

The case study by Kahn and McDonough shows that in cross-functional teams, the quantity of communication between personnel remains the same while the quality of communication increases. Smart emphasizes the lateral structure in cross-functional teams, which forms an effective infrastructure for sharing information among members from different hierarchical levels in the organization.

3.4 EFFECTIVENESS IN CROSS-FUNCTIONAL TEAMS

Based on Cohen and Bailey's Heuristic Model, Holland et al. (1998) propose a model for the effectiveness in cross-functional teams (Figure 10).

In Figure 10, each group of factors is in direct and/or indirect relation with the others, and these connections are created and carried by communication patterns. Task design, group composition, organizational context and environmental factors can be seen as macro factors whereas group psychosocial traits, internal and external processes as micro factors.

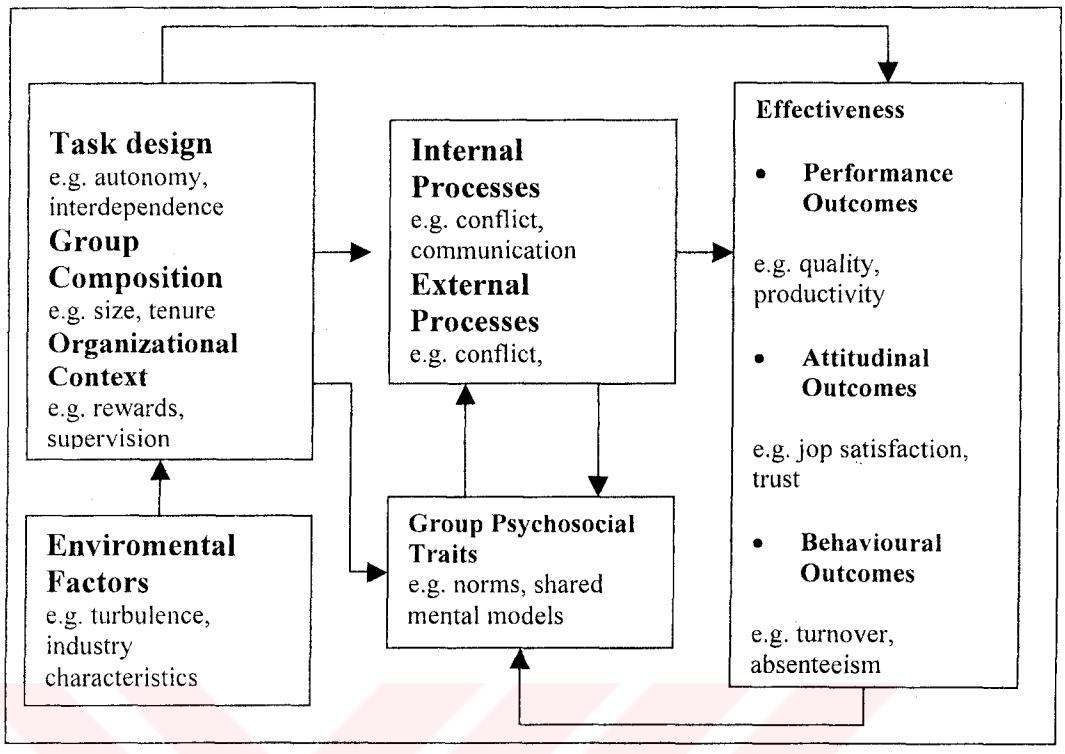

Figure10. A model for cross-functional team effectiveness. Source: Holland et al. (1998).

The factors in the effectiveness of cross-functional teams can be summarized under five main headings (Weiss, 1993; Donnellon, 1996): Authority, dependence, agreement, argument, and communication. In Figure 10, authority can be located at task design and dependence, agreement, argument and communication considered as internal processes and group psychosocial traits.

Among these five basic factors proposed by Donnellon (1996) and Weiss (1993), communication plays a significant role in cross-functional teams and it affects the other four factors. The following chapter will focus on the role of communication in the formation and success of the team, and the ways in which it affects the four other factors.

CHAPTER 4

INTERNAL COMMUNICATION IN CROSS-FUNCTIONAL TEAMS

4.1 COMMUNICATION IN INDUSTRIAL ORGANIZATIONS

Industrial organizations need communication in order to conduct activities that satisfy human needs and want by providing goods and services for private profit (Reinsch, 1996). This effort mainly consists of coding (use, adaptation and creation of languages, symbols and signs) of experiences and information. For industrial organizations communication is vital because lack of communication causes:

- Waste of time and resources,
- Worse business relations,
- Slowness in skill development,
- Loss of motivation,
- Loss of flexibility,
- Slowness in problem solving (Roebuck, 1998).

Most of the errors in communication occur during planning and transmitting the message. Message transmission has three phases:

1- Preparation of the message,

2- Transmission of the message,

3- Confirmation of accurate transmission (Locker, 1995).

In the first phase, preparation of the message, the sender has to check his message to eliminate misunderstandings. Although not all messages cover all the answers for "what, why, when, how, where and who" questions, a message should cover what the transmitter expects it to transmit. The transmission of a message consists of five steps: coding, transfer, channels, perceive, decoding (Figure 11). Confirmation of accurate transmission is obtained by feedback where the receiver becomes a transmitter.

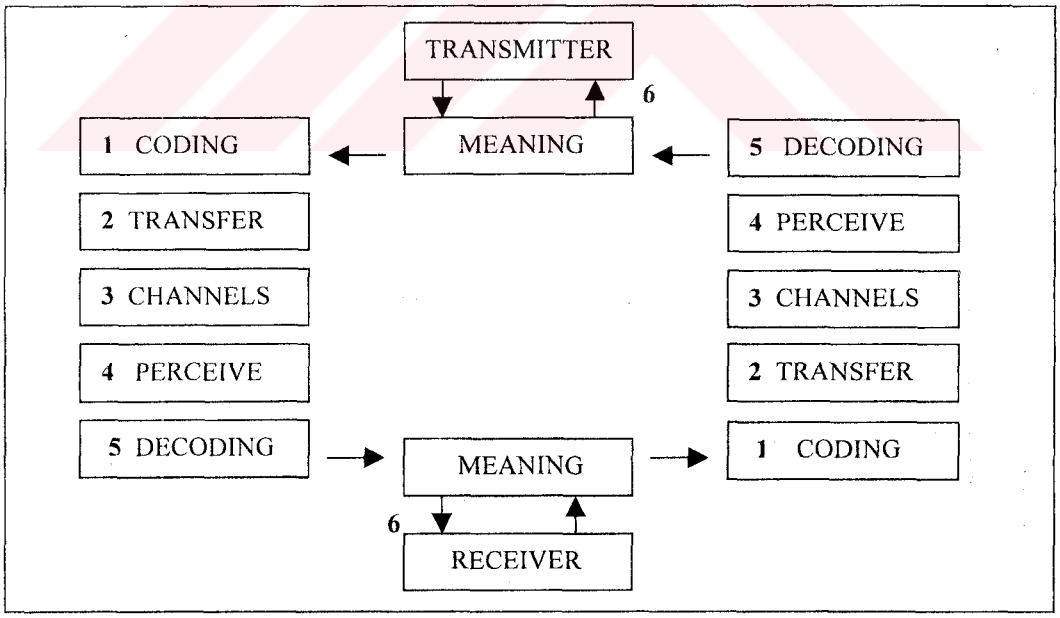

Figure 11. Communication Mechanism (Roebuck, 1998).

The loop in Figure 11 has certain characteristics. The transmitter becomes receiver and the receiver becomes transmitter during the communication. The same mechanism exists in cross-functional team communication(Holland et all,2000).

4.2 ORGANIZATIONAL STRUCTURE AND COMMUNICATION IN TEAMS

According to Wood (1999) good communication is essential to any well-run teamwork and organization. Team communication is highly dependent on organizational structure the team acts in. Organizational structure may limit opportunities or offer new possibilities for teams.

Communication performance in teams is related with organizational culture. According to Donnellon (1996), communication is essential for team activities (and team dynamics), and problems occur in team communication when the organizational culture does not support the team structure and the communication requirements for high-performance. Report system, managerial roles, performance and reward system, and organizational culture are the critical factors for reaching high-performance in teams. For high-performance, teams have to overcome organizational limitations. However this is not an easy task for the teams which act in conservative and rigid organizational structures. As mentioned before, team approach in new product development needs great amount of organizational change and flexibility.

4.3 COMMUNICATION IN CROSS-FUNCTIONAL TEAMS

As mentioned in the previous chapter functional diversity and interdependence are the basic characteristics of cross-functional teams. Cross-functional teams are based on functional diversity, and functional diversity has a positive effect on team performance. However it may have negative effects on performance if team members do not appreciate functional diversity (Ancona and Caldwell, 1990). Furthermore according to Lovelance et al. (2001) " The greater conflict in heterogeneous, rather than homogenous, groups is often due to the difficulty that people have in understanding each other when their backgrounds are diverse."

As mentioned in the previous chapter, communication is the most important factor for effectiveness in cross-functional teams. According to Johannessen et al. "Genuine internal communication is a precondition for the success of the teams and it is important to realize that the team's relationships have a history which can help or impede effectiveness"(1998). Similarly, Horton (2000) indicates that the best way to increase effectiveness in cross-functional teams is to develop techniques for communicating better. Also Perry (1998) states that cross-functional teams face some communication problems in a rigid organizational culture but social and organizational interactions are the basic and key factors to eliminate difficulties in joint work.

Leadership style. Since teams may carry past organizational structure and

experiences into teams' inner-structure, authority in teams may become an organizational limitation. The leadership style within the organization may affect team formation. For example, former hierarchical positions of members may be repeated in team formation. Certainly this is not an ideal situation for team performance and team communication because it creates a hierarchical and vertical communication structure. To eliminate this problem the leadership position in the team should be perceived as an *enabler* position. Enabler position allows a more democratic leadership style than the authoritarian one, and the members feel themselves freer to express their ideas.

Dependence and Trust. According to Cross and Clayburn (1995) "Working as a member of a team introduces different problems and possibilities for the member, in comparison with working alone. Some of the areas of difference can be surmised from the practical necessities of the situation such as the need to communicate with the other members of the team." This view is highly related with the interdependence concept which implies that the members have to work together and trust each other. Shaw (1997) introduces trust as a central factor for organizational success: "Under today's successful, rapidly shifting conditions, trust is more elusive and more essential – than ever. A solid formation of trust best enables high-performance companies and teams to adopt to changing circumstances and to deliver hard business results." Under competitive global market conditions – forcing organizations to empower individuals and teams, to

focus on cross-functional collaboration and horizontal business processes, which require intense interaction– the role of trust is getting more vital.

Shaw (1997) defines three imperatives for trust (Figure 12) which reflect the key points for the interdependence concept: Achieving results, demonstrating concern and acting with integrity.

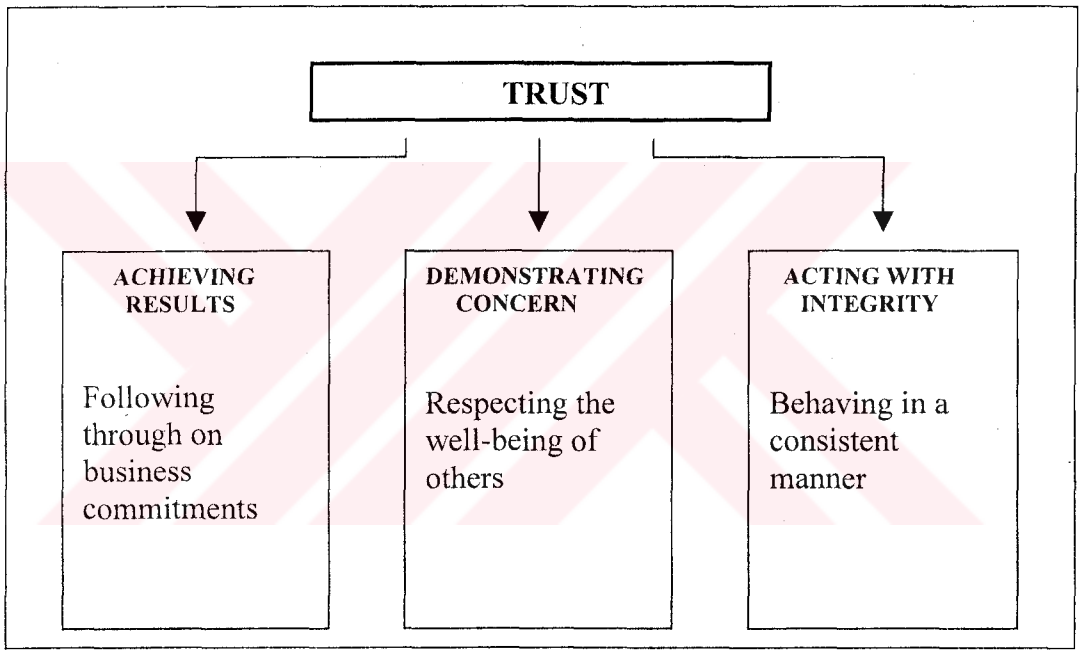

Figure 12. Trust imperatives (Shaw, 1997).

