

A Study of Changes in Nature of Age-specific Design Methodology

With a focus on digital media

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Abstract

There has been a tendency that the history of design is described with focus on design outputs rather than on what lies behind the outputs. This study examines the history of design thorough the changes in nature of 'design methodology' used by designers in each age, instead of focusing on design outputs. First of all, assuming that the design methodology evolves around certain change factors such as a product, a user and a designer from the diachronic perspective reflecting social phenomena of the age, we analyze how it has evolved through the ages and research into the related cases.

As the concept of the product is changed from an industrial product of physical properties to a digital product of virtual properties or a product combined with environment, more items need to be taken into consideration when selecting a design methodology such as usability, target user, service contact, platform, and ecological perspective. In addition, as the users have become active and positively involved in design and equipped with their own design capability, the design methodology that utilizes collective intelligence or involves the user directly into the design process has been devised. As for the designers, the scope of design has become wider to an extent that they have to design the concept of a product, its interaction, contents, service contact and system in general, not to mention its physical appearance. Therefore, integrated thinking and decision-making have become an inevitable part of design and the scope of the designer's work has been expanded to the overall product development process. This study aims at analyzing and summarizing the age-specific characteristics and evolution of the design methodology within the context of correlation between the design methodology and change factors. It is expected that this study can help find useful design methodologies for the future, as a basic research on the development of the design methodology from the historical dimension.

Keywords: digital media, design methodology, design development, design history

1 Introduction

1.1. Background and Purpose

Most design history tends to be summarized with focus on design outputs rather than on the story behind the outputs. For example, purpose and features of a product, its significance in the design history, social background that has brought force the product, and the designer's intention are recorded in various ways. However, the production process and methodology that designer who created the corresponding product is relatively unknown. Also, even though the researches and proposals about individual methodologies are actively made, researches and resources for analyzing the overall evolution are lacked due to tacit-intellectual characteristics of the methodology.

This study focused on research into the process of change in the 'design methodologies' used by designers, who are the subjects of design, rather than on design artifacts that have made the design history. It is expected that this study can be used as a basic research for designers from which they can select better methodologies and develop them further, by reflecting on the design environment in which their senior designers have worked and trials, errors and efforts they have

made.

1.2. Methods

For this study, it is assumed that the design methodology reflects the contemporary social phenomena and evolves around certain change factors from the diachronic perspective such as products, users and designers. Also, this study aims at analyzing how the design methodology has evolved in each era from the perspective of the change factor and finding relevant cases.

In order to study the evolutionary aspects of design methodology, the development phase of the design methodology was summarized in connection with the design paradigm, and change factors were selected. The change factors were selected by observing what factors the previous researchers took into account when they introduced design methodology, and the articles of those who studied the changes in these factors were analyzed.

1.3. Scope

The scope of this study is limited to the methodology related

to digital media. The information revolution Alvin Toffler predicted in 'The Third Wave' had a significant impact on the design and human life in the 21st century. As the design media become popular, objects of design, design environment and user environment have changed. Beyond the traditional design such as architecture, industrial design, visual design and fashion design, the design area has expanded to web, multimedia, motion graphic, virtual reality, and video games. Also, compared to the analog media, the digital media has developed centering on its unique characteristics such as interactivity, hyper-textuality, networking, and virtuality.

We note that this study is a research into design history centering on design methodology in digital media and the sequel to the first research 'A Study on Development of Product Design Process based on Design Paradigm Shift'.

2. Design Methodology

2.1. Definition of Design Methodology

Design process is a generic term for the design manufacturing process in general. It consists of a series of steps until a design is completed. Design method is defined as an appropriate technique used for carrying out those steps.^[1] The terms of design process and methodology are often used interchangeably, because the design industry used them interchangeably in the early stage when the design process was established. Studies of design process and methodology started in earnest in Europe and the United States of America when John Chris Johns, a professor at Manchester Institute of Technology, led a conference on design methodology in 1962. At the time, the movement to systemize the design process was first called the design methodology.

Figure 1 shows a structural diagram in which design process and methodology are separated and the design process is described as a series of problem-solving processes while the methodology is defined as a tool used in each steps of the design process. For example, the 4D model developed by the UK Design Council is a design process comprised of Discover, Define, Develop and Deliver. If there is a specific plan like user shadowing or FGI (Focus Group Interview) during the Discover step, this plan is considered a methodology.

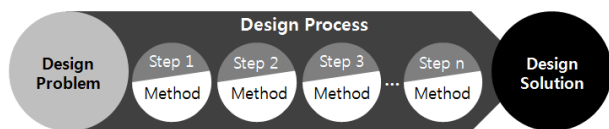


Figure 1 Definition of design process and methodology

Donald Norman advises that it is possible to use the design methodology to ensure a quality design but difficult to achieve a great design only with the methodology.^[2]

2.2. Transition in Design Methodology

In the early 20th century, the manufacture industries such as

automobiles and electronics developed. After that, in the late 20th century, the information/communication industries developed and in the 21st century, the convergence industry has developed through the integration of the information technology and various fundamental technologies.^[3]



Figure 2 Development of industry^[3]

As the industries evolves, so does its design methodologies. For example, as the industry has become more mechanized and automated since World War II, the designers conducted researches for systematizing the design methods to solve design problems that had become more complicated, and created the design process. Since then, the design methodology have continued changing itself, in order to create products that reflect the latest science and technology requirements and show themselves off to meet the users' requirements.

