ISTANBUL TECHNICAL UNIVERSITY ★ INSTITUTE OF SCIENCE AND TECHNOLOGY

NEW USER-CENTERED METHODS FOR DESIGN INNOVATION: A STUDY ON THE ROLE OF EMERGING METHODS IN INNOVATIVE PRODUCT DESIGN AND DEVELOPMENT

M.Sc. Thesis

Bilge Dinçer MUTLU, B.I.D.

JANUARY 2003

ACKNOWLEDGEMENTS

At the first place, I would like to express my gratitude to my thesis supervisor, Assoc. Prof. Dr. H. Alpay Er for his guidance, support, and patience both throughout my research study and all through my graduate education. I sincerely do appreciate his considerable efforts and interest in my personal and academic development.

I am also grateful to all the members of the Department of Industrial Product Design at Istanbul Technical University, especially Prof. Dr. Nigan Bayazıt for her excellent initiatives and support in the development and execution of the graduate program at ITU and Assoc. Prof. Dr. Özlem Er for her support and guidance all through my academic life.

Furthermore, I would like to thank to Arçelik A.Ş. and members of the Industrial Design team for their help and support throughout my graduate study, especially Industrial Design Manager Mr. Bora Bükülmez for all his support in pursuing my graduate education. I would also like to thank to Senior Manager Mr. Erem Demircan, Senior Designer Mr. Adlıhan Tartan, Social Scientist Mrs. Fatma Bozdemir, Intellectual Rights Group Supervisor, Mr. Sertaç Köksaldı, and all members of the Arçelik community for their effort in my research study.

Moreover, I would like to thank to Ken Friedman from Norwegian School of Management for his guidance through my research and all members of the Design Research Society.

In addition, I am thankful to all the faculty of the Department of Industrial Design at Middle East Technical University, especially Assoc. Prof. Dr. Gülay Hasdoğan, for their guidance and support throughout my academic life.

Eventually, I would like to express my gratitude to my family and my friends for their endless love, support, and patience.

Bilge Dinçer Mutlu **January, 2003**

TABLE OF CONTENTS

ABBREVIATIONS

2D : Two Dimensional

3D : Three Dimensional

CAD : Computer-Aided Design

ICSID : International Council of Societies of Industrial Design

OECD : Organization for Economic Co-operation and Development

PDMA : Product Development Management Association

QFD : Quality Function Deployment

R&D : Research and Development

VR : Virtual Reality

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Our era provides us enormous changes and unforeseen advancements in technology, which lead to specific changes in economic and socio-cultural values. Along with the change in values, the society has shifted its focus from production to information and creativity. As a reflection of this shift, the needs and expectations of individuals have changed into a search for new experiences. As a result, the consumer of this era has started to assess novelty, creativity, and innovation.

Companies, in search of satisfying the new expectations of this era's consumer, aspire to be innovative. They try to develop real novel products matching the consumers' real needs and expectations. To achieve this, they utilize certain innovation processes in which design, especially industrial design plays a significant role by creating meaningful products and features for consumers. Along these lines, design innovation emerges as a new paradigm employing certain methods and sources to persist. The methods of the design innovation activity mostly comprise of the methods of the design practice but concentrates on the user as the main source of innovation. These methods not only apply user information to the innovation process but also stimulate users to be creative and involve in the innovative activity.

Design innovation also appears to be promising from the company perspective. When compared to technological innovation, it stands to be less risky, less expensive, less time-consuming, and less a venture for the company, furthermore, more likely to meet the real needs of the consumer. The advantages of design driven innovation to technology driven innovation also denote a change in the corporate insights and the structure of new product development organizations from conventional 'R&D Centers' or 'Product Development Teams' to emerging interdisciplinary 'design teams' or 'design centers.'

Consequently, this study mainly aims to explore the role of design innovation in innovative product design and development and the role of emerging user-centered methods for design innovation.

CHAPTER I

INTRODUCTION

This chapter aims to build an introduction to the research subject. At the end of the chapter, an outline of the thesis structure is given as well.

1.1. Background of the Research Subject

Our society is facing an era of an enormous *change* and a persistently accelerating *development*. This era provides us unforeseen technological advancements and significant changes in socio-cultural and economic values.

Along with a change in values, the epoch has moved from focusing on *production* to gathering *information* and appreciating *creativity*. New socio-cultural and economic values also lead to new expectations and challenges in both the society and individuals. There is an obvious shift from meeting basic needs to satisfying increasingly higher ones, including sensorial, intellectual, emotional, and cultural needs (Marzano, 2000). The individuals of this era no longer run after simply satisfying their basic needs, but expect their senses and intellect to be stimulated with novel *experiences* (Marzano, 2000). Thus, today's consumer, in search of new experiences, instead of conventional commodities, assesses '*novelty*', '*creativity*', and '*innovation*'.

In this new era, along with new economic values and new expectations of '*the new consumer*' (Schmid, 2001), today's companies are under pressure to be '*innovative'* in a variety of levels in their organizations. Companies with the intent of developing new products, consider '*innovation*' as a basic concern to be obtained. Furthermore, the fact of the market that a high percentage of sales come from products that did not exist a few years ago (Von Hippel et al., 2000) forces them to develop *real* novel products matching 'the new consumer's' *real* needs.

Therefore, the process of developing new products needs new incentives and sources to create real novel products matching consumer's real expectations and needs. In addition, to transform these sources into gateways to innovative products, it is needed predefined and structured '*innovation processes*', to be held within the New Product Development process (Crush, 2000). These innovation processes have recently started to address '*design*', specifically '*industrial design*', as the core of the innovative activity (OECD, 1992). Moreover, '*design innovation*', whereas deficient of a generally agreed definition in the literature, plays a significant role in creating meaningful products and features for users. Furthermore, '*innovation by design*', which is terminologically synonymous with '*design innovation*', when compared with technological innovation, is less risky, less expensive, less time-consuming and eventually less venturing the innovator, on the other hand, more advantageous in obtaining meaningful products for the end users.

Providing users with meaningful products stands to be another problematic concern. As per Marzano (1997), the only way to provide users meaningful products is to involve them in the new product development process. To help develop those products addressing the needs and aspirations of the users, there has been an increasing contribution of the social sciences to the design process centering the user as an information source for new products and features. The contribution of practices including ergonomics, contextual inquiry, applied ethnography, and lately user participation has challenged the design methods in the process of innovative product design and development (Sanders, 2001).

Consequently, this research study aims to explore the 'design innovation' concept as a new paradigm to understand the contribution of design to achieve innovation. Furthermore, this study seeks to investigate the sources and methods of this paradigm by questioning the sources of innovation, design methods, and emerging approaches to design. Eventually, an empirical investigation of the researched issues is performed within the context of a case study of an industry-leader Turkish company.

1.2. Structure of the Study

This study includes the following structure:

Chapter I (*Introduction*) aims to build an introductory background to the research subject. In this chapter, the structure of the study is also explained concisely.

Chapter II (*Research Methodology*) presents the research methods carried out through different stages of the research study. Research aims are also outlined in this chapter.

Chapter III (*Conceptual Background*) studies the 'innovation' concept from a variety of perspectives. Categories, levels, and origins of innovation are explored in detail as well. Furthermore, 'innovation' is examined as a process through which new products are created. 'Design', as the most significant activity involving in the innovation process, is studied in terms of its contribution to innovation.

Chapter IV (*Definition and Importance of 'Innovation by Design'*) aims to highlight the importance of 'innovation *by* design' and build a definition of the 'design innovation' concept besides mentioning relevant concepts in etymological and terminological perspectives.

Chapter V (*Sources of Innovation and Design Methods*), before investigating new methods, seeks to review the sources of innovation and design methods. In this chapter, the importance of user needs is discussed as a source of innovation.

Chapter VI (*New User-Centered Methods for Design Innovation*) initially aims to explore the sources of innovation in the 'design innovation' case and eventually seeks to study new methods for 'design innovation' mainly based on user research.

Chapter VII (*Case Study of Arcelik Corporation*) introduces a reference 'design innovation process' carried out in an industry-leader Turkish company, Arcelik Corporation and investigates the role of new user-centered methods in design innovation. This chapter also explains the acquisition, and existing application of the methods in the company organization.

Chapter VIII (*Discussion and Conclusions*) includes a conclusion of the study. The research findings with regard to the research questions are discussed.

CHAPTER II

RESEARCH METHODOLOGY

This chapter aims to introduce the set of methods used throughout the research process. The selection process of the methods and case study subject is also discussed.

2.1. Introduction

This study has entailed various research methods in different phases of the research, from defining the research questions to concluding the findings of the research. Some of the research concerns have needed the investigation of the most appropriate set of methods that properly matches the researched concern. Thus, throughout this study, a variety of common research methods has been referred and in some cases, the research method has been predefined.

2.2. Aims of the Research

The research process has initiated with a preliminary investigation phase in order to define the research questions. According to Yin (1989), "*defining the research question is probably the most important step to be taken in a research study.*" Therefore, the research concerns have been specified in a straight and clear fashion.

Consequently, this research study essentially aims to:

- Clarify the definition and significance of 'design innovation' concept,
- Investigate the sources of 'Design Innovation',
- Explore the role of emerging user-centered methods in 'design innovation'.

2.3. Research Methodology

As stated before, this research study has been executed with a variety of research methods. In every phase of the research process, a different set of research methods have required. Therefore, the selection of the research methods is mostly based on the characteristics of the research topics. However, every research study includes a level of tacit knowledge that could not be classified, the research methods that have been used throughout this study could be outlined as (1) direct inquiries, (2) literature survey, (3) building a definition, and (4) case study.

2.3.1. Direct Inquiries

The emerging advances in communication and information technologies enable researchers to expand their resources globe-wide and stimulate them to challenge conventional research methods. These challenges include direct access to other researches, scholars, institutions, and so on. In particular, E-mail is one of the challenges that provide researchers direct access to people, and communities in a fast and convenient way. Furthermore, researchers, scholars, or professionals utilize e-mail domain to conduct discussions and share insights within discussion lists, broadly named as ‘e-groups’.

‘Design’ and ‘innovation’ studies represent an interdisciplinary character, and involve the contribution of a variety of perspectives, thus, need challenging methods in order to conduct discussions with an interdisciplinary approach. Hence, e-groups constitute an appropriate medium for researchers and professionals to carry out discussions and share insights on ‘design’ and ‘innovation.

Since, one of the most ambiguous research concerns is the definition of ‘design innovation’ concept and both ‘design’ and ‘innovation’ literatures do not comprise an agreed definition of the concept, direct inquiry method would be a proper way to clarify the ambiguity on the research question. Furthermore, to achieve an interdisciplinary perspective to the clarification of the concept, posting inquiries to relevant e-groups would constitute a pertinent step through the clarification process.

Consequently, with the aim of defining the concept, ‘design innovation’; inquiries have been posted to the following e-groups:

Design Research Society: E-group of Design Research Society with 613 recipients, comprising mostly researchers from Europe, Britain, United States, and other countries, and from 'design', 'management', and other disciplines.

PhD Design: International discussion medium with 711 recipients, comprising design theorist, and researchers from Europe, Britain, United States, and other countries, and from 'design', 'management', 'economics', and other disciplines.

Industrial Design Forum: International forum with 627 recipients worldwide, consisting of academicians and practitioners from design discipline.

In conclusion, around a dozen of replies have been received by significant scholars from a variety of perspectives and countries, including professors and theorists from User-Centered Design, Innovation Development, and Leadership & Strategic Design areas. Replies to inquiries comprise implications to the questioned definition and suggestions for research methods and resources. Eventually, 'direct inquiries' constitutes one of the most significant methods executed in the research process of this research study.

2.3.2. Literature Review

The literature review is an essential method for reviewing an existing literature. Blaxter et al. (1996) describes 'literature review' to be "*a critical summary and assessment of the range of existing materials dealing with knowledge and understanding in a given field.*" However, Leedy (1997) suggests that the scope of the field that a literature review study covers might be well beyond the given field. Leedy (1997) argues that the function of literature review is "*to look again at the literature in a related area: an area not necessarily identical with, but collateral to, your own area of study*." Hence, this method stands to be more than a review of existing literature; it is an important tool for a comparative study of interdisciplinary subjects.

Therefore, the interdisciplinary nature of this study makes the literature review the most essential phase of the research activity. This is mostly due to the multifaceted nature of the research topics, which comprise a diversity of concepts including 'design', 'innovation', 'new product development', 'product & process innovation', 'method & methodology', and so on. Moreover, since a variety of perspectives has been influential on these core concepts theoretically, for a comprehensive

understanding, it is essential to study these significant concepts from a diversity of literatures and perspectives. Therefore, throughout the study, essential concepts, and their significant variables have been studied in the extent of relevant literatures, including 'design', 'economics', 'marketing', and 'management'.

The 'literature survey' method also plays a significant role in clarifying an unclear concept, which provides the researcher with grasping concepts from theoretical, etymological, and terminological perspectives. Thus, while studying on the clarification of the 'design innovation' concept, 'design' and 'innovation' concepts have been examined comprehensively both from terminological and etymological perspectives.

2.3.3. Building a Definition

Concerning the aims of this research, the definition of a very significant concept, 'design innovation' needed to be clarified. Since the 'design innovation' concept comprises two core concepts, 'design' and 'innovation', which, themselves, have a wide scope of meanings, this clarification process seemed to be very complicated. For that reason, the methods that would be used to build a definition should be determined carefully. A relevant set of methods was recommended by Ken Friedman (2002) in reply to a direct inquiry. Although the set of methods he recommended corresponds to a general set of research methods, it can also be properly utilized to build a definition. According to Friedman (2002), to arrive with a definition, the researcher should:

1. State the research problem,
2. Discuss knowledge in the field to date,
3. Discuss past attempts to examine or solve the problem,
4. Discuss methods and approach,
5. Compare possible alternative methods,
6. Discuss problems encountered in the research,
7. Explain how the researcher addresses those problems,
8. Explicitly contribute to the body of knowledge within the field,
9. State implications for future research.

Following the above set of methods, the research problem was initially stated as '*clarifying the definition and significance of 'design innovation' concept*'. Afterward, the 'design innovation' term was deconstructed into basic 'design' and 'innovation' concepts, which were reviewed through a variety of literatures from etymological and terminological perspectives. Later, past implications of the 'design innovation'

term were explored. The discussion of the methodology was excluded for the reason that it would be described in this section.

After reviewing all relevant knowledge in the literature, the meanings of the 'design' and 'innovation' terms within the context of 'design innovation' were described. Afterward, the arrived definition of the term, 'design innovation' was stated. Eventually, further issues on 'design innovation' concept were discussed, including the importance of the concept, advantages of the 'design innovation' activity from the company perspective, contribution of the definition to the innovation literature, and so on.

The most significant concern encountered through the definition process was the resemblance in the meanings of 'design innovation' and regular design activity. Thus, after defining the term, the arguments that distinguish two meanings were explained. Another problematic issue that occurred while defining the term was the wide scope of meanings that the term linguistically embraces. Accordingly, before building a definition, the implications of the concepts that construct the term were narrowed down to specific meanings.

2.3.4. Case Study

In the 'case study' phase of the research study, an empirical investigation of the research topics has been carried out. Although the case study method appears only to provide a verification of the validity of a set of already attained research findings, it is a more essential part of the research process, where the findings of a research attain meaning and validity. Yin (1989) argues that the arrived findings of the literature review phase are mostly perceived as the end of a research study. In contrast, literature review is an essential method to construct "*sharper and more insightful questions*" about the research topic (Yin, 1989).

Yin (1989) describes case study as "*the preferred method when "how" or "why" questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within a real-life context.*" Alternatively, Leedy (1997) describes the case study method as an "*in-depth study of the phenomenon of each 'case' in its natural context and including the point of view of the participants.*" From these perspectives, case study method could be suggested as the empirical inquiry of a set of predefined research questions following a

particular set of methods. According to Yin (1989), "*the case study allows an investigation to retain the holistic and meaningful characteristics of real-life events…*" Moreover, Yin (1989) describes case study as an empirical survey that:

- Investigates a contemporary phenomenon within its real-life context; when
- The boundaries between phenomenon and context are not clearly evident; and in which
- Multiple sources of evidence are used.

In conclusion, the case study method has been selected to inquire the research topics in their real-life contexts. Therefore, under the light of the findings of 'literature review' and 'building a definition' phases, the case study was justified in the scale of a Turkish market-leader manufacturing firm as the method of the empirical investigation.

2.3.4.1. Justification of Single-Case Study and Selection of the Case

After the selection of 'case study' as a research method, the next essential step is designing the research study (Yin, 1989). Within this step, the kind of case study that will be carried out and the selection of the case are subject to consideration. Hence, this research has carried out a single-case study. At this point, describing the underlying principles in selecting a single-case study is meaningful.

Yin (1989) describes the raison d'être of the single-case study within three significant conditions. In the first condition, the case study corresponds to a "*critical case*" in examining a well-formulated theory (Yin, 1989). Under this circumstance, the theory clearly presents a set of proposition with the context they are valid, and the aim of the single-case study stands for verifying or enhancing the theory within the proposed context. The second condition arises where the case signifies an "*extreme or unique case*" (Yin, 1989). In this case, the specified situation or hypothesis is so exceptional that only single-case study could be carried out. The third condition comes about in a "*revelatory case*" (Yin, 1989). Through this case, the researcher examines a case which was previously inappropriate to be researched. However, Yin (1989) does not limit the circumstances with these three, these conditions are the ones mostly taken into consideration.

Table 2.1. The number of published patent registrations in Turkey (Arçelik, 2002aa).

	Tübitak	**Aselsan**	**Vestel**	**Netaş**	**Şişecam**	**Arçelik**
Before 1996	22	-	-	-	1	4
1997	7	-	-	-	1	2
1998	11	-	-	-	-	11
1999	4	2	-	1	1	6
2000	11	-	6	3	4	35
2001	1	-	-	-	-	23
TOTAL	**56**	**2**	**6**	**4**	**7**	**81**

Besides here-unlisted motives, the conditions of this research study mostly refer to the second circumstance. The selected subject for case study research, Arçelik Corporation, happens to be the only appropriate subject, a '*unique*' case, depending on a number of reasons. First, Arçelik appears to exploit the highest number of technological, product and process innovations, concerning its highest number of patents pending in Turkish industrial environment (Arçelik, 2002a). Table 2.1 represents a comparative illustration of the number of patent registrations in Turkey.

Table 2.2. Number of patent and industrial design registrations of foreign and domestic corporations in Turkey (Arçelik, 2002a).

	1994	**1995**	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**Total**
Patent Registrations of Arçelik in Turkey	1	1	9	5	11	33	40	34	9	143
Domestic Patent Registrations in Turkey	148	178	187	210	213	273	265	*	*	*
Foreign patent registrations in Turkey	1244	1520	718	1329	2279	2755	3177	*	*	*
Total patent registrations in Turkey	1392	1698	905	1539	2492	3028	3442	*	*	*
Total Industrial Design registrations in Turkey	-	1523	1810	2141	2049	-	-	-	*	*
Industrial Design registrations of Arçelik	-	-	19	27	22	6	9	4	*	87

** Numbers not updated*

On the other side, Arçelik emerges to save the highest number of industrial design registrations, and to make the highest investment in design and R&D activities when compared to its competitors in Turkish industrial environment (Arçelik, 2002a).

Figure 2.1 symbolizes the ratio of the amount of R&D investments to that of net sales. Furthermore, table 2.2 corresponds to a comparative representation of the number of industrial design registrations in Turkey.

Another reason that makes Arçelik a unique case is that Arçelik encompasses the largest industrial design group in Turkish industrial environment (Arçelik, 2002a). One more noteworthy point supports the uniqueness of Arçelik from the perspective of this research study is that Arçelik is the only company to employ a social scientist within its design group in Turkish industrial environment (Arçelik, 2002a).

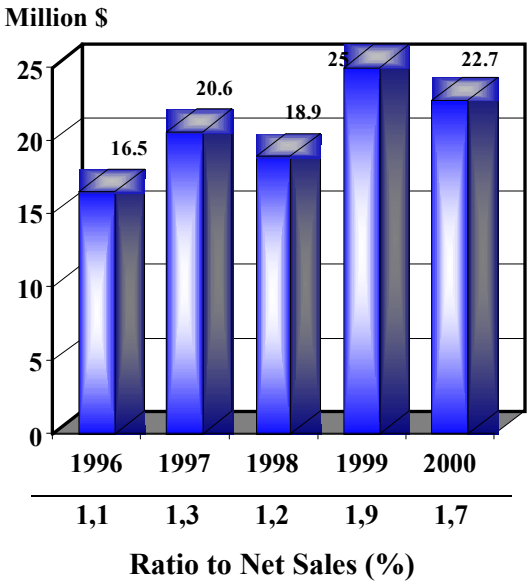


Figure 2.1 R & D investments of Arçelik Corporation (Arçelik, 2002a).

Besides these reasons, the author's past professional experience in Arçelik Corporation helps accessibility to key professionals and documentation, which stands to be a very important advantage in studying such a huge organization as a case study.

2.3.4.2. Data Collection Techniques

Yin (1989) emphasizes the unique strength of the case study method as its capability to comprise a variety of sources of data. Although there might be a larger number of sources appropriate for case study research, he outlines the most significant sources of evidence in six categories as "*documentation, archival records, interviews, direct*

observations, participant-observation, and physical artifacts" (Yin, 1989). According to Cosley and Lury (1987), case study method comprises a set of data collection methods, which could be summarized as follows:

> The case study uses a mixture of methods: personal observation, which for some periods or events may develop into participation; the use of informants fur current and historical data; straightforward interviewing; and the tracing and study of relevant documents and records from local and central government, travelers, etc. (Cosley and Lury, 1987).

Hakim (1987) mentions that case studies typically comprise two or more data collection methods, such as the analysis of administrative records and other documents, surveys, interviews, participant and non-participant observations and collecting other relevant type of evidence. On the other hand, Yin (1994) suggests that case studies should use as many sources as possible, while according to Er (1994); a case study entails the use of at least three of these sources. The case study of Arçelik Corporation mainly relies on interviews, direct observations, documentation, and archival records.

Documentation: Yin (1989) suggests that documentation provides information that could be used in every kind of case study research. Documentary information could be obtained from a variety of corporate or personal documentation, including letters, agendas, event reports, administrative documents, progress reports, and so on (Yin, 1989). According to Yin (1989), the most significant quality of documentary information is that documentation confirms and expands the evidence gained from other sources.

Documentation, including organizational charts, process diagrams, and corporate fact-sheets, was a widely used as a source of evidence through the case study executed within this research study.

Archival Records: Yin (1989) argues that, unlike that of documentation, the relevance of archival records depends on the characteristics of the case study. As per Yin (1989), briefly, service records, organizational records, maps and geographical charts, name lists, survey data, and personal records constitute the archival records.

In this case study, statistical information, archived data on organizational charts and process diagrams, and project archives were used as sources of evidence.

Direct Observations: Observations constitute another significant source of evidence through the case study process. The application of direct observation technique

entails the inspection of the case study "*site*" by an observer or multiple observers (Yin, 1989). Direct observation provides the researcher additional information the research subject.

This case study research involves direct observations executed in the case study site as a source of evidence. Through this technique, a model user research activity has been observed and photographed. Furthermore, a participatory design activity has been observed and output samples were copied.

Interviews: Throughout a case study, one of the most important sources of evidence is attained through interviewing. Yin (1989) describes three major types of interviews in the case study method. First type of interview has an "open-ended" nature, through which the respondent of the interview provides with both facts of matter and his or her own insights in the research concern. In this sense, Yin (1989) illustrates the respondent in this type of interview more as an "*informant*". In the second type of interview, when compared with an open-ended interview, the interviewer follows a certain set of questions in the subject matter. Yin (1989) describes this type of interview as "*focused*" interview. This type of interview may help the interviewer support the facts of matter that the investigator assumes to be already applicable. When executing this type of interview, the interviewer should appear "*naive*" about the subject matter and let the respondent clarify the inquired matter (Yin, 1989). The third type of interview comprises a more structured set of questions, which moves forward as a formal "*survey*" (Yin, 1989). This type of interview might be considered as an effort to corroborate the facts of matter that has already been proved applicable by the research study. According to Yin (1989), in executing all types of interview, tape-recording the interview increases the accuracy of the evidences taken through an interview.

Throughout the case study of Arçelik Corporation, interviews were utilized as the major source of evidence. Concerning the three types of interviews defined by Yin (1989), the "focused" type of interviewed was used through executing the case study.

The selection process of the key respondents also comprises a procedure. In this process, the execution of the interviews has been organized in some 'levels' in the company organization. While determining these levels, this study has referred to the Design Management literature. Chung (1992) mentions that, in a company

organization, design management is performed at three levels, "*strategic, tactical, and operational."* With reference to Chung's (1992) classification, the case study interviews have been executed in all three levels. In the strategic level, Managing Director of Product Management was interviewed. The interview in the tactical level was accomplished with Design Manager, while in the operational level; a senior designer and a social scientist were interviewed.

Throughout this procedure, four sets of questions were prepared and inquired to respondents. The questions was addressed to specific issues in a broad sense that intended to allow the respondent provide all the relevant information on the subject matter. On the other side, besides every question, a set of simplified examples was prepared to assist the respondent to stay on the topic. All interviews were tape-recorded and original manuscripts of the recorded interviews were typed and documented.

2.4. Conclusion

It is evident that, defining and executing the appropriate research methods constitutes the most important part of a research. In some circumstances, the selection and application of the research methods turn out to be more exciting than the research findings. Furthermore, the careful selection of the most appropriate set of methods determines the accuracy and validity of the findings.

This study has initially concentrated on the definition of the research topics. To achieve this, a preliminary literature review was performed. After determining the research topics, keywords and key-concepts, those make up the research topics, were determined to trace relevant literatures. After a comprehensive review of these literatures, the existing knowledge in relevant fields was examined from a variety of perspectives. Moreover, conceptual deficiencies, such as the definition of 'design innovation' concept, in the researched field were determined. As the next pertinent step, these conceptual deficiencies were clarified initially by determining a method and eventually executing it in order to arrive with appropriate definitions. Furthermore, within the framework of these definitions, other research topics were examined by reviewing a diversity of relevant literatures. Lately, a corroboration of the achieved knowledge has been performed with a case study. Eventually, the research findings were concluded and discussed.

In the following chapter, key concepts that make up the research topics will be reviewed in order to build a conceptual background in the existing knowledge in the field. These concepts will be studied initiating from the broad perspective of the innovation concept and lately focusing on the design concept.

CHAPTER III

CONCEPTUAL BACKGROUND

In this chapter, 'innovation' concept is studied in detail from theoretical, historical, and terminological perspectives. In addition, 'innovation' is examined as a process through which a variety of subordinate processes is carried out in order to create new products. In this context, as the most significant activity underlying the innovation process, 'design' is focused on in terms of its contribution to innovation.

3.1. Broad Definition of the 'Innovation' Concept

The term 'innovation' has its roots from the Latin word '*novus*', which means '*new*' and is derived into the verb *'in+novāre'* that covers the meaning '*to make new*'. Therefore, in the broadest context, '*to innovate'* is '*to begin or introduce (something new) for the first time*', and 'innovation' has the meaning of '*the act of introducing something new*' (The American Heritage Dictionary, 2000).

Leonard and Swap (1999) studies 'innovation' truly connected with 'creativity'. According to Leonard and Swap (1999), 'innovation' is the end result of a creative activity. Within this framework, they define '*creativity*' as "*...a process of developing and expressing novel ideas that are likely to be useful*" (Leonard and Swap, 1999). Such a definition emphasizes not only the new, *novel* and *unusual*, but also *'useful'* characteristics of the 'creative activity', which leads to have the potential for utility. They also dwell upon the creative activity to be a 'process'.

From this perspective, as the end result of the creative process, "*Innovation is the embodiment, combination, and/or synthesis of knowledge in novel, relevant, valued new product, processes or services*" (Leonard and Swap, 1999).

In a more technical point of view, 'innovation' is recognized as a synonym for '*invention*', which means '*a new device or process created by study and experimentation'* (WorldNet, 1997). Known to be used quite after the term

'invention', according to the Product Development Management Association, the act of 'innovation' *'...includes invention as well as the work required to bring an idea or concept into final form*' (Rosenau, 1996).

According to Tidd et al. (2001), "*innovation is more than simply coming up with good ideas; it is the process of growing them into practical use*." They expose *invention* as "*only the first step in a long process of bringing a good idea to widespread and effective use*" (Tidd et al., 2001). They distinguish two actions with dramatic examples from history:

> In fact, some of the most famous inventions of the nineteenth century were invented by men whose names are forgotten; the names which we associate with them are of the entrepreneurs who brought them into commercial use. For example, the vacuum cleaner was invented by one J. Murray Spengler and originally called an 'electric suction sweeper.' He approached a leather goods maker in the town who knew nothing about vacuum cleaners, but had a good idea of how to market and sell them –one W. H. Hoover. (Tidd et al, 2001)

3.2. The Theory of Innovation: A Historical and Theoretical Overview

The theory of innovation dates back to the early studies on the capital system. It was Bacon, at the beginning of the 17th century, who suggested a 'science-created utopia' on the role of the developments in science and technology in society. His views were opposed by Bernal of his generation giving importance on the uses of new discoveries for societal wealth rather than their own creation. Later, Smith, in the second half of the 18th century, suggested technological change as a major concern to develop industrial production. In the first half of the 19th century, Marx put forward the view that technological advancements –and improved industrial production- had displaced the 'worker' causing confusion in the social order. Lately, it was Schumpeter, in the first half of the 20th century, who first mentioned 'innovation' "…keeping the capitalist engine in motion." Schumpeter suggested innovations to be imperative for economic growth, commercial profit, and thus, public wealth. Profoundly discussed by scholars from the marketing discipline for ignoring the role of marketing in the theory of innovation, Schumpeter's theory, has later been developed by neo-Schumpeterian economists Freeman and Dosi. Recently, contributions from diverse disciplines including Design, Management, and Marketing have developed the modern theory of innovation (Smith, 1776; Schumpeter, 1934; Freeman, 1990; Elliot, 1985; Sylwestor, 2000).

3.2.1. Development of the Theory of Innovation

Development of the Innovation Theory has its roots in the development of the Theory of Economic Development. The classical economists, including Smith and Ricardo, first studied 'Economic Development'. Later, the Marxists, the neo-classical theorists, the Schumpeterians, and post-Keynesians have had essential theoretical contributions in the theory of economic development.

Smith (1776) was fundamentally the first classical economist to study the theory of technological change and its impact on economic growth. He believes that economic development is a gradual, self-perpetuating process. He builds his theory on the eighteen-century doctrine of natural law. He asserts that, within the control of the natural legal system, each member of the society is free to pursue his self-interest that will result in a harmonious, beneficial economic order. According to him, development has a tendency to become cumulative which results in an increase in the saved capital -Smith describes it as 'Capital Accumulation', which is a fundamental element in economic development and an increase in the extent of the market, finally, will result in an increase in national income and growth in population (Original Source, Smith, 1776; Quoted from Meier and Baldwin, 1957). Smith's classical theory mentions developments to result in "improvements in art" which will lead to further specialization and productivity gains (Meier and Baldwin, 1957). Furthermore, Ricardo examined the classical analysis of economic development in a more analytical manner and in detail.

In the Marxist point of view of the economic development, development occurs in defined stages, for instance, birth, progressive evolution, decline, and death. Modern economists criticize Marx's analysis of economic development as a weak theory such as the other 'stage' theories in the history (Meier and Baldwin, 1957). However, Marx's theory, which covers a variety of topics including economics, sociology, political theory, history, and philosophy, has essential contributions in the understanding of the general system. Moreover, Marxist analysis, though in a pessimistic manner, is first to bring a dynamic point of view in the theory of economic development.

It was later the neo-classical economists including Alfred Marshall, Knut Wicksell and Gustav Cassel, who developed the classical point of view in the economic

development. The neo-classical analysis discusses the economic development as a gradual and continuous process, which has a harmonious and cumulative nature. Marshall (1919) mentions, "…The maxim that 'Nature does not willingly make a jump'…is specially applicable to economic developments." According to the neo-classical point of view, not only economic development, but also technological change and the adoption of new inventions are gradual and continuous (Meier and Baldwin, 1957). Marshall (1930) explains this gradual process as follows,

> And though an inventor, or an organizer, or a financier of genius may seem to have modified the economic structure of a people almost at a stroke,; that part of his influence, which has not been merely superficial and transitory, is found on inquiry to have done little more than bring to a head a broad constructive movement which had long been preparation.

In summary, the neo-classical theorists discuss technological change to occur in a smooth and continuous fashion, which is explained as a gradual "progress and diffusion of knowledge" (Marshall, 1930).

Along with other analyses on economic development, Schumpeterian analysis brings an outstanding point of view in the studies on economic development. Schumpeter (1934, 1939, 1942, 1954a and 1954b), in his views, rejects the neo-classical explanation of economic development as a gradual, harmonious process. According to Schumpeter, instead of a gradual and smooth way, development occurs if a high degree of risk and uncertainty occurs (Meier and Baldwin, 1957).

Schumpeter's theory of economic development combines the state of equilibrium of the neo-classical analysis with the dynamic vision of the Marxist analysis. It is considered that *"...Schumpeter provided the most comprehensive and provocative analysis since Marx of the economic development and social transformation of industrializing capitalism*" (Elliot, 1985). Schumpeter explains the equilibrium state, mostly relying on the general equilibrium theory of neo-classical economist Walras, with the 'circular flow' principle (Schumpeter, 1954b). According to 'circular flow', there is a static equilibrium represented by a constantly repeating circular flow of money and goods. The only events are routine changes to which producers and consumers can easily adapt themselves (Dixon, 2000).

Schumpeter's dynamic theory exposes a disturbance of equilibrium of 'the circular flow' of a constantly growing, static economy by clusters of innovations. Schumpeter believes that, there is no possibility of profiting in the equilibrium state and

innovations are essential to make profit. According to Schumpeter, innovations increase the economic activity by activating other innovators – as Schumpeter's definition, 'entrepreneurs'. This economic activity reaches to a mature state and alleviates itself and economy returns to the state of equilibrium. Thus, Schumpeter believes that innovations lead to the development and growth of the economy, and eventually to prosperity and wealth (Schumpeter, 1939).

> If innovations are being embodied in new plant and equipment, additional consumers' spending will result practically as quickly as additional producers' spending. Both together will spread from the point or points in the system on which they first impinge, and create that complexion of business situations, which we call prosperity (Schumpeter, 1939).

Depending on Schumpeter's theory of economic development, innovations are the driving forces leading a capitalist economy to run:

> The fundamental impulse that sets and keeps the capitalist engine in motion comes from new consumer goods, the new methods of production or transportation, the new markets, the new forms of industrial organization that capitalist enterprise creates (Schumpeter, 1942).

Another complementary concern of Schumpeter's development theory seeks to explain is a 'process of creative destruction'. Schumpeter (1934) explains 'the process of creative destruction' as a replacement of old structures that "*…the great economic and social process by which businesses, individual positions, forms of life, cultural values and ideas, sink in the social scale and finally disappear*" (Schumpeter, 1934).

In Schumpeter's 'Theory of Economic Development', innovations stimulate new innovations, constituting 'clusters of innovations', open new profitable opportunities, obtain profit and growth in the economy, and finally result with an enhancement in the standard of life of the public. Schumpeter suggests that each cluster of innovation –innovations subsequently appearing– is "*…an avalanche of consumers' goods that permanently deepens and widens the stream of real income*" (Schumpeter, 1942).

> If we look at those avalanches of consumers' goods we again find that each of them consists in articles of mass consumption and increases the purchasing power of the wage dollar more than that of any other dollar –in other words, the capitalist process, not by coincidence but by virtue of its mechanism, progressively raises the standard of life of the masses (Schumpeter, 1942).

Therefore, Schumpeter's theory of innovation suggests that innovation, which is the force behind the capitalist economic system, eventually brings about the growth of the economy and the increment in the standard of life.

3.2.2. Innovation, Categories of Innovation, and the 'Innovator'

Different disciplines define and categorize 'innovation' in different ways, while the theory of innovation constitutes a basis for all of them. In addition, the role and position of the 'innovator' differentiates from one discipline or industry to another.

3.2.2.1 Significant Definitions of Innovation

Since Schumpeter (1934, 1939, 1942, 1954a and 1954b) was the first economist, who concentrated on the role of 'innovation' in economic development, neo-Schumpeterian economists including Christopher Freeman (1982) and Giovanni Dosi (1988) has made significant improvements in Schumpeter's arguments.

Freeman (1982) has made one of the most significant post-Schumpeterian studies on the theory of innovation, in which he defines 'innovation' as including *"...technical, design, manufacturing, management and commercial activities involved in the marketing of a new (or improved) product or the first commercial use of a new (or improved) process or equipment*" (Freeman, 1982).

Contemporary marketing literature identifies innovations from the standpoint of the 'investor' in a way that is similar to that of Schumpeter. Cooper (2000) mentions that an innovation relies on the notion of commercial risk. According to him, any change of the product that is perceived by the consumer, and therefore creates risk to the brand, business, or franchise, is considered an innovation. Consequently, as Schumpeter (1939) identifies, supposed commercial risks constitute potential profits for the investor.

3.2.2.2 Categories of Innovation

Schumpeter (1934) classifies innovations in two major categories: Product and process innovations. A process innovation replaces "*...one production or consumption good by another, which serves the same or approximately the same purpose, but is cheaper*" (Schumpeter, 1934). According to him, process innovations also include introducing new materials or supplies with having the potential of producing a unit of product cheaper (Schumpeter, 1934). Although some of the post-Schumpeterian studies on the theory of innovation point out 'organizational innovations' as a distinct innovation category, Schumpeter (1934) includes organizational innovations in process innovations.