4.4 TYPES OF COMMUNICATION IN CROS-FUNCTIONAL TEAMS

Communication in cross-functional teams differs in structure, context and application. It has two basic dimensions: External team communication, internal team communication. This study focuses on internal team communication in

particular but it is inevitable to clarify external communication to understand its effects on internal team communication.

External team communication is the communication of the team with the organization. It is based on report system, and organized by the team leader or enabler of the team. In matrix-structured teams, or in cross-functional teams without a charged team leader it is the members who carry the communication with the organization. External team communication is a continuous process; its objective changes at different phases of the teamwork.

Internal team communication is the communication *between* team members during the teamwork. Locker (1995) defines three types of messages involved in internal communication:

1- Informational messages focus on content: The problem, data, and possible solutions.

2- Procedural messages focus on method and process: Who will do what, and how will the group make decisions.

3- Interpersonal messages focus on people: Promoting friendliness, cooperation and group loyalty.

These messages are carried through communication channels and these channels are built in accordance with various team purposes. Verbal and written

communication channels are the most common ones among these. The differences between verbal and written channels are shown in Table 4.

Table 4. Comparison of verbal and written communication (Roebuck, 1998).

VERBAL-FULLY VERBAL	VERBAL- FACE TO FACE	WRITTEN
ADVANTAGE	**ADVANTAGE**	**ADVANTAGE**
- SPEED - FLEXIBILITY - DELIVERY UNDER THE CONTROL OF TRANSMITTER - ENABLES INSTANT ANSWER	- MORE PERSONAL AND MOTIVATING - MIMICS	- RECORDING - ENABLES REPEATING - SUITABLE FOR COMPLEX MESSAGES - ALLOWS PROCESS TIME
DISADVANTAGE	**DISADVANTAGE**	**DISADVANTAGE**
- CAN BE FORGOTTEN	- NO RECORDING - CAN BE COMPLEX IF IT IS LONG	- LOSS OF TIME - LATE RESPONSE

Concerning cross-functional *design* teams, design artifacts should be mentioned as additional communication channels. The members in design teams use free-hand sketches, mock-ups, three dimensional models and digital models as well as verbal and written communication channels. These artifacts can be considered as part of the professional jargon and they play a vital role in developing design projects. According to Perry (1998), design works depend on communication and design artifacts are the objects of interaction and part of communicative resource.

4.5 THE STRUCTURE OF INTERNAL COMMUNICATION IN CROSS-FUNCTIONAL TEAMS

Every participant in the team brings his or her past experiences into teamwork. Sonnenwald (1996) notes that these experiences consist of specialized work language, differences in work pattern, perceptions of quality and success, organizational priorities, and technical constrains. Team participants need to explore and integrate these differences in design process to create new artifacts, new experiences and new knowledge. This process is facilitated by a communication loop described in Figure 13.

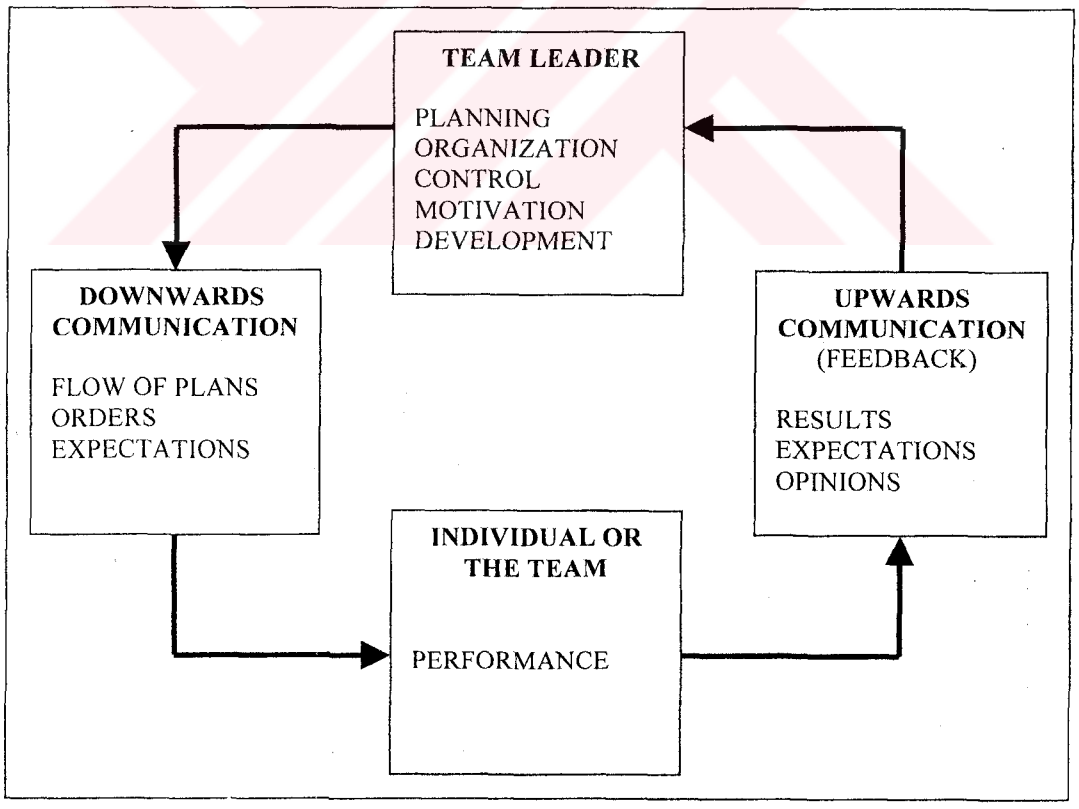

Figure 13. Loop or internal communication in cross-functional teams (Roebuck, 1998).

The most important characteristic of this loop is that it encourages a two-way communication within the team. Feedback mechanism allows each member to participate in teamwork and express his or her ideas during the process. Roebuck draws attention to some feedback problems that may occur in teamwork (1998):

1- No condition for feedback,

2- Fear of unserious evaluation,

3- Fear of contradiction.

According to Moenaert et al. feedback problems occur when the transmitter is not able or unwilling to transmit the information, or the information is not perceived as valuable. They mention three effectiveness requirements for team communication structure (2000):

1- Transparency of communication network: Because of functional diversity and the nature of industrial design activity, cross-functional design teams may have difficulties in creating clear and accessible information.

2- Knowledge codification: It causes problems in cross-functional design teams because tacit knowledge[18] is difficult to codify.

3- Knowledge credibility: This issue is related with trust between team members.

[18] Tacit knowledge entails information that is difficult to express, formalize, or share. It stands in contrast to explicit knowledge, which is conscious and can be put into words. An individual experiences tacit knowledge as intuition, rather than as a body of facts or instruction sets he is conscious of having and can explain to others. Tacit knowledge is "knowing how" while explicit knowledge is "knowing that."(Lubit,2001).

Knutson (1985) notes that different kinds of communication activities dominate different stages of the life of a task group (Table 5).

Table 5. Communication activities and phases of group development (Knutson, 1985).

Phase	Events	Communication Activities
Orientation	Group meets. Members decide how to relate to each other. Group tries to define tasks.	Members make tentative comments, and seek information. Members agree more with each other than in any other phase.
Formation	Members begin to specialize. Leader emerges. Group develops a strategy, its objectives, and procedures to meet goals.	Conflict emerges as leader and strategy are chosen. Positions are stated clearly; ambiguity decreases. Members argue with each other.
Coordination	Group finds, organizes, and interprets information; examines its assumptions. Group considers alternatives but no one advocates a specific conclusion.	Information flows freely but prompts questions, trial interpretations and solutions. Comments include diagnosis, explanation, and substantiation. Conflict is accepted as part of the effort .
Formalization	Group makes and formalizes decision.	Members compliment and congratulate each other.

As mentioned before, Locker (1995) defines several message types. In the *orientation* stage team focuses on interpersonal and procedural messages than informational ones. While developing strategy in the *formation* stage team uses informational messages. Leader is chosen by procedural messages. Conflicts may happen but interpersonal messages solve these conflicts. In the *coordination* stage, the members can use messages of all kinds. Procedural and interpersonal messages are needed in the *formalization* stage.

4.6 CONFLICTS IN INTERNAL COMMUNICATION

During internal communication process it is normal to experience conflicts and arguments. However teams have to reach a consensus to complete the task. Arguments are inevitable but the important point is to control and coordinate them. According to Pinto and Pinto (1993), spending time to solve conflicts has a negative effect on team efficiency. However organizations may spend time on introducing less control and less concentration of power into their structure. Johannessen et al. focus on the potential of cross-functional teams:

> Cross-functional teams will overcome conflicts of interest between departments, lack of integrated information and fragmented decision making. In order to build such teams, the focus has to be the relationships on which they are based. Teams will have a synergy which has a potential to release the creative tension in the organization and to translate the vision into substantive action. Increased sensitivity toward the process and greater familiarity with the overall situation will lead to increased knowledge of the process and vice

versa. In turn this will lead to increased experience and thence to opportunities for increased intra-team communication (1998).

Communication between different members of a design team is a notoriously difficult problem, especially at the early stages of design process (Eckert et al., 2000). Most of the conflicts occur at the concept step. Different interpretations or understandings of the problem may become evident; different members of the team may favor different design concepts. An inevitable part of design teamwork therefore, seems to be identifying, avoiding and resolving conflicts (Cross and Clayburn, 1995).

According to Donnellon (1996), tension in teams can be examined at three levels: Member, team and organization. At the member level, seven conditions create team dynamics: Identity, interdependence, authority, diversity, social proximity, argument and agreement. These dynamics originate from members' values, motives and skills. Most of the tensions between members arise when the members use these dynamics for self-interest.

Macro factors may affect conflicts within a team. For example, if the organizational structure is functional based, identity crises may become deep. An individual-performance-focused reward system increases the possibility of destructive argument within a team (Donnellon, 1996).

Informal social networks play a productive role in solving conflict and tension between members (Holland et al, 2000). In interpersonal communication (communication between members) hearing denotes perceiving sounds, and listening means decoding. Many conflicts between members happen because the transmitter estimates that listening is enough for complete communication. Acknowledgement responses – nods, uh huh`s, smiles, frowns – help carry the message that is delivered (Locker, 1995).

Communication atmosphere in teams also affects agreement process concerning the team tasks. According to Lovelance et al. (2001) there are two factors that affect task disagreement:

1- How free members feel to express task related doubts,

2- How collaboratively or contentiously these doubts are expressed.

Some steps in conflict resolution are offered in the literature. According to Locker (1995) steps in conflict resolution are:

1- Being sure that the members involved really disagree,

2- Checking to see that everyone's information is correct,

3- Discovering the needs each person is trying to meet,

4- Searching for alternatives.

Roebuck (1998) proposes systematic briefings to eliminate conflicts and develop internal communication. Baltaş (2001) states that conflict resolution is member

dependent; he defines four kinds of characters: Avoider, competitive, arrogant, cooperative (Figure 13).

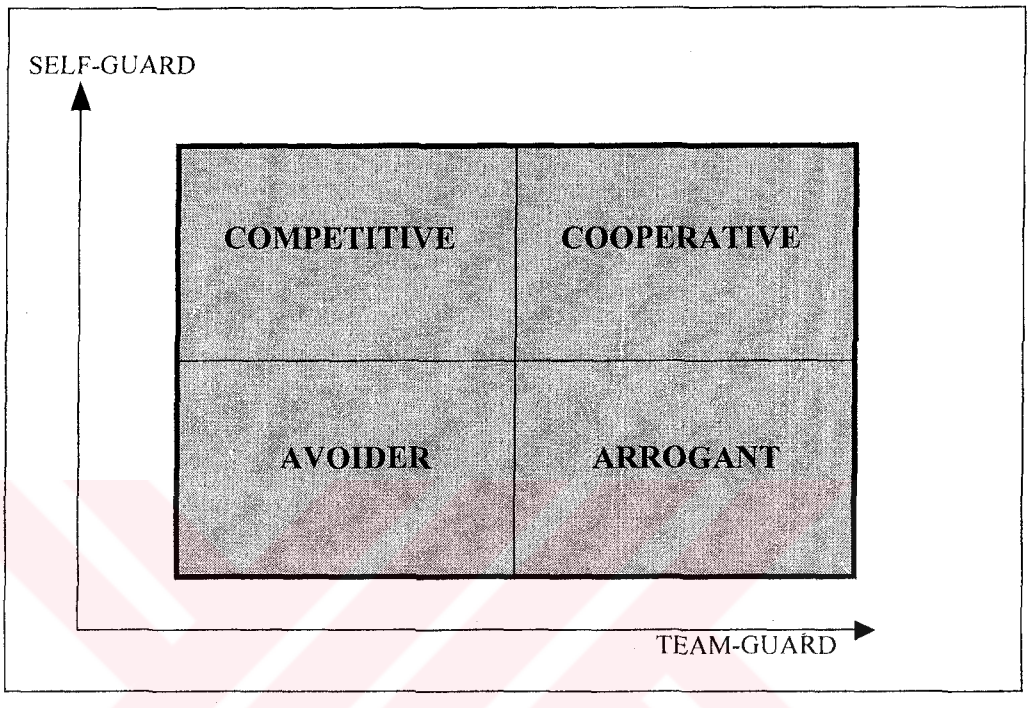

Figure 14. Different kinds of characters within a team (Baltaş, 2001).