Therefore, transition of design methodology for digital media is largely divided into analog, product change 1 (digitalization), and product change 2 (convergence). Centering on the 1970s when digital media becomes a commonplace, it is divided into Pre-digital Media Age and Post-digital Media Age. Since the emergence of digital media, based on the change in the properties of products, which are design outputs, the post-digital media age is subdivided into Product Change Phase 1 (digitalization) and Product Change Phase 2 (convergence).

Industry paradigm	Traditional industry	Information industry	Convergence industry
Design paradigm	Conventional product Analog	Product change 1 Digital	Product Change2 Convergence
Design method	Design Process	User / Usability	Integrated thinking
	1970	Today	

Figure 3 Design methodology trend according to design paradigm

2.2.1. Pre-digital Media Age

As more systematic and rational design methods were required in order to solve design problems that had become more complicated since World War II 2, the design process was introduced. The design process of the time was an efficient production process for mass production, and also an engineering-based process that was developed under the influence of cybernetics that Norbert Wiener advocated as the military system science was expanded into the private sector.

However, unlike the engineering process, the design process

could not measure quantitative problems and as a result it evolved into participatory design and speculation-dispute process.^[4] Today's design process has evolved from the process established during this time, and continues evolving as product properties change and various methodologies are added.^[5]

The below processes has something in common. The design problem analysis is followed by the solution generation.

Table 1 Early studies on the design process^[6]

Proposer	Design process	
Designer / Design researcher	Archer(1963)	Programming - Data collection - Analysis - Development - Communication
	Asimo(1964)	The analysis of the problem - Synthesis of solution - Optimization - Revision - Implementation
	Jones(1981)	Divergence - Transformation - Convergence
	Flikelstine(1988)	Information gathering organization - Formulation of vale model - Generation of candidate design - Analysis of candidate design - Design

Table 2 Design problem solving process by John Christopher Jones ^[7]

Phase	Contents
Analysis phase : A systematic way of thinking, analyze each element	Random list of factors Factor classification Information provider Interrelationships between factors Specifications / Policy
Comprehensive phase : Re-assemble the elements	Creative thinking Partial answers Limiting conditions Combined solution Find the solution
Assessment phase : Review whether the solution solve the problem	Assessment method Evaluation about operations, production, and sale

Table 3 Design process inherited from the previous process and advanced to meet the digital media production^[8]

Proposer	Design process	
Company / Organization	Design council	Discover - Define - Develop - Deliver
	UPA	Analysis - Design - Implementation - Deployment
	Engine	Identify - Build - Measure
	Live work	Insight - Idea - Prototyping - Delivery
	Designthinkers	Discover - Concept - Design - Build -

Designer / Design researcher		Implement
	SNOOK	Discovering - Definition - Designing - Delivery
	IDEO	Observation - Brain storing - Rapid prototyping - Refining - Implementation
	SEREN	Discover - Synthesize - Design - Specify
	Peer insight	Needs findings - Synthesize - Development - Implementation
	InContext	Contextual inquiry - Interpretation session - Data consolidation, Visioning - Storyboarding - Product and system requirements - Paper mockup interviews - Interaction, visual, and industrial design
	Team interface	Discovering - Concepting - Prototyping 0 Specifying - Testing
	Moritz	Understanding - Thinking - Generating - Filtering - Explaining - Realizing
	Russ&Carolyn	Prepare - Understand - Render - Iterate - Test - Enable
	Jodie Moule	Research - Insight - Concept - Design
Designer / Design researcher	Garrett	Strategy - Scope - Structure - Skeleton - Surface
	Cooper, Reimann & Cronin	Research - Modeling - Requirement & definition - Design framework - Design refinement - Design support

2.2.2. Product Change Phase 1: Digitalization

As industry and technology developed, digital products started to be made. As 17,468 ENIAC vacuum tubes manufactured by the US Department of Defense in 1946 were replaced with a transistor in Computer 7000 produced by Thomas Watson of IBM in 1958, and later in 1971 with CPU (Central Processing Unit) called 4004 produced by Ted Off of Intel, the computer had started to become smaller. In 1974, MITS produced a product named Altair 8800 using a CPU from Intel and influenced by this, Steve Jobs made Apple computer, and Bill Gates founded Microsoft, with which personal computers became popular.^[9] As the users became familiar with digital products, the purposes and usages of products had also become diverse, and the users' requirements had become more complicated. In this situation, the studies of methodology to understand the users begun, and the studies of users and usability were accelerated. Also, the methodologies related to User-Centered Design (UCD) and participatory design were introduced.

Table 4 Previous methods vs. UCD^[10]

Previous methods	UCD
Tech-driven Focus on components	User-driven Focus on total solution

Consists of a team with limited background	Consists of a team with diverse backgrounds
Focus on internal specifications	Focus on external methods
No user test before production	User test before production
Defect-centered quality management	User-centered quality management

Table 5 Qualitative UCD examples^[11]

Focus group	Ethnography	Participatory design
Mini Focus groups	Field ethno.	Development panels
1:1 interview	Digital ethno.	Internal participation
Super group	Photo ethno.	
Online discussion	Persona	

2.2.3. Product Change Phase 2: Convergence

In the 21st century, products began to evolve along with complex environmental factors. iPod was first released in 2001 and iTunes Music Store in 2003, followed by iPhone in 2007. Afterwards, a product cannot be sold as a product itself but in combination with product service and/or ECO system. As the user started to use the product within the ECO system and communicate with others, the designer had to design in consideration of the user, the entire system and the interaction among products. Integrated thinking was required for the designers and the product design was expanded to the service design area and the user's participation in the design process was maximized.