Product innovations comprise *'...the creation of a new good which more adequately satisfies existing or previously satisfied needs*" (Schumpeter, 1934). Product innovations also include the creation of completely new products, which proves a monopoly position to the innovator.

In Schumpeter's theory, there are five types of innovations that comprise the following two major categories (Meier and Baldwin, 1957):

Process innovations:

1. A new method of production,
2. A new source of supply of raw material or semi-finished goods,

Product innovations:

3. A new good,
4. A new quality of a good, opening a new market,
5. A new industry structure as the creation or destruction of a monopoly position.

Although Schumpeter (1934) draws a line between product and process innovations, Tidd et al., (2001) suggest that the dividing line is blurred. They give the example of a 'new jet-powered sea ferry' as both a product and a process innovation. Furthermore, according to them, 'innovation can take place by repositioning the perception of an established product or process' (Tidd et al., 2001).

As per Utterback and Abernathy (1975), "*a product innovation is a new technology or combination of technologies introduced commercially to meet a user or a market need*." They define a production process as "*the system of process equipment, work force, task specifications, material inputs, work and information flows, etc. that are employed to produce a product or service*", thus a process innovation is the improvement of process elements, production unit's internal organization structure, supplier interaction, et cetera to improve efficiency and output productivity of a production process (Utterback and Abernathy, 1975).

OECD (1992) also categorizes innovations as 'product innovations (major and incremental)' and process innovations', but distinguishes 'technological innovations' as a diverse category of innovation that contains both product and process innovations. According to OECD (1992), technological innovations, the same as 'inventions', has to be implemented in a product or process to become and innovation that has a commercial value. As indicated by them:

> *Technological innovations* comprise new products and processes and significant technological changes of products and processes. An innovation has been implemented if it has been introduced on the market (product innovation) (OECD, 1992).
>
> *Major product innovation* describes a product whose intended use, performance characteristics, attributes, design properties or use of materials and components differ significantly compared with previously manufactured products. Such innovations can involve radically new technologies or can be based on combining existing technologies in new uses (OECD, 1992).
>
> *Incremental product innovation* concerns an existing product whose performance has been significantly enhanced or upgraded. This again can take two forms. A simple product may be improved (in terms of improved performance or lower cost) through use of higher performance components or materials, or a complex product which consists of a number of integrated technical subsystems may be improved by partial changes to one of the subsystems (OECD, 1992).
>
> *Process innovation* is the adoption of new significantly improved production methods. These methods may involve changes in equipment or production organization or both. The methods may be intended to produce new or improved products which cannot be produced using conventional plants or production methods or to increase the production efficiency of existing products (OECD, 1992).

Utterback and Abernathy (1975), in a distinctive approach, suggest an 'integrative theory' of the innovative process, where they describe 'innovation' in two terms, 'process and product development', and suggest an integration between process and product innovations which is a 'Stage of Development' theory. They explain their theory as follows:

> As a production process develops over time toward levels of improved output productivity, it does so with a characteristic evolutionary pattern: it becomes more capital intensive, direct labor productivity improves through greater division of labor and specialization, the flow of materials within the process takes on more of a straight line flow quality (that is flows are rationalized), the product design becomes more standardized, and the process scale becomes larger (Utterback and Abernathy, 1975).

However innovation theorists dwell upon mostly two types of innovations, product and process innovations, contemporary marketing studies address further types of innovations, for instance, Campbell and Collins (2001) mention innovations in 'finance' and 'customer interface and channel'. Innovation in 'finance' is creating new ways to make profit or attract investment. According to Campbell and Collins (2001), the latest business-to-business exchanges, which seek to change the relationship between buyers and suppliers, and lately, the Internet, has opened the door for an accelerated growth in this type of innovation. 'Customer interface and channel' innovation affect the customer relationship and the go-to market strategy, for example, Internet purchasing and telephone based insurance (Campbell and Collins, 2001).

3.2.2.3 The Innovator: The Concept of 'Entrepreneur'

Schumpeter illustrates innovation as an 'entrepreneurial' action and locates an innovator that he calls 'entrepreneur' at the center of his theory (Meier and Baldwin, 1957). He makes a distinction entrepreneurial activity with ordinary managerial activity:

> The mere head or manager of a firm who runs it on established lines… And surely it is but common sense to recognize that economic function of deciding how much wool to buy for one's process of production and the function of introducing a new process of production do not stand on the same footing, either in practice or in logic (Schumpeter, 1939).

According to Schumpeter (1934), the entrepreneur *"...seeks out difficulties, changes in order to change, delights in ventures.*" Schumpeter distinguishes the 'entrepreneur' figure with the 'capitalist' (Meier and Baldwin, 1957). The capitalist provides the production with a volume of capital and the entrepreneur leads the use of this capital. Marshall (1919) also differentiates the entrepreneur from the capitalist with his leadership qualities: "*It is leadership rather than ownership that matters*."

In his later studies, Schumpeter (1942) argues that the entrepreneur disappears as innovation becomes routine. He mentions that innovations are becoming 'the business of trained specialists' (Schumpeter, 1942). Thus, specialized teams replace the role of the 'entrepreneur' whilst innovation becomes more impersonal and mechanized (Schumpeter, 1942).

3.3. Origins and Levels of Innovation, Summary of Innovation Studies

In the second half of the 20th century, scholars originating from diverse disciplines have made a variety of studies, in which they have aimed "a detailed analysis of how the process of innovation took place in firms and industries" (Coombs et al., 1987). Within these studies, different concerns have been addressed including the diffusion of innovations in manufacturing industry, the R&D activities within enterprises, the origins of innovations, the role of patents, the influence of innovation on competitive trade performance and on productivity growth, etc. (Freeman, 1990). Table 3.1 gives a list and a summary description of these studies.

Table 3.1 A summary of innovation studies (Coombs et al., 1987, updated from Tidd et al., 2001).

Study Name	*Summary Description*
HANDSIGHT	An analysis of the relative contribution of basic science, applied science and technological events to the development of twenty weapons systems. Sponsored by the USA Department of Defense (DoD). (Sherwin and Isenson, 1967).
TRACES	An analysis of the relative contribution of non-mission research, mission oriented research, development and application in the development of five innovations. Sponsored by the National Science Foundation (NSF). (TRACES, 1968).
Project SAPPHO	A comparative analysis of 'paired successful and unsuccessful innovations in the chemical and scientific instrument industries. A total of 43 pairs was investigated (22 chemicals, 21 instruments) and the sample was international. The success / failure criteria were commercial. Also looked at factors associated with 34 of the failures. (Rothwell et al., 1974).
The Hungarian SAPPHO	An adaptation of the SAPPHO pair comparison technique to 12 success / failure pairs in the Hungarian electronics industry. (Szakasits, 1974).
Carter and Williams	Studied the characteristics of 200 technically progressive firms in the UK. (A technically progressive firm was one which, on a necessarily subjective judgment, was keeping within a reasonable distance of the best current practice in the application of science and technology). (1957).
Myers and Marquis	Studied the characteristics of 567 successful technological innovations in five industries in the USA. (Railroad supplies, housing supplies, computer manufacturers, computer suppliers). (1969).
Queen's Award Study	Studied 84 innovations in the UK which gained the Queen's Award to Industry for innovation between 1966 and 1969. Identified factors associated with success and factors causing delay in innovation. (Langrish et al., 1972).
Belgian Study	Studied innovation strategy and product policy in 12 Belgian enterprises over a ten to fifteen year period. Success criterion commercial (profit margin better than 7 per cent). (Hayvaert, 1973).
Dutch Study	Studied the factors affecting the innovation potential of 45 Dutch companies in the metal-working sector between 1966 and 1971. The success criterion was commercial i.e. 1971 turnover of innovations marketed since 1966 X 100 / total turnover 1971, which gives a measure of relative innovative capacity within the sector. (Schock, 1974).
MIT Study	Investigated the factors affecting success and failure in innovation in five industries (automobiles, industrial chemicals, computers, consumer electronics, and textiles) and five countries (France, F. R. Germany, Netherlands, Japan, UK) –total sample consisted of 164 innovations. (Utterback et al., 1975).
Textile Machinery Study	Investigated the factors surrounding the generation of 20 radical and 15 incremental innovations (all commercial successes) in the textile machinery industry. Looked also at the factors associated with 18 failures (10 incremental, 8 radical). The project included the detailed study of some 20 enterprises and the sample was international. (Rothwell, 1976 a and b).
Gibbons, Johnston Study	Compares the relative importance of different sources of information, one of which is the scientific community, as inputs to the innovation process. (Gibbons, Johnston, 1974).
Minnesota Studies	Detailed case Studies over an extended period of 14 innovations. Derived a 'road map' of the innovation process and the factors influencing it at various stages (Van der Ven et al., 1989).
Project NEWPROD	Long-running survey of success and failure in product development (Cooper and Kleinschmidt, 1990).
Stanford Innovation Project	Case studies of (mainly product) innovations, emphasis on learning (Maidique and Zirger, 1985).
Industry and Technical Progress	Survey of UK firms to identify why some were apparently more innovative than others in the same sector, size range etc. Derived a list of managerial factors which comprised 'technical progressiveness' (Carter and Williams, 1957).
Sources of Innovation	Case studies examining different levels of user involvement (Von Hippel, 1988).
Winning by Design	Case studies of product design and innovation (Walsh et al., 1992).

3.3.1. The Origins of Innovation

One of the major concerns that innovation studies represented in Table 3.1 seek to elucidate is the driving force behind innovations. The studies of two of the most significant characters of the theory of innovation, Schumpeter and Schmookler, have produced a debate in the origins of innovation (Coombs et al., 1987). According to Schumpeter (1942), technology is the main driving force behind economic development and thus, growth. On the other hand, Schmookler (1966) emphasizes the role of demand factors as the main determinant of innovative activity. Consequently, the distinction between two ideas brought about one of the most argued issues of the innovation studies, 'the demand-pull / technology-push debate' (Coombs et al., 1987).

A group of empirical studies, most of which were cited in Table 3.1, has aimed to examine these two approaches in terms of their significance as the driving force behind the innovative activity. Mowery and Rosenberg's (1979) analysis of these studies exposes that 'demand' and 'supply' are very important determinants of the innovative activity, while the coupling of 'technology' and 'market' is imperative for the success of the innovation. Coombs et al. (1987) conclude that these studies has shown that innovation is a very complex process and that, therefore, it is not possible any more to consider and particular factor, be it science or user needs as the sole or the fundamental determinant of innovation.

On the other side, according to Freeman et al. (1982), neither technology-push nor demand-pull predominantly lead to innovations, in fact, each leads to the other at different levels of development in the industry. Freeman et al. (1982) determine that technology-push tends to be more predominant in the early stages of development in the industry, while demand-pull tends to prevail in the more mature stages of the product cycle.

The studies of Utterback and Abernathy (1975) represent a similar approach to the origins of innovation in their integrative theory of product and process innovations. They suggest that the origins of innovation changes through different stages of a product's life cycle. According to them, in the earlier phases of a product's life cycle, innovation is "need" stimulated; while in the corresponding phase of the development of a production process, the driving force behind innovation is the

output rate of production. In the more mature phases of a product's life cycle, the product and process innovations are technology stimulated while in the most mature late phases, the stimulation shifts to the cost of the product and efficiency or the production process (Utterback and Abernathy, 1975). Figure 3.1 represents the shifts in the origins of innovation through different phases of a product's life cycle.

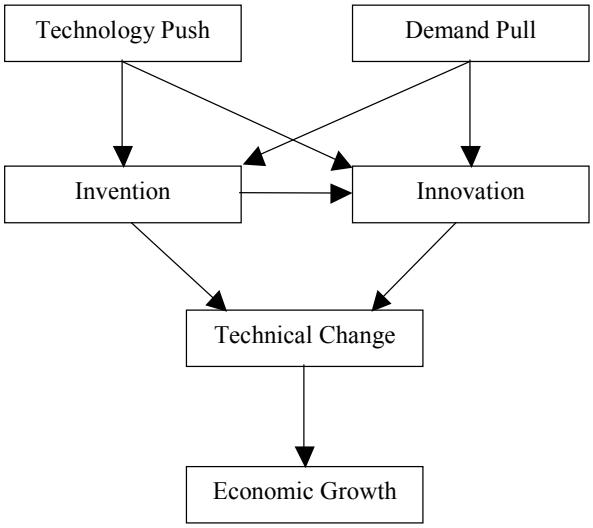


Figure 3.1 The origins of Innovations and their relationship with Economic Growth (Rothwell, 1994; Quoted from Ergin, 2000).

3.3.2. Levels of Innovation

Almost all of the innovation theorists agree that innovations happen in different degrees of *novelty*. This argument is pioneered by Schumpeter (1934), who mentions 'swarming secondary innovations' that compete for a share in the high, monopoly profits of the first new product. Tidd et al. (2001) give the example that 'increasing the speed and accuracy of a lathe is not the same thing as replacing it with a computer-controlled laser forming process'. The degrees of novelty vary from minor, incremental improvements to radical changes that totally change the way a product is perceived or a process is held in an industry (Tidd et al., 2001). Figure 3.2 represents the two dimensions of innovation, different levels of novelty and type of innovation.

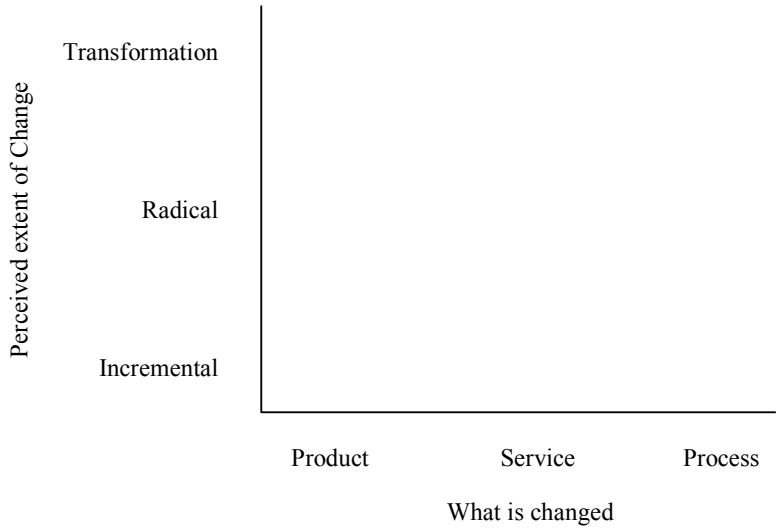
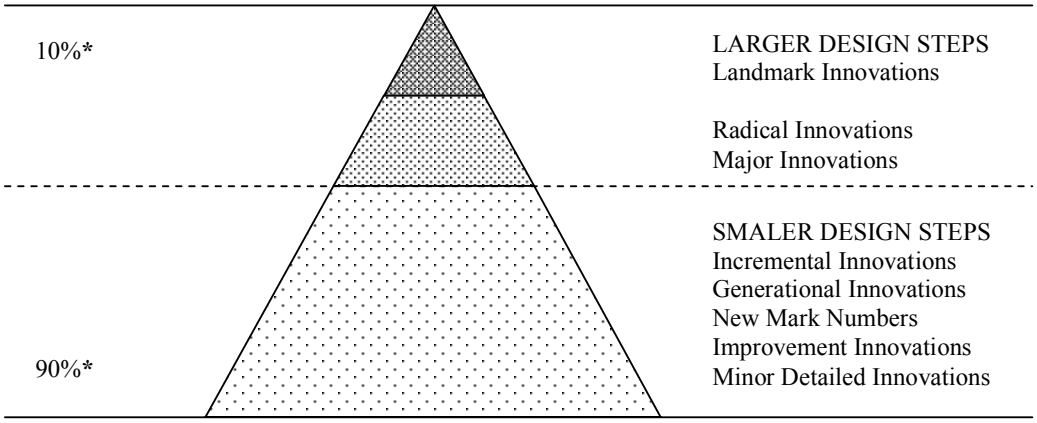


Figure 3.2 Dimensions of innovation space (Tidd et al., 2001).

The importance of incremental innovations has been assessed after the studies of Langrish et al. (1972) on 'post-innovation performance'. Walsh et al., (1992) describe 'post-innovation performance' as attempting 'to see how companies introduce incremental innovations and design changes in order to compete'. According to Walsh et al. (1992), 'the successful companies are those which improve their products in response to user needs and continuously modify and adapt their designs in response to new technologies and competing products'. Also, Freeman (1982) categorizes innovations as (a) incremental innovations, (b) radical innovations, (c) new technology systems and (d) pervasive generic technologies.



* Authors' estimates.

Figure 3.3 Levels of technical change (Rothwell and Gardiner, 1988).

Rothwell and Gardiner (1988) connect the importance of incremental innovations to the high rates of technological change. According to them, during periods of high rates of technological change, there exist relatively few radical innovations in each industry. They discuss that once a radical innovation is introduced to the market, it leads to various incremental innovations, and major or minor re-design variations developed on the radical innovation. Figure 3.3 corresponds to their identification on the technical change, consisting a radical innovation and subsequent incremental innovation.

Rothwell and Gardiner (1988) describe re-designs or re-innovations as "combining the existing with the new." According to them, a re-design is a kind of product innovation that initially employs largely existing technology, but opens up a new and fast growing usage for the user. Both Rothwell and Gardiner (1988), and Walsh et al. (1992) approach re-designs and incremental innovations to be more important economically and commercially than producing the original invention or product innovation. Figure 3.4 shows their approach to re-designs and re-innovations.

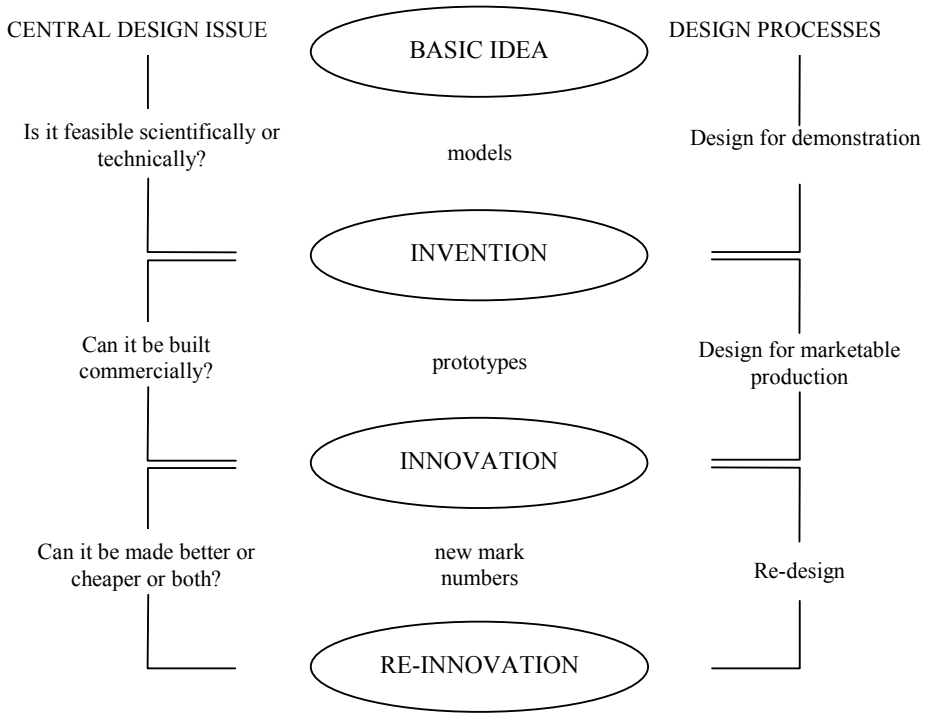


Figure 3.4 States of technical change (Rothwell and Gardiner, 1988).

The term ‘robust design’, which is called ‘dominant design’ by Walsh et al. (1992) and ‘basic design’ by Tidd et al. (2001), is another concept mentioned by Rothwell and Gardiner (1988). According to them, a robust or dominant design is a central design having the flexibility to be differentiated by re-designs to answer a diverse set of user or market needs. The original description of term is as follows:

> A robust design is one that has sufficient inherent design flexibility or ‘technological slack’ to enable it to evolve into a significant ‘design family’ of variants…a robust design is one that can satisfy the evolving needs of a ‘set’ of user segments. For the manufacturer it offers shared experience benefits and economies of scale combined with economies of scope; for the user it offers maximum choice from among a set of well-proven products (Rothwell and Gardiner, 1988).

According to Rothwell and Gardiner (1988), product families, with variations on a robust design, offer the user ‘learning from experience, the enhanced possibility of user-inspired modifications, a wider alternative price-performance packages, and rapid adaptations to changing environments’. Robust designs and product families give the flexibility and economy to the producers when compared to single innovations configured for lean production. For both producers and users, robust designs diminish uncertainties and minimize risks (Rothwell and Gardiner, 1988).

Management literature’s approach to the different levels of innovation is discrete. Cooper (2000) examines product innovation in terms of ‘newness’ of the product in two dimensions, ‘new to the company’ products and ‘new to the market’ products. New to the company products, activate companies to achieve process innovations that aim cost-reduction and risk minimization and incremental product innovations. On the other hand, a new to the market product is the first of its kind on the market, which closely refers to a ‘radical innovation’ with successful market implementation. Cooper (2000) identifies six categories of *newness* in product innovations, (1) new-to-the-world products, that are first of their kind and that create an entirely new market, (2) new product lines, that are not new to the marketplace, but are quite new to the company, (3) additions to existing product lines, that are new items to the company, but fit within an existing product line of the company, (4) improvements and revisions to existing products, that are replacements of existing products in a company’s product line with improvements in performance and perceived value, (5) repositionings, that are new applications for existing products and retargeting of old products to new market segments or for different applications, (6) cost reductions, that are new products designed to replace existing products in the line, with similar

performance and value but lower cost, which also involve significant process innovations. Figure 3.5 represents a matrix of the categories of new products and percentage values of the products in these categories in total new products.

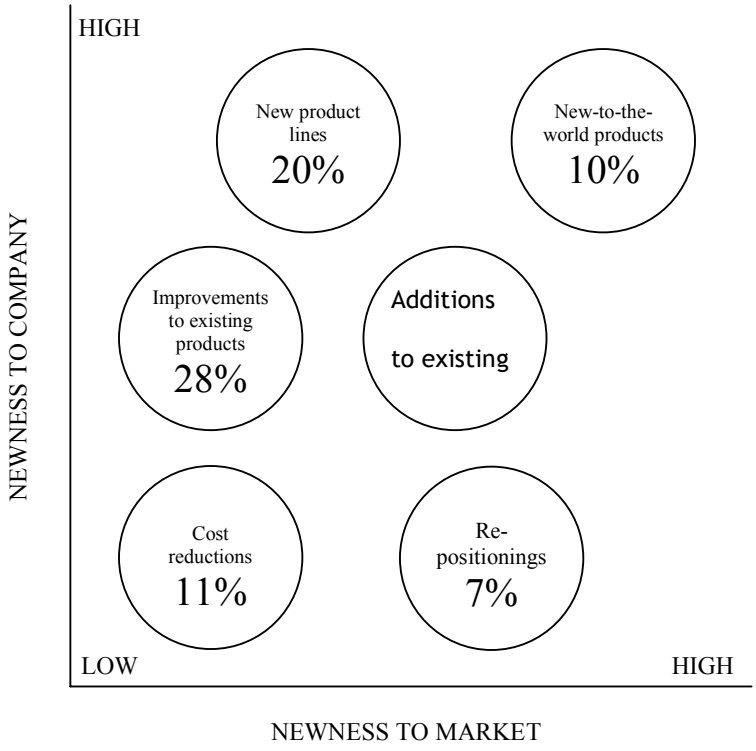


Figure 3.5 Categories of new products (Cooper, 2000).

3.3.3. Product Life-cycle and Innovation

A product, after being introduced to the market, possesses a certain lifecycle, through which the marketable qualities of a product are exposed to certain changes. Rosenau (1996) defines this lifecycle in four stages until the product disappears in the market: (1) introduction, (2) growth, (3) maturity, and (4) decline.

All through a product's lifecycle, numerous innovations, whether product component or process innovations, come out in different degrees, radical or incremental. Myers and Marquis' (1969) study of 567 commercially successful innovations, cited in Table 3.1, provide an extensive resource in understanding the relationship of innovation and product life cycle. Thus, Utterback and Abernathy (1975) rely on the analysis of their study in developing 'an integrative theory of the innovation

process'. Utterback and Abernathy (1975) put forward two models of development in a product's life cycle and suggest a number of integrated stages within the two models that distinguish with a couple of variables. The relationship of these stages and two models of innovation are represented in Figure 3.6.

The first model of development is the 'model of process development', where Utterback and Abernathy (1975) identify definite stages in the development of a production process. These definite stages of the development in a production process distinguish in their characteristics of their evolutionary pattern. As per Utterback and Abernathy (1975), as a production process develops over time, it becomes more capital intensive, direct labor productivity improves through greater division of labor and specialization, the flow of materials within the process takes on more of a straight line flow quality, the product design becomes more standardized, and the process scale becomes larger. Furthermore, in the development of a production process, evolution take place not only in the characteristics of productivity factors but also in secondary factors including the internal organizational structure, the development of a supplier industry for special materials, and technology based on capital goods. Utterback and Abernathy (1975) define these stages as, 'uncoordinated', 'segmental', and 'systemic'.

The 'uncoordinated stage' of the development of production process is the early life of the process and product, where the process is organized mainly on unstandardized and labor-driven operations that rely mostly on general-purpose equipment. In this development stage of a production process, production is very flexible and responds easily to environmental change, but is inefficient on the other hand. In the 'segmental stage' of the development of production process, production systems are more elaborated for increasing production efficiency. Although more sub processes in this stage of development are highly automated, there still exist labor-driven operations still enabling the flexibility of the process. The 'systemic stage' of development is the most highly developed and integrated stage in a production process. This stage demonstrates the maximum efficiency in production, but minimum flexibility to respond the environmental variables. Within this stage, the processes grow to be very integrated and automated; hence, changes and large-scale improvements become slow and costly (Utterback and Abernathy, 1975).

The second model of development that Utterback and Abernathy (1975) put forward along with their study is the 'model of product development'. Within this model, they study on the stages of development of products over time with sequentially emphasizing on, initially 'product performance', then 'product variety or differentiation' and lately, 'product standardization and cost-efficiency'. These sequential stages on the other hand may constitute the production company's competitive strategy in an industry. From this perspective, a company tending to introduce technically advanced products that meet the market for the first time may have a 'performance-maximizing' strategy, one tending to be a follower in obtaining innovation but be ready to introduce new variations and improvements in a product may have a 'sales-maximizing' competitive strategy, and a company entering a market at the later stages of a product's life cycle introducing more standardized and economic versions of a product may have a 'cost-minimizing' strategy. Furthermore, a company's competitive strategy may tend to evolve from one strategy mentioned above to another in time. In addition, through distinct stages of the development of a product or in the different strategies of a production company, the level and sources of innovation vary. Consequently, Utterback and Abernathy (1975) suggest a relationship between the change in product characteristics and the development in production processes, on which these scholars' integrative theory mostly rely on.

According to Utterback and Abernathy (1975), a company with a 'performance-maximizing' strategy might emphasize unique products and product performance in the early phases of a product's life cycle. In this stage of the development of a product, product innovations are mostly stimulated by new market needs and opportunities rather than new scientific results and advanced technology. Also in this stage, there is a high degree of market uncertainty for the product. In the 'sales-maximizing' stage of the development of a product, market uncertainty is less along with product's familiarity to the market. In this stage, the competition in the market is based on product differentiation with dominant or robust designs (as previously explained by the studies of Rothwell and Gardiner, 1988). As the familiarity of the product in the market increases and uncertainty reduces, companies increasingly tend to use advanced technology for incremental product and process innovations. These innovations are mostly stimulated by the demand for increased production output and result in new organization models and product designs as well as improved

production process. In the later phases of a product's life cycle, companies may tend to have a 'cost-minimizing' strategy where the market for the product becomes mature and the product becomes standardized. As product variety is reduced, the emphasis tends to move on product price and production efficiency. With the shift on price competition, production processes become more capital intensive and product and process innovations tend to be mostly incremental. In this stage of development in a product's life cycle, sources of innovation are mostly equipment suppliers (Utterback and Abernathy, 1975).

Consequently, Utterback and Abernathy (1975) combine the two models of development in 'an integrative theory of the innovation process' and conclude their theory with the definition of three stages of innovation process in a product's life cycle. In (1) Stage 1, there is the 'uncoordinated stage' of the development in production process and product 'performance-maximizing' strategy where most innovations are need-stimulated, (2) Stage 2, there is the 'segmental stage' of the development in a production process and product 'sales-maximizing' strategy where most innovations are stimulated by technological opportunities, (3) Stage 3, there is the 'systemic stage' of the development in a production process and product 'cost-

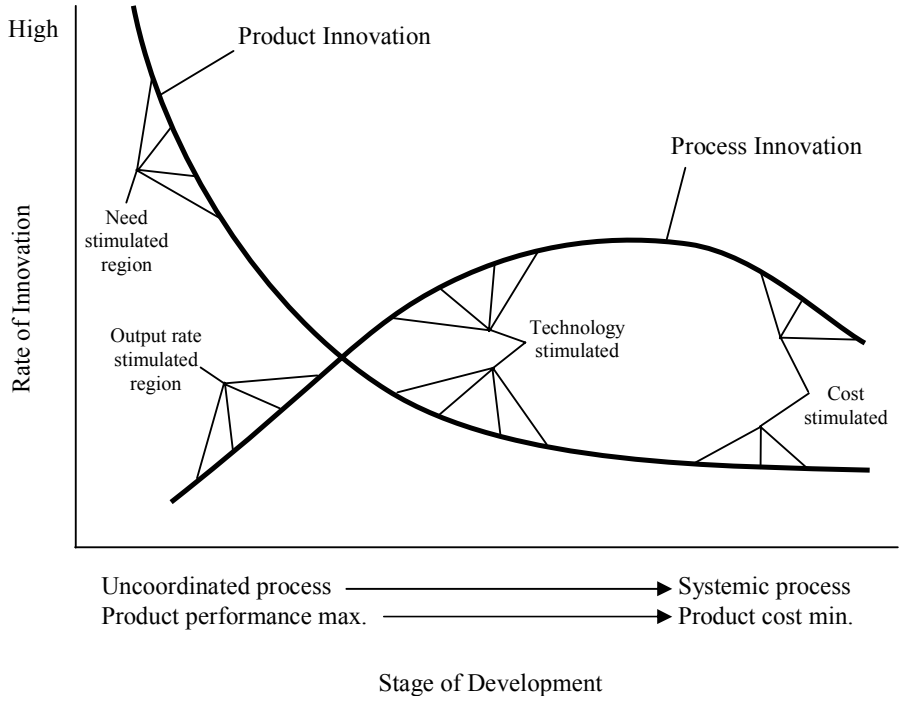


Figure 3.6 Innovation and stages of development (Utterback and Abernathy, 1975).

minimizing' strategy where most innovations are stimulated by production related factors (Utterback and Abernathy, 1975). Figure 3.6 is a comprehensive representation of their integrative theory.

3.4. Innovation as a Process

Throughout the studies on the theory of innovation, innovation is always suggested as a 'process' but there is no agreement about the nature of this process (Coombs et al., 1987). Coombs et al. (1987) describes a dominant linear model of the innovation process, according to which "*innovation is a sequence of stages, starting from either R&D or some perception of demand and ending with a product sold on the market*." In this model, input of each stage is the output of the previous stage in a linear fashion. OECD (1992) explains this model as "*the development, production and marketing of new technologies followed a well-defined time sequence that originated in research activities, involved a product development phase, then led to production and eventual commercialization*".

Although the linear model of the innovation process agrees with both 'technology-push' and 'demand-pull' approaches to the origins of innovation, it is challenged with an 'interactive model' in the contemporary approaches to the innovation process (OECD, 1992). The interactive model of the innovation process is characterized by continuous interaction and feedback, which emphasizes the central role of design (OECD, 1992). As per OECD (1992), this model can be visualized as a path "starting with the new market opportunity and/or a new science and technology-based invention; this is necessarily followed by the 'analytical design' for a new product or process, and subsequently leads to development, production and marketing".

Table 3.2 Rothwell's five generations of innovation models (Original source, Rothwell, 1992; Quoted from Tidd et al., 2001)

Generation	***Key Features***
First / second	Simple linear models –need pull, technology push
Third	Coupling model, recognizing interaction between different elements and feedback loops between them
Fourth	Parallel model, integration within the firm, upstream with key suppliers and downstream with demanding and active customers, emphasis on linkages and alliances
Fifth	Systems integration and extensive networking, flexible and customized response, continuous innovation

Rothwell (1992) suggest that there are five generations of innovation models that evolved over time, originating from the linear model of the innovation process. The complexity and interconnection of the model, and the feedback it supplies increases with the evolution of each generation. In the 'fifth generation' of innovation models, Rothwell (1992) describes innovation as a process with a supreme level of interaction, within the company or with external resources, assisted by IT (Information Technology) networking systems. Even though, late generation models of the innovation process comprise complex interactions and infrastructures, they are based on the same basic framework of the linear and interactive models of the innovation process (Tidd et al., 2001). Table 3.2 shows a summary of Rothwell's generations of innovation models.

Since the 'innovation process' starts with a new market opportunity and/or a new invention and ends with the introduction of a salable product to the market, it involves a series of sub-processes. For instance, within the framework of 'product innovation', the 'new product development' process dominates the innovation process. The 'new product development' process, itself, also consists of sub-processes, that might include basic research, design, development, prototyping, testing, and so on. In this context, terminologically, concepts including the 'innovation process', 'new product development process', 'product development process', 'product design and development process' are generally subject to confusion.

3.4.1. New Product Development

One common description of 'new product development' is "*the process that transforms technical ideas or market needs and opportunities into a new product on to the market*" (Walsh et al., 1992). 'New product development' and 'technological innovation' concepts are often subject to confusion. Walsh et al. (1992) illustrates the difference of new product development from technological innovation as "*the 'new product' concerned might involve only changes in form, components, materials, or even just packaging rather than changes in operation principle or technology*". Figure 3.7 represents a generic process of technological innovation and the place of the development activity.

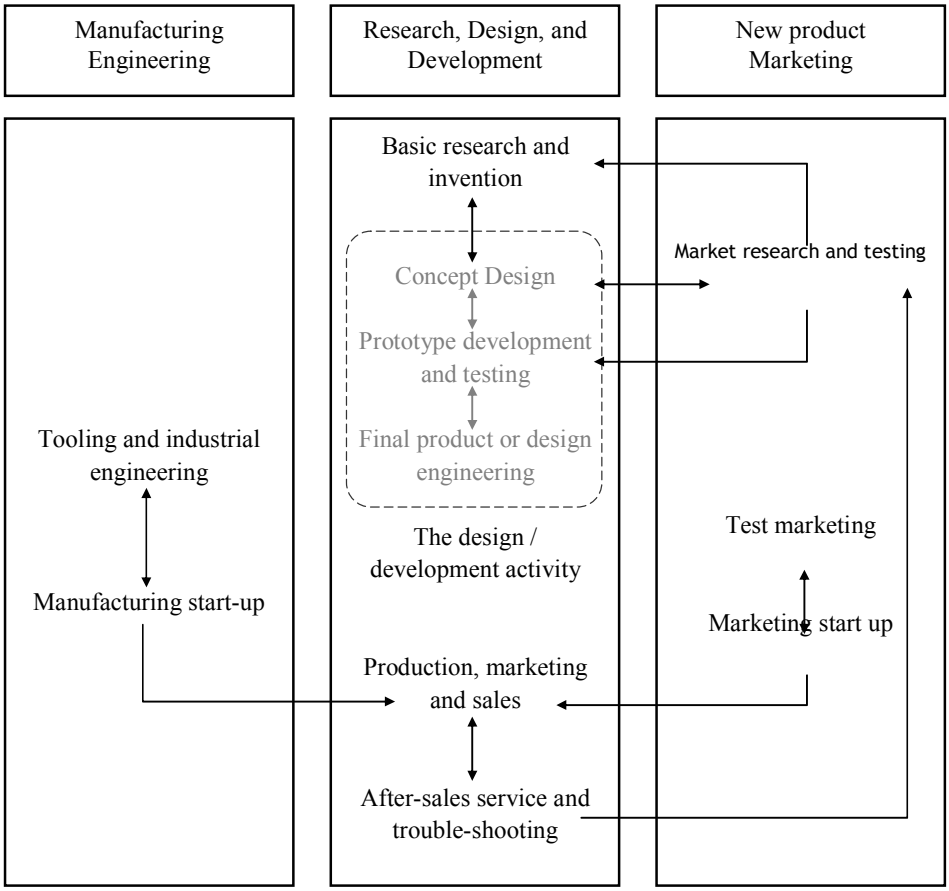


Figure 3.7 The process of technological innovation showing the role of the design and development activity (Roy and Bruce, 1984; Quoted from Walsh et al., 1988).

PDMA defines 'new product development' as *"the overall process of strategy, organization, concept generation, product and marketing plan creation and evaluation, and commercialization of a new product"* (Rosenau, 1996). Therefore, 'new product development' is an integrated 'process', which comprises "*a disciplined and defined set of tasks and steps that describe the normal means by which a company repetitively converts embryonic ideas into salable products or services*" (Rosenau, 1996).

3.4.2. Product Design and Development

In daily and academic literature, 'design', 'product design', 'product design & development' and 'industrial design' terms are often used as synonymous with each other. Some models of the product development process use 'design and development' as identical with the whole 'product development process' (Walsh et al., 1992). From this perspective, 'Product design and development' stands in the

core of the 'new product development' process. Walsh et al. (1992) describes 'product design and development' as "*the activity that transforms the brief or initial market specification into design concepts and prototypes and then into the detailed drawings, technical specifications and other instructions needed to actually manufacture a new product*."