The team roles that emerge during the design process can be recognized by observing communication behavior among participants (Sonnenwald, 1996). Roles are relative to each other; each member can be charged to a role or members` roles may change during the teamwork (Cross and Clayburn, 1995).

4.7 ROLES IN CROSS-FUNCTIONAL DESIGN TEAMS

Team members play different roles in teamwork. These roles can be positive or

negative. The roles are mostly performed through verbal communication and they are either mission or process dependent. Cross-functional *design* teams generate additional kinds of roles related with producing design artifacts such as sketches and models.

4.7.1 Positive Roles

Positive roles help the group built loyalty, achieve its task goals, resolve conflicts, and function smoothly (Locker, 1995):

- *Seeking information and opinions*: Asking questions, identifying gaps in group knowledge.
- *Giving information and opinions*: Answering questions, providing relevant information.
- *Summarizing*: Restating major points, pulling ideas together, summarizing decisions.
- *Evaluating*: Comparing group decisions and working toward standards and goals.
- *Coordinating*: Planning work, giving directions, and fitting together contributions of group members.
- *Encouraging participation*: Demonstrating openness and acceptance, recognizing the contributions of members, calling on quieter group members.
- *Relieving tensions*: Joking and suggesting breaks and fun activities.

- *Checking feelings*: Asking members how they feel about group activities and sharing one's own feelings with others.

- *Solving interpersonal problems*: opening discussion of interpersonal problems in the group and suggesting ways to solve them.

- *Listening actively:* Showing group members that they have been heard and that their ideas are being taken seriously.

4.7.2 Negative Roles

Negative roles and actions hurt the group and the process (Locker, 1995):

- *Blocking:* Disagreeing with everything that is proposed.

- *Dominating:* Trying to run the group by ordering, shutting out others, and insisting on one's own way.

- *Playboy-Clowning:* Making unproductive jokes and diverting the group from the task.

- *Withdrawing:* Being silent in meetings, not contributing, not helping with the work, and not attending meetings.

4.7.3 Design Dependent Roles

Design dependent roles are action based and related with producing design artifacts. Producing quality design artifacts requires special skills.

- *Drawings*: Sketches, technical drawings, diagrams.
- *Mock-ups and three-dimensional (3D) Models:* 3D visualization of ideas.
- *Digital Models:* Digital drawings and models.

In order to study the internal communication issues in cross-functional design teams that were identified in the literature survey, a case study was conducted in an educational context. The next chapter describes the methodology and the findings of this case study.

CHAPTER 5

CASE STUDY

5.1 INTRODUCTION

Teamwork in different fields is emphasized intensively in the literature. Its importance has also been increased in industrial design practice but the empirical studies are very rare. Teamwork in design needs to be supported by empirical studies because of its complex structure. The complexity of design task itself and some of the individual factors create a complicated set of problems for design teams. Even each design task and each team has unique dynamics and behavior; it is difficult to make generalization that fit all cases. Case studies concerning team behavior in design process can help researchers to find out the most important points in teamwork. The major dynamic for empirical studies on teams is theory-based. Although it can be seen, the best way to combine the experiences and different disciplines, in practice too much teamwork is failed at the end. Empirical studies can help researchers to understand team structure and reduce the rate of failure in future teamwork practice. During this research a set of case studies was planned to understand inner-structure of teams. The inner-structure of a team consists of a group of variables. As mentioned before, internal communication

structure is one of these variables. So, once the inner-structure of a team is defined, it is possible to find some data about internal communication.

5.2 METHODOLOGY

In this study, case study is preferred in order to examine the literature findings at near in a realistic environment. Yin has described the usefulness of the case study method as a research tool (1992). Similarly, Harrison indicates that the ability to understand a concept is not enough without a practical application of it (1990). There is not a precise definition of case studies because practices already conducted for case study in many disciplines. However Yin (1992) defines a case study "....is an empirical inquiry that investigates a contemporary phenomenon with its real-life context when the boundaries between phenomenon and context are not clearly evident; and in which multiple sources of evidence is used." Harrison (1990) describes the case study as an extensive examination of some single unit such as a person, school, school district, community or even an event.

After reviewing the literature, first, the researcher defined the key design components for formulating the case study. Second, multiple types of data collection techniques is favored in the application to reduce variables that are out of interest. Third the data is analyzed either as quantitative or qualitative according to its type. Lastly results and conclusions are determined.

5.2.1 THE CONTEXT OF CASE STUDY

The case study was conducted in the Graduate Program of the Department of Industrial Design at the Middle East Technical University. The Middle East Technical University Department of Industrial Design has been offering a Master of Science Program for the last four years. The Master of Science in Industrial Design focuses on the multi-disciplinary character of the field of industrial design, and accepts graduates from various disciplines that include engineering, marketing, management, architecture, interior and graphic design as well as industrial design.

The graduates of the disciplines other than industrial design are required to follow a deficiency program to make them understand the nature of industrial design activity. When they complete the deficiency program the students take some obligatory graduate courses as well as elective courses.

ID501 Advanced Project Development in Industrial Design is a must course with 6 credits which has dominancy on other graduate courses. It is an application-oriented course with a specific emphasis on exploring new methods, new approaches and new problem areas in the cross-disciplinary area of industrial design.

There were several motives for the researcher to conduct the case study in the Graduate program. The main reason was the members of the course were fulfilling the requirements of the cross-functional team structure that is defined previously by the researcher. As shown in Table 6 graduate students had different backgrounds and work experience.

The Graduate program was also different from real professional practice within an industrial organization. Firstly, there was a defined grading system at the end of the term (see Appendix A: Design Brief I), which can be accepted as reward and punishment system. The grading was based on teamwork performance, attendance, assignments, and jury presentations.

Second, there is no formal hierarchical structure. There was a research assistant in one team and some have seniors from different jobs in industry but they are accepted at the same hierarchical level.

Third, students faced new team members in design team formulation. Industrial design graduates were able to work in team formulation during their undergraduate practice but in this course they were in different kind of teams.

Fourth, the team formulation was conscious and based on cross-functional structure which involved students from different backgrounds with different experiences.

Fifth, there were four teams, and every team focused on the same design project in the same defined time limitations, which help researcher to compare teams' inner-structures.

And finally, even there were defined course sessions; teams could also work at different days and weekends without strictly defined working hours.

5.2.2 PARTICIPANTS AND TEAMS

Participants were invited to take part in this case study as part of their course curriculum.

There were 15 students and the gender ratio was 10 female to 5 male. The average age of the participants was 25 years. The backgrounds, the university that they graduated and the current jobs of the participants are given in Table 6.

During the case study the participants are examined in two groups. The first group consists of industrial designers and is called "design background" students. The second group consists of the graduates of disciplines other than industrial design and is called "non-design background" students.

Table 6. Background and Current Job Distribution. The data represented here was obtained at the beginning of the case study.

Industrial designer	Reserch assistant in design department	METU
Industrial designer	Own shoe workshop	METU
Industrial designer	Works as graphic designer in METU	METU
Industrial designer	No Job	METU
Mechanical engineer	Works at ceramic sector	METU
Economician	No Job	BILKENT
Mining engineer	No Job	METU
Interior Architectect	Works in a furniture firm	BILKENT
Electric Engineer	Works as an academician	METU
City Planner	No Job	METU
Matematician	Research Assistant in Mathemtatics Dept.	METU
Petroleum Engineer	No Job	METU
Interior Architect	No Job	BILKENT
Mechanical Engineer	Works in medical sector	METU
Statistictian	Works as textile designer	ANKARA

The students were required to form design teams voluntarily at the beginning of the course and the principle of the formulation was to distribute the backgrounds equally to each team. In each team there ought to be at least one industrial designer. Participants were divided into four teams as required in the project brief. Each team gave a name to themselves:

The team "Quatro" comprised four members (an industrial designer, a mechanical engineer, an economist, and a mining engineer). The gender ratio was 3 male/ 1 female and the average age was 25.

The team "Woodpecker" comprised three members (an industrial designer, an interior architect and an electrical engineer). The gender ratio was 1 male/2 female and the average age was 27.

The team "Zip+" comprised four members (an industrial designer, a city planner, a mathematician and a petroleum engineer). The gender ratio was 0 male / 4 female and the average age was 24.

The team "Shopping Pirates" comprised four members (an industrial designer, an interior architect, a mechanical engineer and a statistician). The gender ratio was 1 male/3 female and the average age was 25.

5.2.3 DATA COLLECTION

At the beginning of the case study, the researcher clarified the aim of the study and took permission from the lecturer and the students to collect data. In accordance with this perspective a 360-minute video recording of all four teams was taken during their design tasks to cover permanent team behaviors, one first questionnaire was conducted during the formal course process as well as personal observations of the researcher. Second questionnaire was applied after another individual project completed by the students. The plan of the whole application is shown in Table 7.

5.2.4 THE PHYSICAL ENVIRONMENT

All four teams worked in the same room. The ` Master Room` (an anonymous name that have given by students and institution) had enough tables and chairs which were grouped for each team, had two computers connected to local network

and internet with 3D Modeling software that was installed, and had a white board, the markers and panels that were attached to the walls to hang the concept memos and presentations.

The working conditions are examined by the first questionnaire to find out ideal physical conditions to complete design tasks in team formulation.

5.2.5 PROJECT AND PROJECT SCHEDULE

As written in the project brief I the project focused on user and product interaction. In the first step of the project, the students focused on 'relabelling technique' originated from Delft University. It was the first application of this technique in the Industrial Design Department in Middle East Technical University. Students were required to choose three mechanical objects and match the user interaction forms of chosen ones with three products that they will design. In the second step, students chose one alternative project that was presented in the preliminary jury and developed it till the final jury as the final product.

Timetable for the first step of the project is shown in the Table 8. The deadline for the final jury was 28th of February and the final jury was on April 2. The total time was 50 days with holidays and the teams spent 12-hours per week in the `Master Room`.

Table 7. Timetable of the Case Study

12 FEB Team formation and Case Study Protocol	13 FEB	14 FEB Relabelling VR - OB	15 FEB	16 FEB	17 FEB	18 FEB
19 FEB Relabelling VR	20 FEB	21 FEB Relabelling OB	22 FEB	23 FEB	24 FEB	25 FEB
26 FEB	27 FEB	28 FEB Preliminary Jury Q1	1 MARCH	2 MARCH	3 MARCH	4 MARCH
5 MARCH	6 MARCH	7 MARCH	8 MARCH	9 MARCH	10 MARCH	11 MARCH
12 MARCH VR	13 MARCH	14 MARCH OB	15 MARCH	16 MARCH	17 MARCH	18 MARCH
19 MARCH OB	20 MARCH	21 MARCH Critique VR	22 MARCH	23 MARCH	24 MARCH External Critique VR	25 MARCH
26 MARCH OB	27 MARCH	28 MARCH OB	29 MARCH	30 MARCH	31 MARCH	1 APRIL
2 APRIL Final Jury **End of case study** VR			29 MAY Individual Project Jury	30 MAY E-mail of Questionnaire Q2		

VR	Video Recording
OB	Observation
Q1	First questionnaire
Q2	Questionnaire

Table 8. Timetable for the first step of the project.

Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12 Team Formation	13	14 relabelling 1	15	16	17	18
19 relabelling 2	20	21 relabelling 3	22	23	24	25
26	27	28 April Preliminary jury				

5.3 FIRST QUESTIONNAIRE

The first questionnaire is applied just after the preliminary jury (see Table 7) and the average response time was 7 minutes. The basic aim of the first questionnaire was to evaluate the factors that affected teamwork. The questionnaire consisted of three sections. In the first section, the questions were focused on personal information such as date of birth, gender, background and current job. The second section evaluated the personal statement about the factors that affected teamwork. The third section had two open-ended questions for personal opinions.

First questionnaire was consisting of 5-point Likert type scale items. The Likert type scale was used to allow participants to select from answers that rate positive and negative to the left or to the right (Busseri and Palmer, 2000).

Before the application of the first questionnaire several pilot studies applied. The aim of these pilot studies was to develop questionnaire to be understood by all participants. The most important drive to develop questionnaire was literature findings.

5.3.1 OPINIONS ABOUT TEAM PRACTICE

The participants were asked to evaluate their opinions about teamwork practice in product design in general. The survey data indicated that the majority of the participants responded 5 'very positive' and 10 'positive' answers (Table 9). There were no neutral or negative answers.

Table 9. Opinion ratings about teamwork practice.

	Very positive	Positive	Neutral	Negative
Non-design background	3	8	0	0
Design background	2	2	0	0
Total	5	10	0	0

Table 10. Distribution of responses by design teams. Note. Teams are indicated by the first letter of their names.