Convergence brought the integration of the customer experience. Thackara(2005) said that current design in networked society is the process to define one system constantly, not the result.^[12] Furthermore, the Copenhagen Institute of Interaction Design(2008) explained that service designers generally design a system and process for providing a comprehensive service to the user, and they introduced service design field as the multidisciplinary field that combines design, management and process engineering.^[13]

The below methodology table shows various approaches from market, stakeholder, user, engineering, etc. to complete the overall system.

Table 6 Stefan Moritz's design methodology^[14]

	Understanding
	Benchmarking, Critical incident tech, Client segmentation, Ecology map, Ethnography, Gap analysis, Experience test, Historical analysis, Service status, 5Ws, Expert interview, FGI, Market segmentation, Mystery shoppers, Insight matrix, Inconvenience analysis, Observation, Probes, Reading, Inspirational specialists, Net scouting, Shadowing, Thinking aloud, Trend aloud. Trend scouting, User survey, Context analysis, Contextual inquiry
	Thinking
	Affinity diagrams, Specification, CATWOE, System thinking, Lego serious play, Think tank, Lateral thinking, Mind map, Parallel thinking, Personality matrix, Priority matrix, Touch points, Visual thinking

Generating	Bodystorming, Brainstorm, Brainwriting, Experience sketching, feature tree, (Group) sketching, Idea interview, Open space technology, Parallel design, Randomizer, Think tank, Unfocus group
Filtering	Card sorting, Character profiles, Cognitive interaction, Diagnostic evaluation, Evaluation review, Expert evaluation, Feasibility check, Focus group, Heuristic evaluation, Personas, Pluralistic walkthrough, Retrospective testing, PEST analysis, Sticker vote, SWOT analysis, Task analysis
Explaining	Camera journal, Character profiles, Mock-ups, Role play, Metaphors, Rough prototyping, Tomorrows headings, Mood film, Persona, Social network mapping, Scenario, Storyboarding visioning, Experience prototype, Try it yourself, Empathy tools, Mood board
Realizing	Behavior sampling, Blueprint, Business plan, Guideline, Intranet, Line of balance, Mind map, Performance testing, Post release testing, Role script, Scenario testing, Service prototype, Simulation, Specifications, Templates, Wizard of OZ

3. Change Factors in Design Methodology change factors

3.1. Selection of Change Factors

User experience is one of the important elements in digital media. A considerable number of the latest design methodology studies is focused on user experiences. Nielsen Norman group explains, "User experience encompasses all aspects of the end-user's interaction with the company, its services, and its products".^[15] On the other word, designers should consider the whole experience between user and product.

On the other hand, the new media is studied based on the communication framework in the media research field. One of the traditional model is Lasswell model. This model analyze the medium by the framework 'who did what to whom and how'. Schramm added interaction element to the existing models and suggested the 'Encoder - Message - Decoder' model.^[16] In these models, 'who' and 'encoder' can be replaced by the designer; 'what and how' and 'message' can be replaced by the product; 'whom' and 'decoder' can be replaced by the user.

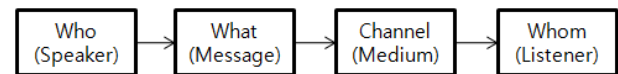


Figure 4 Lasswell's communication model

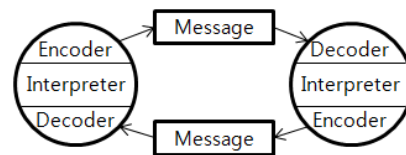


Figure 5 Schramm's communication model

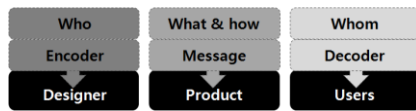


Figure 6 New media analysis framework

It is shown that books on design methodologies generally define the design or design process and introduce the product areas, the designer's roles and the importance of users. It is noteworthy that as shown in Table 7 the recent design books have the design methodology that takes users into account, in addition to the product areas and the designer's roles dealt with the focus in the earlier books on design methodology. In addition, as shown in Table 8, there has been an increase in books that introduce the design methodology associated with the user, starting from the late 20th century.