Walsh et al. (1992) mentions that design activity is subsequent with a 'development' activity, "*in which prototypes are tested and modified until a satisfactory pre-production version of the product has been evolved*." The development activity provides feedback to the design activity for further refinement in the product or service design to improve product eligibility for manufacturing and marketing.

3.4.3. Design

Even though the theory of innovation originates from the theory of economics and theory of technical change, and technical change and 'inventions' are recognized to underlie innovations, modern approaches tend refer to 'design' as the core of the innovation process (Freeman, 1982; OECD, 1992). Contemporary studies on the innovation process strongly emphasize the role of 'design' as the innermost part of the innovation process. Whereas Freeman (1982) initially mention that innovation entails resources such as R & D and design; OECD (1992) strongly highlights the central role of design in the innovation process. According to OECD (1992), design is "*the very core of innovation. The moment when a new object is imagined, devised, and shaped in prototype form.*"

Lorenz also emphasizes the emerging central role of 'design' at a strategic perspective. As per Lorenz (1990), "*the old weapons for achieving real differentiation have become inadequate. No longer can comparative advantage be sustained for long through lower costs, or higher technologies ... the design dimension is no longer an optional part of marketing and corporate strategy, but should be at their very core*."

In its broadest context, The American Heritage Dictionary (2000) defines 'design' *as* "*the purposeful or inventive arrangement of parts or details.*" As per ICSID (2002), 'design' is "*a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles*" as "*the central*

factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange" (ICSID, 2002).

The design activity comprises various subordinate activities addressing a diversity of concerns. Freeman (1983) describes four kinds of design activity:

> *Experimental design:* the design of prototypes and pilot plant leading the preparation of production drawings for the commercial introduction of a new product or process.
>
> *Routine design engineering:* the adaptation of existing technology to specific applications (typical of the design work done by many engineering firms when installing new plant or equipment).
>
> *Fashion design:* aesthetic and stylistic design of items ranging from textiles and shoes to chairs, car bodies, and buildings. (This kind of design may result in novel forms, shapes, or decorations, but often involves no technical change at all.)
>
> *Design Management:* the planning and coordinating activity necessary to create, make and launch a new product on to the market (Freeman, 1983; Quoted from, Walsh et al., 1992).

The design domain also comprises a variety of practices serving to different industries. The Design Council (1988) classifies design practices into four distinct categories:

> *Product design,* including products ranging from ceramics and toys to specific instruments;
>
> *Graphic design,* covering everything from corporate identity and packaging to magazines and film;
>
> *Interior design,* including shops, buildings and exhibitions;
>
> *Fashion and textiles,* ranging from clothing and carpets to jewellery (The Design Council, 1988; Quoted from Walsh et al., 1992).

Figure 3.8 represents the main areas of the design domain comprehensively with a graphical interpretation of the connections between distinct areas.

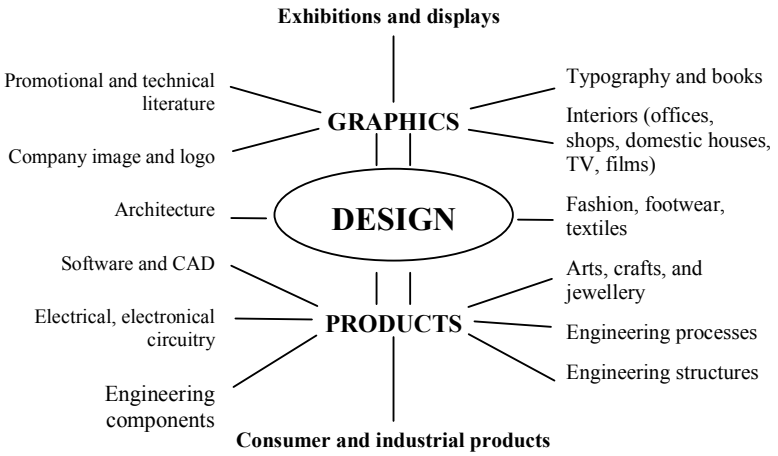


Figure 3.8 The main areas of design (Shirley and Henn, 1988; Quoted from Walsh et al., 1992).

3.4.4. Product Design and Industrial Design

As previously mentioned, contemporary studies on innovation give emphasis to 'design', specifically 'industrial design' as the core concept of the new product development, in the macro-scale, the innovation process (Walsh et al., 1992; Freeman, 1982; OECD, 1992). According to Walsh et al. (1992), design is "*the activity in which ideas and needs are given physical form, initially as solution concepts and then as a specific configuration or arrangement of elements, materials and components*." OECD (1992) depicts the output of the design activity as "*drawings aimed at defining procedures, technical specifications and operational features necessary for the development and manufacturing of new products and processes*."

As the very central activity of new product development, design activity comprises several concepts. OECD (1992) describes these concepts as "initiating design"; illustrating the original invention, "analytical design"; and "*the study of new combinations of existing products and components, re-arrangements of processes and designs of new equipment within the existing state of the art*."

Walsh et al. (1988) mentions that design can constitute a 'strategy' for market success by improving the quality of a product with incremental changes over time. Er (1997) also defines industrial / product design as a strategic process "*containing that knowledge about a product from which it can be materialized and positioned in the marketplace, the answers to the basic 'why' and 'how' questions about a product*."

Marketing literature suggest that 'design' is a tool to achieve competitive strategies. Porter (1980) describes the common types of competitive strategy as 'price', 'focus', and 'differentiation'. Within this framework, a competitive strategy on 'price' aims to reduce costs and convey supplier involvement in product development process and competition with lower costs. Furthermore, a company with 'focus' competitive strategy tends to address to an exclusive market based on consumer demands and specialization for the market. Finally, in a competitive strategy based on 'differentiation', 'design' is a strategic tool for product positioning in the targeted market segment. 'Design' offers differentiation in features including quality, robustness, precision, ease of use, product appeal, and price those convey competitive advantages to the product (Porter, 1980).

However, ‘product design’ and ‘industrial design’ terms are usually subject to confusion. Defining these two distinct concepts is an ongoing debate of the design literature. Although exploring the terminological distinction between two terms is not included in the aims of this research, briefly defining the difference between two concepts would be a helpful attempt for further research.

‘Industrial design’ mainly refers to a ‘practice’ in the entire ‘design’ domain, while ‘product design’ stands for ‘a combination of practices’. Thus ‘product design’ should be considered not as a ‘discipline’, but as an ‘activity’ consisting of the contribution of various disciplines. A ‘product design’ activity appears to inevitably encompass ‘industrial design’ as the central practice harnessing the contribution of all other practices, for instance, engineering design, software design, interaction design, design of product graphics, and so on. The level of contribution of other practices relies on the characteristics of the product, for which the product design activity is devoted.

Walsh et al. (1992) attempt to clarify the controlling role of industrial design within a product design activity. According to them, “*industrial design seeks to rectify the omissions of engineering; a conscious attempt to bring from visual order to engineering hardware where the technology does not of itself provide these features*” (Walsh et al., 1992). They also emphasize the role of design function in accessing all the specialized functions within and outside the company that includes the design function, and assembling the necessary information as input to the product design process.

Consequently, along with a variety of definitions of ‘industrial design’ on which the literature agrees, ‘product design’ refers to ‘a collaborative design activity with a harnessing role of industrial design’ devoted to design a particular product or a range of products.

3.5. Summary of the Chapter

In this chapter, innovation and a variety of relevant concepts have been discussed. The subjects studied in this chapter have initiated from the broad perspective of the innovation concept and lately focused on ‘design’ practice with an emphasis on the role of ‘design’ through the innovation process.

Initially, after a brief etymological definition of the term 'innovation', the theory of innovation has been studied from a theoretical and historical perspective. Schumpeter, as the most significant character of the innovation literature has been studied in detail through studying the development of the theory of development. Besides, the standpoint of Freeman (1982 and 1990), that of one of the most significant neo-Schumpeterian scholars, has been discussed in a variety of subjects. In addition to the theory of innovation, definition, categories, levels, and origins of innovation has been surveyed. Moreover, the interdependency between the development of a product's lifecycle and the change in the innovation pattern has been explored. All through these explorations, a variety of perspectives from diverse disciplines, including those of Tidd et al. (2001), Utterback and Abernathy (1975), Coombs et al. (1987), Rothwell and Gardiner (1988), Walsh et al. (1988, 1992), Cooper (2000) and OECD (1992) has been reviewed.

Afterward, innovation, specifically product innovation, was studied as a 'process', which includes a significant 'new product development process' within (Walsh et al., 1992). The 'new product development process' and subordinate processes held through the new product development process including 'industrial design', 'product design', and 'development' have been investigated. In addition, relevant terminology used in defining these concepts and processes has been explained for further clarification. In examining innovation as a process, studies from a variety of perspectives including those of Walsh et al. (1988, 1992), OECD (1992), Freeman (1983, 1988), and Porter (1980) have been reviewed.

Consequently, within the framework of the aims of this research, this chapter provides a conceptual background on the theoretical, historical, and terminological aspects of a variety of significant concepts relevant to 'innovation' and 'design'.

In the following chapter, another crucial concept, 'design innovation' will be subject for clarification. Core concepts including 'design' and 'innovation' will be reviewed in detail from etymological and terminological perspectives in order to conclude in a definition of 'design innovation'. Furthermore, the importance of the 'design innovation' activity will also be discussed in the next chapter.

CHAPTER IV

DEFINITION AND IMPORTANCE OF DESIGN INNOVATION

The aim of this chapter is to clarify the concept, '*design innovation*'. In this chapter, the importance of '*innovation by design*' is also discussed. The chapter also seeks to address a fundamental definition of the term '*design innovation*'. Within this framework, relevant concepts including '*design*' and '*innovation*' are analyzed in terms of etymological and terminological meanings.

4.1. Conceptual Background of '*Design Innovation*'

The term 'design innovation' is widely used in the daily academic and practical design literature, e.g. popular design magazines, academic journals, etc. However, such terminology does not comprise a generally agreed definition of the concept. As it was studied in the preceding chapter, the theory of innovation reveals a variety of significant concepts, and emphasizes the importance of 'design' in obtaining innovation. Nonetheless, since it has its roots in the theory of economics, the theory of innovation appears to lack in clarifying 'design innovation'.

Linguistically, 'design innovation' appears to embrace two very basic explanations. First explanation, 'innovation *in* design', refers to 'novelties introduced in the design of a particular product or artifact'. The second, 'innovation *by* design', covers 'a new product or artifact or a novelty in a product or artifact acquired by design function.'

This section eventually aims to conclude a definition of the term 'design innovation'. To achieve this, it is essential to make an in-depth review of the scope of possible meanings of sub-concepts including 'design' and 'innovation', and definition of concepts implying 'design innovation'. Thus, before attempting to arrive at a definition, this section seeks to review the literature for above-mentioned concepts.

4.1.1. Broad Definition of '*Design*'

Design, etymologically and linguistically, comprise a wide scope of meanings that makes it difficult to focus on a generic definition. However, design literature comprises a variety of definitions addressing 'design' from various perspectives.

Another concern that blurs the way in building a generic definition is the wide variety of practices that 'design' discipline covers, most of which are represented in the following chapter. While 'design' is considered to define a category of 'innovation', it is more likely to mean the practices that contribute to the new product development activity. Furthermore, as OECD (1992) emphasizes, 'industrial design' plays the most significant role in the development of products and services. Therefore, while 'design innovation' is the subject matter, it is conceivable to consider an integrated contribution of a variety of design practices with the central and harnessing position of 'industrial design' to the innovative activity.

Consequently, this study supposes that 'design' term, in the context of 'design innovation', implies *a design activity with the central role of 'industrial design' and a contribution of a variety of particular practices* interdependently.

4.1.1.1. Etymological Definition of '*Design*'

The word 'design' originates from Medieval Latin of 14th Century from the word '*sign*', which, in its verb form '*signare*', means '*to mark out*'. The word '*signare*' was derived to the verb '*de+signare*', which means '*to create, fashion, execute, or construct according to plan'* having the synonyms 'to create, to contrive and to intend'. The verb form of the word '*design*' was synchronously transferred to Middle English as '*de•sign*' meaning '*to outline, indicate, mean'*, synonymous to the verb '*sign*' (Britannica Webster's, 2002).

The first usage of the noun form of the word '*design*' appears to be by 1588. Here, the word '*design*', is explained as, (1) a purposeful activity, '1. *A particular purpose held in view by an individual or group'* or a '*deliberate purposive planning*', and (2) a project or a scheme, '2. *A mental project in which means to an end are laid down'* or a '*deliberate undercover project or scheme'*. The more contemporary explanations to the word appear with the usage of synonymous words. 'Design', identical with the word '*plot (in plural form)*' means '*a preliminary sketch or outline showing the main features of something to be executed*'. "Another synonymous word for '*design*' is

'*delineation*' which has the meaning of '*an underlying scheme that governs functioning, developing, or unfolding*'. '*Design*' is also used identical to '*pattern*' or '*motif*' which mean '*the arrangement of elements or details in a product or work of art*'. The term design is also explained as, a creative activity, '*the creative art of executing aesthetic or functional design*' (Britannica Webster's, 2002).

From the etymological point of view, Oxford English Dictionary (2002) reveals the evolution of word '*design*' with its usages throughout the history. The first to use the word in its noun form is Shakes in 1588 as "*Thine in the dearest designe of industrie*" with the meaning of '(2) *purpose, aim, and intention'*. At almost the same time, Hooker, in 1593, used the word as '(1) *a plan or scheme conceived in the mind and intended for subsequent execution; the preliminary conception of an idea that is to be carried into effect by action; a project'* in his writing, "*What the lawe of God hath, either for or against our disseignes*". 'Design' means '(3) *the thing aimed at; the end in view; the final purpose*' while Lady M. W. Montagu wrote, "*Happiness is the natural design of all the world*" in 1711. In 1831, Brewster used the word '*design*' as "*The arrangements, therefore, upon which the stability of the system depends, must have been the result of design*" having the meaning '(4) *contrivance in accordance with a preconceived plan; adaptation of means to ends; pre-arranged purpose*". Defoe, 1719, used the word '*in a bad sense*' as a '(5) *crafty contrivance, hypocritical scheming*' in his writing as "*A...faithful...servant...without passions, sullenness, or designs*". It was 17th and 18th Century, when the use of the word 'design' aroused to mean '*a piece of art, a detailed project, or a creative work of art*'. Junius, in '*Painting of Ancients*' in 1638, used the word as "*What beauty and force there is in a good and proportionable designe*" having the meaning of '(6) *a preliminary sketch for a picture or other work of art; the plan of a building or any part of it, or the outline of a piece of decorative work, after which the actual structure or texture is to be completed; a delineation, pattern*'. The word was used in the meaning of '(7) t*he combination of artistic details or architectural features which go to make up a picture, statue, building, etc.; the artistic idea as executed; a piece of decorative work, an artistic device*' by Evelyn in 1644 as "*I was particularly desirous of seeing this palace, from the extravagance of the design*". Alternatively, Ruskin, in 1854, used the word in his writing as "*Design, properly so called, is human invention, consulting human capacity*" with the meaning of ' (8) *The art of*

picturesque delineation and construction; original work in a graphic or plastic art' (OED, 2002).

4.1.1.2. Definitions of '*Design*' in Design Literature

As formerly stated, 'Design' concept has a variety of definitions which arise from a variety of perspectives. These perspectives lead to definitions in functional and strategic levels addressing the general 'design' concept and 'product / industrial design' in particular.

The earliest recorded official use of the term '*industrial design*' by the US Commissioner of Patents dates back to 1913, to distinguish the '*form*' of products, as distinct from their '*function*' (Lorenz, 1990).

ICSID (2002) defines 'design' separately in both functional and strategic perspectives. As per ICSID (2002), 'design' operationally is "*a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles*." ICSID (2002), strategically, define 'design' as "*the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange.*"

OECD (1992) brings a functional perspective by defining 'Design' as "*drawings aimed at defining procedures, technical specifications and operational features necessary for the development of new products and processes*."

One of the most fundamental definitions of 'industrial design' has been stated by Heskett (1980), according to whom "*...Industrial design is a process of creation, invention and definition separated from the means of production, involving an eventual synthesis of contributory and often conflicting factors into a concept of three-dimensional form, and its material reality, capable of multiple reproduction by mechanical means*."

Marzano (2000) defines 'design' in a superior strategic level having "*a role to play in sustaining and encouraging the evolution of civilization, balancing technology, and socio-cultural values*." According to him, 'design', "*by facilitating interaction ... makes new achievements possible, encourage the progression of values and ultimately, support in the pursue of growth, breakthrough and maturity*" (Marzano, 2000).

Porter (1980) argues 'design' as an essential strategic tool for competitive strategy. Thus, 'design' is committed to "*producing attributes with place the products apart from competing offerings within the market*" including "*enhanced quality, expressed via durability, precision, ease of operation and distinctive aesthetics and so on, at an appropriate price*."

Walsh et al. (1992) agree on a broad definition of 'design' as "*the configuration of materials, elements and components that give a product its particular attributes of performance, appearance, ease of use, method of manufacture, and so on.*"

Buchanan (2001) defines design as "*the human power of conceiving, planning, and making products that serve human beings in the accomplishment of their individual and collective purposes.*" According to his definition, design "*is an art of invention and disposition*" with a universal scope that makes it applicable to the creation of any artifact (Buchanan, 2001).

Svengren (1997) argues that design is a problem solving process with visual means and a synthesizing way of thinking. Therefore, 'industrial design' '*implies a visual and conscious process to develop physical objects with functional, ergonomic, economic and expressive concerns*" (Svengren, 1997).

4.1.2. Broad Definition of '*Innovation*'

In comparison with that of 'design', the definition of 'innovation' is, by some means, more clear. While etymologically has its roots in the medieval literature, 'innovation', terminologically has almost a half-century-history. While the definition of 'innovation' still comprises a variety of perspectives, the definitions arrived have been agreed by a diversity of literatures.

Since the goal of this chapter is to arrive at a definition of the concept '*design innovation*', it is indispensable to mention innovations of *products or services*, instead of processes, organizations, customer channel, and so forth.

4.1.2.1. Etymological Definition of '*Innovation*'

Etymological origins of the word '*innovation*' extends to a derivation of the Medieval Latin word '*novus*' of the 15th century, which means '*new*'. The derived Latin word *'in+novāre'* broadly covers the meaning '*to make new*', which is

transformed into English as 'innovate' to mean '*to introduce something new*' (The American Heritage Dictionary, 2000; Britannica Webster's, 2002).

As maintained by Oxford English Dictionary (2002), linguistically the first to use the term '*innovation*' in history is the King Edward VI in 1548 with the meaning of '(2) *a change made in the nature or fashion of anything; something newly introduced; a novel practice, method, etc.*' in his Act 2 & 3 as "*To staye innovacions or newe rites*". The most frequent usage of the term '*innovation*' has the meaning of '(1a) *the introduction of novelties; the alteration of what is established by the introduction of new elements or forms'* as Brende, in 1553 used, "*Perdicas, whose ambicious mynde desirous of innouation, was (he sayde) to be preuented in time*". The word '*innovation*' is also used as identical to '(1b) *revolution*' as Stafford in 1633 used, "*For the same reason of innovation, he besought them to send unto him fiue Lasts of powder with match and lead*". In the Law literature, 'innovation' is used as ' (3) *the alteration of an obligation; the substitution of a new obligation for the old*' as Bell, in 1861, describes '*innovation*' as "*a technical expression, signifying the exchange, with the creator's consent, of one obligation for another, so as to make the second obligation come into the first place of first…"* Contemporary usages of the term '*innovation*' are more likely to address the meaning '(5) *The action of introducing a new product into the market; a product newly brought on the market'*. Schumpeter, in his 'Business Cycles', in 1939, is first to mean '*innovation*' within this framework; "*Innovation is possible without anything we should identify as invention, and invention does not necessarily induce innovation*" (OED, 2002).

4.1.2.2. Definitions of '*Innovation*' in Innovation Literature

Schumpeter, indispensably the most significant character of the innovation literature, provides the initial contribution to the terminological definition of 'innovation'. As per Schumpeter (1934), product innovations cover "*the creation of a new good which more adequately satisfies existing and previously satisfied needs.*"

Utterback and Abernathy (1975) defines a product innovation as "*a new technology or combination of technologies introduced commercially to meet a user or market need*". Even though their perspective implies limitedly a '*technological innovation*', according to them, "*technological innovations which may have market application, lie fallow until markets can be identified or created*." They argue, "*Product*

innovation tends to be driven or stimulated by new market needs and opportunities" (Utterback and Abernathy, 1975).

Freeman et al. (1982) defines 'innovation' as "*the first introduction of a new device, product, process or system into the ordinary commercial or social activity of a country.*"

OECD (1992) brings a distinction between a 'technological innovation' and 'product innovation' due to the implementation of the technological novelty to a product or service and the marketability quality of a product or service. As per OECD (1992), "*Technological innovations comprise new products and processes and significant technological changes of products and processes. An innovation has been implemented if it has been introduced on the market (product innovation)*."

Leonard and Swap (1999) arrive with a multifaceted perspective to the definition of the concept. They define 'innovation' as "*the embodiment, combination, and/or synthesis of knowledge in novel, relevant, valued new product, processes or services.*"

Sethi et al. (2001) associate 'innovation' with a "*meaningful uniqueness*" in new products. According to them, the degree of innovation in a new product is "*the extent to which a new product provides meaningfully unique benefits.*"

4.2. Definitions Implying '*Design Innovation*'

As previously mentioned, both 'design' and 'innovation' studies do not comprise a generally agreed definition of the concept 'design innovation'. However, certain studies which discuss the relationship between 'design' and 'innovation', *imply* such a concept.

While discussing 'design' as a strategic tool for competitive advantage and eventually market success, Walsh et al. (1988) refereed to such a concept. They mention "*new designs enhancing product quality but involving no technical change*," through which they discuss incremental improvements in the quality of a product or service that are less risky and expensive, short term, therefore constitute less a venture for the producer (Walsh et al. 1988).

Walsh et al. (1992) argue that, terminologically, 'design' and 'innovation' often refer to similar activities. Various activities including research, design, development,

market research and testing manufacturing engineering serve to convert "*a new idea, invention, or discovery into a novel product or industrial process in commercial or social use*" (Walsh et al., 1992).

Hilton (2002), broadly defines innovation as "*about bringing change over an extended period, either as a result of a new product or service.*" Since his insight about 'innovation' is "bringing change" to a product or service, 'design innovation' appears to conclude to a change in a product or service brought by design. Hence, according to him, "an innovative design is only innovative once it has been successful in the marketplace and brought about change" (Hilton, 2002).

Table 4.1 Example products whose market potentials have been multiplied by design (Oakley, 1990).

Basic Innovation	*Designed Innovation*
Bicycle	BMX Bicycle
Cassette tape system	Walkman stereo (etc.)
Hovercraft	Hovermower

Oakley's (1990) definition of design includes the definition of 'design innovation'. According to him, design effort is devoted to "*help turn an invention into a successful innovation – or to extend the usefulness of an existing innovation*." He also describes this effort as a "*fine-tuning to achieve a result that suits our needs more accurately*." At this point, Oakley (1990) exemplifies his definition as described in the Table 4.1. Oakley (1990) also points out that 99 percent of the new products in the market is a derivation of an existing application, thus emphasizes the importance of design effort in terms of introducing novelties by extending the usefulness of the existing innovation.

Another perspective that emphasizes the role of design in incrementally improving the qualities of an innovation is the concept of "robust design" (Rothwell and Gardiner, 1988). A number of identical concepts have been used in various studies, for those a 'robust design' (or the equivalent concept) is a design that employs an existing technology, but opens up a new user segment or a competitive advantage in the market. Rothwell and Gardiner (1988) mention the concept of '*re-innovation*' through which producers create "*a special type of design capable of evolving into a design family of variants which meet a variety of changing market requirements.*"

This perspective also explains the 're-innovation' or the 're-design' activity as "*combining the existing with the new*" (Rothwell and Gardiner, 1988).

4.3. Defining '*Design Innovation*'

Before focusing on a definition, determining of the *context* of the defined concept, by some means, clarifies the way to build the definition. Another attempt that helps define the concept '*design innovation'* is to clarify the scope of meanings that '*design'* and '*innovation'* concepts cover. Along with the possible meanings of these concepts that were reviewed in the preceding sections, in what terms these concepts are questioned within the context of '*design innovation*' has also significance.

Accordingly, within the perspective of this study, the concept 'design innovation' constitutes a '*category of innovation*', some of which was summarized in the preceding chapter including technological / industrial innovation, product (radical or incremental) innovation, process innovation, and other sub-categories of innovation. Another topic that this definition seeks to clarify is the '*level of innovation*' in terms of the *novelty* in a product or service obtained through design effort. Such quality determines whether a 'design innovation' is a radical innovation or an incremental one.

In conclusion, it can be stated that 'design innovations' comprise ' (a) *the incremental novelties in the design of an existing product or service, or* (b) *radically new products or services obtained by design effort with no or minimal technical novelty.*' The 'design effort' mentioned in this definition comprises '*a design activity with the central role of 'industrial design' and a contribution of a variety of particular design practices'* interdependently. In addition, within the framework of this definition, 'design innovations' concern both radical and incremental innovations. Moreover, the word 'technical' in the phrase 'technical novelty' implies several meanings, therefore needs clarification. '*Technical'* for The American Heritage Dictionary (2000) means "*of, relating to, or employing the methodology of science; scientific*," whereas 'design' is not limited to employ scientific methods, as described in ICSID's definition mentioned in Chapter III, which suggests that 'design' aims "*to establish the multi-faceted qualities*" of products or service. Therefore, the 'technical novelty' mentioned here comprises '*novelty in a product or service attained by the use of scientific methods or practices*.'

Moreover, this definition covers the two possible linguistic explanations of the term, which were initially mentioned. Hence, the term, 'design innovation', both linguistically and terminologically, embraces those two explanations. First explanation, 'innovation *in* design', covers '*the incremental novelties in the design of an existing product or service obtained by design effort with no technical novelty'* fraction of the definition. On the other hand, the second explanation, 'innovation *by* design' stands for the equal implication with 'design innovation'.

By some means, the difference between 'design innovation' and ordinary product design activity appears unclear. One reason to make a distinctive definition of 'design innovation' is the 'novelty' that the output of the design activity should comprise. The degree of 'novelty' determines whether a 'design innovation' is an incremental or a radical one. It is evident that ordinary design activity may not necessarily encompass a novelty, in terms of a competitive advantage in the market or a meaningful benefit for user.

Another reason to build such a definition is the deficiency of 'design' in the innovation literature. Although the central role of 'design' activity has been recently emphasized in the literature (OECD, 1992; Freeman, 1982), the initial driver of innovation is nevertheless perceived as 'technical change'. For this reason, the literature does not provide a definition for a radical or incremental innovation achieved by design effort, instead of technical change.

4.4. Importance of 'Design Innovation'

Although the literature does not comprise a generally agreed definition of the concept, 'design innovation', a number of studies emphasizes the importance of design effort in improving the quality of a product or service with no technical change. According to Walsh et al. (1988), through re-design, incremental innovations are achieved with less risk, less expense and short time, therefore, less venturing the producer in terms of financial risk and market position. Rothwell and Gardiner (1988) point out the flexibility of the design of a product to meet the evolving needs of a variety of user segments. Porter (1980) identifies design effort as a sole competitive strategy, which, through differentiation and positioning, helps attain a competitive advantage in the market. Oakley (1990) emphasizes that design activity

extends the usefulness of a new or existing innovation and helps the products suit user needs more accurately.

Thus, apart from routine design activity that helps transform technological innovations into product or service innovations or contributes to the incremental improvements in the quality of a product or service, 'design innovation' plays an important role in the competitive strategy of an enterprise that design and develop new products. Such importance mostly originates from the fact that innovation *by* design, when compared to innovation driven by technological novelty, is less risky, less expensive, less time consuming and eventually less venturing the innovator, on the other hand, more advantageous in obtaining the qualities those are perceived by the end-user (Walsh et al., 1988; Porter, 1980; Oakley, 1990).

Another concern that the emerging importance of 'design innovation' appears to elucidate is the level of technical competence needed to achieve innovation. Companies no longer seem to run after highly invested technological competencies those need long-term development intervals. The shift from technology driven innovation to design driven innovation also denotes a change in the corporate insights and the structure of new product development organizations. Accordingly emerging interdisciplinary 'design teams' or 'design centers' have been pointed at instead of 'R&D Centers' or 'Product Development Teams' in achieving 'innovation' (Olson et al., 1995).

In conclusion, even though the complicated relationships and interdependency of the concepts in the design and innovation literature make it difficult to conclude a definition, the absence of the definition of a 'design driven innovation' or 'innovation by design' necessitates building one. Consequently, the definition that has been arrived clarifies the context and research topics of this study, and hopefully contributes to the literature.

4.5. Summary of the Chapter

The main goal of this chapter has been to define 'design innovation' concept. Therefore, a series of preliminary studies has been carried out to arrive at a definition. Through these studies, core concepts including 'design' and 'innovation' have been studied comprehensively from etymological and terminological

perspectives. Furthermore, a literature survey has been carried out to review the definitions that relevantly imply the definition of ‘design innovation’. Eventually, the arrived definition of ‘design innovation’ concept has been explained. The importance of the ‘design innovation’ activity has also been discussed in terms of its contribution to the innovation and design literatures and its advantages from the company perspective.

In the following chapter, sources of innovation and design methods will be reviewed. Initially, sources of the innovative activity and the importance of ‘user’ as a major source of innovation will be studied. Furthermore, the nature of the design activity will also be examined, in terms of the sources of knowledge, the process of design and certain design methods.

CHAPTER V

SOURCES OF INNOVATION AND DESIGN METHODS

The main goal of this chapter is to build a background on the sources of the innovative activity and the methods of design practice. In addition, relevant concepts including ‘need’, ‘need assessment’, ‘design knowledge’, and ‘design process’ are studied.

5.1. Introduction

The innovative activity entails certain kinds of sources and methods to persist. The still ongoing change of our era is challenging the innovative activity and inevitably, the sources and methods that it requires. There has been a shift in the innovation process from the execution of incentive led methods by an individual innovator, to the implementation of predefined and structured methods executed by specialized teams with new forms of input knowledge. The change has also given rise to a shift in the source of innovation from merely searching for technological opportunities to a well-balanced coupling between technical competency and assessment of the needs and preferences of the users.

The case for ‘design innovation’ appears to be rather vague. The emergence of ‘design innovation’ brings new challenges to the innovative activity with the contribution of ‘design methods’ and human-centered approach to the methods of the innovative activity. Nevertheless, how does the increasing importance of assessing user needs as a source of innovation effects the design methods stands to be a question in the ‘design innovation’ context.

As stated in Chapter II, one of the topics that this study seeks to elucidate is the emerging methods focusing on the user as a source of design innovation. Before starting to investigate this topic, throughout this chapter, the sources of innovation, the user and user needs as a source of innovation, design knowledge, the design process, and design methods are reviewed.

5.2. Sources of Innovation

When linguistically considered, 'the source of innovation' axiom appears to cover two basic points of view:

- The origin of the innovative initiative (e.g. an individual, a certain kind of method, a certain form of knowledge, so on.)
- The incentives for the innovative activity (e.g. any entrepreneurial activity, a technological opportunity, market demand, so on.)

Therefore, in this section, the sources of innovation are examined with proper attention to the origin of the initiative, the incentives to innovate, and user as the main source of innovation.

5.2.1. The Origin of Innovative Initiative

Leonard and Swap (1999) mention that innovation is an output of a 'creative activity'. Since innovation is closely connected with creativity, there ought to exist a creative character who exploits his or her creativity to bring about an innovation. Thus, who stands to be this character is one of the main concerns of the innovation literature since the early studies of Schumpeter (various). Since then, a variety of approaches has been put forward by various studies on innovation.

In his early studies, Schumpeter (1934) describes the mere source of innovation as an exceptional individual, the "*entrepreneur*", who has superior energy and ingenuity and delights in change and innovation (Dixon, 2000). In this sense, the source of innovation is mainly based on the personal creativity and initiative of an individual. Schumpeter (1942), in his later writings, argues that the innovative activity is being reduced to routine, along which "*technological progress is increasingly becoming the business of teams of specialists who turn out what is required and make it work in predictable way*s" (Schumpeter, 1942). Therefore, specialized teams in companies have taken the place of the entrepreneur and the innovative activity has become more impersonal and mechanical (Dixon, 2000).

Schumpeter's perspective clearly represents a shift from science-based individual initiative to impersonal, organized, and methodical progression as the main source of innovation, which also represents a shift from '*individual'* '*initiative'* to '*methods*' executed by a certain kind of special '*team*' as the source of the innovation.

Tidd et al. (2001) categorize these teams as the source of technological innovation depending on the industrial sector. According to them, the source of innovation is:

- "*suppliers*" of equipment and other production inputs in agriculture and traditional manufacture (like textiles),
- "*customers*" in instrument, machinery and software,
- "*in-house*" technological activities in chemicals, electronics, transport, machinery, instruments and software,
- "*basic research*" in ethical drugs.

On the other side, Pavitt (1999) categorizes the sources of technological innovation depending on the characteristics of the innovating firm. As per Pavitt (1999), the sources of innovation vary in (1) "*science-based*," (2) "*supplier-dominated*," (3) "*specialized-suppliers*," (4) "*scale-intensive,*" and (4) "*information-intensive*" firms. Table 5.1 represents different types of products and main sources technological innovation categorized relying on the characteristics of the innovating firm.

Table 5.1 Firm characteristics and sources of innovation (Quoted from Tidd et al., 2001).

	Supplier-dominated	*Scale-intensive*	*Science-based*	*Information-intensive*	*Specialized-suppliers*
Typical core products	Agriculture Services Traditional Manufacture	Bulk materials Consumer durables Automobiles Civil Engineering	Electronics Chemicals	Finance Retailing Publishing Travel	Machinery Instruments Software
Main sources of technology	Suppliers Production learning	Production engineering Production learning Suppliers Design offices	R&D Basic research	Software and systems departments Suppliers	Design Advanced users

Alternatively, Riggs and von Hippel (1994) put forward the '*user*' of a product as the source of innovation. Their study on a case of scientific instruments represents that "*when a product user's reasonable expectations of benefiting from a given innovation opportunity are higher than those of a product manufacturing firm, we would expect to find that the user would be more likely to innovate than would the manufacturer*." Within this framework, they suggest that whether the user or the manufacturer of a product would be the source of innovation depends on who would more likely to benefit from the innovation.

Moreover, who stands to be the innovating user of a particular product relies on the type of the product. Table 5.2 represents the variety of innovators of different industry segments. Furthermore, Riggs and von Hippel (1994) suggest that who would be the innovator of a product also relies on the 'value' of the targeted innovation. According to them, 'users' are the source of innovation if the innovation would bring a scientific value to the product, whilst the 'manufacturer' is the innovator if the innovation would create a commercial advantage.

Table 5.2 Variation in the sources of technological innovation (Quoted from Tidd et al., 2001).

	Innovation Developed by					
Innovation Type Sampled	*User*	*Manufacturer*	*Supplier*	*Other*	*NA* (n)*	*Total (n)*
Scientific instruments	77 %	23 %	0 %	0 %	17	111
Semiconductor and printed circuit board process	67	21	0	12	6	49
Pultrusion process	90	10	0	0	0	10
Tractor shovel – related	6	94	0	0	0	16
Engineering plastics	10	90	0	0	0	5
Plastics additives	8	92	0	0	4	16
Industrial gas – using	42	17	33	8	0	12
Thermoplastics - using	43	14	36	7	0	14
Wire termination equipment	11	33	56	0	2	20

* NA = number of cases for which data item coded in this table is not available (NA excluded from calculations of percentages in table.)

Von Hippel (1986) also suggests a specific user profile titled as "lead users" as an important source of new product concepts. He also puts forward a new method to utilize lead users for not only product but also process innovations in both institutional and consumer products industries (von Hippel, 1986).

In conclusion, along with the change in the innovative activity, the origin of the initiative has shifted its focus from individual entrepreneurship to organizational execution. Furthermore, the form of the organization to execute the innovative activity relies on the type of the target product, the industrial sector, the size of the firm and the benefit of the innovation to the innovating organization.

5.2.2. Incentives to Innovate

As studied in Chapter III, studies on the driving force behind innovation have created a still-ongoing debate whether technical change or market demand is the mere incentive to innovate. Theoretically, the two paradigms have their roots in the studies of Schumpeter (various) and Schmookler (1966). Although Schumpeterian viewpoint does not disregard the consumer factor as a determinant for innovations, it suggests that the main driving force behind innovation is 'technical change', namely, 'technology push'. On the contrary, Schmookler (1966) underlines the demand factors as the main determinant of innovation. These two approaches have brought up a debate on whether technology-push or demand-pull merely lies behind innovations.

As some of them are listed in table 3.1, a number of empirical studies have been executed to investigate the role of these determinants in the success of innovations in a variety of industries. Most of the studies (e.g. those of Langrish et al., 1972; Rothwell et al., 1974; Myers and Marquis, 1969; et cetera) have proved that, even though awareness of technological possibilities helps innovations become successful in the market, the most important factor discriminating between a successful and unsuccessful innovation is the extent to which one tries to satisfy the needs of the targeted user segment (Holt et al., 1984). Nevertheless, there are also a number of cases, in which technological opportunities have resulted in successful breakthrough innovations and led to numerous successful demand-stimulated innovations (Holt et al., 1984). Therefore, they argue that there are so complicated interactions between user needs, science, and technology that it is often difficult to determine a particular incentive for the innovative activity.