	W	Q	Z	S
Very positive	2	3	3	2
Positive	1	1	1	2

5.3.2 PARTICIPANTS` OPINION ABOUT TEAM MEMBERS

The participants were asked to rate their opinions about other team members.10 of the respondent indicated that they are `very positive` about team members (Table

11). For the non-design background students `very positive ` approach was higher (8/11) than design background students (2/4). The majority in the members of team Zip+ (3/4) indicated that they are 'positive' (Table 12).

Table 11. Opinion ratings about team members.

	Very positive	Positive
Non-design background	8	3
Design background	2	2
Total	10	5

Table 12 Distribution of responses by design teams.

	W	Q	Z	S
Very positive	3	3	1	3
Positive	0	1	3	1

5.3.3 TEAM FORMATION TYPE

The participants were asked about their attitudes on team formation. For the establishment of the team structure like random type, volunteer type and size of the team, participants` responses were `positive` (8/15), `very positive`(5/15) and `neutral` (2/15) (Table 13). Team Woodpecker gave no 'very positive' answer and the totals of 'neutral' answers were given by them (Table 14).

Table 13. Opinion ratings about team formation type.

	Very Positive	Positive	Neutral
Non-design background	5	5	0
Design background	0	2	2
Total	5	8	2

Table 14. Distribution of responses by design teams.

	W	Q	Z	S
Very positive	0	1	2	2
Positive	1	3	2	2
Neutral	2	0	0	0

5.3.4 PARTICIPANTS` CONTRIBUTION

In this question participants were asked to express their opinions about the contribution of their backgrounds and experiences to the project. The responses were `neutral` (6/15), `positive` (7/15), `very positive` (2/15) (Table 15). The majority of Team Quatro indicated 'Neutral' (3/4) (Table 16).

Table 15. Opinion ratings about background and experience.

	Very Positive	Positive	Neutral
Non-design background	0	5	6
Design background	2	2	0
Total	2	7	6

Table 16. Distribution of responses by design teams.

	W	Q	Z	S
Very positive	0	0	1	1
Positive	2	1	2	2
Neutral	1	3	1	1

5.3.5 SUITABILITY OF THE PROJECT

The participants were asked to rate the degree of suitability of the project for teamwork. Majority of the respondents rated the project suitable (9/15), however two design background students rated 'not suitable' (2/15) (Table 17).

Table 17. Opinion ratings about the suitability of the project.

	Very suitable	Suitable	Normal	Not suitable
Non-design background	2	8	1	0
Design background	0	1	1	2
Total	2	9	2	2

Table 18. Distribution of responses by design teams.

	W	Q	Z	S
Very suitable	0	1	1	0
Suitable	2	2	2	3
Normal	1	0	0	1
Not Suitable	0	1	1	0

5.3.6 PHYSICAL ENVIRONMENT

The effects of physical environment variables on team performance were asked to the participants. According to the answers, the physical environment (the `Master Room`) affected the performance of the teams. 5 questions were asked to indicate the effects of physical conditions. Temperature, lighting, teams` seating requirements and interior design of the room were the variables (Table 18).

Table 19. Total responses to the physical conditions.

	Very effective	Effective	Indifferent	Not effective	Not effective at all
Temperature	7	8	0	0	0
Lighting	2	13	0	0	0
Acoustics	2	9	2	2	0
Seating	5	8	0	0	2
Interior Design	2	8	5	0	0

Table 20. Distribution of responses on 'Temperature' by design teams.

	W	Q	Z	S
Very Effective	3	2	1	1
Effective	0	2	3	3

Table 21. Distribution of responses on 'Lighting' by design teams.

	W	Q	Z	S
Very Effective	0	1	0	0
Effective	3	3	4	4

Table 22. Distribution of responses on 'Acoustics' by design teams.

	W	Q	Z	S
Very Effective	0	0	1	1
Effective	2	3	2	2
Indifferent	1	1	0	0
Not effective	0	0	1	1

Table 23. Distribution of responses on 'Seating' by design teams.

	W	Q	Z	S
Very Effective	2	1	1	1
Effective	0	2	3	3
Not Effective at all	1	1	0	0

The two 'Very Effective' responses were given by the teams, with interior designer members (Table 24).

Table 24. Distribution of responses on 'Interior Design' by design teams.

	W	Q	Z	S
Very Effective	1	0	0	1
Effective	0	3	3	2
Indifferent	2	1	1	1

5.3.7 PHYSICAL PARTICIPATION OF THE TEAM MEMBERS

The participants were asked to what extent the physical participation[19] of team members was important for the team performance. One of the strongest data in this study came when an overwhelming ratio of answers (14/15) agreed about the importance of the physical participation of the team members (Table 25).

Table 25. Opinion ratings about physical participation.

	Very important	Important
Non-design background	10	1
Design background	4	0
Total	14	1

Only 'Important' answer was given by Team Quatro which has a member who attended class from a different city (Table 26).

Table 26. Distribution of responses by design teams.

	W	Q	Z	S
Very Important	3	3	4	4
Important	0	1	0	0

5.3.8 THE IMPORTANCE OF THE INSTRUCTOR

The participants were asked to what extent the support of the instructor was important for the team performance. Many participants (11/15) in the study

[19] The term "physical participation" is used to indicate the attendance of participants to the sessions.

indicated that the course instructor was important in teamwork performance. Two of design background students indicated that the effect of support effects is indifferent for teamwork (Table 27). There was no 'Very Important' answer.

Table 27. Opinion ratings about the importance of the instructor.

	Very important	Important	At Normal Level
Non-design background	0	9	2
Design Background	0	2	2
Total	0	11	4

Table 28. Distribution of responses by design teams.

	W	Q	Z	S
Very Important	0	0	0	0
Important	2	3	3	3
At Normal Level	1	1	1	1

5.3.9 THE IMPORTANCE OF TEAM MOTIVATION IN TEAM PERFORMANCE

The participants were asked about the importance of team motivation in team performance. The strongest data produced by this study came when all participants agreed that team motivation is `very much` on team performance. The answers tightly grouped that indicating all in agreement about the statement.

5.3.10 CONCERNS ABOUT TEAM MOTIVATION

When the concern[20] about team motivation is asked, the majority of the

[20] The word 'concern' is translated from Turkish word 'kaygı'. It reflects the situation of being solicitude; anxiety.

respondents (13/15) indicated that they have `not much` concern and 2/15 ratio claimed `not at all` (Table 29).

Table 29. Opinion ratings about concerns about team motivation.

	Not Much	Not At All
Non-design Background	9	2
Design Background	4	0
Total	13	2

Table 30. Distribution of responses by design teams.

	W	Q	Z	S
Not Much	3	4	3	3
Not At All	0	0	1	1

5.3.11 CONCERNS ABOUT GOAL SETTING AND CONCEPT GENERATION

Concern about concept generation is asked and all design background students stated that they had concern about creating concept as a team, whereas half of the non-design background indicated 'much' (6/11)(Table 31).

Table 31. Opinion ratings about concerns about team motivation.

	Much	At Normal Level	Not Much	Not At All
Non-design Background	6	0	3	2
Design Background	4	0	0	0
Total	10	0	3	2

Answers were different among the same team members (Table 32). In teams, members mainly grouped in 'Much', but there was always a member who had no

concern about concept generation. According to Table 31, that this member is non-design background.

Table 32. Distribution of responses by design teams.

	W	Q	Z	S
Much	2	2	3	3
At Normal Level	0	0	0	0
Not Much	1	1	1	0
Not At All	0	1	0	1

5.3.12 DESIGN PROCESS TECHNIQUE AND TEAM PERFORMANCE

The effect of design process technique on the team performance created by the team was asked. During the case study each team has created unique process during product development. Different design process steps were applied in different order simultaneously. While one team was discussing the concept, other preferred to begin to the process with drawing first sketches or by making mock-ups. The origins of design process technique come from teams' dynamics. Importance of design process technique is rated ` effective` (8/15), `very effective` (4/15) and `normal` (3/15) (Table 33). All design background students indicated 'very effective'. The reason might be the higher past experience in design than non-design background students, and so, design process technique has been perceived as a key factor that affect team performance.

Table 33. Opinion ratings about the importance of design process technique for team performance.

	Very Effective	Effective	Normal
Non-Design Background	0	8	3
Design Background	4	0	0
Total	4	8	3

Table 34. Distribution of responses by design teams.

	W	Q	Z	S
Very Effective	1	1	1	1
Effective	1	2	2	3
Normal	1	1	1	0

5.3.13 CONCERNS ABOUT TIME MANAGEMENT

When the concern about time management was asked the majority of the participants stated that they had concern about time management in teamwork (Table 35).

Table 35. Opinion ratings about concerns about time management.

	Much	At Normal Level	Not Much
Non-design Background	7	2	2
Design Background	4	0	0
Total	11	2	2

All members of the Team Woodpecker responded 'Much' (Table 36). During the case study, all members of the Team Woodpecker were having professional practice at the same time with their graduate program.

Table 36. Distribution of responses by the design teams.

	W	Q	Z	S
Much	3	3	3	2
At Normal Level	0	1	0	1
Not Much	0	0	1	1

5.3.14 CONCERNS ABOUT DECISION MAKING PROCESS

The participants were asked to what extent they have concern about decision-making process. Half of the respondents indicated that they had concern about agreement process, while half of them indicated 'At normal level' (Table 37). None of the participants responded 'Not much' and 'Not at all'.

Table 37. Opinion ratings about decision-making process.

	Much	At Normal Level
Non-design Background	6	5
Design Background	2	2
Total	8	7

In the Team Quatro ¾ of the members indicated 'Much'(Table 38).

Table 38. Distribution of responses by design teams.

	W	Q	Z	S
Yes	1	3	2	2
Neutral	2	1	2	2

5.3.15 CONCERNS ABOUT MEMBERS' VERBAL COMMUNICATION SKILLS

The respondents were asked to evaluate the verbal communication skills of the team members. The survey data indicated that only the 5/15 of the participants

had no concern about verbal communication. Of those surveyed, half of the design background students indicated that they had concern about verbal communication (Table 39). 5/15 responds, as 'Much' is high percentage, which could effect internal communication.

Table 39. Opinion ratings about verbal communication skills.

	Much	At Normal Level	Not at all
Non-design Background	3	3	5
Design Background	2	2	0
Total	5	5	5

The 'Much' ratio increased in the Team Shopping Pirates to 2/4 (Table 40).

Table 40. Distribution of responses by design teams.

	W	Q	Z	S
Much	1	1	1	2
At Normal Level	2	1	1	1
Not At All	0	2	2	1

5.3.16 CONCERNS ABOUT TEAM'S VISUAL PRESENTATION SKILLS

The respondents were asked to evaluate the visual presentation skills of the team members. 9/15 of those participating in the study indicated that they had no concern about drawing and presentation abilities. Only two were design background students. Two of the non-design background respondents indicated that they had concern about drawing skills (Table 41). No design background students indicated 'Much'.

Table 41. Opinion ratings about visual presentation skills.

	Much	At Normal Level	Not Much	Not At All
Non-design Background	2	0	7	2
Design Background	0	2	2	0
Total	2	2	9	2

Table 42. Distribution of responses by design teams.

	W	Q	Z	S
Much	1	0	0	1
At Normal Level	0	1	1	0
Not Much	2	3	2	2
Not At All	0	0	1	1

5.3.17 CONCERNS ABOUT MEMBERS' VISUAL PRESENTATION SKILLS

Related with the previous question (5.3.16) individuals' concerns about visual presentation skills were asked. The survey data indicated that the design background students had no concern at all about their drawing skills (Table 43).

Table 43. Concern about individual drawing skills.

	At Normal Level	Not Much	Not At All
Non-design Background	6	5	0
Design Background	0	2	2
Total	6	7	2

¾ of the members of the Team Quatro responded 'At Normal Level' (Table 44). According to Table 43 all were non-design background.

Table 44. Distribution of responses by design teams.

	W	Q	Z	S
At Normal Level	1	3	1	1
Not Much	2	0	2	3
Not At All	0	1	1	0

5.3.18 CONCERNS ABOUT LEADERSHIP and DOMINANCE

There was no formal and defined leadership required for each team. When the concern about leadership is asked, the survey data indicated that the majority of participants indicated that they had no concern about dominance of one individual as leader. Of those surveyed, 7/15 ratios respond as `neutral` (Table 45). There were no 'Much' response. None of the design background students indicated 'Not Much' or 'Not At All'. According to the open-ended question at the end of the first questionnaire, one design background student answered that he was bored of being in leader position during the study.

Table 45. Concern about leadership.

	At Normal Level	Not Much
Non-design background	3	8
Design background	4	0
Total	7	8

Table 46. Distribution of responses by design teams.

	W	Q	Z	S
Neutral	1	3	2	1
No	2	1	2	3

5.3.19 CONCERN ABOUT SHARING RESPONSIBILITY

The participants were asked to what extent they had concern about sharing responsibility. All participants in the study indicated that they had no concern about sharing responsibility. All participants responded `Not Much` when it is asked about concern on responsibility sharing.

5.3.20 CONCERNS ABOUT RESPECT FOR OPINIONS

The majority of the respondents disagreed with the statement that shows concern about respect to the opinions of the team members. Two of the respondents indicated 'Not At All' (Table 47).