Table 7 Introduction of Product, Designer and User in the Books on Design Methodology

Book			Perspective		
Pub. Year	Title	Author	Product	Designer	User
1970	Design Methods	John Chris Johns	O	O	
1988	A Study of Design Methodology	Daesoon Park	O	O	
1992	A Study of Design Methodology	Yeonwoong Im	O		
1995	Understanding of Design	Kyoungwoo Min	O	O	
2009	Design Methodology	Haechoon Oh	O		O
2010	Managing the Design Process-Concept Development	Terry Lee Stone		O	
2011	This is service design thinking	Marc Stickdom, et al.	O	O	O
2013	Lasting UX Design	Juncheol Ban	O	O	O

Table 8 Emergence of books introducing the user-centered methodology

Pub. Year	Title	Author	User-centered methodology
1995	About Face	Alan Cooper, et al.	User observation, interview, focus group, persona
2004	Rapid Contextual Design	Karen Holtzblatt, et al.	Context research, persona, paper prototype
2009	Designing for the Digital Interface	Kim Goodwin	Interview, persona
2012	Universal Methods of Design	Bruce Hanington, et al.	Behavior map, crowd sourcing, cultural

			survey, ethnography, design workshop, focus group, participatory design, persona, role play, usability test, user journey map
2012	Killer UX Design	Jodie Moule	Contextual interview, survey, diary study, prototype, user test, focus group, design workshop
2012	UX Design process understood with a story	Daum Communication UX lab	User survey, usability test
2013	Design Thinking: Design Science I Create	Gun Na, et al.	Persona, customer journey map

Assuming that the design methodology has been evolving under the influence of a product, a user and a designer as described above, this study analyzes how these factors impact the changes in the design methodology.

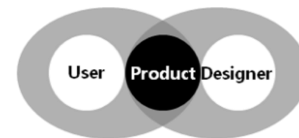


Figure 7 Change factors of design methodology

- Object of change: Product
- Subjects of change: User, Designer

From the perspective of interaction between design and society, a 'product' is an output produced as a result of the design methodology, which is an object that connects the design and the society. The design world creates products that have functions and aesthetics required by the society, and the society continues suggesting its requirements forming a certain culture in cycle. With regards to the product, there are two subjects change: one is the consumer who uses the product and the other one is the supplier who provides the product to the consumer. The consumer can be substituted with to the user, and the supplier with the designer. As the environment where the user uses the product and the environment where the designer designs the product also affect the development of the design methodology, these two environment were examined as well in this study.

3.2. Design Paradigm and Change Factors

Design paradigms and characteristics of the design methodology are summarized in Table 9 for each of the three change factors described above. Columns are divided by major event of each age (pre-digital media, product change phase 1, and product change phase 2), and rows are divided into Background, Value, three Change Factors, and design methodology.

Table 9 Age-specific Changes of Design Paradigm

	Pre-digital media: Analog product	Product change 1: Digital product	Product change 2: Complex environment
Background	Mass production	Computer, user	ECO system, platform, service
Value	Effectiveness	Usability, User experience	Overall experience
① Product	Industrial products (Simple)	Digital products (Complicated)	Environment-combined product (ECO system, Service)
② User	Customer (As mass target)	For user (User-centered)	By user (User-participating)
③ Designer	Exterior design	User-understanding	Integrative thinking
Design methodology	Tech-driven changes (1) Engineer-centered problem-solving process	User-driven changes (1) User context-based methodologies are studied actively: UCD	Convergence-driven changes (1) Platform context added methodology: interaction between device and environment is evolved (2) Service/ECO/Contents - combined methodology
Overall summary	Emergence of designer	Emergence of user	Expansion of product

Overall, before the emergence of digital media, the design process was systematized under the influence of system science and after its emergence, the design methodology started to develop. At first, designs were made to enable mass production of analog industrial products, the designs were technology-oriented but as the digital product emerged, the number of environmental factors to be taken into account for the users increased. As a result, the design methodology has been evolving from the tech-driven design to user and system-oriented design.

3.2.1. Tech-driven changes

As the problem of efficiency and production speed was raised due to the mass production system, specific and systematic design methodologies were needed.^[17] In the tech-driven design environment, designers considered how to make new-function-added products more cheaply.^[18] At that time, the most important design value is effectiveness for mass production.

3.2.2. User-driven changes

As people were using the digital devices such as computer, Smartphone, tablet, etc. and moreover they were using the internet, the importance of the convenient products was increased. We had to shift the industry to user-centered designing.^[18]

3.2.3. Convergence-driven changes

Technology's development speed is getting faster and the industries are getting more connected. Therefore, the spatial constraints and the boundaries between technologies or industries are disappearing. The convergence age makes the usage environment more complicated, therefore the analysis of the business perspective is required for designers.^[19]

New media can exchange the digital information when connected, and it becomes the special domain due to networking and extended time-space.^[20]

Table 10 Characteristics of new media^[20]

	Characteristics	Influence
1	Digitization of information	Integration of the info type
2	A single information transferred by various media	Integration of Media
3	Bi-directional information exchange	Interactive feedback available
4	Networked communication	beyond time and space, decentralization, beyond substance, beyond mobility

3.3. Factor 1: Products

Until digital media emerged, products were mostly industrial products manufactured through mass production. Since the 1970s, products with digital features emerged. In the 21st century, products in which tangible and intangible (service) qualities are integrated appeared. Today, products do not remain as physical items any more. Rather, they provide users with valuable user-specific experiences. As the turn of the 1970s, the designers who had mainly designed physical appearance of products began to design the interaction with the user. Also, unlike the past when they designed products with fixed types of usage, they are now designing smart products that change according to the user's taste even after being released. In other words, the designer has to design a product based on understanding of the characteristics of new media and of the system.