Consequently, Holt et al. (1984) discuss that in order to be a successful innovator, a firm has to assess user needs, identify technological opportunities, and develop, launch and market new and improved products. However, most successful innovations were developed by innovators paying particular attention to 'marketing' and carrying out comprehensive 'market research', according to Holt et al. (1984), "*traditional market research does not provide that understanding of user needs which is essential to successful innovation.*" They suggest that, instead of traditional market research, a special approach to assess the user needs has to be executed in close contact with the targeted user segments. Furthermore, Holt et al. (1984)

indicate that firms could reduce the risk and failure by thoroughly focusing on the users and user needs all through the innovation process. According to them, to achieve this, a firm should attain:

- *better problem definition:* by specifying the needs to be covered by the product early in the innovation process, one will have specific objectives for the further work. These objectives will usually change during the process as the first information is up-dated and new evidence is brought to light.
- *better coordination:* by giving those involved in product innovation projects a clear awareness of what is to be accomplished by means of properly documented need information, it will allow for flexibility, stimulate purposeful behavior and facilitate communication and coordination.
- *better marketing:* by systematic assessment of user needs one will provide realistic sales arguments for those responsible for the planning of marketing operations.

In conclusion, empirical studies that were summarized in Table 3.1 have shown that further than the initiative by 'technology-push' and a variety of implicit minor factors, demand factors are the main incentives to innovate. Therefore, it can be concluded that thoroughly understanding the user needs and expectations is crucial for initiating successful innovations.

5.2.3. Users and User Needs as a Source of Innovation

Before studying the 'users' and their needs as a source of innovation, it is essential to clarify the terminological distinctions between the terms '*user*', '*consumer*', and '*customer*', which are often used as synonymous for each other.

According to the Product Development Management Association, a '*user*' is "*any person who uses a product or service to solve a problem or obtain a benefit, whether or not they purchase it*" (Rosenau, 1996). In this sense, users may also be the consumer of the product or service, or may not directly consume the product or service, but may interact with it for a certain period. This circumstance can be illustrated with a production tool whose user is the tool operator but consumer is the production organization.

The term '*consumer*' refers to a "*firm's current customers, competitors' customers, or current non-purchasers with similar needs or demographic characteristics*" (Rosenau, 1996). However, the scope of the term 'consumer' is paradoxical. The term ambiguously covers both customers and target users of the firms' products or services. On the other hand, the 'customer' term is terminologically more lucid.

Product Development Management describes the 'consumer' as "*one who purchases or uses a firm's products or services*" (Rosenau, 1996).

Marzano (1997) distinguishes these distinct terms by individualizing the terms into human beings who '*use*', '*own*', and '*buy*' a product or service. According to him, customers could be perceived from a number of perspectives and they play certain roles as '*users'*, '*owners'*, and '*buyers'*. The role, 'user' refers to the human being who is merely the user of a product. On the other hand, the 'owner' role represents the 'consumer', while the 'buyer' is the 'purchaser' or the 'customer' of a product or service.

Both innovation and design literatures refer to the term '*user*' to define the human being for whom their activities intend to develop new products or services. Therefore, in search of an understanding of the needs of the human being, primarily the '*user*' term is supposed to be referred to. Conversely, while the purchasing characteristics of a user are considered, the term '*consumer'* should be mentioned. Otherwise, the usage of the term '*customer*' is more likely to relate merely to the purchasing characteristics and needs of a user.

As stated above, the studies on innovations have shown that the innovation process may start due to information about a technological opportunity, however in the majority of the studied cases, the process is started by the assessment of user needs (Holt et al., 1984). Therefore, it can be concluded that an in-depth understanding of the user needs is crucial for successful product innovation. This viewpoint also emphasizes the 'demand factors' as the most valuable source of innovation by means of which a developed product or service would address the users' real needs.

Marzano (1997) mentions that to survive, any company has to respond to the real needs of the consumers, that is "*something that has meaning*." According to him, "*the future is apparently too complex to be foreseen by the limited mind of one person*," therefore, the only way to predict the consumers' future needs is to involve them to the process of developing new products and services (Marzano, 1997). Thus, Marzano (1997) emphasizes the role of thoroughly understanding of the needs of the user in new product development process. He also highlights the obvious shift from individual initiative to user assessment as a source of innovation.

How does user needs are assessed and transformed into user knowledge, as input to the innovation process is another significant concern. As studied in Chapter III, developing products and services is a complex and integrated process with certain kinds of knowledge input and feedback loops through every phase of the process (OECD, 1992). Holt et al. (1984) suggests that, the assessment of user needs can be considered as a linear process interacting with the product innovation process. Figure 5.1 represents the interaction between the need assessment process and innovation process.

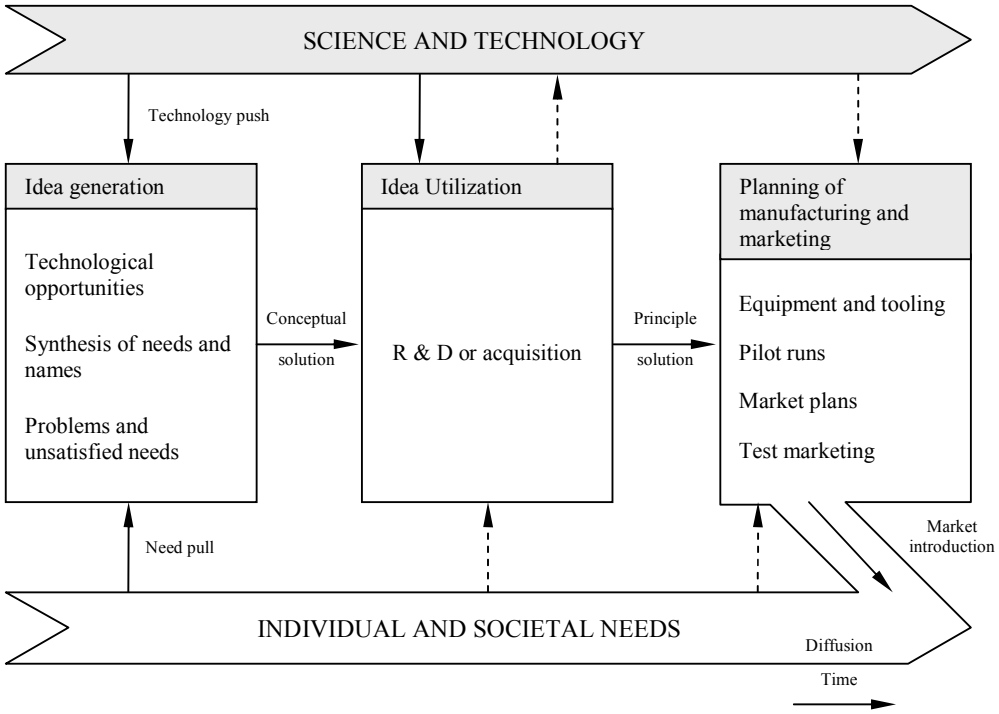


Figure 5.1 Product innovation process and assessment of user needs (Holt et al., 1984).

According to Holt et al. (1984), at the beginning of the innovation process, need related information is rather unclear, while in the further phases of the process, more exact information is needed. Throughout the process, the need related information might contribute in different phases of the product development process including preparation of the product proposal, evaluation of the product concept, development and testing of the prototype and planning of the marketing and manufacturing operations (Holt et al., 1984). Therefore, through different stages of the innovation process, different need related activities could be determined. Table 5.3 represents the different need related activities that Holt et al. (1984) suggest.

Table 5.3 Different need related activities in the need assessment process (Holt et al., 1984).

Need identification:	A problem or a user need is perceived, often in a vague form. This is usually the initiation of the product innovation process.
Need evaluation:	Based on available information the perceived need is analyzed and evaluated, e.g. in connection with preparation of the proposal.
Need clarification:	This involves a systematic study of user needs involved. It may be undertaken in connection with a feasibility study in the last part of the idea generation stage.
Need specification:	Based on assessed needs and their relative strength, relevant need requirements are specified.
Need up-dating:	As the project moves ahead, the needs specified are up-dated at intervals in connection with development of the technology and planning of the marketing and manufacturing operations.

5.2.3.1. The Definition and Categories of 'Need'

Holt et al. (1984) suggests "*a need is concerned with a lack of something that is wanted.*" Within this context, the term '*need'* both conceptually and linguistically appears to cover a broad scope of implications that makes it essential to examine the scope of linguistic meanings. In addition, the term, in the context of 'user needs' comprises a variety of conceptual classifications.

The word '*need*' has its etymological roots in the Old English word '*nēod*' or '*nēd*'. Before it gets its final form, it evolved to 'nede' in Middle English. At present, the word 'need' is used as a synonym for 'distress' and 'necessity' (The American Heritage Dictionary, 2000; Britannica Webster's, 2002). 'The American Heritage Dictionary (2000) defines '*need*' as (1) "*a condition or situation in which something is required or wanted"* (2) "*something required or wanted; a requisite"* (3) "*necessity; obligation"* or (4) "*a condition of poverty or misfortune."*

The Product Development Management Association distinguishes the needs of the 'consumer' and 'customer' with a firm perspective. According to them, a '*need*' is "*a problem to be solved*," while a *'consumer need*' is "*a problem the consumer would like to have solved*" or "*what a consumer would like a product to do for them*" through which they most likely appear to define '*user needs*' (Rosenau, 1996). On the other hand, '*customer needs*' "*either expressed or yet-to-be articulated, provide new product development opportunities for the firm*" (Rosenau, 1996). Their viewpoint, while defining 'consumer needs', represents a universal approach,

through which the 'user' of a product is addressed. Alternatively, their definition of 'customer needs' mostly refer to user need knowledge that would constitute input for the new product development process.

Since the term 'need' also conceptually covers a wide scope of implications; Holt et al. (1984) classify 'user needs' with a variety of contexts. Their classification mainly relies on 'time' and 'emotion' variables and whether the need is an individual or a societal one. Considering the 'time' variable, user needs comprise:

- *Existing needs:* recognized discrepancy between existing and wanted situation,
- *Future needs:* do not exist at present, but will materialize in the future (Holt et al., 1984).

Existing needs of users are rather easy to assess, as users are mostly aware of what are their needs in a conscious manner. The main aim of assessing existing needs is to satisfying functional and emotional needs of the user considering a particular product or service. Through assessing this kind of need, product appeal is the focus of the assessment activity and factors including safety, durability, ease of maintenance, environmental pollution, preservation of resources, and so on are disregarded (Holt et al., 1984). Information related to existing needs is mainly utilized to the product design & development activities in order to improve a product or service.

Assessing future needs of users is important particularly for developing radically new products through the new product development process. The assessment of future needs provide the innovation process with changes in "*need patterns and user preferences*" caused by socio-cultural changes including "*growing urbanization, increasing purchasing power, higher level of education, energy saving, environmental protection*" and so on (Holt et al., 1984). Assessing future needs is also important from the innovating firm's perspective in order to plan future innovation activities and product development facilities. Since developing relatively new products takes a particular time from product proposal to market introduction, future need related information is important for the firm "*to look into the future and find out what the needs, wants and tastes will be when the product is ready for the market*" (Holt et al., 1984).

Holt et al. (1984) argue that, besides future needs; 'new needs' might emerge along with new technological opportunities as well. According to them, users could be

aware of their needs only if they know actual possibilities of a product or service. Marzano (1997) also outlines, "*people are notoriously unable to forecast what is possible.*" As per him, people do not know what they want until they actually see the possibilities. However, the emergence of a 'new need' is only due to the materialization of a technical opportunity.

Another variable that leads to the classification of user needs is 'emotion'. Holt et al. (1984) distinguish user needs as:

- *Emotional needs:* these are concerned with novelty, style, color and other characteristics of an aesthetic nature,
- *Rational needs:* these are concerned with function and use (Holt et al., 1984).

Holt et al. (1984) discuss that satisfying the needs of the user is a subjective issue, which is mostly achieved at the emotional level. In the emotional extent, satisfying user needs rely on responding the need with proper 'values' that users appreciate. These values could be categorized as (1) "*affective values, pertaining to emotions aroused by the use of the product*," (2) "*symbolic values, referring to self-image and status the product holds for the user*," and (3) "*character values, which refer to the personality of the product*" (Holt et al., 1984). The emotional needs of users change also in time, through which significant changes in tastes and preferences take place. Holt et al. (1984) exemplify this circumstance with the textile industry, in which tastes are changed in shorter periods, i.e. seasons.

The last variable to determine the classification of user needs is 'scale', which determines whether the need is an '*individual'* or a '*societal'* one. Individual needs comprise the basic user needs including "*food, clothing, et cetera*" (Holt et al., 1984). These needs have been considerably satisfied in mostly industrialized societies, whereas societal needs stands to be unfulfilled in a number of areas including "*energy, transportation, communication, medical care, occupational health and safety, the quality of working life, education, leisure time, resource depletion, energy conservation, environmental protection, et cetera*" (Holt et al., 1984).

Considering all mentioned above, the 'need' concept is a multifaceted concern that has to be studied from a variety of perspectives. Innovation studies clearly show that user needs constitute the most important and valuable source for innovation in the search for developing products or services that are meaningful to the users.

5.2.3.2. Overview of Methods for Assessing User Needs

The studies on innovation have shown that 'need assessment' is the most valuable input for the innovation process to develop successful products and services (Holt et al., 1984). Nevertheless, the studies that were summarized in Table 3.1 also represent that the need related information is assessed by using informal methods and personal initiatives rather than applying systematic and well-defined methods and procedures.

In contrast, in today's dynamic environment with enormous changes in user needs and expectations, utmost technological advancements, growing international competition and decreasing product life cycles, the only way for companies to survive is a good coupling of thoroughly understanding user needs with an awareness of technological possibilities (Crush, 2000; Holt et al., 1984). To understand the real needs of the users, it is needed to apply systematic, well-defined procedures and '*methods'* through the process of collecting need related information.

Studies on innovation conclude with a number of '*methods'* defined to assess user needs. These methods vary in a couple of factors, such as the industrial sector, targeted degree of novelty in the product or service, and so on. In their study, Holt et al. (1984) conclude to 27 different methods of assessing need related information. Considering the large number of methods, Holt et al. (1984) classify these methods into three categories:

- *Utilization of existing knowledge:* this is relatively cheap way of obtaining information about user needs. The major problems are to locate the most important sources, to train and make those involved need-conscious, and to develop and maintain a practical procedure for systematization, registration, and utilization of relevant data,
- *Generation of new information:* this approach requires a relatively great effort and therefore a more expensive way of assessing user needs. One has to plan and implement special activities in order to provide the information. On the other hand, the information acquired in this way is usually more complete and reliable.
- *Provision of need information by other methods:* this group includes informal approaches, i.e. information related to user needs obtained by informal contacts with knowledgeable persons, and 'environment-related methods' such as product safety analysis, ecological analysis, and resource analysis (Holt et al., 1984).

Table 5.4 represents a complete list of these methods under the categorization above and brief descriptions of these methods. Nevertheless, it must be reminded that innovation studies represent a broad perspective to the need assessment activity. Therefore, the methods summarized in Table 5.4 have a nonspecific nature to be applied in several industries and by different organizations.

Table 5.4 Methods for obtaining need related information (Holt et al., 1984).

Existing Information	
Customer Information	Directly provided from customers through normal business contacts
Staff Information	Acquired and reported in connection with normal business contacts
Government Information	Provided by systematic surveillance of current and anticipated legislation
Competitor Information	Systematically collected information concerning products, patents, and activities of competitors
Trade Fairs	User information provided by exhibiting products, by studying products of competitors, and by talking with potential users
Literature	Need information provided through printed material such as books, standards, journals, reports, etc.
Experts	Systematic questioning and/or creative talks with researchers and other knowledgeable persons
Generation of New Information	
User Questioning	Systematic collection of information regarding problems and needs
User Employment	Hiring of people with user experience for a shorter or longer period
User Projects	Purposeful project cooperation with existing and potential users
Multivariate Methods	Graphical and mathematical models based on user perception of product characteristics
Dealer Questioning	Systematic collection of data related to user needs
User Observation	Systematic study of what is unsatisfactory by observing and analyzing the behavior of those involved
Active Need Experience	Working in a relevant environment for a certain period of time
Simulation	Performing or observing the work in a laboratory or other setting where a real-life situation is created
Brainstorming	Creative thinking based on free association, deferred judgment, and cross-fertilization
Confrontation	Creative thinking stimulated by analogies
Morphological Analysis	Creative thinking by a systematic break-down of problem in parts
Progressive Abstraction	Ranking of relevant needs in a hierarchical order
Value Analysis	Creative thinking stimulated by study of primary and secondary function and their costs
Delphi Method	Succession of iterative statement with participants interacting by written communication
Scenario Writing	Development of alternative futures
System Analysis	Systematic analysis of problems and needs caused by changes in a system or related subsystems
Other Methods	
Informal Contacts	Information provided through informal talks with people willing to indicate problems, needs and wishes
Product Safety Analysis	Study of product in order to minimize injuries, damages, and losses
Ecological Analysis	Improve environmental consequences of a proposed product
Resource Analysis	Improve resource utilization in a proposed product

5.2.3.3. Organizing for Need Assessment Activity

The study of Holt et al. (1984) represents only a fraction of methods designed for need assessment to be used the innovation process. The vast number of methods in the literature also entails organizations to progress a careful selection, planning, and application of a 'system' of methods. Holt et al. (1984) argues that this activity of developing a 'system' of assessing user needs would influence by a number of factors in a firm including business concept, corporate strategy, type of market, driving force behind technological development, structure of the user segment, access to the user segment, and attitude of management.

Another concern in developing a system for the need assessment activity is the selection of proper organization to execute this systematic activity. The innovation literature does not generally signify a type of organization to carry out the need assessment activity. However, innovation studies mostly agree that the overall task of assessing user needs should be assigned to a specified organizational unit and other organizations, those execute the innovation process, should manage the applicable need assessment methods through developing and marketing new products or services (Holt et al., 1984).

Holt et al. (1984) also suggest "*successful identification of user needs depends considerably on the personal sensitivity of those who are in contact with users, i.e. their ability to perceive needs and unsolved problems*." In this sense, the members of the organization to be in contact with users should be selected from people with high sensitivity to problems and needs of users. Holt et al. (1984) mentions that people "*with a creative mind*" are more apt to identify problems and needs of the users.

5.3. Design Knowledge, Design Process and Design Methods

The practice of 'design' utilizes certain forms of input and specific methods through the design process. Apart from other practices, 'design' practice pays particular attention to '*design methods'*, mostly due to the 'ill-defined' nature of design problems, which are 'context' and 'situation' dependent. Design activity deals with a large number of different and, often, conflicting aspects, which entails a systematic and methodological approach to the problems (Buijs, 1998).

The resolution of these ill-defined problems also needs the utilization of certain forms of knowledge to be obtained from a variety of sources. The knowledge that design activity requires might also incorporate 'tacit' forms of knowledge and depend on 'expertise' in particular industries (OECD, 1992). Therefore, due to the nature of the design activity, a number of sources of knowledge are employed through the design process.

Consequently, this section reviews initially the sources and characteristics of 'design knowledge' and eventually 'design methods' that process such knowledge in solving design problems. In addition, 'design process' as the process of executing these processes is also studied.

5.3.1. Design Knowledge

The word knowledge has its roots in the word 'knowlege' of Middle English (Britannica Webster's, 2002). According to The American Heritage Dictionary (2000), '*knowledge'* is broadly "*familiarity, awareness, or understanding gained through experience or study.*" Britannica Webster's (2002) defines '*knowledge'* at the first place as (1) "*the fact or condition of knowing something with familiarity gained through experience or association*" (2) "*acquaintance with or understanding of a science, art, or technique*." Therefore, it can be concluded that 'knowledge' comprises an 'individual' circumstance of 'knowing' resulted by 'experience' or 'study'.

As stated before, design activity incorporates certain forms of knowledge that might comprise 'tacit' or 'explicit' information. For Buijs (1998), design activity is a process of information processing. The mentioned 'information' here comprises of information about the customer, competitors and their products, manufacturing processes, available materials, environmental consequences, logistics, after-sales service, maintenance, safety regulations, legal standards, quality, distribution system, and about the socio-cultural context in which the customers want to use a new product (Buijs, 1998).

Alternatively, Friedman (2000) suggests that 'knowledge' differs from 'information' in that 'knowledge' represents "*agency and purpose.*" According to him, "*information may be stored in information system*s" while "*knowledge is embodied in human beings*." Here, Friedman (2000) emphasizes that 'knowledge' is an

individual act based on individual accumulation of acquaintance and understanding gained by experience.

Moreover, Friedman (2000) puts forward that design knowledge comprises of several domains of knowledge, those represented in the taxonomy in Table 5.5. According to him, each domain of knowledge requires the design practitioner a broad scope of skills and awareness with a systematic way of thinking to utilize them through design practice.

Table 5.5 Taxonomy of the domains of design knowledge (Friedman, 2000).

Domain 1: *Skills for Learning and Leading*	**Domain 2:** *The Human World*	**Domain 3:** *The Artifact*	**Domain 3:** *The Environment*
Problem Solving **Interaction Method** **Coaching** **Mind Mapping** **Research Skills** **Analysis** **Rhetoric** **Logic** **Mathematics** **Language** **Editing** **Writing** **Presentation Skills** *Public speaking* *Small group* *Information graphics*	**The Human Being** *Human Behavior* *Information semantics* *Knowledge creation* *Physiology & ergonomics* *Research & methodology* **The Company** *Organizational management & behavior* *Business economics* *Company culture* *Leadership* *Administration* *Future planning* *Process management* *Change management* *Process skills* *Company functions* *Governance* *Logistics* *Production* *Marketing* *Finance* **Society** *Trends* *Legal issues* *Media* *Social economics* *Communication* **The World** *World trade* *European Union* *USA* *Asia* *Cross-culture issues* *Political economics* **Theory basics** *Culture theory* *Sociology of knowledge* *Reception theory* *History of design* *Sociology of taste* *Content analysis* *World history* *Paradigm analysis* *Models*	**Product development** *Methodology* *Market research* *Innovation research* *Problematics* *Product generation* *Creating new products* *Transforming old products* *Product regeneration* *Correcting problems* *Improving products* *Positioning* *Re-engineering (lean production)* **Design** *Product design* *Ergonomics* *Product semantics* *Product graphics* *Functionality* *Graphic design* *Visual ergonomics* *Typography* *Corporate design* *Behavioral design* *Information design* *Knowledge design* *Process design* **Manufacturing** *Technology* *Operations* *Statistical quality control* *Logistics* *Process management*	**Natural environment** *Ecology* *Evolution* *Environment* *Impact* **Built environment** Cityscape Economy Social web Infrastructure Traffic Telecommunications Airports Food distribution Human ecology **Architecture** *Informated buildings* *Usage* *Architecture as idea* *Architecture as corporate identity* *Profile architecture* **Interior** *Furniture* *Interior as corporate identity* *Psychology* *Function* *Social structure* *The shape of work* *The shape of play* *The shape of private life* **Installation** *Philosophy of space* *Culture theory* *Art ideas* *Inquiry*

Furthermore, the increasing change and enhancement in user needs entail design practitioners to apply sophisticated level of knowledge in order to respond user needs satisfactorily (Popovic, 1999). Therefore, henceforth, design practice needs a more in-depth assessment of user knowledge and "*integrate design knowledge and domain-specific knowledge about the product users*" (Popovic, 1999). User knowledge must comprise a thorough understanding of users, their needs, their knowledge and experience of the products and services they use. Popovic (1999) suggests, "*designers should begin designing with good knowledge of the users, and include users as a part of the project team*."

5.3.2. Design Process

In Chapter III, the innovative activity has been described as process, which also embodies a set of processes within. Design as a major function in the innovation process, also constitutes a process with certain stages, inputs and outputs. The design literature involves numerous models describing the nature of this process. However, these models do not agree with each other that makes it impractical to depict a generic model of the design process. Therefore, some of the most significant models in the literature have been studied in this section.

Jones (1992) illustrates the design activity as a three-stage process embodying analysis, synthesis, and evaluation stages. He identifies these three stages as: (1) '*divergence'* through which the design problem is broken into pieces, (2) '*transformation*' comprising the rearrangement of pieces in a new way, (3) '*convergence*' testing the output of the 'transformation' phase by putting the new arrangement into practice. The model of Jones (1992) of the design process represents an extensive approach to the design process that most of other approaches agree to some extent. Furthermore, in this model, every stage is increasingly less general and more detailed than the one before it (Jones, 1992).

The initial stage of this model is the '*divergence'* phase, which aims "*to de-structure or destroy, the original brief while identifying these features of the design situation that will permit a valuable and feasible degree of change*" (Jones, 1992). In this phase, the boundaries of the design problem are extended so that it can provide designers a wide space to seek a solution to the studied design problem. Through this

phase, the points that are open to any change are identified as well as the fixed points of the design problem.

According to Jones (1992), the second phase of the design process is '*transformation'*, which is the stage of high-level creativity. In this stage, "*judgments of values, as well as of technicalities, are combined in decisions that should reflect the political, economic and operational realities of the design situation*" (Jones, 1992). Jones (1992) argues that the output of this stage does not represent an optimal solution, but a general character of the design solution.

The third and eventual phase of this model of the design process is '*convergence'*, which aims "*to reduce a range of options to a single chosen design as quickly and cheaply as can be managed and without the need for unforeseen retreats*" (Jones, 1992). Through this phase, the imperfect solutions of the 'transformation' phase are finalized to an optimal design and launched as the final output of the whole design process.

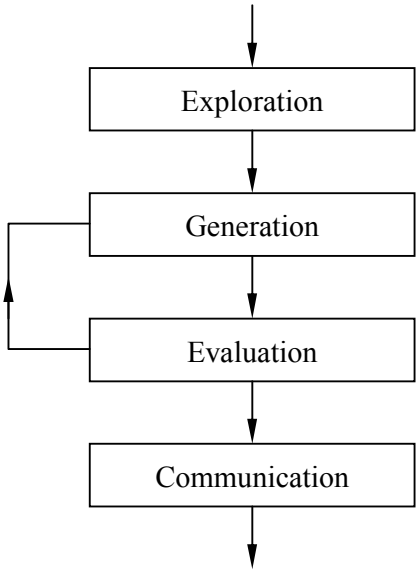


Figure 5.2 Simplified four-stage model of the design process (Cross, 2001).

The above model represents a very general outlook of the design process that almost every study on the nature of the design process agrees. However, the design literature signifies a variety of models of the design activity with different levels of specification. Cross (2001) also suggests a simplified model of the design process

that consists of four stages that are (1) exploration (2) generation (3) evaluation (4) communication. Figure 5.2 represents his simplified model of the design process.

In this model, the 'exploration' phase represents the phase when the designer investigates both the problems of the design situation and solutions concerning those problems. In the 'generation' phase, the designer generates design proposals, through which he or she considers many aspects in relation with the proposal, including materials, components, functions, structure, and so on. Later, in the 'evaluation' phase, the generated design proposals are evaluated and refined in order to ensure that the design proposal meets certain criteria to be a solution to the defined design problem. The eventual stage of the design process is 'communication' through which the evaluated design proposal is given the final form. The output of this phase is the detailed description of the final form of the design that signifies a guide the production of the artifact.

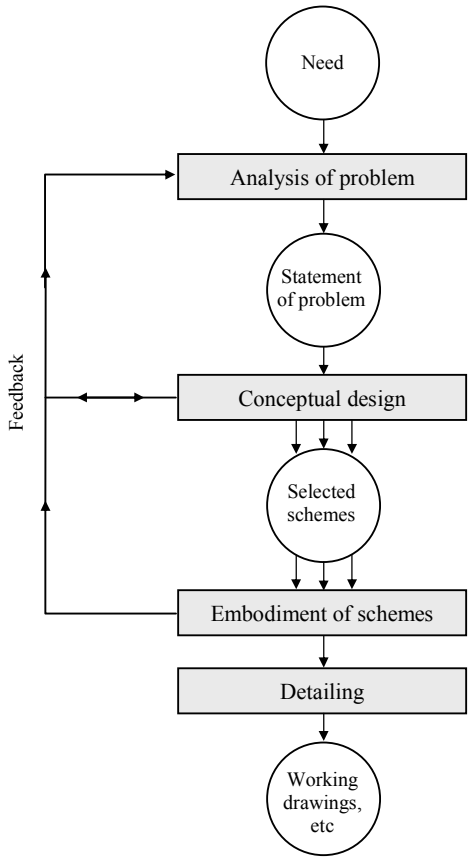


Figure 5.3 French's model of the design process (Original source, French, 1985; Quoted from, Cross, 2001).

Cross (2001) also suggests that the 'evaluation' phase does not always lead to the 'communication' phase and may give a feedback to the 'generation' stage of the design process. According to him, these 'feedback loops' provides the generation of new and more satisfactory concepts and helps the process achieve a less imperfect output of the design process. Within this perspective, Cross (2001) refers to French (1985), who suggests that feedback loops might return to earlier stages of the process. According to French (1985), the analysis of the problem is a rather small but important phase of the design process that feedback loops should provide returns to this initial phase.

In his model, the process starts with the input of a 'need' that activates the first phase of the process, which is the 'analysis of the problem'. The major output of this phase is the 'statement of problem' along with the information on certain design criteria relevant to the design problem. The statement of problem leads to the 'conceptual design' phase, through which "*engineering science, practical knowledge, production methods and commercial aspects need to be brought together*" (French, 1985). The output of the 'conceptual design' phase is broad solutions of the design problem in certain 'schemes'. In the next phase, named the 'embodiment of schemes', these schemes are evaluated and arranged in a final set of drawings. 'Detailing' is the eventual stage of the design process, through which the details of the final design are decided and transformed into final drawings as the output of the design process.

Whereas the model that French (1985) suggests that the initial stage of analyzing the problem is important, some studies on the nature of design process discuss that the initial stage of the design process needs far more 'analytical' work and an in-depth understanding of the design process. These studies exemplify this situation mentioning "*plenty of examples of excellent solutions to the wrong problem*" (Cross, 2001). The model that Jones (1992) suggests could also be considered as a simplified example of these 'analytical' models of the design process.

One of the significant models of the above-mentioned 'analytical' approach is that of Archer (1984). His model comprises six types of activity including:

- *Programming*: establish crucial issues; propose a course of action,
- *Data collection*: collect, classify, and store data,
- *Analysis*: identify sub-problems; prepare performance (or design) specifications; reappraise proposed programme and estimate,

- *Synthesis*: prepare outline design proposals
- *Development*: develop prototype design(s); prepare and execute validation studies,
- *Communication*: prepare manufacturing documentation (Original source, Archer, 1984; Quoted from, Cross, 2001).

The model that Archer (1984) suggests distinguishes from other models in that it utilizes multiple sources of knowledge and embodies numerous feedback loops throughout the process. Archer (1984) also splits the design process into three main phases, which are (1) analytical, (2) creative and (3) executive. According to Archer (1984), in the 'analytical phase', the activities comprise 'objective observation' and 'inductive reasoning' while the 'creative phase' mostly rely on 'involvement', subjective judgment', and 'deductive reasoning'. Eventually in the 'executive phase', final decisions are made; the design is finalized in the form of drawings, schedules, etc (Archer, 1984). Figure 5.4 represents Archer's model extensively.

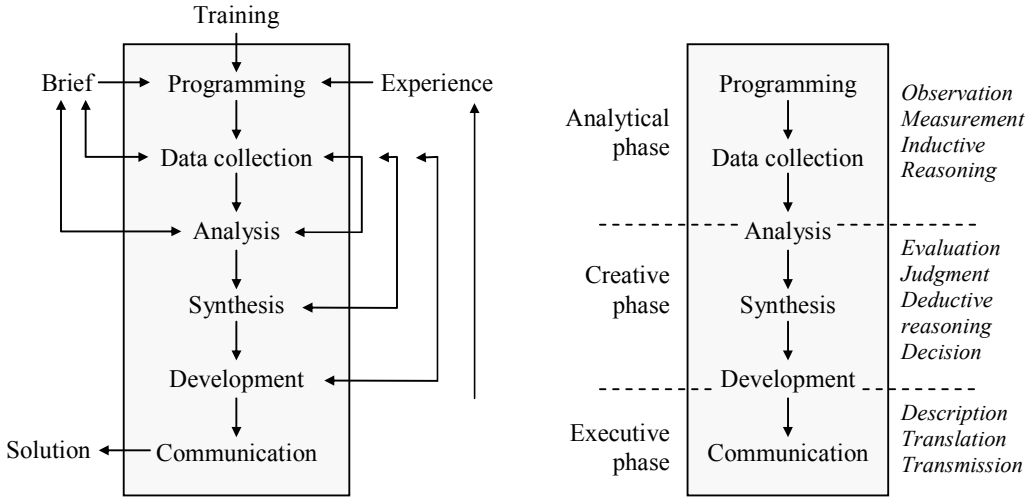


Figure 5.4 Archer's model of the design process (left), and his three-phase summary of his model (right) (Original source, Archer, 1984; Summarized and quoted from, Cross, 2001).

Recent studies on the nature of the design process suggest more detailed and interactive models of the process. However, in the same way as Cross (2001) discusses, they by some means obscure the general structure of the design process. Therefore, considering the aims of this study, models that rather represent the general structure of the design process are studied.

5.3.3. Design Methods

The vague nature of the design activity necessitates certain '*methods'* to be carried out. Design literature describes a set of 'design methods' whereas some sources mention a 'design methodology'. Whether these two phrases refer to each other or not is usually subject to confusion. Therefore, before studying 'design methods', these terms need clarification.

The word '*method'* originates from Middle French, '*methode'*, or Middle Latin, '*methodus'*, while it is also believed to have its origins in Middle Greek, '*methodos'* (Britannica Webster's, 2002; OED, 2002). The American Heritage Dictionary (2000) defines 'method' as (1) "*a means or manner of procedure, especially a regular and systematic way of accomplishing something*" (2) "*orderly arrangement of parts or steps to accomplish an end*" (3) "*the procedures and techniques characteristic of a particular discipline or field of knowledge*." Bunge (1999) describes 'method' as "*a regular and well-specified procedure for doing something: an ordered sequence of goal-directed operations.*"

On the other hand, the word '*methodology'* is a late derivation of the word '*method'*, into '*method+ology*' (OED, 2002; SOED, 1993). According to The American Heritage Dictionary (2000), '*methodology'* is (1) "*[a] a body of practices, procedures, and rules used by those who work in a discipline or engage in an inquiry; a set of working methods [b] the study or theoretical analysis of such working methods*" (2) "*the branch of logic that deals with the general principles of the formation of knowledge.*" Mautner (1996) describes '*methodology'* as (1) "*the discipline, which investigates and evaluates methods of inquiry, of validation, of teaching, etc.*" (2) "*a theory within that discipline.*"

The terms '*method'* and '*methodology'* distinguishes in many perspectives. Friedman (2002) mentions that a method is "*a way of doing something*" while "*methodology is the comparative study of method.*" He also underlines that methodology is often confused with 'methods' or 'methodics', which is "*the collection of methods within a field.*" Bunge (1999) also distinguishes between method, as "*a regular and well-specified procedure for doing something: an ordered sequence of goal-directed operations*" and methodology as "*the study of methods. The normative branch of epistemology; a knowledge technology.*"

In conclusion, although a 'design methodology' may exist within a distinct context, 'design methods' should be referred to while implying certain procedures and techniques executed through the design activity. Moreover, this section aims to make a general review of the most common methods agreed within design literature and utilized by design practitioners.

5.3.3.1. Origins of Design Methods

The emergence and development of conventional design methods mainly rely on individual efforts and insights of design practitioners and other individuals in relation to the production of artifacts, while conventional methods have emerged due to the needs of the complicated nature of the design activity. Cross (2001) suggests that some of the contemporary methods are extensions or clarifications of the implicit methods that design practitioners have always used. Some design methods are adapted from other research-oriented areas such as operational research, decision theory, management sciences, and so on, whereas some are developed by rational efforts in order to meet a certain need for a specific method. Furthermore, through different stages of the design process different design methods serve different purposes (Cross, 2001).

According to Cross (2001), contemporary methods have two principal features in general, which are formalization of certain design procedures and externalizing design thinking. Through formalization, the omissions of the design activity originating from implicit methods are reduced. This feature also enables the designer to widen his or her approach to the design problem and extend his or her search for possible solutions appropriate for the problem (Cross, 2001). Through externalizing, the design process gets out of the designer's individual intuition, and is represented with certain tools such as charts, diagrams, and so on. Cross (2001) discusses that externalizing design thinking is significantly helpful in handling complicated problems. This feature of design methods also promotes teamwork; by which the design process is represented in a shared medium in lieu of the designer's own thinking.

One more concern about design methods is that they are perceived as diminishing the creativity of design process by preventing the individual intuition and creativity of designers. Cross (2001) opposes this viewpoint by emphasizing the role of design

methods in novel and complicated circumstances where the intuition of an individual is not sufficient in the resolution of the design problem. Furthermore, besides rational design methods mainly devoted to problem solving, there are creative methods enabling creativity within teams through the design process. Consequently, in the next sections, besides a general review of the conventional design methods, 'rational methods' and 'creative methods' of the design activity are reviewed.

5.3.3.2. Conventional Methods

Jones (1992) argues that the initiator of the design activity is the 'craftsman' who was the "*maker-of-things*". The craftsman uses the skills and methods of the craftsmanship to evolve shapes into products. Nevertheless, the factors that resulted in the occurrence of the 'industrial revolution' also brought about new skills and methods in early design activity. In fact, the most significant change in the design activity is the need for 'drawing' a product or structure before its production, which eventually led to the emergence of the method, '*design-by-drawing*' (Jones, 1992; Cross, 2001).

Jones (1992) argues that the 'drawing-by-design' method has given rise to significant changes in industrial production. According to him, the initial effect of this method is that by "*specifying dimensions in advance of manufacture*" it turned out to be possible to "*split up the production work*", through which the 'division of labor' in production could be obtained. Furthermore, making drawings before production enabled the planning of products or structures that are "*too big for a single craftsman to make on his own*" (Jones, 1992). Through making scaled drawings, the parts of a huge product or structure could be shared into the production of numerous craftsmen and later brought together to form the final product. The use of drawings has not only enabled to increase the size of the products, but also led to increase the number of production. By splitting up the product into small, standardized components, the drawings enabled the production of these components simultaneously and in large numbers (Jones, 1992).