Table 47. Opinion ratings about respect for opinions.

	Not Much	Not At All
Non-design background	9	2
Design background	4	0
Total	13	2

Table 48. Distribution of responds by design teams.

	W	Q	Z	S
No	3	3	4	3
Never	0	1	0	1

5.3.21 CONCERNS ABOUT ABILITY TO WORK TOGETHER

The respondents were asked to rate concerns about working together. 13/15 of the respondents indicated that they had no much concern about working together

(Table 49). Design background students gave all 'At Normal Level' answers. The reason may be past experiences in design teamwork.

Table 49. Opinion ratings about working together.

	At Normal Level	Not Much
Non-design background	0	11
Design background	2	2
Total	2	13

In the Team Quatro all the answers were 'Not Much' (Table 50).

Table 50. Distribution of responses by design teams.

	W	Q	Z	S
Neutral	1	0	1	0
No	2	4	3	4

5.3.22 POSSIBLE FUTURE PROBLEMS

At the end of the first questionnaire, possible future problems were asked in an open-ended question form. 6 of non-design and design background students indicated that more effort on multi-functional structure would increase productivity. 3 of non-design background students claimed that they could not carry their background experience to the project effectively. A design background student answered that he could not express himself effectively because of the level of the team. He used the term 'average level', which sometimes obstructs him to keep the team level at average. By this way he was claiming the other team

members were insufficient. One design background student claimed that the process could be slower in the future because of the negotiation process. A non-design background student expressed that participation of the members could be a problem in the future. One design background student indicated that there could be problems at grading. Same student also indicated that he became bored with being dominant and acting as coordinator.

Again, a design background student claimed that there could be dominancy problems in the team. He was uncomfortable because of the age differences in the team.

Apart from these problems, a non-design background student expressed that one future problem could be the dominancy of a team in the class.
5/15 participants gave no answer to this question.

5.4 DESIGN PROCESS OBSERVATIONS AND INFERENCES

During the case study observations were made to examine the procedural and design artifacts that are the ways of communicating in design teams. Observations can be grouped into two subgroups. The first group consisted of video recording, for which the researcher attended all the courses during six week and recorded critical team meetings, juries and team critiques with lecturer. The second group consisted of written data that the researcher took notes as well as with personal observations.

In the first part, procedural artifacts are examined. Most of the procedural artifacts were verbal. So the research showed interest on team conversations. Written documents that were produced by the participants were rare, and most of them were used in presentation sheets so it is better to consider them as design artifacts (Figure 15). Design artifacts are studied in the second part.

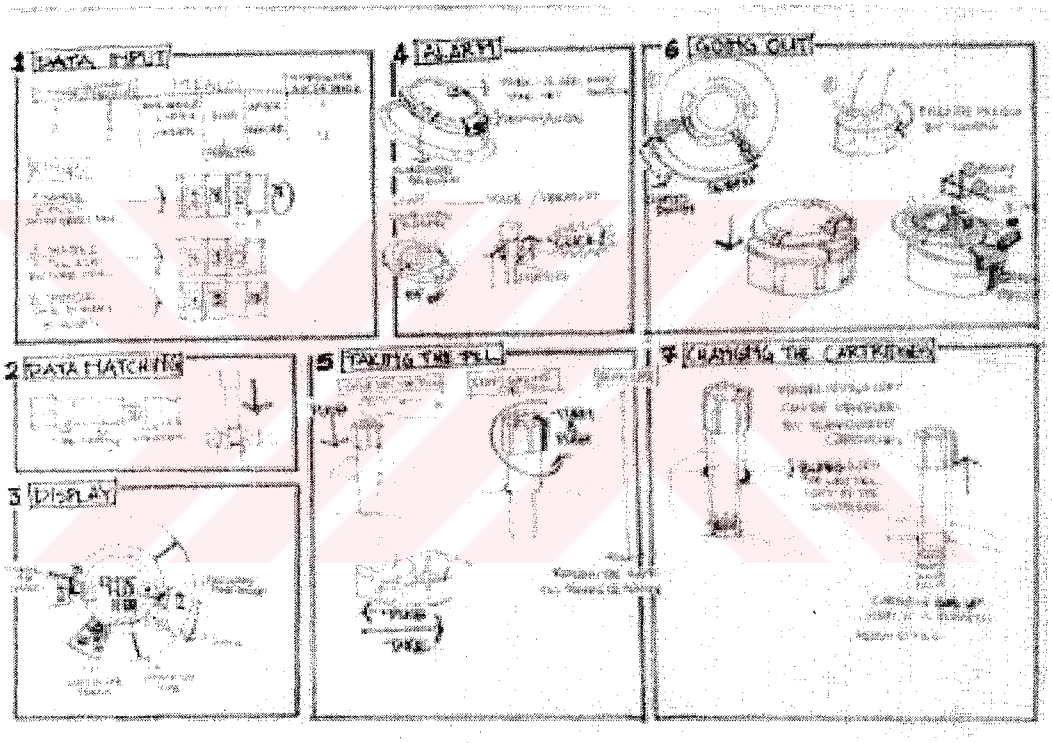

Figure 15. Combination of procedural artifact with design artifact.

5.4.1 PROCEDURAL ARTIFACTS

The procedural artifacts are the artifacts that are created during the whole design process as mentioned before in Chapter 4. These could be the roles that members

played or the design artifacts that they created. Each artifact that teams created can have positive and negative effects.

In the light of the observation results, roles can be divided into three subgroups:

1 Positive mission and process dependent procedural roles

2 Design process dependent roles

3 Negative mission and process dependent roles

In the first section positive mission and process dependent roles are examined.

5.4.2 POSITIVE MISSION and PROCESS DEPENDENT PROCEDURAL ROLES

Team members know their roles and functions and are as well as facilitators for other team members who are affected by his role or function. There was no formally defined role sharing between participants. Roles and functions came out during the team meetings. Team meetings are one of the ways to solve design problems and aims to reach a consensus. There are several factors for effective and sufficient team meetings. (Preparation, participation, timing etc.) But perhaps the most important factor for team meetings is the roles and functions of the team members. If we define the roles in the team by this way, it could be easy to find out the internal communication structure. As mentioned before, there was no leadership position in team structure in the study. Leadership is shared between team members during the case study. So, it positively affects team performance because the shared leadership is a key factor for effective teamwork and so internal communication.

Some different role adaptations could be observed by checking team conversations, which were recorded by video. Following examples will illustrate roles that were established and played within the team and influenced what happened.

Because of the case study protocol between participants and the researcher, names of the team members are kept hidden and coded with letters that have no relation with the participants' original names.

Mission dependent roles and functions include catalyst functions that help to reach the goal and objectives of the team. The goal and the objective can be separated and be explained differently. The goals are the accomplishment of the tasks. The objectives are the facilitators to reach that goal. The kind of roles focuses on to analyzing and evaluating the knowledge and opinions by effective communication. Process dependent roles are necessary for total success. They try to construct relations on dependence and trust by effective communication. By this way their duties match with objectives. They try to eliminate problems before they appear. These opportunistic problems can be apathy, withdrawal, personal conflict, and power and influence struggle.

As mentioned before, many of the roles and functions are defined in the literature. To make it clear, the researcher grouped a set of them to match with team

conversations. Some roles that are diagnosed during the case study are listed below:

1- Initiating
2- Information seeking
3- Information giving
4- Opinion seeking
5- Elaborating and clarifying
6- Coordinating
7- Summarizing
8- Orienting
9 - Standardizing and evaluating
10- Energizing
11- The Procedural Technician
12- Recording
13- Testing
14- Encouraging
15- Harmonizing- Mediating
16- Tension Reliving-Conciliating
17- Confronting
18- Compromising
19- Gate keeping and expediting
20- Following
21- Ventilating
22- Diagnosing

During the case study each team member act each role and they were not planned actions. Participants share roles during the different phases of the design process. Let's illustrate roles with just a few examples, which were established and played within the team during the team meetings, and influenced what had happened.

1- *Initiating Role*

L- … Let's focus on this issue from shopping perspective.

D- But we have no idea about customer.

L- Then, let's focus on consumer behavior.

This 'initiating' role shows that the members create alternatives. In design team activity, initiating activity can be seen intensively. This is why so many alternatives are scanned and searched for the best fit for the requirements.

2- *Information Seeking*

H- … Well, it is better to use the 'blue tooth' technology for the headphones.

I- What do you mean?

H- Transferring data without cables. Ericsson uses it.

I- We have to search for limitations and costs.

'Information seeking' role clarifies the knowledge differences between team members. Participant 'I' encourages Participant 'H' to make the term clear. By this way other team member shares the knowledge and can join the discussion actively.

3- *Information giving and* 4- *opinion seeking*

I- We will have difficulties because of this detail. Trust me.

G- It was just an opinion…(silence and turns to Participant H) What is your opinion?

H- I have got no idea now.

'Information Giving' Role and 'Opinion Seeking' role can be seen in this dialog. Participant 'I' shares his/her opinion by experience and 'G' consults other members.

5- *Elaborating and Clarifying*

N- You are talking about the same solution (after discussion between Participant A and Participant O)

Participant N is 'Elaborating and Clarifying' and 'Coordinating' the ideas of other two member. N is trying to eliminate the misunderstanding between A and O.

7- *Summarizing*

I- So at the end, we will decide display, camera. But we have to finish mock-up. Okay?

'I' draws attention on 'Summarizing' and stressed on time. This role helps team members when they felt frustrated about the process. It is an important activity that occurs after the team meetings and a dense discussion.

10- *Energizing*

E- Come on! There is no time to lose. (laugh)

'Energizing' role is used by 'E' to encourage the members. This role can sometimes combine with `Initiating` Role and `Orienting` Role.

12- *Recording*

During the case study, J was taking notes about decisions and trying to keep a permanent record data about team activities. Recording role became identical with J and the aim was to create a memory for the team.

13- *Testing*

J- Any problem? Let's draw the presentation.

'J' is `Searching` and `Testing` for consensus.

For all the teams, corporation and the participation on opinions were high. There was no fatal problem that will effect the whole teamwork. Even there was no formal structure of interaction between participants, their listening and information sharing abilities were high. Interactions focused on sincerity, trust and discussions focused on persuasion and advice.

As mentioned before there was not much personal argument between team members and the arguments based on design problems. Following examples will illustrate process dependent roles and functions:

14- *Encouraging*

J- … I am an engineer.

K- So it is right time to show your abilities (laugh)

'K' is `encouraging` 'J' and helps him/her joining in the process.

15- *Harmonizing and Tension Reviling*

A- I'm talking about the cap. The ring can be reciprocal (while drawing sketches). There is a hole here; the patient can take drugs by turning the ring.

O- There is no hole here (while drawing sketches). He can open the cap after he turns the ring. Understand?

L- Offf (flustered)

A- Look, It is better....

P- You do not listen to me.

N- Both of you are talking about the same thing. We have a communication problem (Laugh). Let me draw.

'N' is trying to 'harmonize' the efforts and try to 'decrease the tension (Tension Reliving)' by finding common points and making jokes.

17- *Confronting*

H- I will go to the canteen. Do you want anything? (While other group members were discussing a problem)

J- Don't go. We have too many things to do.

J is `confronting` H's participation problem.

19- *Gate keeping and Expediting*

L- What is your opinion F?

C- He is always so silent (laugh)

`Gate Keeping` and `Expediting` aims to encourage the silent members to participate in the team effort. This role helps to use communication channels clear. 'L' is inviting 'F'.

22- *Diagnosing*

B- We need time to accomplish the project. We have to meet at this weekend.

'B' is focusing on time problem. She/he diagnoses and offers a solution to come over the problem.

Some roles could not be recorded because of the limitations of the video recording. There was one camera and observer during the case study but the teams were working simultaneously so it could not be possible to record them all. At the same time some team practices are made at different locations like one members' house and different times from official working hours.

5.4.3 DESIGN PROCESS DEPENDENT ROLES

Unlike the Mission and Process dependent roles, design process roles are acquired a character of their own. In this case study, design process comprised different steps that began from concept generation and ended with final presentation. In each step, participation of the team members was observed.

According to the video records, in concept generation step every member on each team participated equally and concepts are found by consensus of the team members. There was no domination of a member in this step. In concept presentation, design artifacts are prepared by common effort of the team members.

5.4.3.1 FREEHAND DRAWING

Some design background student became dominant in preparation of design artifacts because of the drawing skills that they had (Figure 16).