Table 11 Product Factors

	Pre-digital media	Product Change #1	Product Change #2
Product	Industrial products (Simple)	Digital products (Complicated)	Environment-combined product (ECO system,

			service)
Product case	Leica 1A Camera (1929)	Apple iMac, Nokia mobile	Apple, Android, MS
Product composition	HW	HW + SW	HW + SW + Service
Design target	Physical appearance	Interaction included	Platform + ECO + CP
Product tendency	Fixed	Flexible, Evolving (User-dependent)	
Design consideration	-	Understand new media	Understand the whole environment (Platform + ECO)

3.3.1. Industrial development process and product properties

Figure 4 shows the industrial development process introduced when German Industry 4.0 Report in 2013 suggested the direction of future products. It shows that the products have evolved together with the production process, as technology developed.

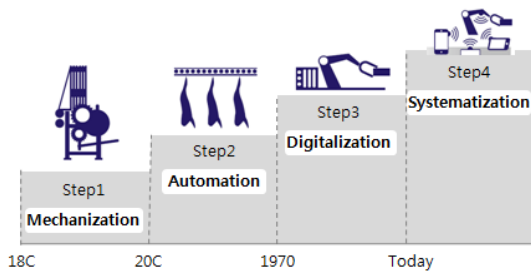


Figure 8 Industrial development process^[21]

As the loom and the conveyor belts were invented after the Industrial Revolution, the production process has become mechanized and automated, making mass production possible. On this background, IT technology developed, making it possible to digitalize the production process and the products, connecting necessary devices to interwork with the system. As the interworking with the system was established, the entire industry has become systematized.

These changes in products are similar to the concepts of Web 1.0 / 2.0 / 3.0 that had once been popular. The biggest feature of Web 2.0 is ‘movement of power to the user’.^[22] The users, who used to be the accommodating party of contents, started to actively communicate, generate and share information under an open online environment. Web 3.0 is a web environment in which the computer understands and infers information resources and provides services appropriate for the user’s usage pattern. As the IoT environment was established and the computer has become intelligent, the expectations for intelligent services have become higher.

Table 12 Web 1.0/2.0/3.0^[23]

	Web 1.0	Web 2.0	Web 3.0
Time	1990~2000	2000~2010	2010~2020
Keyword	Access	Participate, share	Context
User	Manual	Participatory, open, sharing	Expanded
Content usage patterns	Producers: provide content, Users: use content	Users = Producers	Intelligent web provide tailored contents
Search	Search only in internal search engines	Open data in multiple sites (Open API)	Tailored search
Information used by	Human	Human	Human, computer
Technology	Browser, Web	Broadband, server management	Semantic web, clouding computing, contextual awareness
Device	PC	PC+Mobile	PC+Mobile+ α
Overall characteristics	Static Closed	Dynamic Open, standard	Tailored Intelligent

Ministry of science, ICT and future planning(South Korea, 2013) pointed out that the broadcast service is changing from a one-way communication to interactive, moreover integrated services, because smart devices have come into common use.^[24]

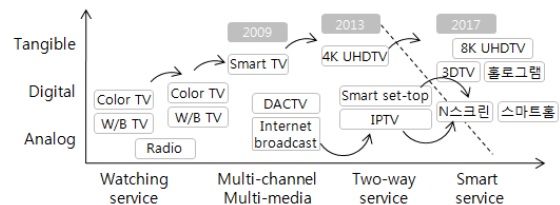


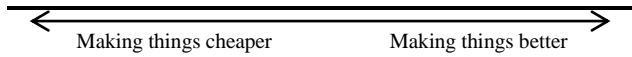
Figure 9 Evolution of the broadcast service^[24]

3.3.2. Subject of product innovation

Joohyun Park(2011) divides the subjects of product innovation, who make it possible to produce cheaper and better, into five categories: price, technology, function, user and design. She claims that these subjects can make products better by strategically reflecting the user and providing new experiences. Here, design is defined as having a role of creating new experiences and values, and a process of transition from efforts to make things cheaper to efforts to make them better.

Table 13 Expansion of subjects that lead innovation^[25]

Price	Technology	Function	User	Design
Efficiency of expenses	Technological development and quality improvement	Addition of new and diverse functions	Strategic reflection of user’s need	Creation of new values by providing new experiences








On the other hand, Dongseok Lee (2013) explains that products are created in order to provide new experiences, applying new business/ECOSystem, services, equipment/interaction devices, UI, and usability as shown in Table 8. According to him, designers not only design product appearance but also design products in various types such as device concept, interaction methods, ecosystem, and services. As the area of design is expanded from part to whole, the role of designer is also expanding across the design process in general.

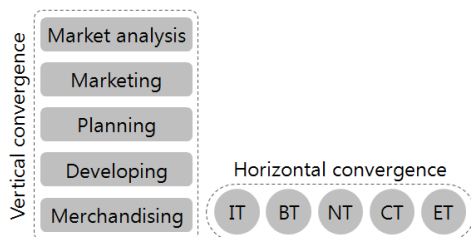
Table 14 Expansion of new experiences (types of innovation)^[26]

New business/ECO system	iPod + iTunes, iPhone + Appstore, KakaoTalk + Game
New service	Netflix, Chomp, FlightCar
New device	Kindle, Flip, JawboneUp
New interaction	iPod - Click-Wheel, MS - Kinect
New UI/Usability	Sony - XMB (Cross Media Bar), Gmail - Conversational View, Dropbox, Mailbox

Future IT convergence technology research Council (South Korea, 2010) classified the convergence types based on convergence level. It provides different products in one package or engrafts different products to provide a new value.