In conclusion, the use of the 'design-by-drawing' method not only resulted in significant changes in the industry, but also activated the emergence of 'design' as a practice. Obviously, drawing, as a method, is beyond depicting the shape or components of a product in a two-dimensional media. Through 'design-by-drawing'

method, a designer is able to "*see and manipulate the design as a whole*" and "*rapidly plot the trajectories of moving parts and predict the repercussions that changing the shape of one part will have upon the design as a whole*" (Jones, 1992).

Jones (1992) describes the 'design-by-drawing-' method as "*to draw, and to redraw, successive alterations, either on different part of a large piece of paper or else on a series of tracings from the original sketch or layout*." Although this method dates back to the evolution of crafts, it still stands to be an appropriate method for designers to express and communicate their contribution to the design problem. Jones (1992), on the other hand, argues that this method has certain weaknesses while it is the creation of an individual designer reflecting merely his or her individual insight to the design problem. According to him, the critical weakness of this method is "*not conveying anything about the needs of users or about the problems of manufacturers*" (Jones, 1992). Even though this flaw of the method could be, to some extent, overcome by "*making models and prototypes which can be seen and tested and also by making calculations to check the performance of critical parts*" (Jones, 1992).

Moreover, although the 'design-by-drawing' method has revolutionized the 'design-by-making' approach of the craftsman, it does not meet the requirements of more multifaceted situations, where the design should adequately respond the expectations of both the user and the manufacturer. Jones (1992) also argues that the experience of only one person is inappropriate to meet the requirements of novel situations.

Consequently, design activity entails the contribution of multiple perspectives to meet certain requirements of the studied situation. Accordingly, the methods of the design activity become complicated and need a systematic approach to be executed. According to Cross (2001), design problems have become too complex to be resolved adequately utilizing the conventional methods. In this respect, contemporary design methods provide a more comprehensive and systematic approach to design problems.

5.3.3.3. Creative Methods

Since creative thinking is an extremely important part of the design process, some design methods are devoted to stimulate creativity in design process. According to Cross (2001), these methods aim to promote the generation of ideas by "*removing*

the mental blocks that inhibit creativity" of by "*widening the area in which a search for solutions is made*." Creative methods also aim to help group creativity and encourage teamwork in a seamless fashion through the design process. The most well-known and practiced creative methods are 'brainstorming', 'synectics', and 'enlarging the search space / removing mental blocks' (Cross, 2001; Jones, 1992).

***Brainstorming*:** Jones (1992) defines 'brainstorming' method as aiming "*to stimulate a group of people to produce many ideas quickly*." Although he mentions that, this method increases the 'quantity' of the ideas, he argues that it may also foster the 'quality' of the ideas generated. His argument is supported by the definition suggested by Cross (2001), who describes this method as an activity "*for generating a large number of ideas, most of which will subsequently be discarded*." From this perspective, it can be concluded that 'brainstorming' method aims to quickly elucidate as much ideas as possible to avoid overlooking valuable ones.

In practice, the 'brainstorming' activity is executed in particular 'sessions'. A 'brainstorming' session generally requires the contribution of four to eight people preferably from diverse disciplines and a group leader as the facilitator of the meeting. The members of the participating group might not consist of experts in the subject area and rather people from diverse areas having a certain degree of familiarity to the subject. Although there should not be any hierarchical order, the group is supposed to an organizational leader, who makes sure that the method is executed procedurally. The leader should initially devise "the problem statement" concerning the aims of the session. Initially, the members of the group are asked to spend some time on the problem statement and write down the ideas that they first come up with (Jones, 1992; Cross, 2001).

In the next step, each member of the group is asked to read aloud one idea that they have been produced. Afterward, all members of the group are asked to build on the stated idea. At this point, it is critical that no criticism should be allowed, because the aim is not evaluating the idea but trying to take it ahead and develop it. There should be a small break after each idea is expressed, therefore to allow the members of the group generate and write down further new ideas. It is important to note each idea and subsequent ideas on one small card that would make it easier to eventually classify the ideas. A 'brainstorming' session should be concluded as soon as the group stops producing novel ideas. However, the optimal time for a 'brainstorming'

session is twenty to thirty minutes. The eventual phase of a 'brainstorming' session is the evaluation phase, through which the ideas are sorted into related groups. The use of small card is particularly helpful in this stage of the session. Finally, the generated groups indicate certain solution areas to the studied problem and the ideas represent possible solutions

Cross (2001) suggests certain rules to be followed throughout the 'brainstorming' activity. According to him, a 'brainstorming' session could be efficient only if these rules are agreed. He outlines the main rules of the brainstorming activity as follows:

- No criticism is allowed during the session.
- A large quantity of ideas is wanted.
- Seemingly-crazy ideas are quite welcome
- Keep all ideas short and snappy.
- Try to combine and improve on the ideas of others (Cross, 2001).

In conclusion, the 'brainstorming' method provides the design process with a variety of perspectives that could not be gained through conventional methods. This method could be applied simply and directly and at any stage of the design process, unless the design process is stabilized. The 'brainstorming' activity might also be used to generate 'information' instead of 'ideas' (Jones, 1992).

Synectics: According to Jones (1992), in 'synectics', the aim is "*to direct the spontaneous activity of the brain and the nervous system towards the exploration and transformation of design problems.*" Cross (2001) identifies 'synectics' as the formalization of "*analogical thinking*." Similar to 'brainstorming', 'synectics' is a group activity, through which the members of the group try to generate and combine ideas to develop a creative solution to a certain problem. This method differs from 'brainstorming' in that the group tries to generate ideas together on a particular design problem, instead of trying to generate as much ideas as possible. In addition, a 'synectics' session takes much longer than a 'brainstorming' session (Jones, 1992; Cross, 2001).

The 'synectics' activity comprises two major steps. In the initial step, a problem statement is introduced to the group and the members of the group are asked to "*make the strange familiar*" using analogies (Cross, 2001). This step results in a "*conceptualization of the problem*" with the main elements of the design problem. In the eventual step, the group is asked to "*make the familiar strange*" by transforming

the result of the preceding section using analogies. In the output of this step, unusual and creative analogies are expected, which might lead to novel solutions (Cross, 2001).

Cross (2001) categorizes the analogies used through 'synectics' method as (1) 'direct analogies' arrived by looking for a biological solution to a similar problem; (2) 'personal analogies' by which the group supposes what it would be like for oneself to be the system or component that is subject to design; (3) 'symbolic analogies' that are used to relate two things with poetic metaphors and images; (4) 'fantasy analogies' that constitute desires for impractical things to happen in a magical fashion.

In conclusion, the 'synectics' method provides unusual and creative solutions for a design problem, however it involves certain risks and disadvantages. Jones (1992) argues that 'synectics' seems to be appropriate only for the middle stages of the design process. The method initiates with so little input from the design problem that the output of this activity might not comprise relevant solutions or a proper formulization of the design problem. The output of the 'synectics' method is mainly a "*general solution to a recurrent problem*" (Jones, 1992).

'Brainstorming' and 'synectics' methods are mostly based on stimulating creative thinking by generating ideas that might lead to creative solutions to a defined problem. Another way of promoting creative thinking is expanding the boundaries of the space where the design activity tries to find solutions for a certain problem. 'Enlarging the search space / removing mental blocks' is one of the most widely-known methods with this approach of facilitating creative thinking.

Enlarging the Search Space: The aim of this method is expanding the solution areas of the design problem with certain techniques. Jones (1992) identifies this method as "*removing mental blocks*" which aims "*to find new directions of search when the apparent search space has yielded no wholly acceptable solution*." Cross (2001) suggests four techniques in practicing this method as (1) 'transformation' through which the search for a solution is transformed from one solution area to another, (2) 'random input' which is used to facilitate creativity by providing random inputs from any source, (3) 'why? why? why?' by which the search space is extended through asking 'why?' questions about the problem, (4) 'counter-planning' which is used to

challenge an existing solution to a problem by suggesting its opposite. This method is rather applicable when the search area for a complex problem is limited to generate any solutions.

5.3.3.4. Rational Methods

The creative phase is the most important stage of the design process in search of 'novelty' through the design activity. However, the design activity also requires certain methods that bring a systematic approach to the whole design process. Hence, 'rational methods' aims to enhance the quality of both the design decisions and the product. Rational methods might comprise creative methods as well, but as Cross (2001) suggests, creative methods and rational methods are 'complementary' activities to obtain a systematic approach to the design activity.

Cross (2001) exemplifies the rational methods in its simplest form as a 'checklist', which "*formalizes the process by making a record of items which can be checked-off as they are collected or achieved until everything is complete*." A checklist externalizes the information of the tasks to be achieved in lieu of keeping them in mind with the risk of overlooking some of the tasks. This method also encourages teamwork, by which the tasks could be divided into minor tasks to be achieved by a team. The checklist illustrates the systematic approach to a set of tasks, whereas the design activity entails complicated methods or a set of methods to be systemized.

Cross (2001) indicates a set of rational methods covering all stages of the design process. Figure 5.5 represents an overview of his set of methods in different stages of the design process.

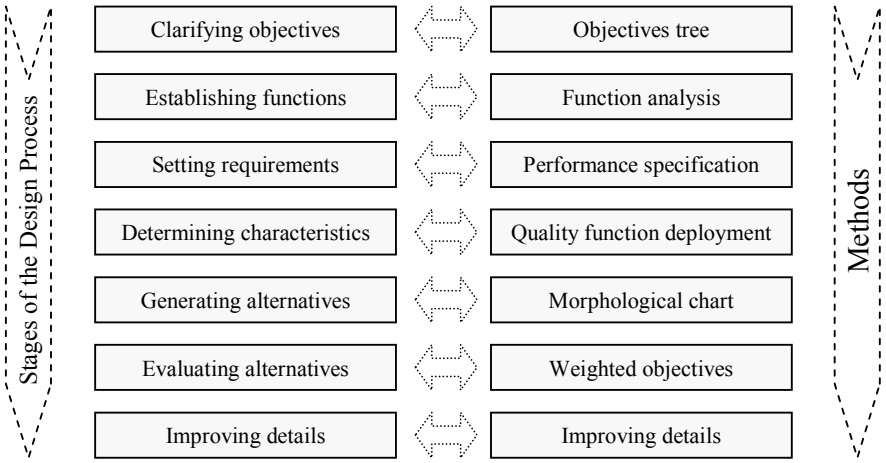


Figure 5.5 Simplification of Cross's set of rational methods (Cross, 2001).

According to Cross (2001), these methods serve different purposes in different stages of the design activity. In his suggestion, each method might lead to the initiation of the subsequent one, whereas alternative methods might replace the methods applied in his coupling. He suggests the following combination of methods to be applied in the subsequent stages of the design process.

The Objectives Tree Method: This method refers to the important first step of the design process where the objectives of the design activity are clarified. Cross (2001) defines the aim of the 'objectives tree method' as "*to clarify design objectives and sub-objectives, and the relationships between them*." While practicing this method, three main steps should be followed. Initially, a list of design objectives is prepared utilizing a variety of sources such as the design brief, expectations of the client, arguments of the design team and so on. In the latter step, the listed objectives and sub-objectives are grouped in a hierarchical order. Eventually, an illustrative tree of objectives is drawn representing the hierarchical relationships and linkages between all objectives.

The 'objectives tree method' helps the design team achieve a clear and helpful statement of objectives, which represents the set of objectives and the outline of the path that would be followed in order to achieve those objectives. The output of this method also helps the design team and their clients agree on the stated objectives.

The Function Analysis Method: To adequately meet the stated objectives of the design activity, instead of solutions, essential functions of a solution should be established. This attempt defines the level of the design problem, i.e. whether a problem should need a radical design change or a design improvement. Regarding this, the 'function analysis method' aims "*to establish the functions required, and the system boundary, or a new design*" (Cross, 2001).

According to Cross (2001), the 'function analysis method' entails five main steps to be carried out, which are (1) expressing the overall function of the design activity in terms of transforming process inputs into outputs, (2) dividing the overall function of the design activity into a set of essential sub-functions, (3) illustrating the interactions between sub-functions in a block diagram, (4) drawing the system boundary that defines the functional limits of the design solution, and (5) searching for suitable components to meets the sub-functions and the interactions among them.

In conclusion, the 'function analysis method' method draws the outline of the essential functions that the output of the design activity would be expected to satisfy. Therefore, the design team is enabled to develop alternative solutions that meet these predefined functions.

The Performance Specification Method: Although identifying the objectives and functions of the design activity clarifies the requirements of a design solution, they are not identified in exact limits. For that reason, certain boundaries should be set to the solution space for the design team to search for solutions. Cross (2002) describes the aim of 'the performance specification method' as "*to make an accurate specification of performance required of a design solution*."

Cross (2001) signifies the procedure of this method in four phases that comprise (1) considering the different extents (the level of generality) that the solution might cover in an applicable manner, (2) deciding on the extent to study in, (3) apart from any solutions, identifying the required performance characteristics, and (4) precisely specifying specific performance requirements for each characteristics.

In summary, the 'performance specification method' helps the design team determine and specify the design problem in order to establish the study space and means of adequately resolving the problem for the designers. This method identifies the necessary performance that the solution should achieve instead of physical components of the product. Furthermore, Cross (2001) suggests that the 'performance specification method' could also be used in the later phases of the design process in evaluating the arrived solutions whether they exist within the specified boundaries of the specified performance.

The Quality Function Deployment Method: Cross (2001) discusses that there exists a disagreement between the marketing 'attributes' and production 'characteristics' of a product, which is mostly due to a distinction between the specifications of the design solution and the needs of customers. As per him, understanding the needs and expectations of customers, in terms of product 'attributes', is essential to meet them with appropriate characteristics of the design solution. Accordingly, he suggests the 'quality function deployment (QFD) method' aiming "*to set targets to be achieved for the engineering characteristics of a product, such that they satisfy customer requirements*" (Cross, 2001).

Cross (2001) describes seven major steps in executing the QFD method, that are (1) identifying customer preferences in terms of product attributes, (2) classifying the attributes in terms of importance, (3) assessing the attributes of the competing products, (4) drawing a matrix of product attributes counter to design characteristics, (5) identifying the relationships between product attributes and design characteristics, (6) identifying the possible interactions between design characteristics, and (7) specify necessary figures to be achieved to ascertain the design characteristics.

In conclusion, the QFD method suggests that "*the voice of the customer*" is the most valuable factor in the commercial success of a product (Cross, 2001). Thus, the QFD method is based on in-depth understanding of the customer and the determining design characteristics in the light of its findings. Cross (2001) mentions that QFD method is such an excessively comprehensive method that it could be utilized in multiple stages of the design process.

The Morphological Chart Method: Considering all of the phases of the design process, 'generating alternatives' stage stands to be the most essential and central one, through which novel solutions or re-orderings of existing solutions to a design problem is generated in different levels of novelty. In this essential phase of the design process, the 'morphological chart method' provides designers with "*the complete range of elements, components, or sub-solutions that can be combined together to make a solution*" (Cross, 2001).

Cross (2001) suggests that the 'morphological chart method' would be classified as a rational method, while according to Jones (1992), this method is essential to search for creative ideas, therefore might stand to be a creative method.

The practice of 'morphological chart method' aims "to *widen the area of search for solutions to a design problem*" (Jones, 1992). The aim of this method appears similar to that of 'enlarging the search space' method, while the use of 'morphological charts' differs in its use in the "*exploration of unbounded and undefined problems*" (Jones, 1992). Cross (2001) signifies the aim of this method as "*to generate the complete range of alternative design solutions for a product, and hence to widen the search for potential new solutions.*"

Jones (1992) identifies the 'morphological chart method' to develop in three main steps, which are (1) definition of the functions that any satisfactory design should be able to perform, (2) listing a broad range of sub-solutions on a chart, and (3) selection of an satisfactory set of sub-solutions that meets the set of functions.

In summary, according to Jones (1992), facilitating creative thinking by 'morphological charts' prevents the design team to overlook novel solutions to the design problem. Furthermore, this method has the advantage of concluding a matrix in a short time if the set of functions are identified properly at the initial stage of the activity.

The Weighted Objectives Method: Subsequent to the generation of alternatives, these alternative solutions need to be evaluated in order to choose the solution which best fits the statement of objectives that the design solution has initially meant to achieve. However, particular characteristics of different solutions might match different aspects in the design objectives. Therefore, the 'weighted objectives method' provides the evaluation and comparison among alternative solutions by differently weighing the initial design objectives (Cross, 2001).

Cross (2001) mentions that the main aim of the 'weighted objectives method' method is "*to compare the utility values of alternative design proposals, on the basis of performance against differentially weighted objectives.*" The practice of this method entails a five-step-process to be carried out including (1) listing the initial design objectives, (2) identifying numerical rankings to the objectives and ordering them, (3) giving comparative weightings to the objectives, (4) determining certain performance parameters or utility scores for all objectives, and (5) analyzing and comparing the comparative utility values of the alternative solutions, multiplying each parameter score by its weighted value and arriving to the alternative solution having the highest sum value.

The 'weighted objectives method' appears to be the most rational method reviewed in this section. Since the evaluation method is merely based on the assignment of quantitative measures to the qualitative aspects of a design solution, the numerical output of this method might not represent the best selection. For that reason, Cross (2001) discusses that the evaluation the results values might based on the comparison

and discussion of utility value profiles instead of simply choosing the highest sum value.

The Value Engineering Method: The design process is also applicable for improving the 'value' of an existing product, while the same effort could be devoted to increasing the 'value' of a novel design solution by improving the details of the design. Cross (2001) classifies the 'value' that a product might have as (1) the value of a product to its purchaser; the extent that the purchaser perceives a product as worthy, and (2) the cost of a product to its producer; the extent that the producer reduces the design, manufacturing and delivery costs of a product. Therefore, the 'value engineering method' seeks to improve a product by reducing cost or increasing value, or usually to achieve both.

According to Cross (2001), the aim of the 'value engineering method' is "*to increase or maintain the value of a product to its purchaser while reducing its cost to its producer*." Cross (2001) identifies five main phases to be followed through this process including (1) making a list of the components of the product and determining the function of each component, (2) identifying the values of determined functions, (3) specifying the costs of the components, (4) investigating solutions for improving the value of the product without increasing the cost or reducing the cost of the product with no change in the value, and (5) assessing and selecting the alternative improvements. Cross (2001) emphasizes that the operation of the 'value engineering method' method necessitates the participation of members of different departments, such as design, marketing, production, and so on.

The 'improving details' phase of the process of design is necessary for improving the value or reducing the cost of both an existing product and an eventually arrived design solution. Therefore, the 'value engineering method' appears to be essential to improve the quality of the output of the design process and eventually the product.

As stated before, the above-studied rational design methods comprise only Cross's suggestion and simplification for a set of methods executed through the design process. Although there exist numerous design methods serving the same or distinct purposes, the above-mentioned methods could be considered as a classification general design methods concerning the design process.

5.3.3.5. Design Evaluation Methods

Although the design process is widely known as a problem solving activity, the solution of the design problem, instead of the product, often becomes the main goal of the design process. Thus, some of the major aspects of a product might be overlooked, such as its interaction with its user, user needs, and preferences, and so on. According to Popovic (1999), "*the products should manifest the end user's point of view, from initial concept to their distribution to the market place.*" Therefore, user knowledge should be included into the design process from the early stages and pursued all through the process. To gain user knowledge, the design activity should employ certain procedures including (1) research, (2) evaluation of same products/systems, (3) evaluation of related products/systems, and (4) evaluation of predicted products/systems (Popovic, 1999).

Consequently, '*evaluation'* appears to be a crucial activity to be carried out throughout the design process. The design literature mentions numerous tools, methods, and techniques for evaluation, hence, the selection of the suitable ones relies on the objectives of the design activity and the functions that are intended to be evaluated. The utilization of evaluation methods serves dual purpose; (1) to evaluate the usability of the design solutions, and (2) to gain in-depth knowledge about the users. These methods are employed at different stages of the design process. Table 5.6 and 5.7 represent the most common evaluation tools, techniques and methods.

Table 5.6 Common evaluation tools (Popovic, 1999).

TOOLS	PURPOSE	DESIGN PROCESS STAGES
CAD simulation and Virtual reality (VR)	*To evaluate design and its perceived use.*	*Concept development stages*
Mock-up evaluation	*To evaluate product usage with users' participation*	*Concept development stages*
Prototype evaluation	*To verify design outcome under real circumstances*	*Different stages of the design process*

Table 5.7 Common evaluation methods and techniques (Popovic, 1999).

EVALUATION METHODS/TECHNIQUES	PURPOSE	DESIGN PROCESS STAGES
Checklists	*To define operations of a product/system and identify users' needs*	*Early stage of the design process and field test*
Focus group	*To identify user issues and their importance*	*Any stage of the design process*
Interviewing users	*To identify users' needs*	*Any stage of the design process*
Observation techniques	*To define dynamics of the artifact/system/environment*	*Final design stage and field test*
Protocol analysis	*To evaluate a design, users' expertise levels and understand users' concept of products*	*Any stage of the design process*
Task-analysis	*To define and evaluate operational procedures of human/product/system*	*Concept development stage, final design stage and field test*

Evaluation Tools: One of the most common evaluation tools is '*CAD simulation models*', which are "*representations of artifacts or artifact interfaces that can be stimulated, assessed and changed during the design process*" (Popovic, 1999). The utilization of this tool enables the testing of several design alternatives before the final decision stage. This tool might be used through different stages of the design process.

Further advances in CAD systems provide novel tools for the use of evaluation methods. One of the emerging high-tech evaluation tools is '*Virtual Reality (VR)*', which makes it possible to evaluate the design solution in its virtual context through all phases of the design process. The utilization of these high-tech tools also enables the design and evaluation of extreme environments such as space stations without constructing a tangible model (Popovic, 1999).

Design solutions are also assessed by the evaluation of '*mock-ups'*, which comprises the participation of the users. This tool might also be used to analyze and evaluate the suitability of an artifact to its real-life environment. Popovic (1999) suggests different simulation techniques for 'mock-ups', including (1) simulation of design features, (2) simulation of interface and proposed user interaction, and (3) simulation

of the contextual environment of an artifact. 'Mock-ups', as a usability-testing tool, should be used in the conceptual development stage of the design process.

Another significant tool for design evaluation is the use of '*prototypes'*. According to Popovic (1999), the evaluation of 'prototypes' is the most effective tool for the evaluation of a design solution. This tool mainly aims to evaluate a design solution in its real context and to provide in-depth knowledge about the relationship between the product and its contextual environment. Although 'prototype' evaluation is performed in the eventual phase of the design process, the emergence of computer-aided rapid prototyping techniques enables early applications through the process.

Evaluation Methods and Techniques: The use of evaluation methods varies depending on a variety of factors, such as the type of product, type of industrial sector, the evaluated aspects of the design or artifact, et cetera (Holt et al., 1984). Most common evaluation methods comprise '*checklists'*, '*focus users' group'*, '*interviewing users'*, '*observation techniques'*, '*protocol analysis'*, and '*task analysis'* (Popovic, 1999).

'*Checklists'* are mainly used "to define operations of a product / system and identify users' needs" (Popovic, 1999). The use of 'checklists' provides only an impression about the usage of an artifact, instead of in-depth user knowledge. According to Popovic (1999), this method is also useful in determining the deficiencies of the artifacts that are similar to the evaluated artifact.

Another design evaluation method is employing a '*focus users' group*', which could be applied at any stage of the design process. Popovic (1999) describes this method as "*identifying the issues that are important for the users but were not taken into consideration by designers.*" In the practice of this method, a group of users is asked to evaluate the design alternatives by discussing the product features. The user groups might be categorized into their level of knowledge in the usage of the product. The key member of a 'focus users' group' discussion is the facilitator, who has the role of managing the group dynamics.

According to Popovic (1999), '*interviewing users'*, as an important design evaluation tool, aims "*to identify users' needs and better understanding their culture and the contextual environment in which artifacts are going to be used.*" The 'interviewing users' method provides in-depth knowledge about both the cultural and functional

needs of users. Popovic (1999) classifies interviews as (1) unstructured, through which the investigator asks unrestricted questions and identified the important issues for the user, (2) semi-structured comprise again open-ended questions but has a rather systematic approach, and (3) structured, which consists of predefined set of questions. Furthermore, the 'interviewing users' method could be applied at any stage of the design process.

'*Observation techniques'* are utilized mainly to understand the difficulties that the users face through interacting with an artifact or system. Popovic (1999) identifies this method as defining the dynamics of the product / system / environment. The process is executed by directly observing the artifact in use, or analyzing video and audio recordings of the evaluation process. Moreover, this method should be applied at the final design phase of the field test.

Through the '*protocol analysis'* method, human behavior is studied in different domains of expertise (Popovic, 1999). Usually, video and verbal recording of user activities are produced and later converted into transcripts to be analyzed and interpreted. This method could be used at any stage of the design process.

Another common design evaluation method is '*task analysis'*, which mainly aims to evaluate the interactions between products and their users with an emphasis on the interface and usability of the product (Popovic, 1999). Through this method, the overall activity of users are analyzed and represented in schematic expressions, such as diagrams, charts, and so on. Popovic (1999) suggest that, in some cases, 'protocol analysis' and 'task analysis' methods could be complementary methods.

5.4. Summary of the Chapter

In this chapter, the 'sources of the innovative activity' and 'design methods' have been reviewed. Furthermore, relevant topics, including 'user needs', 'need assessment methods', 'design knowledge', and 'design process' have been examined. The study of above-mentioned topics mainly refers to innovation and design literatures, with minor input from social sciences.

The 'sources of innovation' has been studied from two perspectives, which are (1) the origin of the innovative initiative, and (2) the incentives for the innovative activity. Initially, 'the origin of the innovative initiative' (e.g. an individual, a certain kind of method, a certain form of knowledge, so on.) has been explored. In this

sense, the studies of Schumpeter (various), Pavitt (1999), Tidd et al. (2001), and Riggs and Hippel (1994) have been reviewed. Afterward, the 'sources of innovation' have been studied in terms of 'the driving force behind innovations' (e.g. any entrepreneurial activity, a technological opportunity, market demand, so on.). Concerning this, mainly the studies of Schumpeter (various), Schmookler (1996), and Holt et al. (1984) have been reviewed. After that, demand factors, especially 'users' and 'user needs' have been examined as the main driving force behind innovations. Within this perspective, the 'need' concept, 'categories of need' and 'need assessment methods' have been reviewed.

After investigating the 'sources of the innovative activity'; topics including 'design knowledge', 'design process', and 'design methods' have been studied with an emphasis on the methods of the design process. Afterward, various models of the 'design process' have been examined from the perspectives of two significant studies, those of Jones (1992) and Cross (2001). Subsequently, 'design methods' have been explored in categories including 'conventional methods', 'creative methods', 'rational methods' and 'design evaluation methods'. Moreover, initially, 'the origins of design methods' have been explored concisely. Eventually, a summary of the chapter has also been appended.

Consequently, this chapter introduces a background on the sources of the innovative activity, and methods and the process of design activity ahead of investigating new user-centered methods for design innovation.

In the next chapter, further implications of the issues studied in this chapter will be discussed for the case of design innovation. Furthermore, emerging user-centered methods for design innovation have been investigated. In this sense, concepts including 'user research', 'participatory design' and 'post-design' will be discussed within the context of design innovation.

CHAPTER VI

NEW USER-CENTERED METHODS FOR DESIGN INNOVATION

The aim of this chapter is to explore emerging methods centering user 'experience' as the main source of innovation. In addition, the changes in the nature of the design activity and new approaches to the practice of design are studied. At the end of the chapter, three illustrative design innovation methods are studied.

6.1. Introduction

As discussed in Chapter I, the expectations of today's consumer have shifted from conventional commodities to novel experiences that satisfy not only their basic needs but also superior ones including sensorial, intellectual, emotional, and cultural needs. Creating novel '*experiences'* for consumers necessitates focusing on, besides their basic needs, deeper aspects of their lives, their emotions, aspirations, vice versa. Therefore, in a process of designing experiences for consumers, in-depth 'user research' appears to be the main source of knowledge. Besides utilizing user knowledge, the design process might also employ users in numerous phases of the design process including not only the evaluation phase but also conceptual and creative / generative phases. Utilizing users as a source of innovative knowledge and as creative individuals requires new techniques, methods, and tools. Consequently, this chapter studies the new role of users in the design innovation activity as the main source of innovation and also new methods and approaches that are utilized through attaining user knowledge.

6.2. Changes in the Nature of the Design Activity

Enormous changes of our era result also in changes in the nature of the design activity. Design, while increasingly being perceived as the core activity of innovation (Freeman, 1982; Oakley, 1990; OECD, 1992), is being challenged with new sources, methods and approaches. The 'design innovation' paradigm appears to bring the

design activity new objectives and focuses, whereas new approaches such as 'user-centered' and 'participatory' design lead to changes in the methods, techniques and tools that the design activity entails.

6.2.1. Challenges of the Design Innovation Paradigm

As discussed in the previous chapter, the major source of innovation stands to be the demand factors. Since this argument was concluded by the innovation literature (Schmookler, 1966; Myers and Marquis, 1969;Langrish et al., 1972; Rothwell et al, 1974; Holt et al., 1984; etc.), the case for 'design innovation' still needs specification. The innovation literature approaches to the sources of innovation with a broad perspective, which is mostly due to the effort to broadly cover all the functions of the innovative activity. The 'technology-push / demand-pull' paradigm also stands merely applicable for a general product innovation perspective.

At first, since 'design innovation' has been defined to encompass "*no or minimal technical novelty*", the source of innovation in the 'design innovation' case appears not to originate form a technological opportunity. Therefore, the main source of innovation in the 'design innovation' paradigm should comprise demand factors. Specifically, user 'needs' stands to be a major knowledge and source of innovation for the 'design innovation' activity. In relation to this, Green and Jordan (1999) mention, "*What is clear is that purely technical competence is increasingly being taken for granted in modern product design, that the human aspect is becoming more prominent in product competition.*"

What is more about the 'design innovation' activity is that since it is "*novelty obtained by 'design' effort*," it should utilize the input sources and methods of the 'design' practice. As stated in the previous chapter, the 'design effort' mentioned here comprises "*a design activity with the central role of 'industrial design' and a contribution of a variety of particular design practices*."

Consequently, in the 'design innovation' paradigm the main source of innovation could be signified as user needs but with a coupling of the knowledge and methods of the 'design' practice. However, new approaches appear to reformulate this perspective and blurring the boundaries between user research and design activities. The emergence of 'user-centered' approach to design practice and newer approaches

including ‘co-design’, ‘participatory design’, ‘postdesign’ and vice versa introduce new tools and methods to the ‘design innovation’ paradigm.

6.2.2. User-Centered Approach to the Design Activity

By which practice should user research be conducted is one of the major concerns of the innovation process. Innovation literature (Holt et al., 1984) represents a broad perspective to need-related activities, and does not signify a particular discipline to facilitate user research. However, Holt et al. (1984) describes need assessment activity as a process to be executed parallel to the innovation process and according to them, “*overall responsibility for need assessment should be given to one organizational unit, but those participating in product innovation processes should master and use proper need assessment methods in their work.*”

Nevertheless, the emergence of user-centered design has naturally clarified the scene and brought together design practice and user research activity. The contribution of user-centered practices in the design activity has augmented the understanding of ‘user’ needs. As per Sanders (2001), the emergence of user-centered design has happened by a step-by-step contribution of user-centered practices in the practice of design. The gradual convergence of user-centered practices and design practice has initiated by the contribution of practices from ‘biological’ and ‘social’ sciences to the practice of design and augmented the understanding of user experience (Sanders, 2001).

Buur (2002) argues that the user-centered approach has emerged as a reaction to the requirement for meeting user needs in the design of computer interfaces, and later evolved as a design field comprising of a variety of approaches. Buur (2002) describes the emergence of the user-centered approach as follows:

> The term User Centered Design has grown in popularity up through the 1990’s as a reaction to the one-shot involvement of users in usability testing, and to the cognitive psychology dominance of the Human Computer Interaction field. This reaction has hardly fostered a new, coherent field of design and research, but it has sparked a beginning of something new for those who have adopted the term.
>
> User Centered Design presently covers a diversity of attitudes and approaches as to just how it is best to involve users and ensure user-centeredness in design. And in this fast moving world of emerging technologies and changing roles, it is not likely that we will see a convergence, or that a convergence is even worth wishing for – A standard for the Good is the Enemy of the Best (Buur, 2002).

Sanders (2001) argues that the emergence of the user-centered approach to the design practice initiates with the contribution of ergonomics and human factors practices to the design practice those aim to meet the bodily needs of users. However, this approach recently covers the contribution of a broad range of practices to the design discipline and aims to meet a wide scope of emerging needs of users. Sanders (2001) outlines the development of the user-centered approach in terms of step-by-step contribution of user-centered practices to the design practice as follows:

- ***Fit to the body*** was emphasized in the field of '*ergonomics'* or '*human factors'*.
- ***Fit to the mind*** was seen in the introduction of '*cognitive ergonomics'*, leading to new fields such as information design and interaction design in the 1980's.
- ***Fit to the social aspects*** of human behavior came with the advent of '*applied ethnography'* and '*contextual inquiry'* in the 1990's.
- ***Fit to the emotional domain*** is just now receiving attention, as seen in interest areas such as '*affective human factors'*.
- ***Fit to the dreams and aspirations*** of the people who will buy and use the goods and services that we design is the next step (Sanders, 2001).

User-centered approach is not only a model providing need-related information to the design process, but also an understanding that focuses on user experience rather than the product or the design problem. Marzano (1997) emphasizes the shift from focusing on products to user experience as "*What consumers want is not products, but benefits. We therefore need to shift our focus from products to customer benefits.*" According to Kelley (2001), before the emergence of the user-centered approach, the focus was purely on products and the users of the products were seen as "*stupid*." He exemplifies this approach with the statement of an executive from the 1930s automotive industry as "*It's not that we build such bad cars; it's that they are such lousy customers.*" Moreover, Sanders (2002a) identifies user-centered design as *"designing objects for users*."

6.2.3. New Approaches and Concepts in User-Centered Design

The above-mentioned contributions and developments in the user-centered approach to the practice of design have resulted in the emergence of "*a new design space*" (Sanders, 2001), and newer approaches and concepts in the practice of design. The new design space entails an in-depth collaboration with social sciences and "*everyday people*" (Sanders, various; Thackara, 2001; Sanders and William, 2001; Marin and Schmidt, 2001).

The design activity, its methods and sources, have also changed from depending on individual intuitions of designers to relying on 'collaborative' designing. Thackara (2001) suggests that designing is no longer a heroic activity that creation of products, services, experiences could be manipulated by "a design genius working in isolation" from people.

6.2.3.1. Design for Experiencing

The advancements in technology and industrial production have brought about unforeseen high-tech features and attractive qualities of today's products and services. However, enabling these high-tech features has also resulted in making them ordinary for the people using them. Therefore, people have become assessing 'intrinsic' qualities of products and services, rather than 'attractive' qualities that have already been granted (Marzano, 2000). Consequently, today's commodities have lost their 'economic' value, those intend to satisfy people's basic needs, and replaced by higher values those mean to stimulate people's 'experiences' (Marzano, 2000).

According to Arbak (2000), commodities constitute only tangible expressions of intangible 'experiences', given that "*the tangible qualities of the 'products' are simply expressions of the intangible experiences they provide for people.*" Arbak (2000) suggests that the output of the design activity is not only tangible products, but also "*the present and future experiences those products provide*." Alternatively, as per Marzano (2000), "*stimulation of both senses and intellect*" creates an experience, while their "*perception and understanding that determines whether the experience has been a positive or negative event in the eyes of the individual*." Therefore, Marzano (2000) argues that the only way to provide 'positive experiences' is through "*a better understanding of people's emotions, sensorial perceptions and cultural values.*" He emphasizes the value of user experience as follows:

> This society would be one in which our psychological need to expand our experience and to achieve goals would be fed and met. It would be a world where 'traveling' was as important as 'arriving', where the process of making a cup coffee was as important – and enjoyable – as the cup of coffee itself (Marzano, 2000).

Correspondingly, Kelley (2001) suggests that addressing experiences comprise "*thinking verbs, not nouns*," that is focusing on experiences, rather than objects. He

illustrates this argument with "*the goal is not a more beautiful store…it's a better shopping experience*" (Kelley, 2001).

With regard to the above, one of the challenges that user-centered approach has recently brought to the practice of design is the perspective that focuses on 'user experience' rather than commodities. Within this perspective, "design for experiencing" or in other words, "experience design" appears as a new approach to the whole product design activity (Sanders, various; AIGA, 2002). AIGA (American Institute of Graphic Arts, 2002), distinguishes 'experience design' from product design as follows:

> Experience design is the way in which meaning is communicated in the network society, where no point of contact has simple beginning and end, and all points of contact must have meaning embedded within them… (AIGA, 2002).

According to Sanders (2001, 2002c), 'design for experiencing' focuses on "*the whole user experience*", which comprises not only the present experience, but also past and future experiences of user. On the other hand, Thackara (2001) argues that 'experiences' could not be designed, where the design activity could only provide elements of products, such as interfaces, environments, and so on that offer the experience. Consequently, Sanders (2002a) suggests that 'design for experiencing' could only be achieved is user's whole experience that comprise past, present and potential experiences with a product or service is accessed, therefore these experiences could be utilized as the source of inspiration in the design activity.