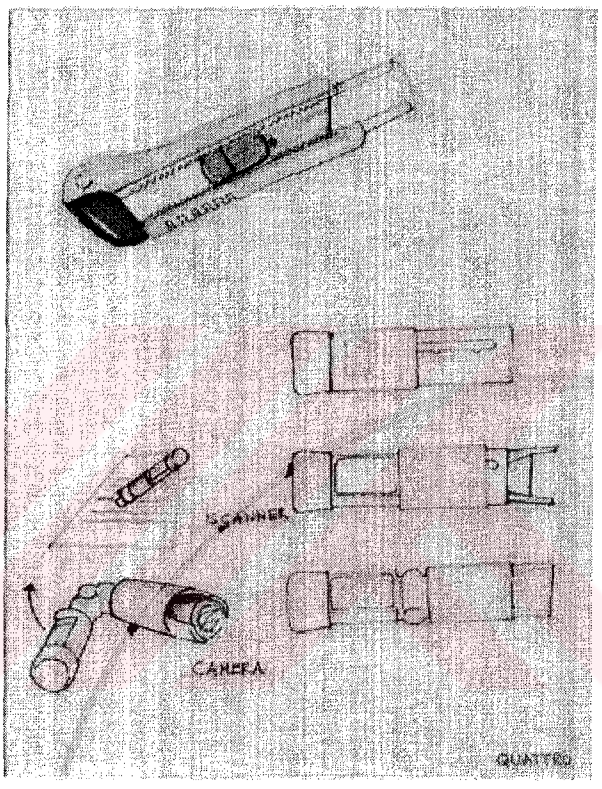

Figure 16. Freehand drawing of a design background student.

Before the study, dominance of the design background students were estimated; but during the case study it was seen that every team member tried to participate in the drawing management, but the quality of the drawings can be of a topic of discussion and have not been evaluated in this research. Major point is a desire to

participate. Skills and the dominance of the designers could be detected easily on video-recording data.

An evidence of dominance of the free hand drawing of a designer is determined in Team Woodpecker (Figure 17). In contrast to the mentioned statement there were team members who rarely try to produce freehand artifacts so they focused on written artifacts.

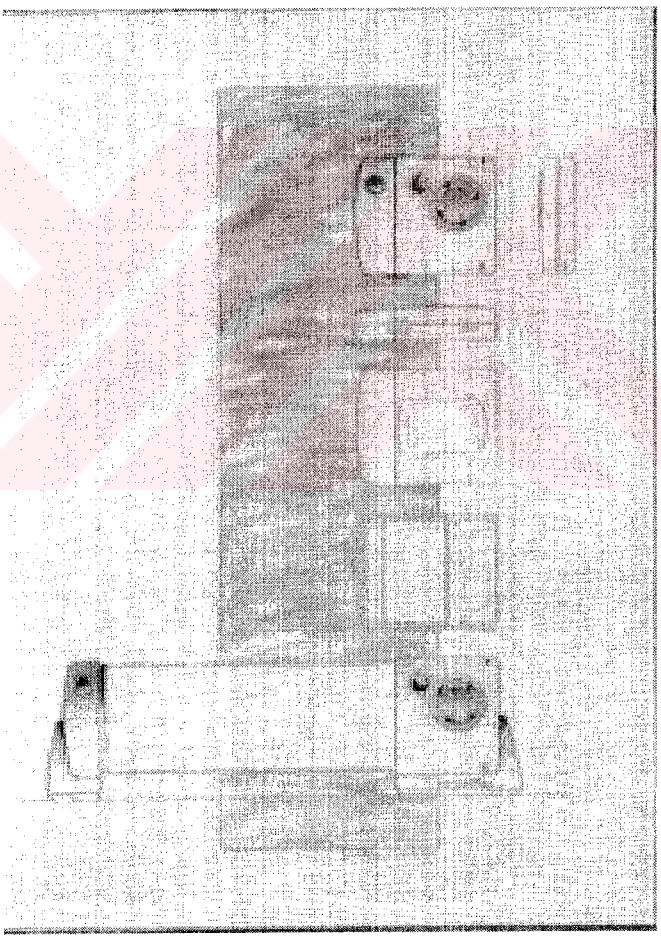

Figure 17. Presentation of Team Woodpecker. Note. All drawings of the team is produced by design background student.

Much of the team conversations shaped around sketchbook and design artifacts supported by verbal communication and facilitated the clarity.

5.4.3.2 MOCK-UPS and 3D MODELS

Mock-ups were produced with common effort. Each individual produced several pieces and passed them to other team members to build a complete piece. It was an organized action and there was no role dominance.

5.4.3.3 FORM CREATION

At the beginning of the case study it was estimated that arguments will be dominated on form creation. However, this step was completed in a mild environment for each team. Some arguments occurred during concept generation.

Perhaps the most important factor in creating the form in mild environment was the project concept itself. Each team chose mechanical products and their forms were taken as reference for the new product that the students created (Figure 18). New forms were also created under the pressure of mechanical and electronic details.

The project concept, relabelling, gave strong data for mission and procedural dependent roles because of its structure that encouraged students to discuss on creating project concept, but it limited form creation because the students imitated the mechanical product as a reference (Figure 18).

The domination of role examined in Team Quatro and Team Woodpecker. Design background students gave the decision of form of the product. To illustrate this statement following conversation will be a good example:

J- When will we begin details?

H- First wait `G` to make decision about form (While G was drawing a sketch about form of the product. Note that G was a design background student.)

Figure 18. Form creation Process.

5.4.3.3 3D MODELING and DIGITAL TOOLS

Even there were computers with 3D software installed; not all computer applications were made in the `Master Room`. 3D Modeling takes considerable amount of time because of its nature and it's hard to make this kind of application in team formation in the same computer. All computer applications are done by design background students. The results of the questionnaire show that the non-design background students indicated their weaknesses on computer modeling.

3D modeling and digital tools were not commonly used because the teaching staff did not stipulate it as requirement. Due to this situation data collection was limited.

5.4.3.4 PRESENTATIONS

The logic of presentations a was combination of presentation made at the end of each session and the jury presentations.

Three kinds of juries are examined:

1 Session Jury

2 Preliminary Jury

3 Final Jury

Session juries were made at the Master Room at the end of each relabbeling process. There were teaching staff, students and the observer. The observer

recorded presentation on video. The language was Turkish. Duration of presentations were between 10-15 minutes and the students presented their ideas with the help of design artifacts. The roles changed in every session and each individual played an active role except a non-design background student. Every student participated in the discussion session at the end of each presentation.

Preliminary jury was made in the Master Room with limited staff who were invited for the jury. The presentations were made in English because a foreign instructor also participated as a teaching staff in the course.

The final jury was made in a corridor in the Faculty of Architecture where the Industrial Design Department is located. There were seven jury members. And it was open to all teaching staff and students to express their ideas about projects. The jury was video recorded.

With the help of the video recording and the personal memos of the researcher, role division is examined in verbal jury presentations. It was not so organized and there was no interference between the team members; but the basic aim was to complete the missing parts.

The verbal communication percentages of the team members were unbalanced and some participants dominated with %60 of the total jury conservation. Being consistent, some team members were silent in jury conversation with %5 of total presentation.

At final presentation, teams seem to be satisfied with the end product. Team members mentioned some insufficiencies and defectiveness of the final products during the final presentations. They connected these negativenesses due to time limitation in the project and time that is spent to mature team structure.

This study does not include the criticism of the final product. As an informal opinion of the researcher, final products did not reflect the potentials of the cross-functional team structure. Lack of detailing and issues as manufacturability were not clear. This situation, perhaps, highly related with the lack of team experiences of the team members and fictitious structure of the project.

5.4.3 NEGATIVE MISSION and PROCESS DEPENDENT ROLES

Negative roles come from the nature of the teamwork. If they are dominant, they can damage the communication channels. Some of the negative roles are:

Aggression
Blocking
Shutting off
Analyzing and labeling
Yes-butting
Recognition seeking
Self-confessing
Playboy-Clowning
Dominating

In the case study, negative roles and functions were rare and the atmosphere was mild. It may because they were being video recorded. Some negative roles occurred during the teams' activities, which could still be accepted because of the

nature of the design work. Most of the negatives roles and function were occurred during selection of design alternatives that the teams produced. It was an important process due to the future design efforts would be built on selected alternative. Catalyst for the agreement was time pressure on teams. To accomplish the task teams agreed on the alternative that best fits to the brief and include all participants opinion. The lack of formal listening structure and the excessive number of opinions cause some negative roles (blocking, shutting off, yes-butting) to occur, but there was no intention of the team members to behave negative. Playboy-Clowning that making jokes can be unnecessarily accepted by the sincerity level of the team members. The dosage of cynicism and jokes were appropriate and gave no harm to the design process.

5.5 INTERNAL EVALUATION

Just after the preliminary jury, an internal evaluation sheet was distributed by the lecturer to evaluate team performance depending on the strengths and weaknesses.

There was a discussion session among teaching staff and students, and each team expressed their weaknesses and strengths. All data were recorded on the white board at the Master Room and copied to a sheet of paper to keep the data permanent. Results of internal evaluation are listed below:

Team Zip+

Strength: Good teamwork

Everyone shares the work, knows the responsibility

Weakness: Dealing with details deeply, loss of time

Team Shopping Pirates

Strength: Multidisciplinary background of the team members

Weakness: specifying the problem area

Team Quattro

Strength: Multidisciplinary background of the team members

Weakness: not knowing each other

Team Woodpecker

Strength: Multidisciplinary background of the team members

Weakness: Team members work while also continuing the master program

Lack of time

Every team indicated that the multi-disciplinary structure was a strength. This data matches with the results of the first questionnaire (see. Sec 5.3.22).

Team Zip + expressed dealing with details as a loss of time. While diagnosing Harmonizing and Tension Reviling, the sample dialog was between the members of Team Zip +. If the dialog is examined, a listening problem between team members can be identified. During the communication, verbal communication was not supported with clear and sufficient freehand artifacts.

Team Quatro indicated 'not knowing each other' as a weakness. Each team paid time to know each other and it led to loss of time.

The weakness of the Team Shopping Pirates matches with the concern that they expressed at Section 5.3.11.

As an external factor, Team Woodpecker expressed participation problem as a weakness. In Section 5.3.72 14/15 participants indicated that the physical participation is one of the most important factor for success. All the members of Team Woodpecker indicated 'Very important' to this question.

5.6 SECOND QUESTIONNAIRE

After a six-week case study period, participants began a new project. It was an individual project (see Appendix 5: Design Brief II) and focused on pleasurable and sensual aspects of products. After the final jury (May 29) one questionnaire is e-mailed to the participants to examine differences between teamwork and individual work. The form of the questions was designed to find out the differences between teamwork vs. individual work and to check the preferences and performance of the participants`. By this way it would help to evaluate the personal strengths and weaknesses of the participants.

10 (8 non-design background and 2 design background) of the total 15 participants responded the questionnaire (Table 51). The distribution of the participants are listed below:

Table 51. Distribution of participants in questionnaire.

	Woodpecker	Quatro	Zip +	Shopping Pirates
Non Design Background	2	3	1	2
Design Background	1	1	0	0

5.6.1 INDIVIDUAL PROJECT PERFORMANCE

The participants were asked to evaluate their individual performance. The questionnaire data indicated that the majority of the participants rated as `Good` (Table 52). There was no negative answer.

Table 52. Evaluating individual project performance.

	Non-Design Background	Design Background	# of Responds
Very Good	1	0	1
Good	5	2	7
Fair	2	0	2
Total	8	2	10

5.6.2 STRENGHTS and WEAKNESSES in INDIVIDUAL WORK

The participants were asked to indicate their individual strengths and weaknesses concerning the project that was developed individually. Concept generation got

the highest rating as strength and detail design got the highest as weakness (Table 53 and Table 54).

Table 53. Strengths that indicated about individual project.

	Non-design Background	Design Background	Total
Concept Generation	5	2	7
Concept Presentation	5	1	6
Form Creation	4	1	5
Final Presentation	4	1	5
Function Appointing	4	0	4
Technical Research	4	0	4
Freehand Drawing	3	1	4
Computer Modeling	1	2	3
Comprehension of the problem	2	1	3
Material Selection	2	0	2
Interface Design	2	0	2
Prototype	1	0	1
Detail Design	1	0	1

The data is examined procedural and design artifacts based. The results indicated the differences between non-design and design background students.

Table 54. Weaknesses that indicated about individual project.

	Non-design Background	Design Background	Total
Detail Design	4	1	5
Prototype	2	2	4
Comprehension of the problem	3	0	3
Freehand Drawing	3	0	3
Computer Modeling	3	0	3
Final Presentation	3	1	3
Technical Research	1	1	2
Concept Generation	1	0	1
Interface Design	0	0	0
Material Selection	0	0	0
Form Creation	0	0	0
Concept Presentation	0	0	0
Function Appointing	0	0	0

Table 55. Rating of procedural artifacts by non-design background students.

	Procedural Artifacts			
	Non-Design Background			
	Weakest		Strongest	
1st	Comprehension of the problem	3	Concept Generation	5
2nd	Concept Generation	1	Function Appointing	4
3rd	Function Appointing	1	Technical Research	4
4th			Material Selection	2
5th			Comprehension of the Problem	2

Table 56. Rating of procedural artifacts by design background students.

	Procedural Artifacts			
	Design Background			
	Weakest		Strongest	
1st	Technical Research	1	Concept Generation	2
2nd			Comprehension of the Problem	1

According to the Table 53 Concept Generation is rated as strength in 1st place both for design and non-design background students. Non-design background students indicated more strength and weaknesses in procedural artifacts. Lack of the sample size at design background students may be the reason for the limited number of responses than non-design background students. Comprehension of the problem and concept generation rated both as a weaknesses and strength for non-design background students. Contrast to the design students, technical research got high rating as strength from non-design students.