Table 15 Classification of the convergence^[27]

Type	Convergence level	Description	Example
Bundle 	Weak  Strong	Provide multiple products in a single package	iPad+iTune
Overlap 		Add the same function between different service	Online Stock Trading + Electronic Dictionaries
Hybrid 		Integrate two or more elements to achieve a specific goal	All-in-One OA, Smartphone
Fusion 		Provide new value by combining products and services	Mp3 player, iPad, PMP



Feature 10 How to converge^[28]

Choonseong Leem(2011) divided into vertical convergence and horizontal convergence. Vertical convergence means the convergence between the processes where the product is consumed in the market and horizontal convergence means the convergence between different technologies that belong to the different industry.^[28]

3.4. Factor 2: User

The concept of user emerged as the concept of design was born after the Industrial Revolution. At first, however, it was more like the target purchaser of mass-produced products or rather close to the stakeholder whose opinion was worthy of being reflected. Then, as the focus of the product shifted from practical and aesthetic values to reflective and hedonic values, the user's need became personalized beyond being subdivided. In order to study the users, studies about usability, cognitive psychology, emotional design and digital culture started. In this process, UCD, user participatory design, crowd-sourcing, and open API, etc. emerged.

Table 16 User and usage environment factors

	Pre-digital media	Product Change #1	Product Change #2
User	Customer (As mass target)	For user (User-centered)	By user (User-participating)
User needs	Simple	More complicated	Customized (Example: Nest)
Usage environment		(1) Computer (2) web	(1) Mobile device, (2) ECO
Usage value	Practical, Aesthetic	+ Reflective	+ Hedonic
Design theory		Usability, Cognitive Psychology, Emotional Design, etc.	Digital culture
Design methodology		UCD (Survey, Focus Group Interview, Contextual Inquiry, Diary study, etc.)	User-participating design (co-creation), Crowd sourcing, Open sourcing

3.4.1. Emergence of user

Production of goods before mass production targeted a limited consumer base and the usage of the goods was relatively simple. Therefore, the cultural and symbolic significance of the consumer wanting to have the goods and the practical value of convenience of using the goods had more importance than the user's needs and usage pattern. Then, after the mass production became possible following the Industrial Revolution, the customer base expanded and the companies began to recognize the consumers. Also, as the market became more segmented, the user's needs and interaction became more diverse. Accordingly, a variety of products were released

and even the products customized to individual users, like Nest that learns the user's propensity of use and his environment like ambient temperature and humidity, and the products which evolve based on the user's needs began to emerge.

On the other hand, the environment in which the user uses a product has also gradually evolved. Starting from web-connection in the late 20th century, it has evolved into the online environment, such as inter-user connection, inter-device connection, and crowd connection, in which the user can connect to whatever, whenever and wherever he or she wants. Furthermore, it can evolve into products with functions one needs, thanks to ECO system with which one can purchase contents.

As the society became economically/culturally prosperous, the users' level of knowledge has become higher and their role has also expanded. Recently, centering on the IT sector, new ideas using collective intelligence have been proposed such as crowd-sourcing that receives proposals from users and open API that opens API for developers to develop new ideas from the outside. By this, the users no longer stay as passive user but transform themselves into designers and developers who put forward new ideas and develop new products.

Figure 5 shows the process of transition in the level of users' participation in the design process, as summarized by Jisun Lee (2013). In the 1980s, the users participated in the product test; in the 1990s, they participated in the prototype test; in the 2000, they participated in generation of ideas; and in the future, she predicted that that the users will invent products or be the subject of product innovation.

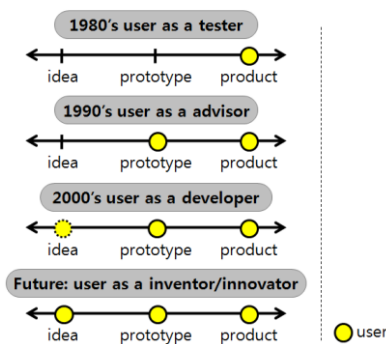


Figure 11 Changes in users' participation in the process over time^[29]

On the other hand, the concept of user had existed in the past as well, which recognized the user as a being that passively accommodated products. In 1970, John Chris Johns explained the proprieties of communication in the order of sponsor, design team, supplier, producer, distributor, purchaser, user and system operator, while mentioning about the difficulty in communicating with the interested parties in conducting design works. Here, he considered the user merely as the objects whose opinions the designer had to listen to.^[30]

3.4.2. UCD (User-centered Design)

Functions and usage of digital products were complex and

difficult, and the Internet environment was unfamiliar to the users. The users wanted the products to be easy and smart and in this process, experience design and UCD methodology were developed centering on 'user experience', 'usability' and 'user cognitive psychology'. Jesse James Garrett defined the elements of user experience as strategy, scope, structure, skeleton and surface, and he explained how these element affect each other in his book 'The element of user experience(2002)'. And Peter Merholoz, et, al. defined UX as strategic activity and they insisted that UX innovates the products as one of the leading management activities in their book 'Subject to change(2008)'.^[31] Representative UCD methodologies are user observation, focus group interviews, usability testing and diary study, which aim at observing and investigating the users to get insights.