6.2.3.2. Co-Design or Collaborative / Participatory Design

The developments in user-centered approach and the focus on 'user experience' have also resulted in a new paradigm, which is based on collaboration with users in the beginning of the design process, namely 'co-design', 'collaborative design', or 'participatory design' (Sanders, various; Martin and Schmidt, 2001; Sanders and William, 2001; Stone et al., 2002; Dandavate et al., 2000; Thackara, 2002). The emergence of this paradigm mainly relies on the need for an in-depth understanding of users' experiences and aspirations in order to "*address the real needs or fulfill the dreams of people*" (Sanders, 2001).

Martin and Schmidt (2001) mention "*participatory design is founded on the belief that users are creative and can play an active role in the design process*" and argue this paradigm to be based on designing not only 'for' users, but also 'with' them. The

main objective of collaboration with users in the design process is to gain an in-depth understanding of users' experiences and dreams. As per Martin and Schmidt (2001), innovations would be successful since they are derived from the real experiences and aspirations of users. Correspondingly, Thackara (2001) argues that designing 'with' people, not 'for' them, "*can bring the whole subject of 'user experience' literally to life.*" From this perspective, according to Thackara (2001), "*success will come to organizations with the most creative and committed customers*." In the same way, Marzano (1997) suggests that the only way to provide people meaningful products is to involve them to the new product development process.

The participatory / collaborative approach comprises the contribution of the users, consumers, customers and other stakeholders in the product design process (Sanders, 2000a). Sanders (2001) discusses that people play different roles in the design process, where they are "*consumers when they shop*", "*customers when they buy*", and "*users when they interact with objects*". She suggests that participatory approach involves "*everyday people*" and conceive of people in "*a holistic way.*" Correspondingly, Martin and Schmidt (2001) argue "*as design is informed and inspired by users we begin to see them beyond their roles as users and as actual people*."

In the participatory / collaborative approach to the design practice, the tools and methods of the user-centered approach is also being challenged. Through collaboration, not only what people 'say' and 'do', but also what people 'make' could be assessed (Sanders, various; Martin and Schmidt, 2001; Sanders and William, 2001; Stone et al., 2002). Sanders (1999, 2002a) suggest that the user-centered approach, through which what people say, think, do, and use could be assessed, is not enough for an in-depth understanding of people's feelings and dreams. According to her, understanding the whole user experience entails the utilization of several procedures, those listed below:

- We can listen to what people say.
- We can interpret what people express, and make inferences bout what they think.
- We can watch what people do.
- We can observe what people use.
- We can uncover what people know.
- We can reach toward understanding what people feel.
- We can appreciate what people dream (Sanders, 1999).

Sanders (1999) argues that utilization of each procedure provides different levels of knowledge about people's experiences. Listening what people 'say' provides only '*explicit'* knowledge; those are limited to be expressed in verbal form, where through watching what people 'do', only '*observable'* knowledge could be assessed. On the other hand, analyzing what people 'make' offers '*tacit'* knowledge, through which people's feelings and dreams are understood, and eventually their 'latent needs'

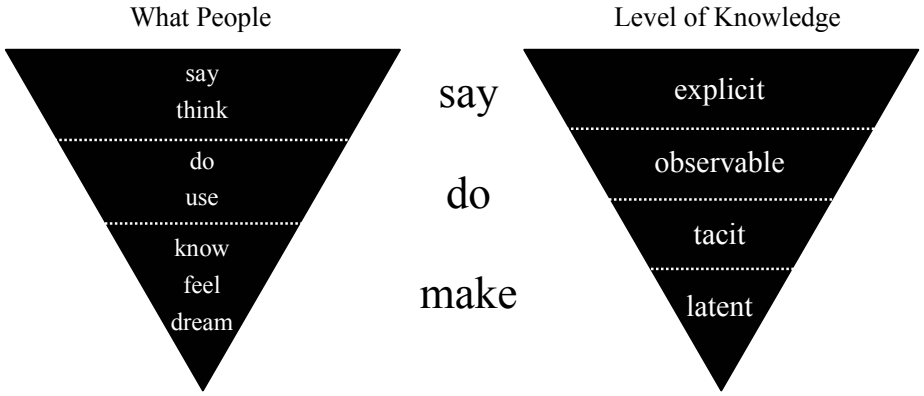


Figure 6.1 Accessing user experience (Sanders, 1999).

could be reached. Figure 6.1 represents Sanders's framework of accessing user experience.

As studied in the previous chapter, in the present models of the design process, users participate in the middle or end of the process, typically at the concept evaluation phase or in usability testing. Nevertheless, the participatory / collaborative approach suggests that participation in these stages does not provide a truly user-centered approach, thus entails taking part in the "*fuzzy front end*" of the new product development process (Sanders and William, 2001). Consequently, Sanders and William (2001) suggest that people could contribute creatively if they participate the early creative phases of the new product development process.

6.2.3.3. New Roles within New Approaches

The developments in the user-centered approaches and the emergence of participatory / collaborative approaches also bring about a change in the role of both the users and designers through the design process. Sanders (1999) argues that the participatory approach has resulted in a shift in the source of the design activity from 'individual creativity' to 'collective generativity', which entails all the stakeholders

of the collective design activity to be creative. Within this framework, Martin and Schmidt (2001) suggest that the creativity of designers is inspired by the generativity of users, where the main focus of the collective vision is on "*meeting the needs*" of users. They argue "*designers draw inspiration from users, not just from a set of design criteria*" (Martin and Schmidt, 2001). Equally, Sanders and Dandavate (1999) indicate, "*designers can use the ideas generated by the users as sources of design inspiration and innovation*."

Sanders (2001) argues that the participatory approach also demands from designers a "*new respect for ordinary people*", a respect for their creativity and expression of their ideas and dreams in order to truly understand the user experience. Correspondingly, Martin and Schmidt (2001) suggest that when designers accept that people are creative, "*empathy*" becomes the source of creativity in the design process. According to them, through empathizing with users, the ideas of the designers becomes more adjusted to the experiences that they aspire.

Furthermore, Thackara (2001) puts forward that the supremacy of the designer in the design process is reduced to a less creative level with collaborative design. He mentions, "*the era of the lone design genius working in isolation is over*". Therefore, the new role of the designer in the collaborative design process is subject to question. With regard to this question, Sanders (2001) suggests that designers would be "*the creators of 'scaffolds' or infrastructures upon which non-designers (such as users) can express their creativity*." According to her, designers would contribute to the evolution of "*a new language*" with which ordinary people could create and express their own ideas and dreams and communicate them with designers.

Consequently, within the emerging participatory / collaborative approach, all the stakeholders of the collective design activity are expected to be creative, where the role of the designers are to create scaffolds that users could easily express their creativity and to truly empathize the experiences and aspirations of the users utilizing a new language through communicating with them. Moreover, with new approaches and the changes in the roles of the participators of the design process, the source of innovation of the design activity appears to become more relying on the creativity and needs of the users.

6.2.3.4. Postdesign

All above-mentioned approaches and concepts bring about changes in the sources, tools, and methods of the design activity and the roles of both the users and practitioners, whereas "postdesign" emerges as a new "mindset" that institutionalize and converge the new participatory / collaborative approaches and the developments in the design activity. The Postdesign Community (2002) describes "postdesign" as follows:

> Postdesign is a new mindset. It transcends the traditional domain of design by making user experience (as opposed to products or services) the focus for inspiration and ideation.
>
> Collaboration with the social sciences has enabled the emerging Postdesign community to focus on new ways of accessing and then impacting the deeper meanings of people's life experiences.
>
> Postdesign is participatory in that it emphasizes the active participation of all stakeholders in the product or service development process. This makes the deliverables more meaningful to the people who will ultimately benefit from them.
>
> Postdesign is not about specific methods, tools or processes. Rather, it is about an ongoing internalization of customer experience. Resonance with one's customers enables postdesigners to quickly respond to people's changing needs and aspirations (The Postdesign Community, 2002).

On the other hand, Sanders (2002a) entitles "postdesign" as a 'culture' that will affect what companies design and produce in the future. According to her, the 'postdesign' mindset challenges the qualities of the conventional user-centered approach and the products of this mindset should simultaneously be "*useful, usable and desirable*" (Sanders, 1999). She suggests that the "*marketing-driven product era*" would soon end and a collective approach that blends and blurs "*feeling and thinking*", "*feminine and masculine*" and "*buying and selling*" would emerge (Sanders, 2002a).

The emergence of "postdesign" mindset is also stimulated with the advances in technology that challenges the tools that people utilize through expressing their ideas and feelings. Sanders (2002b) exemplifies these challenges with the introduction of new digital tools that enable ordinary people to express themselves (e.g. the use of graphic applications on the computer that does not require any expertise in the graphic design field). Such challenges also enable ordinary people to be 'creative' in expressing themselves (e.g. the emergence of personal homepages on the Internet, people designing their own shoes and decorating their own t-shirts, and so on).

Consequently, "postdesign" understanding illustrates a new domain where all people are creative and can express and communicate their ideas and feelings easily. Within this framework, the role of design practice is also changing towards an effort to build an appropriate 'language' for people to express and communicate themselves. In this sense, design practice entails a collective approach, the collaboration of interdisciplinary design and research practitioners and ordinary people (non-practitioners) to work together in creating a collective language.

6.3. New User-Centered Methods for Design Innovation

The tools and methods of the design practice are also being challenged with the emergence of above-mentioned approaches. Since these approaches focus on the 'user' as the main source of inspiration and innovation in the design activity, new methods and tools have emerged to understand the 'user experience' comprehensively. For instance, Sanders (2001) argues that participatory design "*is based on the belief that all people are creative and can express their unmet needs and dreams when given the appropriate tools*." Therefore, participatory approach demands from the design practice new 'tools' and 'methods' that would create a language that enables people to express their ideas and dreams.

However, since the utilization of user research activities in the design process is widespread (IDEO, 2002), moreover participatory approach has almost a one-century-history relevant fields including planning and architectural design disciplines (Bayazıt, 1982), in what sense these sources and methods are entitled to be 'new' still appears open to question.

On the subject of this question, it can be suggested that the novelty in the emerging tools and methods mostly relies on the increase of the importance of users and user experience as a source of design inspiration and innovation. The change towards focusing on users as a source for the creative process necessitates an in-depth understanding of the user experience, therefore, new tools, and methods that enable such and understanding. Actually, these 'new' tools and methods do not stand to be inventively novel, but could be described as they are adapted from other disciplines, mostly those from social sciences.

Moreover, the recently growing importance of ‘design’ in achieving innovation and the emergence of ‘design innovation’ paradigm have brought about significant changes in design methods and stimulated to the emergence of new methods. Additionally, one more reason that makes these methods novel is that they have accessed the practical domain of the design discipline recently. Consequently, in this section, a number of emerging design methods centering the user as a source of innovation is examined.

6.3.1. Background of New Methods

The emergence of user-centered approach and the developments in the user-centered design domain has led to emergence of several methods in time. These methods are mostly based on understanding ‘user needs’ in order to create user-related knowledge to the design activity. However, some of them include different levels of collaborative approaches whereas some others comprise modifications of conventional market research activities. Table 6.1 represents a list of user research activities in the practical domain of the design discipline, which relies on a research performed for a leading global design firm, IDEO in 1994 (IDEO, 1994).

Table 6.1 List of user research methods that are currently used (IDEO, 1994).

Typology	Particular Method	Example Companies
Co-Design	Lead user *Susan Holder*	*Von Hippel; Business & capital goods*
	Rapid prototyping *Ed Matthews*	*Cubicomp, Helisis*
	Usability testing *David Yelding*	*ID, Michael Schrage, IDEO*
	Beta testing	*Software companies; Lotus, Apple, Ameritech*
	Co-designing /blank model studies	*Many software companies; Steelcase, Xerox, Parc, Schuler & Namioka, Arent & Mander (Apple)*
Co-Research	Visual anthropology/think aloud protocols	*C-star/Andersen Consulting*
	Train novice observers	*Some MBA programs (U of T), SF General Hospital*
	Enable user / visual scans	*Imagenet*
	Projective & visual research methods	*Perception Research Services*
	Rapid ethnography *Don Norman*	
Current Customer Information	Customer return cards	*Most consumer manufacturers*
	On-line information / sales figures	*Neilsen, IRI on-line service and sales lines*
	Public information sources	*Government records, Census data, Trade associations*
	In-built tracking & intelligence	*Apple disk that checked your hard drive*
		Xerox self-diagnostic computers
	Real-time information	*Dell, The Limited, The Gap*
	Test markets /probes / pilot studies	*Nike (10,000 people)*
	Expeditionary marketing	*Sony, Nike, Japanese electronics companies*
	Customer visits / parties / promo events	*Saturn, Lexus, Lifestyle magazines*
	Promotional retail	*Promotional retail Niketown, Tupperware parties, Yamaha listening post*
Direct Design Experience	Alpha testing	*All designers*
	User as developer (intuition)	*Founder companies (Nike, Sony, Apple, Body Shop)*
	Skunkworks /internal champions	*3M, Rubbermaid*
	Design studio transplants	*California auto design studios*
		Milan Swatch design lab
	Role play /immersive experience *Pattie Moore*	*Foote Cone and Belding with Laskerville*
Expert Observation	Longitudinal analysis *James Fozard*	*Radcliffe College, Mass. (longitudinal studies on women)*
	Video ethnography *Françoise Brun-Cottan*	*Doblin Group, E.lab, Envirosell, Interval, Lollopalooza exhibit*
	Task analysis / time and motion studies	*Frederick Taylor & scientific management*
	Direct observation *Neville Stanton*	*IDEO, Envirosell*
	Physical trails	*Philippe Starck and trash in the 'back door'*
	Physiological testing	*Dreyfus anthropometry, Visibility testing, Boeing Computer Simulation*
	Shadowing *Siamack Salari*	*IDEO Envirosell*
Future Creator	Future concept prototypes	*AT&T "You will" Concept cars*
	Popular futurism, science fiction	*Bladerunner (Syd Mead & Ridley Scott), William Gibson*
	Live the Future	*C-Star/Andersen Consulting, Interval, Xerox Parc, Japanese culture*
Imagine and Act Out	Scenarios *Alison Black*	*IDEO*
	Long range scenarios	*Global Business Network (Peter Schwartz and Shell)*
	Role play *Colin Burns*	*Interval / Imagenet*
	Explore, represent, share *Denis O'Brien*	*Royal College of Art, London*
Professional Trackers	Lifestyle studies	*Sanyo lifestyle research, Youth Experts, Toshiba Lifestyle Institute*
	Professional futurists	*John Naisbitt, Alvin Toffler, Institute for the Future*
	Expert interviews (Delphi)	*GBN, IFTF, Management Consultants (industry analysis)*
	Opinion polls *Robert Worcester*	*MORI, Gallup, Dataquest, Yankelovich, JDPower*
	Questionnaires, surveys	
	Trend tracking	*Li Edelkoort Faith Popcorn*
Stimulus and Interview	Individual interviews *Wendy Gordon*	*Envirosell, Research companies*
	Focus groups *Hannele Hypponen*	*Cheskin + Masten, Odyssey Research, Wharton Group*
	Conjoint techniques *Miriam Comber*	*Kansei Analysis, Control Technologies (Phil Swift)*
	Preference testing	*Perception Research services*
	Non-directive testing	*Cheskin + Masten*

Moreover, the above table categorizes the user research methods depending on illustrative case studies that are in current usage. Actually, example companies those utilize each case might also use supplementary methods or other above-listed methods.

6.3.2. Review of Emerging Methods

This section comprises concise reviews of three illustrative design innovation methods, those accessed by literature survey and direct contacts with the practitioners. Actually, each method or tool in the practical domain stands to be the industrial 'know-how' of the practitioner, therefore protected under regulatory legislations. However, in this era of enormous and fast changes, practitioners do not hesitate to expose the methods they develop to some extent, while they could, and must, go beyond these methods while their competitors try to imitate and adapt their methods. Moreover, developing new tools and methods constitutes a research facility itself, therefore needs the collective vision of other researchers in order to be developed, and consequently needs to expose the output of this research facility.

In the following three sections, three of the emerging methods are concisely illustrated from the practitioners' perspectives. For that reason, a brief description of each practitioner is also included.

6.3.2.1. The Use of 'Projective / Generative Tools' at SonicRim

The emergence of the participatory / collaborative approaches has brought about the emergence of new tools and methods that are based on collaborative design activities. One of the most significant and recently emerged collaborative methods is that of SonicRim, which has been developed and employed by the firm.

SonicRim is a new 'design research' firm located in the United States of America and devoted to research and practice participatory design methods to understand user experience and help utilize user knowledge as a source of innovation (SonicRim, 2002). The firm is founded by four design researchers who declare, "*we have became participatory evangelists as we have seen the influence of this mindset on innovation and communication, both internally and externally*" (Sanders, 2000a).

Actually, SonicRim proposes a set of methods including, besides new participatory tools and methods, those originate from user-centered design approaches and

2conventional market research activities. What makes their approach distinctive is the emerging utilization of participatory methods and their merging all the methods they utilize to get the most out of the understanding of user experience. Their model of methods comprises assessing what people 'say', 'do', and 'make', and converging all the appropriate knowledge to synthesize an output of their understanding of the user experience (SonicRim, 2002). Figure 6.2 shows the "say-do-make" framework of this model.

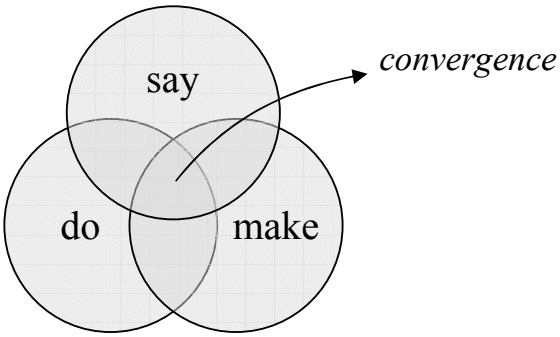


Figure 6.2 The "say-do-make" framework of SonicRim (SonicRim, 2002).

Moreover, this model includes understanding not only 'present' experiences of the users, but also 'past' and 'future' experiences in order to empathize the whole user experience (SonicRim, 2002). Figure 6.3 represents the "say-do-make" framework of this model with time scale.

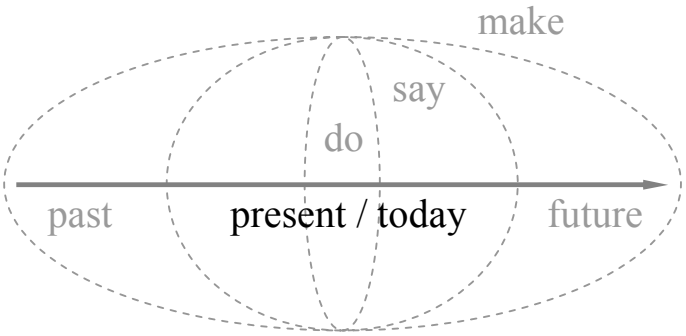


Figure 6.3 The "say-do-make" framework with time scale (Stone et al., 2002).

Assessing what people 'say' has certain methods originating from conventional market research and understanding user experience by observing what people 'do' has been brought to the design discipline with user-centered approaches. The novelty

in the model of SonicRim stands to be assessing what people 'make' through collaborative studies with designers, researchers, and actual people.

In their model, it is suggested that they have generated 'a new language' for collaborative design research, through which people can could easily express their ideas and communicate them with others (SonicRim, 2002; Sanders, 2000b). Sanders (2001) argues that this language is based on "*an aesthetics of experience rather than an experience of form*" and comprises of "*a mixture of visual and verbal, of concrete and abstract, of positive and negative, of male and female*" elements. SonicRim entitle the elements of this new language "*toolkits*", which include verbal and predominantly visual components (SonicRim, 2002). These toolkits are categorized into (1) emotional toolkits; those enable people to create artifacts such as 'collages' or 'diaries' that represent 'stories' and 'dreams', and (2) cognitive toolkits; through which people create artifacts such as 'cognitive maps', 'three-dimensional models of functionality', 'diagrams of relationships' and 'flowcharts of processes' (Sanders, 2002a). The artifacts that are created using the latter type of toolkits represent "how people understand (and misunderstand) things, events, and places" (Sanders, 2002a). Therefore, some of these tools aim "*to elicit emotional response and expression from people*", while some others mean "*to uncover meaning and cognitive understanding*" (Sanders, 2000b). These toolkits also vary in the consisting components as follows:

- Toolkits made up of two-dimensional components (e.g. paper shapes and color photographs),
- Toolkits made up of three-dimensional components (Velcro-covered forms together with Velcro-backed buttons, knobs, and panels),
- Toolkits designed to elicit the expression of stories and narratives over time (Sanders, 2000b).

The model that SonicRim utilize in understanding the user experience comprises four major steps. In the first step, "*immersion*" phase, participants (people) are asked to produce documentations of their thoughts, feelings, and ideas about the experience under investigation. This step usually takes place in the natural context of the participant (e.g. participant's home or office), whereas the next three steps happen in collaboration with the researchers. The next step is "*activation of feelings and memories*", through which participants are conducted in collaborative exercises where they use specific toolkits to evoke and activate their memories and feelings. In the third step, which is entitled "*dreaming*", participants are asked to take part in an

exercise with a specific toolkit, those mean to stimulate their dreaming about their future or an ideal experience. In the final step, the "bisociation and expression" phase, participants are invited to express their ideas with abstract and ambiguous toolkits (Sanders and William, 2001; SonicRim, 2002).

Throughout the above-mentioned stages of the participatory activities, numerous tools and exercises are utilized in order to stimulate participants to use their natural creativity in expressing their ideas and feelings. There are sets of tools and exercises for each stage of the participatory activity, which are specified for each stage, but not limited in number and arrangement. Moreover, occasionally some tools and exercises are designed specifically for a particular project. The tools and exercises are classified in two main categories, as "pre-meeting immersion tools" and "tools for the group meeting" (Sanders and William, 2001).

The aim of 'pre-meeting tools' is enhancing the information the experiences of the participants before the group meetings. These tools include:

Workbooks: those comprise different types of questions, including "*demographic information, opinions and information about people own or use*."

Diaries / day-in-the-life exercises: on which participants record their daily experiences and give details about daily attitudes.

Disposable cameras: those enable the participants visualize the instances of their experiences and enhance the quality of the documentations of their experiences.

Pre-meeting tools provide the participatory activity a profound knowledge about the experiences of the participants in their natural contexts. The knowledge that is obtained with utilization of 'pre-meeting tools' is later processed with the 'tools of the group meeting' "*to allow participants to use their previous immersion to stimulate creative exploration*" (Sanders and William, 2001). The 'group meeting tools' comprise:

Collages: through which people express their experiences using pictures and words. Creating 'collages' includes four main steps; those are 'brainstorming', 'pilot testing', 'refinement', and 'production'. In the 'brainstorming' phase, the aims is "to provide the participants with the means to communicate across a wide array of experiences" and expand their insights with an understanding of other people's experiences. The 'pilot testing' phase involves asking people unfamiliar with the task

to evaluate the prepared toolkit and give feedback about it. In the 'refinement' phase, the elements of the toolkit are refined into an appropriate set of components. The 'production' phase is the final phase of the process of creating collages, through which visual and verbal elements of the toolkit are combined into collages. Figure 6.4 represents a sample collage toolkit and people creating collages collectively.

Figure 6.4 A sample collage toolkit and people creating collages collectively (SonicRim, 2002).

Cognitive mapping: those enable people "*to map out processes and events, or their understanding of categories or systems*" (Sanders and William, 2001). These tools help people express complicated concepts through simplifying and directing their ability to communicate their ideas. The process of developing a cognitive map entails following identical steps with those of the process of creating collages. Figure 6.5 illustrates a sample cognitive mapping toolkit and a developed cognitive map, which would be difficult to express verbally.

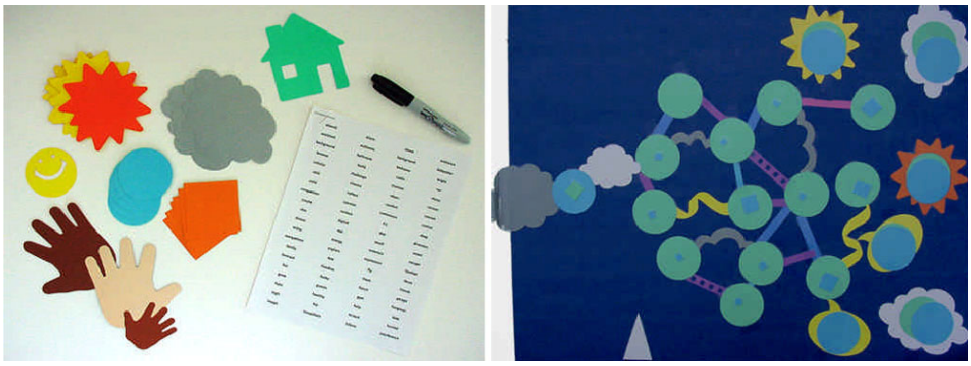


Figure 6.5 A sample cognitive map toolkit and a developed cognitive map (SonicRim, 2002).

Velcro-modeling: which allows people "to embody and express their ideas in low-fidelity, three-dimensional models" (Sanders and William, 2001). Building Velcro models is usually conducted subsequent to the exercises that are performed in immersion, activation, and dreaming phases of the participatory activity. This exercise enables participants to actively represent their ideas in a practical way. For instance, in studying a car cockpit, participants might be given a model cockpit coated with Velcro and asked to arrange specific controls, displays, and features in order to create their ideal cockpit. Figure 6.6 represents a sample Velcro-modeling toolkit and a father and son collaboratively building a three-dimensional model.

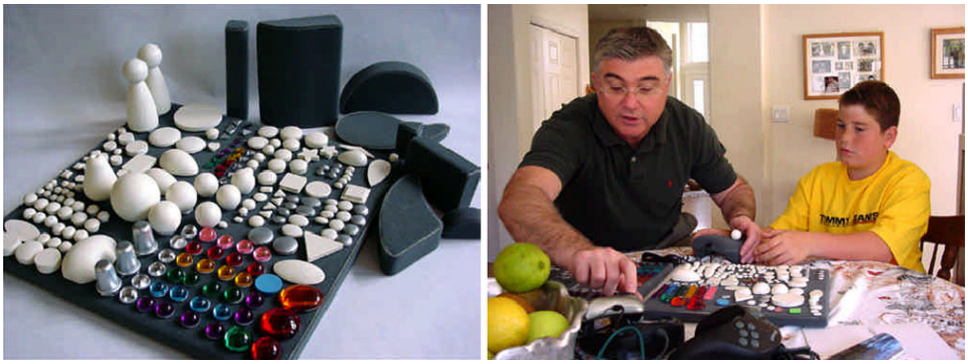


Figure 6.6 A sample cognitive map toolkit and a developed cognitive map (SonicRim, 2002).

Lifestyle scenarios: which enable people "*to describe the activities and experiences they encounter on a daily basis*" (SonicRim, 2002). Creating lifestyle scenarios could also help participants "*to realize and articulate their ideal experiences with products and processes*" (SonicRim, 2002). The output of this exercise facilitates people

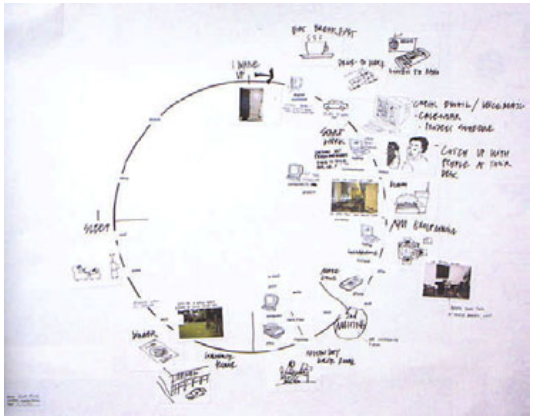


Figure 6.7 An example lifestyle scenario created by a participant (Takiguchi, 2000).

understand their daily experience and how a product might fit into their lives. Figure 6.7 shows an illustrative lifestyle scenario developed through this exercise.

The use of above-mentioned toolkits and exercises constitutes SonicRim's model of understanding user experience by examining what people 'make'. In this model, the generative tools stimulate the creativity of ordinary people, while the artifacts, such as collages, cognitive maps, and Velcro-models that they have generated using these toolkits stimulate the creativity of the designers. Design and design research practitioners become immersed in the experiences and aspirations of people while participants talk about the artifacts they have created using these tools. Nevertheless, these tools are employed simultaneously with conventional methods those assess what people 'say' and observe what people 'do' in order to understand people's unmet needs and dreams. The convergence of the outputs of these activities constitutes the major input of the design process.

Consequently, SonicRim's model of understanding user experience stands to be an emerging approach to design practice.

6.3.2.2. The Lead User Method

Another method that points out user participation as a source of innovation is the 'lead user method', that is suggested by the innovation literature (Von Hippel, 1988; Riggs and Von Hippel, 1994;Von Hippel and Sonnack, 1999; Von Hippel et al., 2000; Holder, 2002). However, the initial research on the 'lead user' concept relies on innovative activities in technology-intensive industries, such as the scientific instrument industry (Riggs and Von Hippel, 1994), the recent and potential applications appear applicable for design-intensive industries, such as consumer durables and consumer electronics industries.

Furthermore, the 'lead user method' has been recently practiced by a variety of industries with different objectives. For instance, Nestlé, the world's largest food producer, a Switzerland based company founded in 1866 (Nestlé, 2002), has utilized the 'lead user method' for 'strategy development' for custom food production (Von Hippel and Sonnack, 1999). Moreover, the most striking and comprehensive use of this method has been performed by 3M (Minnesota Mining & Manufacturing) Corporation, a United States based company founded in 1902, that function in a broad range of industries from medical instruments to office equipments (3M, 2002),

that has recently adapted this method to its new product development organizations (Von Hippel et al., 2000; Von Hippel and Sonnack, 1999).

There are a number of factors that makes this method distinctive from other user research methods. First, the emergence of this method has not happened as a user research method, but as a new model for the innovative activity, that considers users as the sole innovator of products or processes in specific industries. This model relies on the following argument:

> When a product user's reasonable expectations of benefiting from a given innovation opportunity are higher than those of a product manufacturing firm, we would expect to find that the user would be more likely to innovate than would the manufacturer (Riggs and Von Hippel, 1994).

Second, unlike other user research methods, this model does not focus on the target user profile, but covers collaboration with users on the leading edge of the target market and those from industries that face similar problems with the target market. Furthermore, although the 'lead user method' is not specifically meant for the design activity, this model covers a broad product development perspective with particular focus on user participation, therefore produces user-centered product innovations.

The innovation studies (Knight, 1963; Freeman, 1968; Lionetta, 1977; Von Hippel, 1976, 1977; Vander Werf, 1982; Riggs and Von Hippel, 1994), those brought about the emergence of the 'lead user' concept argue that this concept relies on two basic principles (Von Hippel et al., 2000). First, "*many commercially important products are initially thought of and even prototyped by users rather than manufacturers*" (Von Hippel et al., 2000). This argument also agrees with the findings of the previous chapter on the main source of innovation, which is user needs, rather than technological opportunities. Second, "*such products tend to be developed by "lead users" –companies, organizations, or individuals that are well ahead of market trends and have needs that go far beyond those of the average user*" (Von Hippel et al., 2002).

The 'lead user' model is strongly based on a specific user profile; therefore who stand to be on the leading edge of the market trend is a major question. Cerha (1970) describes 'lead users' as follows: "*For any product field there is a group of consumers who are passionately interested in it, actively seek all they can to read about it and whose attitudes and behavior consequently change in advance of the general trend*." According to Von Hippel and Sonnack (1999), 'lead users' are those

who (1) "*expect to get high benefit from innovation and so have a strong incentive to innovate*," and (2) "*are ahead of a target market with respect to one or more important trends*." The lead user profile demands needs that are well ahead of the trend, which would be demanded by more users as the market trend moves forward. Figure 6.8 represents the shape of a market trend and the position of lead users.

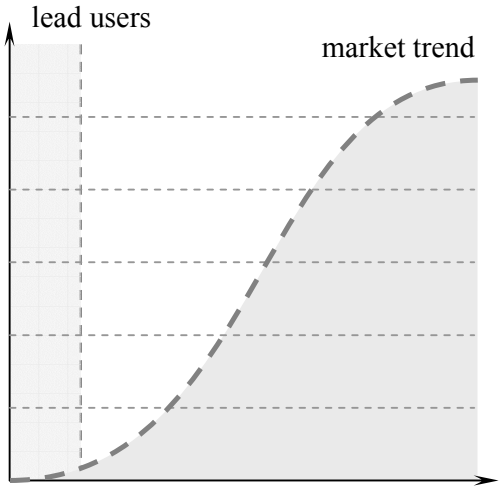


Figure 6.8 The shape of the market trend and the position of lead users (Von Hippel et al., 2000).

The 'lead user method' is based on the principle that "*information on needs and solutions is very nonuniformly distributed in the population, and that the best information on any topic is held by only a few lead users and lead use experts*" (Von Hippel and Sonnack, 1999). Whereas lead users constitute an exceptional part of the users of a target market, identifying them stands to be a difficult task. This activity entails a 'networking' approach is used, through which telephone interviews are conducted to reach the experts in the leading edge of the target market and ask them for people who would know more about the topic than they do, "*people who are farther up on the 'pyramid of expertise"*" (Von Hippel et al., 2000). In this process, people who have noticeable expertise in the investigated field (e.g. research professionals in the field) are reached and asked for their recommendations about other experts; those have more relevant knowledge about the topic. This activity depends on the finding that "*people with a serious interest in any area or problem tend to know people who know more about it than they do*" (Von Hippel and Sonnack, 1999). After reaching the front-end users of the market, the networking approach is continued in order to find experts in relevant fields, which face identical problems in a more or less extent with the investigated field. Von Hippel et al. (2000)

illustrate how the lead users of a target market and relevant fields are identified as follows:

> Consider how an automobile manufacturer would apply the lead user process. If the company wanted to design an innovative braking system, it might start by trying to find out if any innovations had been developed by drivers with a strong need for better brakes, such as auto racers. It wouldn't stop there, however. Next, it would look to a related but technologically advanced field where people had an even higher need to stop quickly, such as aerospace. And, in fact, aerospace is where innovations such as ABS braking were first developed: military and commercial aircraft pilots have a very high incentive to stop their vehicles before running out of runway (Von Hippel et al., 2000).

Identifying lead users is the most critical task of the 'lead user method', whereas preceding and subsequent phases also stand important. However, the sequence and the contents of these phases might vary both in the application of the organization and the characteristics of the innovation that is pursued. Therefore, in this study, the 'lead user process' that is carried out at 3M Corporation is illustrated as the most significant application of the 'lead user method'.

3M's lead user method entails four steps to be followed subsequent to the identification of a 'cross-disciplinary' project team, the "*lead user team*" (Von Hippel et al., 2000). This four-step-process basically comprise:

(1) **Laying the foundation**: In this initial phase, the lead user team identifies the target market and the type and level of innovations the product development team would address.

(2) **Determining the trends**: Since lead users are people who are ahead of a specific market trend, the market trend of the target market should be identified. Therefore, in this stage, experts in the field involving the target market are interviewed in order to understand the emerging technologies and leading-edge applications in the field.

(3) **Identifying lead users**: This step proceeds with the networking with people in the field of the target market and relevant fields to identify the users in the leading edge of these markets. Moreover, in this step, the lead user team begins to gather relevant information on potential innovations and ideas as input to the innovation process.

(4) **Developing the breakthroughs**: In this eventual phase of the lead user method, the lead user team, in collaboration with the identified lead users and other in-house teams, performs several workshops, those last two or three days. Throughout these

workshops, participants initially work in small groups and eventually come together to finalize design concepts that are generated in these workshops.

After performing this process, the lead user team refines the output of the workshops in terms of their relevance to the initial goals of the process and presents them to senior management. Since the concepts are approved, the rest of the product development activity proceeds to commercialize the concepts as innovations.

Consequently, the lead user method stands distinctive with the participatory nature it comprises and by addressing a specific user profile in a specific market in contrast to the postdesign approach. On the other hand, this model strongly emphasizes the role of user needs and participation in product innovation as follows:

> User-developed innovations are novel products or services developed by individuals or firms that expect to benefit from using them. Manufacturer-developed innovations are those developed by individuals or firms that expect to benefit from making and selling them.
>
> This approach differs conceptually from other approaches to idea generation in an important way. All idea generation processes collect some information from users and then employ that information to generate or refine further within the product or service manufacturing firm. However, methods vary in terms of how much of the "idea" they seek to obtain from users versus how much they attempt to generate within the manufacturing firm (Von Hippel and Sonnack, 1999).

The novelty in the lead user method stands to be the approach that relies on not only utilizing information about user needs but also the solutions that are generated by users. Consequently, in this model, the emphasis is more on finding innovative ideas that have already been ideated by users rather than generating ideas in-house. This relies on the premise that some users usually think about a problem or their needs more profound than the manufacturers or product development teams, therefore come up with more innovative ideas.

6.3.2.3. Design Innovation Process at IDEO

Another illustrative method is carried out by IDEO, which is celebrated as the most innovative design firm in the world (Myerson, 2001). IDEO is the world's most widely known design firm located in the United States of America, founded initially as David Kelley Design in 1978, and later merged with British design firms Matrix and ID TWO to form IDEO in 1991 (Myerson, 2001; IDEO, 2002).

What makes IDEO distinctive in terms of achieving design innovation comprises a couple of premises. First, IDEO is known as the most 'innovative' design firm with

coupling design methods with user-centered approach into a unique 'design innovation' framework. The corporate motto, "*IDEO helps companies innovate…we design products, services, environments and interactions*", stands as an illustration of the company's focus on innovation (IDEO, 2002). Furthermore, Myerson (2001) entitles IDEO as the "*masters of innovation*." Moreover, user-centered approach is another focal point in the corporate strategy, which is emphasized as "*IDEO built its success on user-centered design based on research and observation that lead to a deep understanding of human needs*" (IDEO, 1999).