Table 57. Rating of design artifacts by non-design background students.

	Design Artifacts			
	Non-Design Background			
	Weakest		Strongest	
1st	Detail Design	4	Concept Presentation	5
2nd	Freehand Drawing	3	Form Creation	4
3rd	Computer Modeling	3	Final Presentation	4
4th	Final Presentation	3	Freehand Drawing	3
5th	3D Modeling	2	Interface Design	2
6th			Detail Design	1
7th			Computer Modeling	1
8th			3D Modeling	1

The results showed differences within the non-design students. Freehand drawing and final presentation took highest ratings both as weakness and strength.

The group was equally divided to the teams. It is surprising that any of interior architect or city planners rated freehand drawing as strength even they had past design studio practice in their field.

Table 58. Rating of design artifacts by design background students.

	Design Artifacts			
	Design Background			
	Weakest		Strongest	
1st	3D Modeling	2	Computer Modeling	2
2nd	Final Presentation	1	Form Creation	1
3rd	Detail Design	1	Final Presentation	1
4th			Freehand Drawing	1
5th			Concept Presentation	1

Different from the non-design background students both design background students rated computer modeling as strength. Surprisingly prototyping activities like making mock-ups and models are rated weakest even they had past

experiences. One design background student rated final presentation as weakness; however he prepared his teams final presentations for the juries.

5.6.3 MOST DIFFICULT STEP in INDIVIDUAL WORK

The most difficult step in individual project was asked and the answers were supported by the open-ended questions to write comments about the causes. Comprehension of project brief, sketching, detailing, computer modeling, and prototyping and presentation skills were the problematic issues for some of the participants (Table 59).

5.6.4 COMPARSION of TEAM vs. INDIVIDUAL DIFFICULTIES

Related with the previous question, participants were asked whether they experienced the same difficulty during the team work. 3 of the 10 participants commented positively. 7 of the 10 participants commented negatively (Table 60).

Table 59. Most difficult step in individual work and causes.

	Non-Design Background	Design Background	Total	
Time management	3	0	3	The project time was too long for the participant to keep the motivation constant.
Critiques	1	0	1	The participants claimed that the critiques from teaching staff were not orienting.
Presentations	1	0	1	Subjective and insensitive grading approach affected.
Drawing	2	0	2	Lack of knowledge of non-design background students felt difficulty.
Prototyping	2	0	2	There was not enough time for 3D modeling application.
Product	0	1	1	The project had limitations and it was difficult to keep motivation constant.
Comprehension	0	1	1	Being from a different discipline and clarity of the design brief affected comprehension of the problem area.

Table 60. Team vs. Individual Difficulties.

	Non-Design	Design	Total	Causes
Yes	3	0	3	Lack of freedom in teamwork, being from different disciplines and have different design approaches.
No	5	2	7	Sharing of the responsibility in team practice, discussion atmosphere created by members, high motivation

5.6.5 PREFERENCE FOR TEAMWORK vs. INDIVIDUAL WORK

The participants were asked about their preferences between teamwork and individual work for further studies. Eighty percent of the participants indicated that they would prefer teamwork (Tab. 61).

Table 61. Teamwork vs. Individual Work Preference.

	Non-design background	Design background	Total
Team	6	2	8
Individual	2	0	2

Justifications on preferences are shown in Table 62.

Table 62. Justifications on preferences.

Teamwork	Individual work
Fun	More freedom
Instructive	Faster
Trust on process	Easier
Productivity	Adaptation problems
Reducing personal incapacity	
Structure quality	
Responsibility and discipline	

This data show that the majority of the participants are satisfied from team practice.

5.6.6 MOTIVATION IN TEAMWORK vs. INDIVIDUAL WORK

When the ratio of motivation is asked in teamwork vs. individual work both design background students stressed that the motivation was higher in teams than individual performance. Only 2 of the non-design background students emphasized that the motivation on individual performance was higher than teamwork (Table 63).

Table 63. Motivation in teamwork vs. individual.

	Non-design background	Design background	Total
Team	5	2	7
Individual	3	0	3

This data matches with the results of the first questionnaire. In Section 5.3.9, motivation is claimed as one of the most important factor for team practice.

5.6.7 EMPLOYING BACKGROUND AND EXPERIENCE: TEAMWORK vs. INDIVIDUAL WORK

The participants were asked whether they employed their backgrounds and experiences better in teamwork vs. individual work. The majority of the non-design background indicated that they employed their background and experiences better in individual work (Table 64).

Table 64.Employing background and experiences in teamwork vs. individual.

	Non-design background	Design background	Total
Team	1	1	2
Individual	7	1	8

5.6.8 TIME MANAGEMENT IN TEAMWORK vs. INDIVIDUAL WORK

When the effectiveness of the time management was asked between teamwork and individual work, individual performance was preferred. As mentioned before some participants indicated teamwork as a slow process than individual work. In teamwork every opinion was judged and filtered by each dependent member to find a consensus (Table 65).

Table 65. Time management in Teamwork vs. Individual work. Note. One non-design background and one design background student did not answer question.

	Non-design background	Design Background	Total
Team	3	0	3
Individual	4	1	5

5.7 LIMITATIONS OF THE CASE STUDY

Some data can be missed in the case study because one researcher conducted the study and he was not able to observe all the interactions in the four teams simultaneously. It was impossible to collect all data because noteworthy amount of the teamwork was carried outside the studio and formal studio time. Video recording time was restrictive to determine all design and communication process.

This case study is incapable to monitor real life conditions because the project was fictitious. The members of teams knew that their designs would never be built. During the projects some real life variables (e.g. application of the technology and materials) are not considered. To eliminate this difficulty, one experienced designer from electronic sector participated in one weekend session to give critiques for material and technology.

During the study the atmosphere was mild because the projects were non-profit. Observants knew that they were recorded. They may have suppressed their feelings due to this fact.

Sample size was limited by the scope of the course. The composition of the participants was the students who accepted to the Graduate program.

The background of the researcher might be a limitation because of making comparisons between design and non-design backgrounds.

At the end of second questionnaire, %66 of the responses returned.

However, the researcher believes that these effects were not distorting whole study results, so these effects were acceptable sacrifices for the controlled environment and being under the stress of video recording.

5.8 THE FINDINGS OF THE CASE STUDY

Perhaps the most important point in this case study is that all the teams accomplished their task in a given time and fulfilled the requirements defined in the design brief. Although some concerns were reported in the first questionnaire, there were no significant signs of arguments to destroy the team structures.

When all the issues addressed are taken into account, the participants seem to agree that *motivation, physical participation and being open-minded* are the key factors for the internal communication.

Another significant finding is related with the members who carry their past individual experiences to the teamwork practice, which directly effects internal communication of the team. The roles that are derived from internal communication have roots in background and past experiences.

The first questionnaire indicates that there are no great differences between design background and non-design background students in using verbal communication channels. The difference between non-design and design background is examined during producing design artifacts. Role division in producing procedural artifacts is highly related with participants' personality. But the case study showed that teamwork practice gave chance to each member to express his/her ideas with drawing without judgment of others.

The case study indicates the social process side of the design process. From this perspective, it can be emphasized that the internal communication in design teams has an organic bond with social process. This leads design process to be more complex when cross-functional team approach is applied.

5.9 FURTHER STUDIES

During the case study some set of variable arrangements (e.g. different physical environment, instructor, task) are not arranged because of the time and institutional limitations.

Different team combinations could be arranged to search for differences. Individual and team expectation could be asked to examine the similarities and differences. In the study, expectations were only asked as grading.

Different design teams could be picked from undergraduate program, graduate program and consisting experienced graduates to search for the effects of design and team experience in cross-functional team practice.

CHAPTER 6

CONCLUSION

In the present study, the importance of team approach in new product development process in industrial organizations was examined through the survey of literature.

The literature highlights the fact that, in comparison to other new product development models, the teamwork approach shows superiority. A substantial body of the literature surveyed emphasizes the complexity of the new product development process and their approach offers that the cross-functional design teams is considered as one of the best ways to handle this complexity by departmental integration. However, each group formation in departmental integration does not show real team characteristics. This assumption reflects the fact that teams differ in practice and the context in which they operate.

Cross-functional design teams are affected by macro and micro factors. Thus, many teams fail because of the organizational and individual limitations. To

eliminate this problem, organizational structures should be flexible and the members who act in the teams should be open-minded.

The findings indicate that the mature cross-functional design teams are associated with several organizational benefits in new product development: increase in speed, ability to handle complexity, diversity, improvement in quality and creativity, increase in motivation and increase in the quality of communication.

Through a variety of illustrated studies in the literature, five factors are determined as the effectiveness factors for cross-functional design teams: authority, interdependence, agreement, argument and communication. It has been estimated that communication is the dominant factor that combines all other four factors in itself.

The literature shows that positive internal team communication helps to create artifacts and promotes socializing. This view is also supported by the case study. According to the case study, positive approach on teamwork between members encourages teamwork practices. The results from the case study are as follows:

1) *Motivation and Participation:* The study shows that motivation and performance are highly related with participation. Not suprisingly team motivation and physical participation got the highest ratings for effectiveness.

2) *Agreement Process:* In comparision to individual work, cross-functional design teamwork is claimed to be slower than individual effort because of the agreement process. Perhaps the most significant reason for this is that members had concern on agreement process at the beginning of the study.

3) *Strengths of Cross-Functional Teamwork:* The results support the fact that cross-functional teams reduce individual incapacity by interaction, create discipline, build responsibility and motivation.

4) *Functional Diversity*: The overwhelming majority of the participants claim that the functional diversity strengthen the team.

5) *Leadership:* During the case study, leadership has not been observed; but three design background students demostrated enabler position.

6) *Design Artifacts:* Participants who indicated concerns about drawing skills were the participants who rated drawing skills as weakness.Creation of design artifacts are rated as the weakest process than other design processes between non-design background students. Suprisingly, three dimensional modelling, detail design and final presentation were indicated as the most difficult steps by design background students.

7) *Background and experience:* The data collection from the case study involves that the role distribution differs between team members throughout the design process. Apart from design process dependent roles, professional diversity did not affect the role distribution. From this it is possible to estimate that the role diversity is highly linked with personality.

6.1 DISCREPANCIES BETWEEN LITERATURE SURVEY FINDINGS AND CASE STUDY FINDINGS

Most of the literature survey findings match with case study findings but several differences are observed:

1- Contrary to the literature, teamwork is claimed to be slower than individual work by participants.
2- Significant domination of experienced individuals is not diagnosed during the design process.
3- The harmful effects of background diversity did not affect the total internal communication.
4- No significant effects of background diversity are diagnosed during producing procedural and mission dependent roles.

6.2 RECOMMENDATIONS

From the data that is involved during the study, it is possible to deduce some recommendations:

1. Industrial organizations which try to get a share from market should attach importance on new product development because the economic success of industrial organization depends on their talen to identify the needs of customers and to rapidly create and launch products that they meet these needs as well as producting them at low cost.
2. For a productive new product development process, industrial organizations should import and support cross-functional design team structures in their bodies. Product development is an interdisciplinary activity requiring integration of all functions of the industrial organization. Succesful development requires many different skills and talents. As a result, development teams should involve people with a wide range of different training, experience, perspectives and personalities.
3. To build high-performance cross-functional design teams, industrial organizations should pass through several team experiences. Even the industrial organizations are dispirited form problematic team experiences in their first trial, they should inured to the process as trial ground. They should attach improtance to the organizational learning.

4. Cross-functional design teams should integrate constructive communication techniques in their structure for an effective team experience.
5. For high-performance, teams should pay regard to success factors that are highlighted above such as trust, respect, being open-minded and participation in sessions and team discussions.
6. Industrial design students should be trained for future teamwork experiences at under graduate and graduate level. This will led them to experience failures as well as success. More insights will be gained in more isolated environment a way form organizational realities.

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APPENDIX A

Design Brief I

Middle East Technical University Department of Industrial Design
Spring 2001
Prof. K. Munshi & Inst. Fatma Korkut
ID 501 Advanced Project Development in Industrial Design

An application oriented course with spesific emphasis on exploring new methods, new approaches and new problem areas in the cross-disciplinary area of industrial design.

February 12, 2001

PROJECT I: Interaction Styles

In this project we are going to focus on the issue of style as product-user interaction.
While exploring the interaction styles in electronic products, we are going to experiment with a specific technique developed at the Delft University of Technology: Interaction Relabelling. The following key article describes the idea underlying this technique:

Djajadiningrat, J. P., W. W. Gaver and J. W. Frens. 2000. Interaction relabelling and extreme characters: Methods for exploring aesthetic interactions. Proceedings of DIS '00, Designing Interactive systems, ACM, New York.

Main tasks

Team formation and Project theme (Today)

You are encouraged to form teams voluntarily. Each team would preferably consist of 3 members, and in each team there ought to be at least one industrial designer. Read and discuss the key article, and decide on a project theme that you are going to focus on. Please submit the project theme today at the end of the class.