3.4.3. User participatory design

While UCD is a method of designing based on understanding the user, the user participatory design is to have the user participate in designing. In the user participatory design, the users actively participate in a variety of design activities such as information collection, idea generation, modeling and evaluation. It is known to be started in Scandinavia in 1970.

Table 1 7 Participatory design conducted by Experientia^[32]

Client	Target	Methods
Sitra, Finland	Apartment	'Low2No' residential environment design project conducted in Helsinki, Finland, in which users created the apartment layout in 3D. In the end, Sitra/SRV decided to make a public sauna for residents.
Vodafone, India	Mobile phone	Indian rural / low-income urban residents were to make mobile phones of their own through collage work of magazine pictures, and then do presentation on it. They made prototypes, and did card-sorting for their expectations about the phone functions.
CVS Pharmacy, USA	Pharmacy	A wide range of national-intellectual researches were conducted in pharmacies in Italy, Germany, England and USA. In the pharmacies, designers worked as staff and idea workshops were held with the CVG creative team.

3.4.4. Crowd-sourcing

Crowd-sourcing is a compound word of crowd and outsourcing, in which a number of people perform a project by voluntarily responding to public research subjects. Some companies operate the crowd-sourcing for the purpose of listening to the users' voice or for the purpose of finding out more ideas. They invite the external experts and the public to participate in the product development process, and share with the participants the return of the product.

Table 18 Examples of crowd-sourcing^[33]

Innocentive 2001 USA	Scientist-centered online R&D community in the field of basic science, pharmaceutical, life science, etc. When a company uploads a research subject to the community website, the community members suggests ideas. When an idea is selected, the member who suggested the idea is awarded prize.
Wilogo 2006 France	Design community with more than 13 thousand members, which designs company logos. When a customer places an order, designers in the community upload more than 50 designs within a week, and its members evaluate/vote for the best.
Threadless Late 2000 Chicago, USA	Online T-shirts production and sales site, of which members participate in production. When member designers submit designs, the final design is selected through verification by Questions and Answers.
Quirky 2009 New York, USA	Quirky starts to produce products based on general users' ideas. When general users submit ideas, the member users vote for the best idea. Once an idea is selected, it is produced and sold by the external experts within two weeks.
Open IDEO 2010 USA	When IDEO creates a challenge topic, anybody can suggest a solution. The challenge is developed in three steps of 'Inspiration', 'Concepting' and 'Evaluation' and all participants can participate in all these processes.
Ideacream 2010 Korea	Ideacream discloses ideas about product improvement to consumers, and receives proposals from them. The Here, consumers act as planner, designer, copywriter, and/or storyteller.

Crowd-sourcing in which a company/organization presents the topic is expanded to crowd-funding in which individual users presents the topic. The user uploads his or her idea to the crowd-funding site, to introduce the idea and raise the funds for production costs. People participate in funding, based on the product idea only and, when the enough funds are raised, the proposer produces the idea, and sends out the product to the people participated in the funding or share profits with them according to the scale of their investments.

Table 19 Examples of crowd-funding^[34]

Indiegogo 2008 USA	Recognized as the first case of crowd-funding, and known for its motto 'DIWO (Do It With Others)'. It also develops public-interest campaigns and thus is known for its nature of public interest. Even the target amount is not reached, the raised fund is delivered to the project coordinator
KickStarter 2009 USA	Under the slogan of 'Be Creative', it performed lots of fundraising activities in its early years to support arts. In recent years, as the fields that require fundraising became more diverse such as games, films, design, music and technology, this site has become the most popular funding site for start-up companies. If the target amount is not reached, the product is cancelled

and the raised fund is returned to the contributors.

An example of crowd-sourcing combined into the design methodology is frogmob by frog. The frogmob asks people all around the world to observe what are popular in their areas, take pictures of them, and upload the pictures. Designers can understand how people live and what certain things mean in each area, with respect to a particular topic.^[35]



Figure 12 Frog's Frogmob site^[35]

3.4.5. Open API

Platform companies equipped with ECO system such as Apple and Google form an environment where they coexist with other developers, by disclosing the developer tools to the developers so that they can develop mobile applications that operate on their platforms. In the early 2000s, Amazon and eBay were the first that published product data to the third parties and distributed their profits. In 2005, Google released map API, so that a variety of mash-up services were created. With this as an opportunity, Yahoo, Microsoft, Twitter, Facebook, Delicious, Flickr and many other companies started to support open API and developer tools.

3.5. Factor 3: Designers

The image of designers has changed from artisans, through people who design the appearance of product to look good, to the ones who understand the users and who do integrative thinking. In other words, the designers are required to do a holistic design that takes into account not only formativeness and aesthetics but also the users and the environmental factors.

Table 20 Designer and design environment factors

	Pre-digital media	Product Change #1	Product Change #2
Designer	Exterior design	User-understanding	Integrative thinking
Design environment	Maximize efficiency (Design a production-optimized product)	Consider user, buyer, stakeholder, client, etc.	Device-Platform, Service - ECO
Design theory	Efficiency, formativeness, design scientification,	Usability, Cognitive Psychology, Emotional	Integrated thinking

	design process	Design, etc.	
Design methodology	Linear design process	UCD	Service design

3.5.1. Designers with analog media

The early design methodology focused on analyzing and solving problems in the industrial phenomena, centering on engineering problems. At the time, the machine produced products and therefore the designer had to be good at drawing (the design) rather than good at making. Until the end of the 19th century, the objects of design were decorative pieces attached to the outside of products and the designers of the time were mainly in charge of decorative design and pattern design.^[37] Also, as the products were simple and the users' needs were not complicated, the designers focused on the study of form. It was this time when the formative researches were active in Bauhaus and Ulm University (Hochschule für Gestaltung Ulm).