Second, IDEO stands distinctive to come up with a unique "*design innovation process*" (IDEO, 1999) which makes their method an illustrative subject of this study. They suggest that a user-centered approach constitutes the basis of their process and this process is "*inspired by watching real people*" (Kelley, 2001). IDEO's user-centered design model mostly comprises 'listening' and predominantly 'observing' people. Kelley (2001) mentions, "*seeing and hearing things with your own eyes and ears is a critical first step in improving or creating a breakthrough product.*" IDEO's model rejects conventional market research activities, as Kelley (2001) mentions:

> We are not big fans of focus groups. We don't much care for traditional market research either. We go to the source. Not the "experts" inside the company, but actual people who use the product or something similar to what we're hoping to create.
>
> It's precisely this sort of observation-fueled insight that makes innovation possible. Uncovering what comes naturally to people (Kelley, 2001).

This model focuses on user 'observation' in order to understand "*people's latent needs*" and process the acquired 'empathy' as a source of innovation. Figure 6.9 represents snapshots from activities those involve watching and listening users in their real-life contexts and talking with experts.

Figure 6.9 Watching and listening people in their real-life contexts, talking with experts (IDEO, 2002).

Figure 6.10 Brainstorming sessions those stimulate creativity and innovativeness (IDEO, 2002).

Another premise that makes IDEO distinctive is that IDEO's '*innovation process*' is the focus on 'creative methods', such as 'brainstorming', and design evaluation tools such as 'prototyping'. IDEO's approach to creative methods relies on the focus on collaborative creative study through 'brainstorming', rather than individual creativity of designers. Kelley (2001) mentions:

> Many companies…tend to believe that truly creative individuals are few and far between. We believe the opposite. We *all* have a creative side, and it can flourish if you spawn a culture to encourage it, one that embraces risks and wild ideas and tolerates the occasional failure (Kelley, 2001).

Therefore, 'brainstorming' stands to be one of the most important tools to stimulate the creativity of the 'design innovation process'. Kelley (2001) mentions that 'brainstorming' is an important part of IDEO's culture. As a part of this culture,

Figure 6.11 Product and interface prototypes (IDEO, 2002).

IDEO's brainstorming method has unique qualities, those evolved from company's hands-on experience and resourcefulness in creative methods and focus on innovation. These features of IDEO's brainstorming method mostly aim to stimulate creativity and innovativeness in the design group. 'Prototyping' also has an important place in IDEO's 'innovation process', as the motto "*a prototype is worth one thousand drawings*" is frequently declared (IDEO, 2002). Kelley (2001) mentions, "*focused prototyping helps resolve little critical problems one by one.*"

IDEO's 'design innovation process' comprises seven major steps (IDEO, 1999):

(1) **Understand and prepare**: comprises analyzing "*the market, the client, the technology and the perceived constrains on the problem*" (Kelley, 2001). Moreover, in this phase, the project team, project goals and design criteria are identified.

(2) **Research and observe**: through which people are observed in their real-life contexts for their emotions (likes and dislikes) about products, problems they face with products, and their latent needs, that are not addressed by current products.

(3) **Analyze and synthesize**: includes analyzing observations and user research, generating use scenarios, and assessing needs and opportunities.

(4) **Ideate and visualize**: constitutes the most creative phase of the 'IDEO design innovation process', through which 'brainstorming' sessions are performed on the subject of the analyses of observations and user scenarios. Moreover, in this stage, the ideas that are generated in the 'brainstorming' sessions are visualized in naïve forms (e.g. caricatures, storyboards, etc.). Usually rough prototypes are produced in this stage.

(5) **Filter and select**: covers classifying the large number of ideas generated in the brainstorming sessions into categories and collectively selecting of promising concepts among them. Selected concepts are given 'characters' and a set of evaluation criteria (strengths and weaknesses) for these characters are determined.

(6) **Develop and refine**: comprises making improvements in the selected concepts, roughly prototyping them, and evaluating them in order to get feedback. Evaluations are performed by the project team, the client, experts in the field, and people form the target market.

(7) **Realize and direct**: constitutes the eventual phase of the process, through which, using the evaluations obtained in the previous phase, prototypes are improved, and given the final form. Moreover, in this phase, the concepts are given the aesthetic qualities as well as the interactive features. This phase eventually comprises setting directions for the commercialization of the concepts.

The above-mentioned steps of IDEO's 'design innovation process' might be followed by an 'implementation' phase depending on the commercialization plan that is determined at the end of the process. Figure 6.9 represents IDEO's seven-step 'design innovation process' with simplified listings of sub-activities.

Understand and Prepare **#1**	*Build the teams* *Tools for collaboration* *Learn the process* *Define goals* *Define criteria*
Research and Observe **#2**	*Markets and users* *Stakeholders* *Technology* *Competition* *Use environments*
Analyze and Synthesize **#3**	*Needs and opportunities* *Use scenarios* *User types* *Evaluation criteria* *Directions for exploration*
Ideate and Visualize **#4**	*Brainstorming* *Visualizing* *Scenarios of use* *Interaction scripts* *Clusters and themes*
Filter and Select **#5**	*Evaluation scenarios* *Prototypical users* *Value propositions* *What to say "No" to* *Big ideas*
Develop and Refine **#6**	*Iterate on "Big ideas"* *Zoom in on details* *Business story* *Use scenarios*
Realize and Direct **#7**	*Mockups, prototypes* *Design language* *Interaction language* *Challenges and uncertainties* *Directions for next steps*

Figure 6.12 IDEO's seven-step 'design innovation process' (IDEO, 1999).

Consequently, IDEO's 'design innovation process' stands distinctive mostly with a methodical coupling of design methods, including creative methods and evaluation

tools and methods, and user-centered approach that focuses on user experience and needs as a source of innovation. Furthermore, the mindset that lies behind the notion of IDEO emphasizes the role of 'design', 'design methods' and 'user-centered approach' in innovative product development.

6.4. Summary of the Chapter

In this chapter, the emerging approaches and user-centered methods have been studied within the 'design innovation' framework. Initially, the emerging changes in the nature of the design practice have been studied. Furthermore, the challenges that the 'design innovation' paradigm brings to the design activity have been examined. From this perspective, the emergence of 'user-centered approach' to the practice of design has been studied. Moreover, new approaches including 'design for experiencing', 'co-design', 'collaborative / participatory design' and 'postdesign' have been examined. The role of both the 'users' and 'designers' within new approaches has been explored as well. Afterward, the emergence of new user-centered methods and the increasing role of user-research methods in the design activity have been reviewed. Eventually, three illustrative methods, which focus on users as the source of innovation, have been studied. The distinctive qualities of these methods in terms of design innovation have been discussed as well.

Consequently, considering the aims of this research, this chapter comprises a study on the emerging approaches to the design activity and new user-centered design methods within the 'design innovation' framework.

In the next chapter, the research topics will be investigated with a case study of a reference method performed in Arçelik Corporation. Initially, a brief description of Arçelik's corporate profile will be presented. Furthermore, the structure of the product development process and the development and the present structure and role of user research activities in the product development process will be investigated. Eventually, the role of user related activities and design methods in obtaining product innovation will be explored.

CHAPTER VII.

CASE STUDY: EXPLORATION OF EMERGING METHODS FOR DESIGN INNOVATION IN ARCELIK CORPORATION

In this chapter, the emerging methods studied in the previous chapter are explored in the context of a case study. Initially, the corporate profile of the case study subject is briefly introduced. Development of design in the company is summarized with a historical perspective. Eventually, the currently emerging user-centered design methods are discussed in the framework of this research study.

7.1. Introduction

Considering the research questions of this study, in the previous chapters, concepts including innovation, design, new product development, design innovation, etc. are discussed; relevant topics such as the sources of innovation, design methods, emerging approaches to design, design methods are explored. As justified Chapter II, in this phase of the research study, an empirical investigation of the research topics are carried out in an industry-leader Turkish company, Arçelik Corporation.

In the framework of this case study research, corporate documentation, archival records, direct observations, and interviews are utilized to build the necessary knowledge on the researched issues in the company context. Consequently, this Chapter explores the new user-centered methods for innovative product design in the context of a case study subject.

7.2. Introduction of Arçelik Corporation

Arçelik, the leading private sector company in Turkey, is the Koç Group's, one of the top 500 corporations in the world for Forbes International Magazine, manufacturer of high quality durable consumer goods. It is also one of the major manufacturers of household appliances in the world. Arçelik products are sold within Turkey under

Arçelik brand as well as exported worldwide under Beko, Altus and several OEM brands (Arçelik, 2002b).

Arçelik was established in 1955 and entered the Turkish Appliances Sector by producing its first washing machine in 1959 and its first refrigerator in 1960. In the 1970's and 80's, the company rapidly expanded its product line opening the refrigerator, vacuum cleaner, and dishwasher plants. In 1999, Arçelik acquired Ardem, the producer of cooking appliances in June, and merged it with the Turkish Electricity Industries. With the merger of Atilim and Gelişim Marketing Companies in December, Arçelik has become a corporate hegemony under the name of Arçelik A.Ş. (Arçelik, 2002b).

Today, Arçelik, with a production capacity of 6 million appliances per year, is one of the ten largest companies in appliance sector in Europe exporting its products to over 36 countries around the world (Arçelik, 2002b).

Recently, Arçelik included, in its organization, Blomberg, German household appliances company and its brand Blomberg; Elektra Bregenz, Austria household appliances company and its brands Elektra Bregenz, Tirolia; Leisure and Flavel, cooker brands of UK; Arctic, Romania's leading manufacturer of refrigeration appliances and its brand Arctic (Arçelik, 2002b).

7.2.1. Corporate History

Arçelik A.Ş. is one of the historical landmarks of Turkish industrial development. Arçelik's becoming a world-wide recognized corporation also represents Turkey's development in the international industrial league. Table 7.1 includes a brief timeline of Arçelik's corporate history.

Table 7.1 Arçelik corporate history timeline (Arçelik, 2000b).

1955	Establishment of Arçelik in Sütlüce.
1959	Production of first washing machine.
1960	Production of first refrigerator.
1968	Manufacturing plant moved from Sütlüce to Cayırova.
1975	Beginning of production at Eskişehir Refrigeration Plant.
1977	Establishment of Ardem, manufacturer of Cooking and Heating Appliances Company together with Türk Demir Döküm Company. Beginning of production at Eskisehir Compressor Plant.
1979	Inauguration of İzmir Vacuum Cleaner Plant.
1991	Establishment of R&D Center. Establishment of Consumer Information Service.
1993	Beginning of production at Ankara Dishwasher Plant.
1996	Establishment of Air Conditioner Plant at Çayırova.
1998	Three year guarantee application started. Six Sigma Methodology implemented. Artesis Co. established.
1999	Ardem, Türk Elektrik Endüstrisi, Atılım and Gelişim merged into Arçelik.
2000	Arçelik-LG Air Conditioning Industry and Trade Inc. starts production.
2001	National marketing and sales operations of Beko products which managed by Beko Ticaret, placed under management of Arçelik A.Ş. İzmir Vacuum Cleaner Factory and Topkapı Engine-Pump Factory merged and relocate to Çerkezköy to improve efficiency.
2002	Blomberg, German household appliances company and its brand Blomberg, Elektra Bregenz, Austria household appliances company and its brands, Elektra Bregenz, Tirolia were acquired. Leisure and Flavel, cooker brands of UK were acquired. Arctic, refrigeration company of Romania and its brand Arctic were acquired.

7.2.2. Business Recognition

Arçelik brand has remarkably high brand recognition in the domestic market. The chart below represents this high recognition of the brand. Figure 7.1 represents a comparison of the major Turkish brands in terms of their recognition in the domestic market.

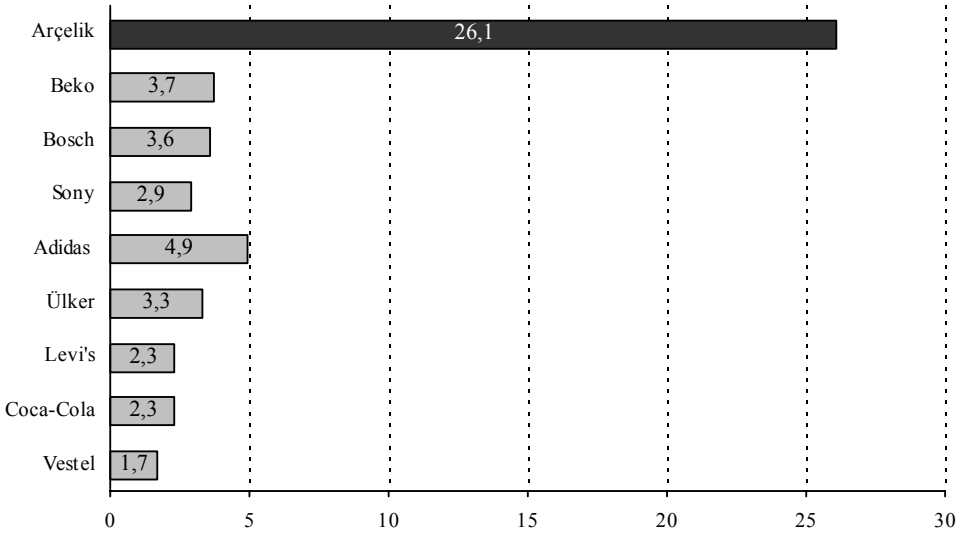


Figure 7.1 Brand recognition of Arçelik brand in domestic market (Arçelik, 2002b).

After winning the Tüsiad-Kalder Quality Grand Prize in 1997 and reaching the finals in the 1998 EFQM European Quality Award, Arçelik was the first appliance production company to win the EFQM Success Award in 2000 (Arçelik, 2002b).

Honored with numerous environmental and energy awards, Arçelik not only provides quality products and services, but also fulfills its public responsibility by successfully offering education that creates added value, and sponsoring activities in arts, culture, environmental protection, and sports (Arçelik, 2002b). Table 7.2 provides a list of the awards that Arçelik has received in the following five years.

Table 7.2 Awards that Arçelik received in the following five years (Arçelik, 2000b).

1997	Winner of the National Quality Award.
1997	Winner of the Environment Award of Istanbul Chamber of Industry.
1998	Winner of the First National Technology Award.
1999	Winner of the Second National Technology Award.
2000	Prize winner of EFQM, European Quality Award.
2001	Turkey's "Most Admired Company" – Capital Magazine.
2002	Public Relations Association, Türkiye "Altın Pusula" Award.

According to the Istanbul Chamber of Industries research on the 500 large industries, Arçelik was chosen first place in the private sector for 13 times in the last 16 years (Arçelik, 2002b).

7.2.3. Business Breakdown & Market Position

Maintaining its position as the market leader in the Turkish market, Arçelik provides service to 14.5 million families in the domestic market and 4.5 million users in the international markets with 50 million products every day (Arçelik, 2002b).

Continuing its international activities through the BEKO brand, the company's monthly exports of refrigerators is 85,000 units and dishwasher exports is around 60,000 units. In 2001, there was a 24% increase in exports over last year reaching $251 million. At this point, 26% of the international sales came from the international markets. Of the sixty-six countries exported to, 60% is to the European Union. Arçelik has a 12% share of the UK refrigerator market- clear evidence of success achieved in the international markets (Arçelik, 2002b). Figure 7.2 represents the breakdown of Arçelik export sales.

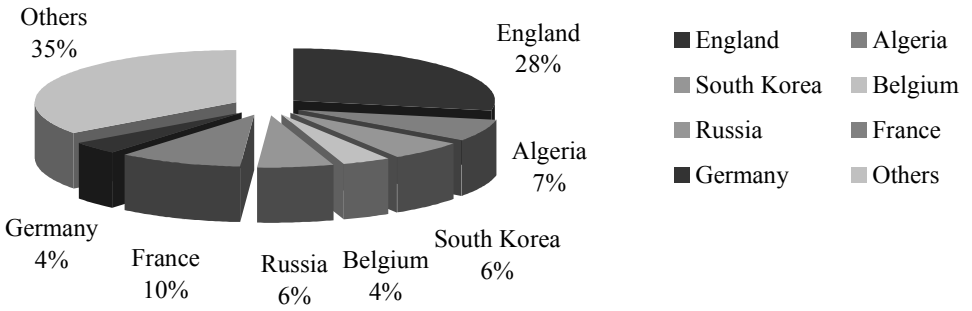


Figure 7.2 Breakdown of export sales, 2002 (Arçelik, 2000b).

7.2.4. Arçelik Shareholders

As Turkey's largest private sector company, Arçelik has several shareholders. Koç Group holds the largest share and the managerial domination. Figure 7.3 represents company's shareholders.

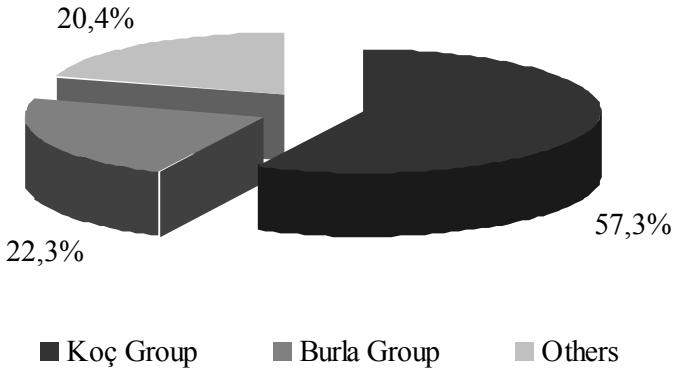


Figure 7.3 Arçelik A.S. Shareholders (Arçelik, 2000b).

7.2.5. Product Range

Arçelik, with its widely recognized international and domestic brands, has a wide product range varying from household appliances to fitted kitchens. Below is a list of its product range. Table 7.3 represents the organization in the Industrial Design Management Unit.

Table 7.3 Arçelik product range (Arçelik, 2000b).

Major Household Appliances	Refrigerators	Dishwashers
	Freezers	Ovens
	Washing Machines	Mini-midi ovens
	Washing Dryers	Hobs & Cooker Hoods
Electronics	TVs	Fax
	Videos, DVDs	PCs
	Audio Systems	Telephones
	Car Audio Systems	Computer Desks
	Satellite Receivers	TV/Audio Entertainment
		Cabinets
Heating, Ventilation, & Air Conditioning	Air Conditioner	Water Heaters
	Heating Appliances	
Built-ins	Refrigerators	Hobs
	Dishwashers	Cooker Hoods
	Ovens	Chimney Cooker Hoods
Small Home Appliances	Vacuum Cleaners	Ventilations
	Kitchen Appliances	Personal Care Products
	Irons	
Components	Compressors	Motor-Pumps
	General Motors	
Fitted Kitchens		

7.2.6. Investments and R&D in Arçelik

Arçelik has a high expenditure of investment, mainly on production and technology development. The total of investment costs for the following 5 years is US$ 305 million. In the year 2001, investment allocated to R&D was US$ 14.1 million, which is 1.5 % of net sales.

In Arçelik, R&D is an important technological resource for new product development and a major investment initiative. The recently reorganized Research and Technology Development Center, which is based at its head office in Çayırova, occupying over 10.000 m² and is the work base for a team of scientists and engineers

devoted to the development of reliable, efficient, environmentally friendly, quiet, and smart products which offer value for money and are best suited to customer needs.

7.2.7. Arçelik Quality & Environment Assurances

Arçelik's manufacturing plants are accredited to the quality management system ISO 9000, ISO 14000, and BVQI, and each holds various national safety approvals such as BEAB, VDE etc. Table 7.4 provides a list of certificates for international standards and quality assurances.

Table 7.4 Arçelik Standards and Quality Assurances (Arçelik, 2000b).

Certificates of International Standards
• ISO 9001-TSE
• ISO 14001-SGS Yarsley
• BVQI
Product Certificates
• CE-European Union
• FİMKO-Finland
• SEMKO-Sweden
• ITS, BEAB-United Kingdom
• TUV, VDE-Germany
• AFNOR-France
• ROSTEST-Russia
• UL-USA
• SA-Canada
• IRAM-Argentina
• KETI-S.Korea
• ISCIR-Rumania
• CCIB-China
• POLISH STANDARDS-Poland
• AGA-Australia

In order to introduce Environmental Management Systems in all its establishments Arçelik has revamped its current facilities and they are all now designed to protect the environment and to supply the efficient use of natural resources.

In 1995 the Dishwasher, Washing Machine and Refrigerator plants embarked on the quest to embrace the use of the Environmental Management Systems within their

daily operating practices. Accreditation to the internationally recognized Environmental Management System (BS7750) was achieved in the Çayırova Washing Machine plant in December 1995, the system being verified by SGS Yarsley, UK. This achievement meant Arçelik became one of the first manufacturers in Europe to be independently acknowledged as having environmentally friendly business practices.

Against the environmental pollution and the threatening disappearance of natural resources, Arçelik has taken various steps to improve public awareness and approach towards the environment, and has sponsored the "International Environment and Peace Organization" both in 1994 and 1995.

7.3. User-Centered Design in Arçelik Corporation

Design is a key function in Arçelik new product development organization; a central unit providing the information flow between product development units, and an unchanging element of every the new product development process. However, this position of the design function has had a long development in the company organization.

7.3.1. Development of Design in Arçelik Corporation

Although design has been utilized in the company since the 60s, 'industrial design,' as a function, has been mentioned since the late 80s, when the domestic household appliances market met the European brands. Arçelik, until then was more a production-oriented company, capable of producing licensed products of the German Household Appliances Brand 'Bosch' and alternating products just by minor face-lifting, color, and graphic appliances. Design used to be held only in product differentiation (Mutlu, 1999).

In the 80s, being inspired from the Japanese 'Reverse Engineering' paradigm, Arçelik started investing in Research & Development and decided to establish an R&D Department. This decision was the starting point of the overall development processes in the company history. Since R&D had strong investments and supports from the top-management and the governmental resources, the production organization was encouraged to develop products developed by Arçelik's own engineering resources. This also led to definite new product development process

within the company. In this process, R&D Department was positioned for technology development. The Product Development Department, which was then a central unit located in the head office, was positioned for the preparation and adaptation of the developed products for the production process (Mutlu, 1999). Figure 7.5 represents the product development process utilized until the mid 90s.

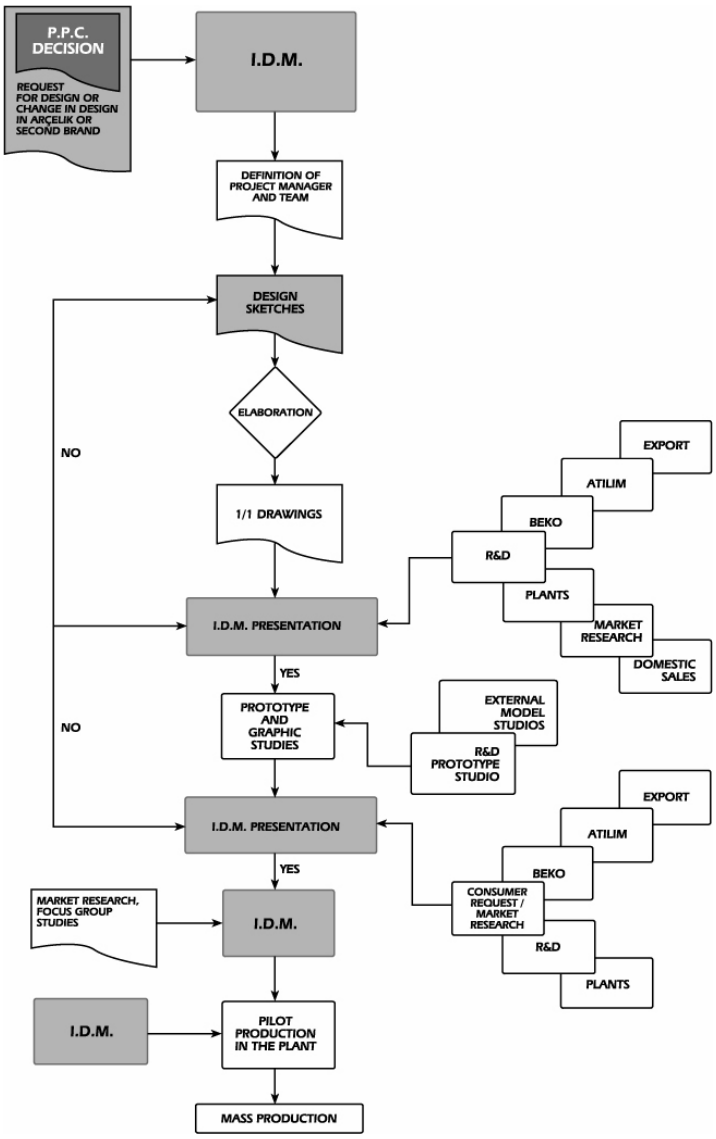


Figure 7.4 Product Development Process until the reorganization in mid 90s (Mutlu, 1999).

In mid 80s, with the growing need for design in the new product development process, industrial designers were employed in the Product Development Department. In late 80s, while the central Product Development Department was

divided into local Product Development Units to be located in each production plant, an Industrial Design Department was formed under the Manufacturing Management division.

In the mid 90s, an overall restructuring in the company organization led the Industrial Design Department to become a Management Unit located under a new Product Management division, which also assigned to control the Product Development and Product Management Units.

7.3.2. Current Design Organization and New Product Development Process

In late 90s, Arçelik experienced a profound restructuring in the product design and development organization, which also represented a change in the company's understanding of design and user research. As a part of this change, in 1999, Arçelik hired IDEO in the context of a Washing Machine Project to transfer the know-how in design process and user research. A six-month conceptual design project was carried out by a joint team of IDEO and Arçelik designers, engineers, and product managers (Arçelik, 2002c).

The two main outcomes of this project were; first, a conceptual washing machine design; second, and more importantly, the reorganization of the design management unit and the redefinition of both design and development processes. The main change in Arçelik's understanding of design and new product development was the increase in the importance given to user research in the product design and development process. Within the framework of this change, all of the user research activities, except market research, were relocated under the design management unit. The main user research lab, which was formerly located under the Product Management Unit, was relocated to function within the design organization. Moreover, a social scientist was hired to become a part of the design team and run the facilities taken in this user research lab, which is named as the Consumer House. Figure 7.6 represents the organization in the Industrial Design Management Unit.

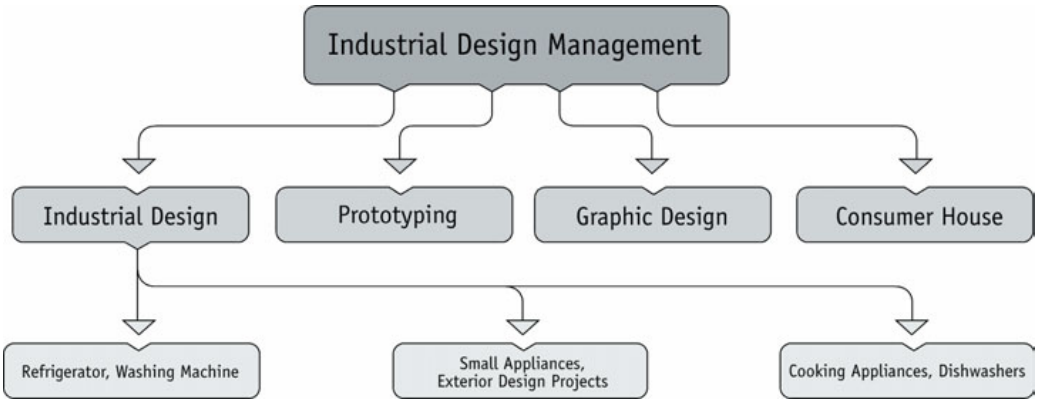


Figure 7.5 Organization in the Industrial Design Management (Arçelik, 2000c).

The change in the importance given to user research also led a change in the overall product design and development process. User research, while previously being held in the later phases of the design process and / or the beginning of the development process in the form of conventional user research methods such as focus groups, brought to the earlier stages of the design process. Figure 7.7 represents the reformed new product development process in Arçelik Corporation.

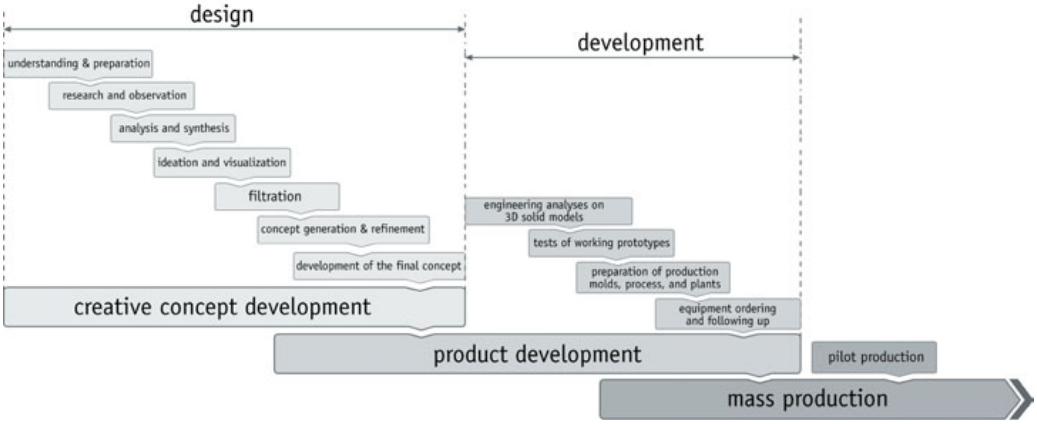


Figure 7.6 Restructured New Product Development Process in Arçelik (Arçelik, 2000c).

7.3.3. Design Process

Since the establishment of the design department, Arçelik has made a high investment in design as well as the investment made to R&D. This has led to the development of a solid expertise and unique methods in industrial design in the

department for more than a decade. While this hands-on expertise was coupled with the methods being learned from IDEO, Arçelik came up with a unique design process including a set of conventional and new design methods. Figure 7.8 represents Arçelik's seven step design process.

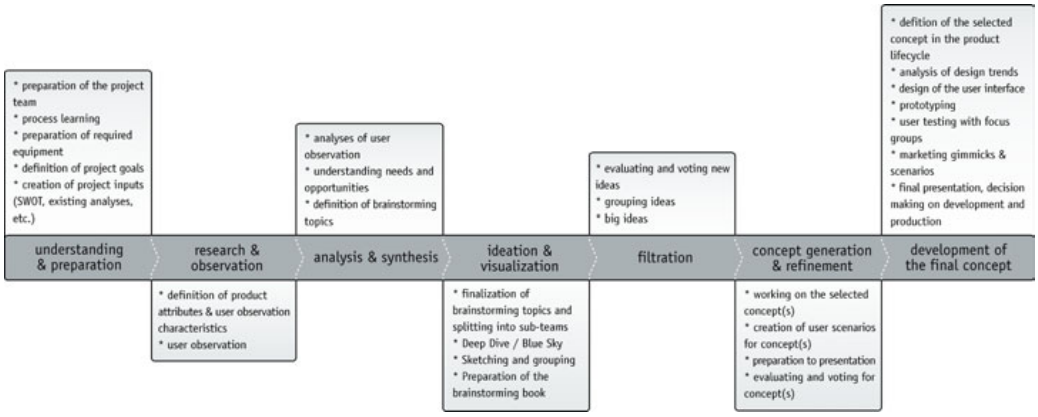


Figure 7.7 Design Process in Arçelik (Arçelik, 2000c).

Each step of this seven-step design process consists of an individual set of task. Brief explanations of these tasks for each step are as follows:

Understanding and Preparation: The first step of the design process comprises four tasks. In the first task, "*Preparation of the Project Team*," a team is assigned for the project comprising members from different disciplines (such as members of design, engineering, prototyping, marketing, and R&D staff), along with a project leader and a technical coordinator. The second task, "*Preparation of Project Equipment*," comprises providing and preparing the necessary equipment, such as providing cameras for field user observations, allocating required design workstations, registering the Consumer House for use. In the third task, "*Definition of Project Timing and Goals*," project timing, extension tolerances, and deliverables are planned, and project goals are determined in terms of the target market and user profile, the level of novelty needed, etc. In the last task of this step, "*Definition of Project Inputs*," a SWOT analysis is prepared considering the initial concerns of the project, also a 'need' analysis is made using inputs from the users, dealers, services, producers, etc.

Research and Observation: This step of the design process consists of two main tasks. In the first task, "*Definition of Product Possessors and User Observation*

Target," all product possessors including users, certified dealers, certified services, OEM resources, suppliers, etc. are determined and user observation targets are resolved considering domestic market users, export market users and other marketing channels. The second task, "*User Observation*," comprises video recordings, digital photo shoots, and interviews with users, services, and dealers in the natural environments that product is in interaction with the user.

Analysis and Synthesis: The third step of the design process includes three main tasks. The first task, "*Analyses of User Observation*," comprises sharing the observation records with other team members, and determination and listing of the significant issues with the participation of all team members. In the second task, "*Understanding Needs and Opportunities*," the listings taken from the user observation analyses are transformed into tables, and the items in these listings are classified into groups. The last task, "*Definition of Brainstorming Topics*," includes once more classifying the grouped items under main headings (such as "*ease of use*," "*security*"), and determining the brainstorming topics considering these headings.

Ideation and Visualization: As one of the major steps of the design process, the fourth step consists of three main tasks. In the first task, "*Finalization of Brainstorming Topics and Splitting into Sub-Teams*," the brainstorming topics determined in the previous step are finalized and these topics are broken down into chunks and these chunks are assigned to sub-teams that are also determined in this step. For each sub-team, a team facilitator is assigned to assist and lead to the sub-team during brainstorming sessions. The next task of this step, "*Brainstorming: Deep Dive / Blue Sky*," includes performing brainstorming sessions in each group in a predetermined duration of time, and circulating topics within groups. The outputs of these sessions are listings of the generated ideas. In the final task of this step, "*Sketching and Grouping*," ideas generated in brainstorming sessions are converted into simple and quick sketches; these sketches are classified into groups (i.e. ease of use, loading, unloading, etc.) to form a brainstorming book.

Filtration: This step of the design process comprises three tasks. The first task, "*Evaluating and Voting New Ideas*," comprises, with the participation of both the project team and decision making staff, evaluation and voting of grouped new ideas in with a certain procedure. In the next task, "*Grouping of Ideas*," ideas are filtered considering the vote ratios, and the chosen ideas are regrouped depending on features

and conceptual similarities. The last task, "*Bid Ideas*," comprises extracting the "big idea" in every group, and assigning these main ideas names and icons, and finally characterizing every icon with usage scenarios.

Concept Development and Refinement: There are three main tasks in this step of the design process. In the first task, "*Working on the Selected Concept(s)*," the selected concept(s) is refined and evaluated considering marketing and engineering concerns. The next task, "*Creation of User Scenarios and Preparation to Presentation*," includes building visual and narrative user scenarios for each concept, performing marketing and engineering analyses (SWOT) and time forecasting, making descriptive sketches of the concepts (i.e. 3D / colored sketches), and getting prepared for the concept presentation. In the third task, "*Concept Evaluation and Voting*," the project team and the decision making staff once more come together to choose and agree on the final concept, make decisions on necessary modifications, discussing product features with marketing and engineering staff, and determining features to be patented.

Development of the Final Concept: As one of the major steps in the design process, this final step comprises seven main tasks. The first task, "*Determining Production Timing*," comprises making decisions on the timing of production and introduction of product features concerning market facts and production requirements. In the next task, "*Analyses of Design Trends*," recent and future design trends are explored in order to modify the project with reference to these trends. The third task, "*Design of the User Interface*," includes finalizing product design in ergonomic and aesthetic means using 2D and 3D CAD tools, and making engineering analyses using generated drawings. In the fourth task, "*Prototyping*," full-scale prototypes of the final design is built using conventional prototyping and high-tech rapid prototyping techniques. The next task, which is respected as one of the most important tasks of the design process, "*User Testing with Focus Group*s," includes testing the product design by introducing users from the target user group full-scale prototypes and 3D illustrations, and recording the feedback taken from these user testing sessions. In the sixth task, "*Marketing Gimmicks and Scenarios*," marketing analyses of the final design are completed, marketing gimmicks, advertising strategies, and marketing scenarios are determined with the purpose of making marketing recommendations specific to the designed product. The last task of the design process, "*Final*

Presentation, Decision Making on Development and Production," comprises presentation of the finalized design to all relevant groups in the company (i.e. top management, middle management, shareholders, distributors, etc.), and collectively making decisions on project continuation to development and production levels (Arçelik, 2002c).

7.3.4. New User-Centered Design Methods

As mentioned before, in 1999, Arçelik had a major change in its approach to new product development and started relying more on user research as an input to the design process. Industrial Design Manager Bora Bükülmez (2002) suggests that a company who wants to innovate and be competitive in the market should look at its customers. He describes the change in Arçelik's understanding of user research as "*…previously, by intuition, there was a tendency to ask to the user for their demands…however, you can not get the innovative idea directly by asking the user…you should observe the user in her natural environment and interpret what you observe and make predictions…*" (Bükülmez, 2002).

With this change company's understanding of new product development and user research, certain steps and tasks of the design process are specialized to perform new user-centered design methods. Although user feedback is taken all through the design process, there are two main points where the design process interacts with the user (Bozdemir, 2002). The first point of interaction is the front end of the design process, where no design decision is made and user creativity is needed to some extent, while the second point is at the end of the design process, where the development decision is not yet taken and user creativity is not needed, but testing is the primary purpose (Bozdemir, 2002). In Arçelik, user research is being held to have an understanding of:

- Factors that affect preferences in buying certain brands and models,
- General behavior of use,
- Product features that please users,
- Problems of use and user complaints,
- Users' perception of product outlook,
- Users' perception of ease of use,
- Product functionality,
- Users' ideation of an ideal product and user comments,
- Product appeal,
- Product-price relationships (Arçelik, 2002c).