Relabelling

Choose three mechanical products. It is preferable that the product have many moving parts and they are rich in terms of user actions. Since we are going to explore and try out user actions, choose products that you have access to.
Timetable for relabelling sessions

Monday	tuesday	Wednesday	Thursday	friday	saturday	sunday
12 team formation	13	14 relabelling 1	15	16	17	18
19 relabelling 2	20	21 relabelling 3	22	23	24	25
26	27	28 preliminary jury 13:40				

Important deadlines

Preliminary jury February 28, 2001 Wednesday 13:40
Sketches fully describing three alternative solutions
Full scale mock-ups for each alternative

Final jury April 2, 2001 Monday 10:00
All the material presented at the preliminary jury
Drawings fully describing the final product
Full scale model

Grading
The grading will be based on team work performance, attendance, assignments, and jury presentations.

APPENDIX B

Internal Evaluation

METU ID 501 Spring 2001
Team performance Review
Internal Evaluation, 28 February 2001

The strengths of our design team:

The weaknesses of our design team:

Areas/ activities I am more interested in during the teamwork:

Areas/activities I am less interested during the teamwork:

	very poor								*excellent*
Team synergy	1	2	3	4	5	6	7	8	9

APPENDIX C

First questionnaire

SIRA:.....TARİH:.....
SÜRE:.....
Bu görüşmede size ekip çalışmasını etkileyen faktörler hakkında sorular soracağım.Verdiğiniz cevaplar kimliğiniz açıklamadan kullanılacaktır.İstenilen cevaplar bir skala halindedir ve size her soruda sorulacaktır.

Kişisel Bilgiler:

1- **Ad, soyad** :
.....

1-a **Cinsiyet** : ☐ Erkek ☐ Kadın

1-b **Doğum Tarihi** : ...,.....,19....

2- Meslek, Lisans, Mezuniyet Tarihi,(Varsa diğer yüksek lisans derecesinin alanı):

.....,.....,.....,.....

3- Bir yerde çalışıyorsa, çalıştığı yer ve görevi:

.....,.....

4- Ürün Tasarımında ekip çalışması uygulamasına yaklaşımınız nedir?

1	2	3	4	5
ÇOK OLUMLU	OLUMLU	NORMAL	OLUMSUZ	ÇOK OLUMSUZ

5- Projenin başlangıcı dahilinde ortaya çıkacak ürün tasarımı ekibinin elemanlarına karşı tutumunuz nedir?

1	2	3	4	5
ÇOK OLUMLU	OLUMLU	NORMAL	OLUMSUZ	ÇOK OLUMSUZ

6- Projenin başlangıcı dahilinde ortaya çıkacak ürün tasarımı ekibi kuruluş formasyonuna karşı tutumunuz nedir?
(TESADÜFİ BİR OLUŞUM, GÖNÜLLÜ OLUŞUM VE ELEMAN SAYISI GİBİ FAKTÖRLERİ DÜŞÜNEREK CEVAP VERİNİZ)

1	2	3	4	5
ÇOK OLUMLU	OLUMLU	NORMAL	OLUMSUZ	ÇOK OLUMSUZ

7- Başlangıç aşamasında mevcut birikim ve tecrübenizin proje katkısı açısından düşünceleriniz neydi?

1	2	3	4	5
ÇOK OLUMLU	OLUMLU	NORMAL	OLUMSUZ	ÇOK OLUMSUZ

8- Sizce verilen projenin ekip çalışmasına uyumluluğu nedir?

1	2	3	4	5
ÇOK UYUMLU	UYUMLU	NORMAL	UYUMSUZ	ÇOK UYUMSUZ

Fiziksel çevrenin ekip çalışmasına etkisi konusunda size birkaç adet soru soracağım. Bu soruları cevaplarken ekip çalışması performansına yönelik etkileri çercevesinde cevaplamanızı istiyorum

9- Sizce mekanın sıcaklık düzeyi ekip performansını etkiler mi?

1	2	3	4	5
ÇOK ETKİLER	ETKİLER	PER. İLİŞKİSİ YOK	ETKİLEMEZ	HİÇ ETKİLEMEZ

10- Sizce mekanın aydınlatma düzeyi ekip performansını etkiler mi?

1	2	3	4	5
ÇOK ETKİLER	ETKİLER	PER. İLİŞKİSİ YOK	ETKİLEMEZ	HİÇ ETKİLEMEZ

11- Sizce mekanın akustiği ekip performansını etkiler mi?

1	2	3	4	5
ÇOK ETKİLER	ETKİLER	PER. İLİŞKİSİ YOK	ETKİLEMEZ	HİÇ ETKİLEMEZ

12- Sizce ekibin aynı mekan içinde fiziksel çalışma formasyonu ekip performansını etkiler mi?

1	2	3	4	5
ÇOK ETKİLER	ETKİLER	PER. İLİŞKİSİ YOK	ETKİLEMEZ	HİÇ ETKİLEMEZ

13- Sizce mekanın iç tasarımı ekip performansını etkiler mi?

1	2	3	4	5
ÇOK ETKİLER	ETKİLER	PER. İLİŞKİSİ YOK	ETKİLEMEZ	HİÇ ETKİLEMEZ

Şimdi size ekibin iç iletişimini etkileyen faktörlere ilişkin bazı sorular soracağım.

14- Ekip elemanlarının fiziki katılımı ekip performansında ne kadar önemli?

1	2	3	4	5
ÇOK ÖNEMLİ	ÖNEMLİ	NORMAL DÜZEYDE	ÖNEMSİZ	ÇOK ÖNEMSİZ

15- Öğretim görevlisi ekip performansında ne kadar önemli?

1	2	3	4	5
ÇOK ÖNEMLİ	ÖNEMLİ	NORMAL DÜZEYDE	ÖNEMSİZ	ÇOK ÖNEMSİZ

16- Ekip motivasyonu ekip performansında ne kadar etkili?

1	2	3	4	5
ÇOK ETKİLİ	ETKİLİ	NORMAL	ETKİSİZ	ÇOK ETKİSİZ

17- Ekip motivasyonu konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

18- Hedef belirleme ve konsept yaratma konusunda sıkıntıya düşeceğiniz doğrultusunda kaygınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

19- Ekibin belirlediği ürün tasarımı süreç tekniklerinin ekip performansına etkisi ne kadar?

1	2	3	4	5
ÇOK ETKİLİ	ETKİLİ	NORMAL	ETKİSİZ	ÇOK ETKİSİZ

20- Bir tasarım ekibinin üyesi olarak zamanı etkin kullanma konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

21- Bir tasarım ekibinin üyesi olarak karar alma sürecinin etkinliği ve süreç verimliliği konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

22- Ekip bireylerinin sözel iletişim becerileri konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

23- Ekibin görsel sunuş becerileri konusunda kaygınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

24- Bir ekip üyesi olarak görsel sunuş becerileriniz konusunda kaygınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

25- Ekip içinde liderlik ve baskın karakter konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

26- Sorumluluk paylaşımında kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

27- Ekip çalışmasında fikirlerinize saygı ve eleştirilerdeki saygı konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

28- Birlikte çalışma becerisi (Ekip toplantısı, sunuş, görsel sunuş, vb gibi) konusunda kaygılarınız var mı?

1	2	3	4	5
ÇOK VAR	VAR	NORMAL DÜZEYDE	YOK	HİÇ YOK

29- Sizce ileride ID501 Stüdyo dersi dahilinde takım çalışması yaparken karşılaşabileceğiniz problemler neler olabilir?

.....
.....

BELİRTMEK İSTEDİĞİNİZ DİĞER FİKİRLERİNİZİ YAZINIZ:.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

TEŞEKKÜR EDERİM!

APPENDIX D

Second Questionnaire

ID 502 Stüdyo dersinin ikinci projesini, bir önceki takım çalışmasından farklı olarak Bireysel bir proje ile tamamladınız. Aşağıdaki sorular her iki projede farklı olan Takım/bireysel calışma performans farkını değerlendirmeye yöneliktir. Soruları cevaplarken bireysel proje sürecinizi dikkate alarak cevaplayınız. Değerlendirmeleriniz Kişisel bilgileriniz SAKLI tutularak takım çalışmasına yöneklik yüksek lisans tezinde veri olara kullanılacaktır.

Anketi cevaplayabilmek için, cevapların yanına "+" ekleyiniz. Açıklamalar için çizili alana yazabilirsiniz.

Bireysel çalışmanızdaki performansınızı değerlendiriniz.

--- Çok İyi
--- İyi
--- Orta
--- Kötü
--- Çok Kötü

Bireysel projenizde en güçlü olduğunuz aşama hangisi idi? (Birden fazla işaretliyebilirsiniz)

--- Problemi kavrama
--- Konsept yaratma süreci
--- Konsepti sunuş süreci
--- Sketching
--- Ürün fikrine fonksiyonların ve alt fonksiyonların atanması
--- Teknik araştırma
--- Malzeme seçimi
--- Form yaratma
--- Arayüz tasarımı
--- Detay, birleşme çizimleri
--- Bilgisayar modelleme
--- Prototip hazırlama
--- Final sunuşu

Bireysel projenizde en zayıf olduğunuz aşama hangisi idi? (Birden fazla işaretliyebilirsiniz)

--- Problemi kavrama
--- Konsept yaratma süreci
--- Konsepti sunuş süreci
--- Sketching
--- Ürün fikrine fonksiyonların ve alt fonksiyonların atanması
--- Teknik araştırma

--- Malzeme seçimi
--- Form yaratma
--- Arayüz tasarımı
--- Detay, birleşme çizimleri
--- Bilgisayar modelleme
--- Prototip hazırlama
--- Final sunuşu

En zorlandığınız aşama ne idi?, Neden?

Takım çalışması sırasında aynı aşamada zorlandınız mı? Neden?

--- Evet
--- Hayır

Herhangi bir tasarım projesinde hangi çalışma sistemini tercih edersiniz? Neden?

--- Takım Çalışması
--- Bireysel Çalışma

Motivasyonunuz hangi çalışma sisteminde yüksekti?

--- Takım Çalışması
--- Bireysel Çalışma

Birikim ve tecrübelerinizi hangi çalışma sisteminde daha iyi aktarabildiniz?

--- Takım Çalışması
--- Bireysel Çalışma

Zaman kullanımı hangi çalışma sisteminde daha etkindi?

--- Takım Çalışması
--- Bireysel Çalışma

Teşekkürler!

APPENDIX E

Design Brief II

Middle East Technical University Department of Industrial Design
Spring 2001

Prof. K. Munshi & Inst. Fatma Korkut
ID 501 Advanced Project Development in Industrial Design

PROJECT III: Pleasurable and sensual aspects of products

If we look around we find ourselves surrounded by a large number of artifacts and products like TVs, DVDs, cell-phones, furniture, textiles, computers, gadgets and appliances. All these things are man made, hence designed by some person, group or company. Sometimes we find ourselves overwhelmed by these artificial objects around us and start questioning their relevance to our lives. Yet we seem helpless as we are so dependent on these and cannot conceive life without these objects. We see no escape.

However, designers are in a fortunate situation in the sense that they can control the design of products and are qualified to do so in such a way that these objects besides being functional can also be pleasurable.

In this project we will explore the pleasurable and sensual aspects of products and see how these qualities can be enhanced. We will take the function or utility for granted and see how forms, colors, textures can be help do this. Another aspect that we may look at is the ritualistic aspect of their use, which enriches both the product and the user. One of the good examples is Japanese Tea Ceremony of which you must have known, whereby after relishing the taste of freshly made tea you are supposed to look at the cup intently and savor its visual qualities – the texture, the cracks in the ceramic, the pattern etc. It is some kind of meditative experience to internalize the visual experience. We find this ritualistic way of treating very ordinary day-to-day tasks in many cultures, to enliven and enrich life.

Main Tasks

A. Find some examples in Turkish culture. Explain why you made this choice.

B. List the products which are part of this pleasurable, sensual, leisurely or ritualistic experience (many times you will find these are traditional products)
C. Prepare texture and color boards as described in the brief
D. Give contemporary interpretation to these products and redesign to enhance the qualities further.
E. Make several alternatives (min. 5) – high quality renderings of soft models on computer
F. Choose one and make a physical model.

Texture and color exercises

Search for textures, which are, interesting and appealing for you; explore your immediative environment (indoors, outdoors), collect samples and/or take photographs. You may look at different materials, organic or man made structures. Prepare at least ten examples.

Explore the use of color in your immediate surroundings; focus on man-made objects or structures in which color(s) makes a major contribution to the pleasurably of a product or structure, take photographs. Prepare at least ten examples.

Mount each sample on photograph on an A4 board; include a brief description (approx. 80 words).

Preliminary jury May 7, 2001 Monday 9:40
High quality renderings or computer models (A3)
Texture and color boards

Final Jury May 23, 2001 Wednesday 13:30
High quality renderings or computer models (A3)
Exquisite (foam) model finished in white or colored (full scale)

Grading Preliminary jury %50, Final jury %50