3.5.2. Designers of Product Change #1

As the industry and technology advanced, humans began to imagine. In 1984, William Gibson of the USA published 'Neuromancer' that fictionalizes a man in search of the cyberspace and in 1985, Bruce Sterling published 'Schismatrix Plus' that deals with mechanistic world and genetic modification. Products also began to evolve based on the human imagination. In order to meet the people's expectations, designers had to be capable of understanding the users by observing and analyzing them and capable of imagining product concepts, rather than merely capable of drawing well or making well.

3.5.3. Designers of Product Change #2

In order to meet the complex needs of the society, the designers are put into the product development from the product concept planning stage. It is not that they start to design after receiving a proposal from another department but they participate in the product development from the planning process. In addition, the designers carry out the project while listening to the requirements of various people, such as users, clients, company, and other stakeholders. Therefore, they should be able to understand the entire product development processes including product planning, design, development, marketing, sales, etc., and also should have communication skills for smooth communication with relevant departments.

Recently, some companies organize their design teams with interdisciplinary human resources in order to flexibly solve design issues. People with various backgrounds and knowledge in visual design, industrial design, product design, interaction design, HCI(Human computer interaction), HFE(Human factor engineering), computer science, industrial engineering, cognitive psychology, literature, sociology, etc. proceed with the design work together. For example, Yamazaki Kazuhiko, et. al.(Japan IBM) introduced their UCD team that consists of various experts in their book, 'The Concept and Practice of User Centered Design(2005)'. In their

team, an UCD leader, marketing planning specialist(s), user researcher(s), UX designer(s), visual/industrial designer(s) and evaluation expert(s) are the key members of the team. And they said that engineer(s), manual writer(s), sales manager(s), service support staff(s), a product planning team also participate in the UCD activities.^[38] In addition, Jodie Moule also introduced her UX team in her book 'Killer UX design(2012)'. Her team consists of researcher(s), visual designer(s), interaction designer(s) and developer(s). They developed a recipe app for UX project case study.^[39]

3.5.4 Change in the designer's roles

The work of the design department in the product development process within a company has been gradually extended to the front. Figure 8 shows the process of change in the designer's roles, summarized by Yoo-ri Koo (2009). It is shown that the designer's role has evolved from a discriminator limited to the design stage, in a more active and integrated direction. to a passive integrator, to an active integrator role and then to a value creator.

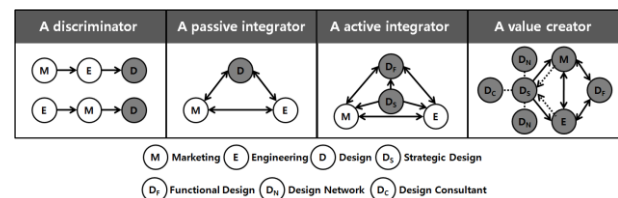


Figure 13 Change in the designer's role:
Evolution to a value creator^[40]

The designer in the past could not participate in major decision-making processes for business but only maintained their positions but recently has been given the role of participating in major decision making processes.

Claudia. B. Kotchka, who is in charge of design innovation in P&G, also introduced a similar type of design development in The Front End of Innovation Conference 2006. She divided the development types into four steps – Stage 1 where design mind is lacked; Stage 2 where style is improved; Stage 3 where functions are improved; and Stage 4 where problems are solved - and the characteristics of each stage agree with the age-specific image of the designer.

Table 21 Development type of designs^[41]

Development type		Description
Stage 1	Clueless: Lack of design mind	Basic features of the product are focused but the form of the product or the user-friendliness is not considered
Stage 2	Style improvement	Appearance and packaging of the product are made stylish
Stage 3	Function improvement	The form of the product is partially modified and its functions are improved, to increase the consumer's satisfaction
Stage	Problem	Design and company's capability are

4	Solving	focused on meeting the consumers' essential needs
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4. Conclusion

So far, this paper has examined how the age-specific properties of the products, users and designers influenced the design methodology. As the nature of the product changed from industrial products of physical type into digital products and environment-related products, factors to consider at the time of selecting a property design methodology have been added such as practicality, user, service contacts, platforms, ECO system, etc. Also, the users have become more active and equipped themselves with development capability, methodologies that utilize collective intelligence or involve the users directly in the design process have been devised.

Also, the designers' roles have been expanded to designing the product concept, interaction, contents, service contact and system in general as well as the physical appearance of the product. As For this reason, the designers are required to do integrated thinking and decision-making and to reflect on the overall product development process. This analysis has significance in that it classifies and summarizes the age-specific characteristics and evolution of the design methodologies within the correlation between the design methodologies and the change factors. The design methodology is one aspect of the history of design, which has evolved together with the development of society and design. It is expected that this study can be used as basic research on the design methodology in the historical dimension. In addition, we hope that this will help designers understand the process of selecting the design method.

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