In response to the findings of this research, the Industrial Design Management;

- Optimizes similar or disparate user demands,
- Directs user interface projects,
- Contributes to market research,
- Helps apply user demands into technological features,
- Follows technological novelties and product trends in terms of functional, aesthetical, usage, ergonomic features,
- Provides input to the Product Development process,
- Define revisions of products and parts if necessary (Arçelik, 2002c).

Most of the user research activities are being held in the Industrial Design Management's Consumer House, while some are performed in their natural environments (Bükülmez, 2002). User research activities being held in the Consumer House are performed following a preset procedure. Figure 7.9 represents the procedure followed in the focus group research.

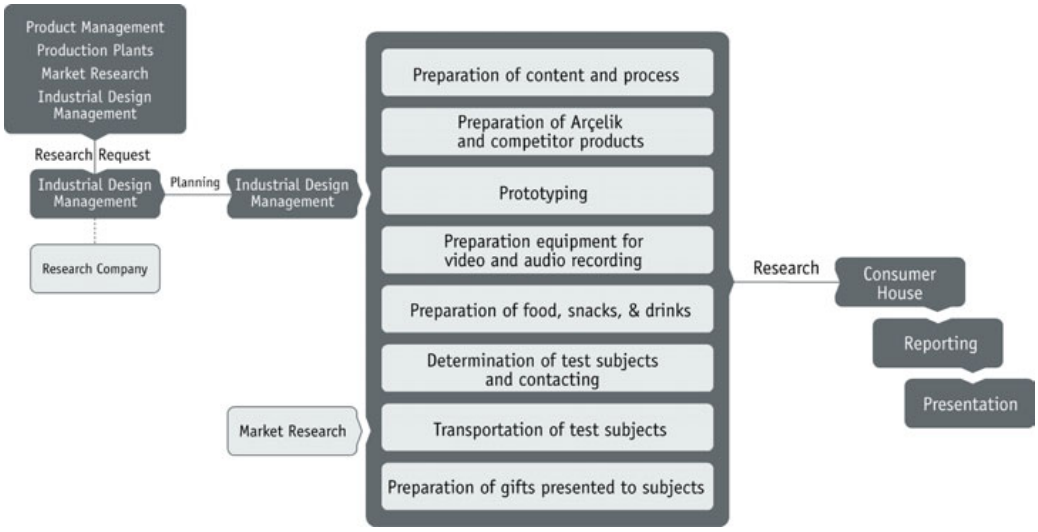


Figure 7.8 Focus Group research process in Arçelik Consumer House (Arçelik, 2000c).

Considering the two factors, 'when' user research is done (i.e. at the end of the design process, etc.) and 'where' it is performed (i.e. natural environment of use, etc.), Arçelik's user research activities can be roughly categorized into three main groups:

User Observation: Observing users is a crucial user research activity in Arçelik. Bükülmez (2002) suggests that the only way to find the most satisfying solution to a design problem is to go down to the source of the problem, which could be done by observing users in the natural environment of use, where products are used in actual circumstances. For example, if the product to be designed is a respiration device, the natural environment is a hospital, thus the observation should be performed in the hospital; if the product is a washing machine observations should be done in houses (Bükülmez, 2002).

User observation is done with two purposes; first, observing user-product interaction in the natural environment of use / purchase / repair to determine problems and find opportunities; second, observing users in the research lab comparing different brands and discussing product features in order to determine the factors that affect their purchasing decision, and their demands and complaints about product features. Both observations are done in the front-end of the design process. In the observations performed in the natural environment of use, the social scientist and an assigned market researcher run research sessions. The outcomes of these sessions are video and audio recordings of product usage / purchase / repair, and the answers given to

questionnaires asked by the researchers. These results are analyzed and ordered by the social scientist and presented to the project team in a presentation format. In the observations performed in the lab environment, besides the facilitator of the observation session, which is either the social scientist or an assigned market researcher, members of the project team conduct research sessions from out of research subject's sight (behind one-way-visible glasses). Figure 7.10 represents a user observation session in the lab environment with benchmarking purposes.

Figure 7.9 User Observation in the lab environment for benchmarking purposes (Arçelik, 2000c).

User Participation: Involving users in the design process is a fairly new phenomenon in Arçelik. User participation sessions have a rather flexible procedure and are conducted in some projects. In these sessions, where user participation and creativity are expected, particular methods called "*simulation techniques*" are utilized. One of the major techniques used in Arçelik is "*collages*," in which subject users are asked to visualize their 'ideal' product through building full-scale 2D collages by cutting and pasting pictures and drawings of existing products, not necessarily Arçelik products. After these collages are produced, users are asked to 'characterize' their designs by assigning names and icons. The idea behind characterization is to understand what users expect their products to look like; their implicit expectations that they can not verbally describe, or build with collages (Bozdemir, 2002). Figure 7.11 shows collages of an electronic dishwasher panel produced by users in Arçelik Consumer House. The collage on the right is characterized with a name, "smiling face."

Figure 7.10 User Collages for a new dishwasher panel. Assigning icons, names, and characters to designs; a "*smiling face*" panel on the right (Arçelik, 2000c).

Another technique is "*interactive design,*" in which users verbally describe the product / part / feature they desire and an allocated designer makes simultaneous sketches and tries to match these sketches to subject's descriptions by discussions. Sometimes designer's help goes beyond sketching and rapid prototyping is utilized in this technique. For instance, if the user research session is performed in three sequential groups, and there have been negative responses from the first two groups to the color of a button, designers and prototyping staff quickly prepares an alternative colored button for the third group to get immediate response (Bozdemir, 2002).

The outcomes of user participation sessions are collages that are produced by subject users, drawings created by designers assisting users to visualize their ideas, video and audio recordings of sessions, and reports that are prepared by the social scientist by analyzing the questionnaires and interviews done with subject users (Bozdemir, 2002).

Focus Group Research: When compared to other user research activities being held in Arçelik, Focus Group research is a rather conventional user research method and has predetermined procedures. Focus Group research sessions are performed at the end of the design process where full-scale visual prototypes and full-scale 3D sketches of a product design is prepared to be discussed and compared by user groups. The main purpose in performing Focus Group research is making a "proofing" of designed products / features, in a sense, take users' approval (Tartan, 2002). In this method, user groups from the target user segment are invited to conduct to the research session. Different user groups are formed with users in

different age, socio-economic and education levels. In short discussion sessions, users are asked, first, to discuss the features and overall design of the prototyped design, and second, compare this product with competitor products and / or other Arçelik products.

The outcomes of Focus Group sessions are statistical data of users' reaction toward the tested product design in a report format. The statistical data is interpreted by the project team to apply changes to the product design if necessary. Since Focus Group research is a rather comprehensive research study, the outcomes sometimes affect strategic decisions.

As broadly summarized above, user research methods have an increasing importance in new product development activities being held in Arçelik. In all levels of the product development organization, strategic, tactical, and operational levels, the new mindset, which emphasizes user-centered design as a necessary approach to achieve innovation in company's products, seems to be digested and practiced in all new product development activities.

7.4. Summary of the Chapter

In this chapter, the previously studied concepts are explored in a case study context, where an industry-leader Turkish company's new product development organization and its approach to user-centered design methods are studied. Initially, corporate facts are introduced, and a brief historical overview of the development of the product development organization is presented. Moreover, development, organization, processes, and methods of current design organization are discussed. Eventually, the company's approach to user research is examined, and user research methods utilized in the design organization are briefly summarized.

In the next chapter, all of the studied concepts within the confines of this research study are discussed briefly. Initially, 'design innovation' concept and its significance are discussed utilizing the findings of Chapter III and VI. Afterward, user-centered design is discussed as the primary source of design innovation using the findings in Chapters V, VI, and VII.

CHAPTER VIII.

CONCLUSION

This chapter includes a conclusion of the research study. In this chapter, research questions are reviewed and the findings of the research study are discussed within the framework of these research questions.

8.1. Introduction

As stated in Chapter II, the aims of this research study were to:

- Clarify the definition and significance of 'design innovation' concept,
- Investigate the sources of 'Design Innovation',
- Explore the role of emerging user-centered methods in 'design innovation'.

This research study started with a central inquiry questioning if 'design innovation' might be a new paradigm to think about the relationship between design and innovation, or in other means, the contribution of design to attain innovation. This central query has also brought up secondary questions; such as, "if this is a new paradigm to consider design as a vital function in innovation, what is the structure of this paradigm, and what sources does it use", and "if this paradigm uses design as its core function, does it also utilize design methods, if so, what kind of methods are these, and how they are utilized". Therefore, throughout this research study, relevant concepts are explored with reference to these questions.

Consequently, in this chapter, research findings are summarized in respect to these questions. Furthermore, at the end of this chapter, further research possibilities and limitations of this research study are discussed.

8.2. Design Innovation

As stated above, the central question of this research study is the clarification of the concept 'design innovation.' Therefore, relevant fundamental concepts are explored

including ‘innovation,’ ‘invention,’ ‘new product development,’ and ‘design.’ Using this background knowledge as a basis, a definition of the term ‘design innovation’ is reached along with a brief discussion on the importance of ‘design innovation.’

One of the major findings of the research on the history of the Theory of Innovation is the shift of focus from sole technical change perspective to an understanding that employs a variety of different perspectives and practices, especially those of social sciences and design. As stated before, the phrase ‘technical change’ mentioned here implies changes, improvements, novelties ‘*attained by the use of scientific methods or practices*.’ As a significant theorist in the field of economy, Christopher Freeman, in his definition of innovation, is one of the first scholars highlighting design to involve in the making of a new product or equipment (Freeman, 1982). Moreover, Schumpeter, argues that innovation is no longer an activity carried out by a sole inventor, in his words, “entrepreneur,” but becoming the business of trained specialists, and interdisciplinary teams. More recently, OECD (1992) pointed out the role of design, specifically industrial design in the innovation process. According to OECD (1992), industrial design is the very core of innovation. With reference to this, and as stated along with the definition of ‘design innovation,’ design innovation is attained through ‘*a design activity with the central role of ‘industrial design’ and a contribution of a variety of particular design practices,’* and as another major finding of this research study shows, there is an increasing emphasis on activities adapted from the social sciences.

Another major finding of the research on the relevant topics around the concept ‘design innovation,’ is that, from the classical theory of Economic Development to current understanding of ‘innovation,’ the eventual goal of the economic development, thus innovation, is the increment in the standard of life, in Smith’s words, “*the wealth of nations*” (Schumpeter, 1942; Smith, 1776). Similarly, the ‘design innovation’ model, as one of the main outputs of this research study, also employs user-centered design methods, emphasizing the focus on human-centered aspects such as usefulness, usability, and human emotions.

The above highlighted points in the research on the design innovation concept render a definition of a concept such as ‘design innovation’ meaningful. Especially the change of focus in the innovation and new product development circles from

technological innovation to design and the increasing importance of consumer studies in these fields make such definition necessary.

Furthermore, such definition is also necessary from the perspective of design literature. The design activity mentioned in the definition of 'design innovation' and ordinary design activity needs to be separately considered in terms both methodological and practical terms. Thus, within the framework of this definition, the difference between 'design innovation' and ordinary design activity is determined as the 'novelty' factor that 'design innovation' comprises, whereas ordinary design activity does not necessarily have to encompass such a novelty.

Another significant issue that needs clarification in this model is the distinction between technological innovation and design innovation. As stated before, technological innovation entails a technical change or novelty, where design innovation brings a novelty attained through design effort with no or minimal technical novelty. The essential difference that lies behind this distinction is not the type of change but the approach taken toward innovation. This difference between two approaches can be explained in basic terms that technical change represents a 'scientific' approach, while novelties attained by design effort stands for a variety of approaches from the Humanities to the Arts. Figure 8.1 represents a schematic representation of kinds and categories of innovation.

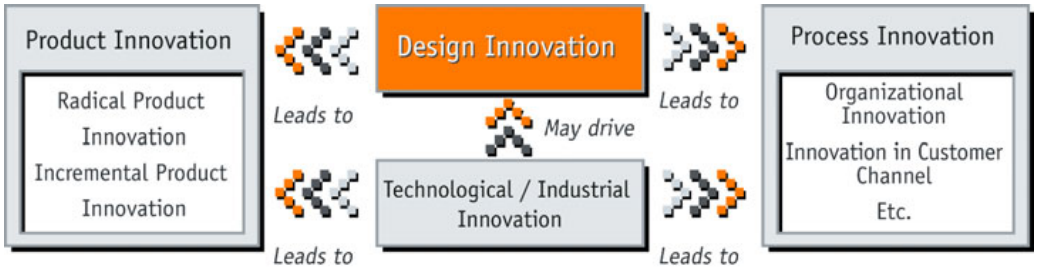


Figure 8.1 A schematic representation of the categories of innovation and their cross-relations.

Within the framework of the definition of design innovation, we can argue that 'design innovation' plays an important role in the competitive strategy of a new product development organization. Furthermore, when compared to technological innovation, design innovation comprises several advantages from both the innovator's perspective and en-user's point of view. 'Design innovation,' vis-à-vis technological innovation, remains less risky, less expensive, less time consuming,

and eventually less venture from the company perspective, conversely, more beneficial from the end-user perspective. In addition, with 'design innovation,' new product development activity requires a lower level of competency to achieve innovation, which also avoids long-term development intervals. From the organizational point of view, the shift in organizations' emphasis from technological innovation to 'design innovation' also indicates a change in the corporate insights and the structure of new product development organizations from conventional 'R&D Centers' or 'Product Development Teams' to interdisciplinary 'design teams' or 'design centers.'

In conclusion, 'design innovation' shows potential to become a new mindset to understand the emerging approaches to design and their contribution to innovation, and a bridge to close the theoretical gap between the design literature and the innovation and economics studies. Furthermore, practical applications promise organizations long term benefits along with the advantage of more meaningfully and satisfactorily responding the changing consumer needs.

8.3. Sources of Design Innovation

The clarification of the concept 'design innovation' brings up secondary questions, one of which is '*if this is a new paradigm to approach innovation, what are the sources and methods of this particular model of innovation.*' To explore this, design, innovation, and new product development studies are reviewed to build an understanding of the sources of innovation, the demand factor as a driving force in innovation, the role of user studies in the innovation literature, sources of the design activity, design process and methods, and other relevant topics.

The major finding of this exploration is that, there is an increasing importance of 'user' in the source of design activity and innovation. Dating back to the studies of Schumpeter and Schmookler, there is a still-ongoing debate in the innovation literature on whether the driving force being innovation is a 'technology push,' or it is a 'demand pull.' Although different approaches have different explanations for this dilemma; some emphasizing one of them as the driving force of innovation while others suggest that innovation entails both factors; there is an obvious increase in the importance given to 'user needs' as an essential base for demand factors.

The emphasis on 'need,' or 'user need' has started with using market data such as sales figures, marketing feedback, etc. This need assessment based on quantitative data is later extended by the use of new sources and methods taken from social sciences; those provide qualitative data on need such as user questioning, user observation, etc. According to Holt et al. (1984), "*traditional market research does not provide that understanding of user needs which is essential to successful innovation.*" Moreover, these sources are broadened by utilizing the methods of design practices, such as creative thinking methods taken from the engineering design practice, etc. Recently, design methods are also challenged by new methodological approaches those require users to be a part of the creative product design and development process, such as collaborative methods, etc. Consequently, as one of the major findings of this research, user needs and expectations can be highlighted as the most significant source for design innovation.

Along with the developments in the innovator's side, demand factors have also changed particularly over time, e.g. more demanding and participatory consumers. To respond these changes in demand factors, innovation process needs new approaches to understand changing needs and expectations. Emerging approaches to design emphasize the creativity of 'users' and the change in the role of design practice from a predominantly creative activity to a more human-centered practice that comprises an indistinct combination of design and human-centered practices.

Moreover, the future might be predicted to bring about a new design paradigm and a new design language, those give emphasis to, rather than 'perceivable qualities', 'enabling qualities' of products or services, which enables people to express their own creative intuitions. Figure 8.2 represents the gradual increase in the importance given to user in the design and innovation processes, and author's predictions for a step further in this gradual increment.

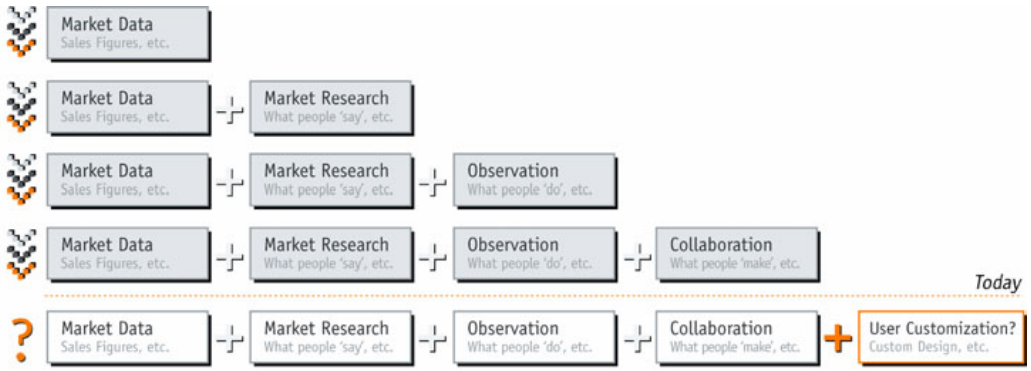


Figure 8.2 Increasing role of 'user' as a source of design innovation.

In conclusion, along with the importance given to technological development, there has been a growing emphasis on new ways, methods, and approaches to understand user needs and expectations as an output for the innovation process. On the other hand, in the case for design innovation, user needs and expectations is the main source of innovation.

8.4. New User-Centered Methods for Design Innovation

As stated above, the role of user needs as an input for design innovation has been increasing, and new approaches and methods are required to be executed. This finding brings up another question for this research study that is "*which specific methods and approaches could signify a model for the 'design innovation' paradigm*." In exploring this question, new user-centered approaches to design, design methods were reviewed and illustrative examples of user-centered methods were examined. Moreover, a single case study of an industry leader consumer goods manufacturer in Turkey was carried out in this study.

Research findings indicate that the practice of design is being massively challenged with the emergence of new approaches, especially those emphasizing user experience and creativity as a source of innovation in the design activity. These approaches are announcing a new mindset in the practice of design that puts user research in the core of the design activity, where user research is no longer an activity based on conventional user analysis but based on a thorough understanding of user experience and expectations. Studying user experience is essential to understand the latent needs and emotions of users. Sanders (2001) mentions that in-depth understanding of user's

experiences and aspirations is necessary in order to "*address the real needs and dreams of people.*"

Emerging changes in the design practice not only bring up a new mindset, but also challenge the way to execute the practice of design, namely design methods. The focus on user research also stresses a focus on user research methods as an essential part of the design methodology, which results in the emergence of new design methods that emphasizes user research as the core activity of the creative design process, thus design innovation activity. Unlike conventional user-related study, new methods demand users' collaboration to all phases of the design activity, particularly in the creative '*fuzzy front-end*,' where the main character of the innovation is structured. Case study research findings have also proved the tendency to bring user participation to the front-end of the design process.

New methods not only require employing user research methods or using adapted techniques from the social sciences, but also provide new tools and techniques. Sanders (2001) argues that this new design mindset "*is based on the belief that all people are creative and can express their unmet needs and dreams when given the appropriate tools*." Therefore, new methods provide a new design language comprising new tools and techniques enabling users to express their ideas and dreams as a part of the design activity.

In conclusion, the emerging changes in the design discipline bring about a convergence between the practice of design and human-centered practices, therefore lead to the emergence of a new design mindset, which focuses on understanding user experience, collaborating with users and fostering innovation by user creativity. Therefore, the role of new methods stands to be '*enabling user experience and creativity to foster innovation by design.*'

New methods challenge not only the tools and techniques used by design discipline, but also the role of both users and design and design research practitioners. They also revolutionize the organizational aspects of the innovative activity to proceed relying more on research and collaboration.

8.5. Further Research

In this research study, a wide array of topics is explored around a central research question. Most of the research findings are new to the field of design and innovation, and may have further implications in terms of both practice and further research (i.e. doctoral research, etc.). Therefore, this research is promising to contribute to the design and innovation studies in the Turkish and global academic environments and to be extended to further research studies.

However, there have also been certain limitations through the research process. One of these limitations is that the confines of a master's level research do not provide enough time and resources for a comprehensive exploration of the research topic(s). Moreover, the scale and certain limitations of the Turkish industrial environment practically prevented multiple case studies of comparative nature, and limited the research in a single case study. The use of overseas cases was not possible due to lack of research funding and time limitations.

~

REFERENCES

3M, 2002. *3M Corporation Website*, http://www.3m.com.

AIGA, 2002. *AIGA Experience Design Community Manifest*, http://www.advance.aiga.org.

Arbak, J., 2000. Designing Experiences, *Domus M*, **6**, 200-201.

Archer, L. B., 1984. *Systematic Method for Designers*, in Developments in Design Methodology, Ed. Cross, N., Wiley, Chichester, UK.

Arçelik, 2002a. *Corporate Documentation*, Arçelik Corporation, Center for Research and Technology Development, Istanbul.

Arçelik, 2002b. *Corporate Website*, http://www.arcelikas.com.

Arçelik, 2002c. *Corporate Documentation*, Arçelik Corporation, Industrial Design Management, Istanbul.

Bayazıt, N., 1982. *Design Theory and Methods: Participation to Planning and Design*, Istanbul Teknik Üniversite Matbaası, Gümüşsuyu, Istanbul (In Turkish).

Bell, J. A., 1992. Adam Smith's Theory of Economic Development: 'Of the Natural Progress of Opulence'*, Journal of Economics & Finance*, **16 / 1**, 137-145.

Blaxter, L., Hughes, C. and Tight, M., 1996. *How to Research*, Open University Press, Buckingham / Philadelphia.

Bozdemir, F., 2002. *Case Study Interview*, Arçelik Corporation, Department of Industrial Design, İstanbul, April 31, 2002.

Britannica Webster's, 2002. *Encyclopedia Britannica Online / Merriam-Webster's Collegiate Dictionary*, Online Edition, Encyclopedia Britannica Inc., http://www.britannica.com.

Buchanan, R., 2001. Design Research and the New Learning, *Design Issues*, **17 / 4**, 3-23.

Bükülmez, B., 2002. *Case Study Interview*, Arçelik Corporation, Department of Industrial Design, İstanbul, April 31, 2002.

Buijs, J., 1998. Viewpoint: Towards a New Theory X, *Creativity and Innovation Management*, **7 / 1**, 17-22.

Bunge, M., 1999. The Dictionary of Philosophy, Prometheus Books, Amherst, NY.

Buur, J., 2002. *The Practice of User Centered Design in Manufacturing Industry*, Mads Clausen Institute for Product Innovation, Sonderborg, Denmark (in press).

Campbell, M. and Collins, A., 2001. In Search of Innovation, *The CPA Journal*, April 2001, 26-35.

Cerha, J., 1970. *Inventing Products to Fit the Future Market*, ESOMAR Research for New Product Development Seminar, Neu Isenberg, Germany, November 4-7, 1970.

Chung, K. W., 1992. *The Meaning of Design Management and Its Strategic Value*, A paper presented in 4th International Design Management Research and Education Forum, London Business School and Design Management Institute, 8-10 April 1992, London.

Coombs, R., Saviotti, P. and Walsh V., 1987. *Economics and Technological Change*, Rowman & Littlefield Publishers, New Jersey, USA.

Cooper, R. G., 2000. *Product Leadership: Creating and Launching Superior New Products*, Perseus Books, Cambridge, MA.

Cosley, D. and Lury, D., 1987. *Data Collection in Developing Countries* (2nd edition), Falmer Press, Oxford, London.

Cross, N., 2001. *Engineering Design Methods: Strategies for Product Design*, John Wiley & Sons Ltd., UK.

Crush, P., 2000. New Product Development: Letting staff be creative*, Marketing*, **13**, 27.

Dandavate, U., Steiner, D. and William, C., 2000. Working Anywhere: Co-design through Participation, in *Collaborative Design*, Eds. Scrivener, Ball and Woodcock, Springer-Verlag Limited, London.

Demircan, E., 2002. *Case Study Interview*, Arçelik Corporation, Product Management, April 31, 2002.

Dixon, F. D., 2000. Schumpeter – Fifty Years Later, *Journal of Macromarketing*, **20 / 1**, 82-88.

Elliot, J. E., 1985. Schumpeter's Theory of Economic Development and Social Change: Exposition and Assessment, *International Journal of Social Economics*, **12 / 6-7**, 6-28.

Er, A., 1994. *The Emergence and Development Patterns of Industrial Design in Newly Industrialized Countries with Particular Reference to Turkey*, Ph.D. Thesis, Institute of Advanced Studies, Manchester Metropolitan University, Manchester.

Er, A., 1997. Development Patterns of Industrial Design in the Third World: A Conceptual Model for Newly Industrialized Countries, *Journal of Design History*, **10 / 3**.

Ergin, A. Ö., 2000. *Dynamics of product innovation in the Turkish manufacturing industry: The case of a medium-sized electrical home appliance company: Master's Thesis*. METU, Graduate School of Natural and Applied Sciences, Ankara.

Freeman, C., 1982. *The Economics of Industrial Innovation*, 2nd edition, Frances Pinter, London.

Freeman, C., 1990. *The Economics of Innovation*, Edward Elgar Publishing, England / USA.

French, M. J., 1985. *Conceptual Design for Engineers*, Design Council, London.

Friedman, K., 2000. *Creating Design Knowledge: From Research into Practice*, IDATER 2000, Loughborough University, UK.

Friedman, K., 2002. *Personal Inquiry*, Replies posted: April 01-08,2002.

Green, W. S. and Jordan W. S., 1999. *Human Factors in Product Design: Current Practice and Future Trends*, Taylor & Francis, London, UK.

Hakim, C., 1987. *Research Design: Strategies and Choices in the Design of Social Research*, Allen & Unwin, London.

Heskett,. J., 1980. *Industrial Design*, Thames and Hudson Ltd., London.

Hilton, K., 2002. *Defining 'Design Innovation'*, Reply to Mail List Inquiry, Post Time: April 01, 2002, 14:27, Reply Time: April 04, 2002, 19:15.

Holt, K., Geschka, H. and Peterlongo, G., 1984. *Need Assessment: A Key to User-oriented Product Innovation*, John Wiley & Sons Ltd., Chichester.

Holder, S., 2002. Lead User Method, in *User Research Methods Overview*, IDEO, http://www.presenceweb.i3net.org//methodslab/body.php3.

ICSID, 2002. *Definition of Industrial Design*, International Council of Societies of Industrial Design, http://www.icsid.org.

IDEO, 2002. *IDEO Corporate Website*, http://www.ideo.com.

IDEO, 1999. *IDEO Innovation Israel Corporate Presentation*, Turkey, August 1999.

IDEO, 1994. *User Research Methods Overview*, A Comprehensive Research on User Research Methods by Methodslab, http://www.presenceweb.i3net.org//methodslab/body.php3.

Jones, J. C., 1992. *Design Methods*, Van Nostrand Reinhold, New York.

Kelley, T., 2001. *The Art of Innovation: Lessons in Creativity from IDEO, America's Leading Design Firm*, Currency Books, New York.

Köksaldı, S., 2002. *Personal Interview*, Arçelik Corporation, Center for Research & Technology Development, May 10, 2002.

Leedy, P. D., 1997. *Practical Research: Planning and Design*, Prentice-Hall, New Jersey, USA.

Leonard, D. and Swap, W., 1999. *When Sparks Fly: Igniting Creativity in Groups.* Harvard Business School Press, Boston, Massachusetts

Lorenz, C., 1990. *The Design Dimension,* Basil Blackwell, Oxford.

Marshall, A., 1919. *Industry and Trade*, Macmillan and Co., Ltd., London.

Marshall, A., 1930. *Principles of Economics*, Eighth Edition, Macmillan and Co., Ltd., London.

Martin, P. and Schmidt, K., 2001. *Beyond Ethnography: Redefining the Role of the User in the Design Process*, InCA: IDSA-SF's Online Magazine, Spring 2001, http://www.idsa-sf.org/inca.

Marzano, S., 1997. *What does the smile in my grandfather's mirror have to do with customer's first choice, Corporate Presentation,* Philips Electronics N.V. Eindhoven, The Netherlands.

Marzano, S., 2000. *New values for the new millennium, Corporate Presentation*, Philips Electronics N.V. Eindhoven, The Netherlands.

Mautner, T., 1996. *A Dictionary of Philosophy*, Blackwell, Oxford, UK.

Meier, M. G. and Baldwin E. R., 1957. *Economic Development: Theory, History, Policy.* John Wiley & Sons, Inc., New York.

Mowery, D. and Rosenberg, N., 1979. The influence of Market Demand Upon Innovation: A Critical Review of Some Empirical Studies, *Research Policy*, **8**, 102-153.

Myerson, J., 2001. *IDEO: Masters of Innovation*, Laurence King Publishing, London.

Mutlu, B. D., 1999. *Design Briefing in Arçelik Corporation: Industrial Design Studio Term Paper*, Istanbul Technical University, Graduate Program of Industrial Design, Turkey.

Nestlé, 2002. *Nestlé Corporation Website*, http://www.nestle.com.

Leedy, P. D., 1997. *Practical Research: Planning and Design,* Sixth edition, Prentice-Hall, Inc., New Jersey.

Oakley, M., 1990. *Design Management: A Handbook of Issues & Methods,* Basil Blackwell, Oxford.

OED, 2002. *Oxford English Dictionary*, OED Online Version, Oxford University Press, http://dictionary.oed.com.

OECD (Organisation for Economic Co-operation and Development), 1992. *Technology and The Economy: The Key Relationships*, OECD Publications, Paris.

Olson, E. M., Orville, C. W., and Ruekert, R. W., 1995. Organizing for Effective New Product Development: The Moderating Role of Product Innovativeness, *Journal of Marketing*, **59**, 48-62.

Pavitt, K., 1999. *Technology, Management, and Systems of Innovation*, Edward Elgar, Northampton, MA.

Popovic, V., 1999. Product Evaluation Methods and Their Importance in Designing Interactive Artifacts in *Human Factors in Product Design: Current Practice and Future Trends*, Pp. 26-35, Eds. Green, W. S. and Jordan, W. P., Taylor & Francis, London.

Porter, M. E., 1980. *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. Free Press, New York.

Riggs, W. and von Hippel, E., 1994. The Impact of Scientific and Commercial Values on the Sources of Scientific Instrument Innovation, *Research Policy*, **23**, 459-469.

Rosenau, D. M., 1996. *The PDMA Handbook of New Product Development*, John Wiley & Sons, US.

Rothwell, R. and Gardiner, P., 1988. Re-Innovation and Robust Designs: Producer and User Benefits, *Journal of Marketing Management*, **3 / 3**, 64-72.

Rothwell, R., 1992. Successful Industrial Innovation: Critical Success Factors for the 1990's. *R&D Management*, **22 / 3**, 221-239.

Sanders, E. B. N., 1999. *Postdesign and Participatory Culture*, Useful and Critical: The Position of Research in Design Conference, Tuusula, Finland, University of Art and Design Helsinki, September 9-11, 1999.

Sanders, E. B. N., 2000a. *Honey, It's So Obvious*, InCA: IDSA-SF's Online Magazine, Summer 2000, http://www.idsa-sf.org/inca.

Sanders, E. B. N., 2000b. Generative Tools for CoDesigning, in *Collaborative Design*, Eds. Scrivener, Ball and Woodcock, Springer-Verlag Limited, London.

Sanders, E. B. N., 2001. A New Design Space, *Proceedings of ICSID 2001 Seoul: Exploring Emerging Design Paradigm*, Oullim, Seoul, Korea, **317-324**.

Sanders, E. B. N., 2002a. *Beyond User-Centered Design* (Two Parts), Online Published Article, http://www.sonicrim.com/red/us/pub.html.

Sanders, E. B. N., 2002b. Scaffolds for Experiencing in the New Design Space, in *Information Design*, Eds. Institute for Information Design Japan, IID.J, Graphic-Sha Publishing Co., Ltd., Japan (In Japanese).

Sanders, E. B. N., 2002c. From User-Centered to Participatory Design Approaches, in *Design and the Social Sciences,* Ed. Frascara, J., Taylor & Francis Books Ltd., London.

Sanders, E. B. N. and Dandavate, U., 1999. Design for Experiencing: New Tools, in *Proceedings of the First International Conference on Design and Emotion*, Eds. Overbeeke, C. J. and Hekkert, P., TU Delft, the Netherlands.

Sanders, E. B. N. and William, C. T., 2001. Harnessing People's Creativity: Ideation and Expression through Visual Communication, *in Focus Groups: Supporting Effective Product Development*, Eds. Langford, J. and McDonagh D., Taylor and Francis, London.

Sethi, R., Smith, D. C., and Park, C. W., 2001. *Cross-Functional Product Development Teams, Creativity, and the Innovativeness of New Consumer Products,* Journal of Marketing Research, **XXXVIII**, 73-86.

Schmid, G. and Davis, M., 2001. *Ten-year forecast: New consumers creating a new marketplace*. Institute for the Future, Menlo Park, CA.

Schmookler, J., 1966. *Invention and Economic Growth*, Harvard University Press, Cambridge, USA.

Schumpeter, J. A., 1934. *The Theory of Economic Development*, Harvard University Press, Cambridge, Massachusetts.

Schumpeter, J. A., 1939. *Business Cycles: A Theoretical, Historical and Statistical Analysis of the Capitalist Process*, McGraw-Hill, New York.

Schumpeter, J. A., 1942. *Capitalism, Socialism, and Democracy*, Harper & Brothers, New York.

Schumpeter, J. A., 1954a. *Economic Doctrine and Method: A Historical Sketch*, Translated by R. Aris, Allen & Unwin, London.

Schumpeter, J. A., 1954b. *History of Economic Analysis*, Oxford University Press, New York.

Smith, A., 1776. *Wealth of the Nations*, Dent, London.

SOED, 1993. *The New Shorter Oxford English Dictionary,* Edited by Lesley Brown, Oxford University Press & Clarendon Press, Oxford.

SonicRim, 2002. *SonicRim Website*, http://www.sonicrim.com.

Stone, R. B, Chung, W. C., Kasprzak, B. L. and Sanders, E. B. N., 2002. *User Research as the Primary Inspiration for Packaging & Branding Strategies*, Online Published Article, http://www.sonicrim.com/red/us/pub.html.

Svengren, L., 1997. Industrial Design as a Strategic Resource: A Study of Industrial Design Methods and Approaches for Companies' Strategic Development*, The Design Journal*, **0 / 1**, 3-11.

Sylwestor, K., 2000. *The Political Economy of Science, Technology and Innovation.* Edward Elgar Publishing, Cheltenham, UK.

Takiguchi, N., 2000. Doing Research with People, Not on People: SonicRim's "CoDesigning" Concept, *Axis Magazine*, 16- 21.

Tartan, A., 2002. *Case Study Interview*, Arçelik Corporation, Department of Industrial Design, İstanbul, April 31, 2002.

Thackara, J., 2001. *No More (Design) Heroes*, Doors of Perception, In the Bubble with J. Thackara, http://www.doorsofperception.com/In+the+Bubble.

The American Heritage Dictionary, 2000. *The American Heritage Dictionary of the English Language,* Fourth Edition, Houghton Mifflin Company, United States.

The Postdesign Community, 2002. *The Postdesign Manifesto v 4.0*, http://www.postdesign.net/pdManifesto.html.

Tidd, J., Bessant, J. and Pavitt, K., 2001. *Managing Innovation; Integrating Technological, Market and Organizational Change*, 2nd edition, John Wiley & Sons Ltd., West Sussex, England.

Utterback, M. J. and Abernathy, W. J., 1975. A Dynamic Model of Process and Product Innovation, OMEGA, *The International Journal of Management Science*, **3 / 6**.

Von Hippel, E., 1986. Lead Users: A Source of Novel Product Concepts*, Management Science*, **32 / 7**, 791-805.

Von Hippel, E., 1988. *The Sources of Innovation*, Oxford University Press, New York.

Von Hippel, E. and Sonnack, M., 1999. *Breakthroughs to Order at 3M*, MIT-SSM Working Paper, January, 1999.

Von Hippel, E., Thomke, S. and Sonnack, M., 2000. *Creating breakthroughs at 3M.* Health Forum Journal (Reprinted - Harvard Business Review, Sept.- Oct.1999), July/August 2000, 20-27.

Walsh, V., Roy, R. and Bruce, M., 1988. Competitive by design, *Journal of Marketing Management*, **4 / 2**.

Walsh, V., Roy, R., Potter, S. and Bruce, M., 1992. *Winning by design: Technology, product design and international competitiveness*. Basil Blackwell, Oxford.

Yin, R. K., 1989. *Case Study Research: Design and Methods*, Newbury Park: Sage Publications.

ABOUT THE AUTHOR

Bilge Dinçer Mutlu was born in Kayseri, Turkey, in 1978. He completed his primary education in Kayseri and secondary education in İçel. He received his Bachelor's Degree in Industrial Design from Middle East Technical University, Department of Industrial Design in 1999. He graduated with the highest standing of the Faculty of Architecture. During and after his undergraduate degree, besides his assistantship, he worked in various institutions as interaction designer, advertising and graphic designer, and industrial designer. After his graduation, he took part in Arçelik Industrial Design team for two years. In 2001, he received Fulbright Scholarship to pursue graduate education in the United States. He is currently enrolled to the graduate program in Interaction Design in Carnegie Mellon University, Pittsburgh, PA, USA. He is also working as a research assistant in the Human-Computer Interaction Institute of Carnegie Mellon University.

His professional interests comprise *Design Theory, Design Management, Design Research, New Product Development, Interactive Systems Design, Human-Computer Interaction, Pervasive Computing*, and *Robotics*.