1. INTRODUCTION

1.1 Research Background

Service design is becoming sophisticated and diverse and the industrial sectors seem to be expanding in combination with it. In particular, a combination system of product and service, such as the Product-Service System (PSS), adoption of intangible service elements to tangible products or application of visible items to invisible service categories, has taken on significant importance. A PSS is considered as a system to innovate products and sales by adding service with distinctive features, so it is expected that PSS can satisfy the customer value proposition. It is obviously beyond the existing manufacture and sales system of products. However, since the definition of PSS, methods of shaping PSS, and systematic methodologies for PSS are not sufficiently discussed and service design methodologies are applied without modification, problems have emerged. The reason is that issues of service, such as service providers, user interactions, and touchpoints, are focused on, but the detailed use stage of products and emotional expectation value are overlooked. The core concept of PSS is the convergence of products and services, and it is imperative to design in order to connect the functions and uses of products with services. Therefore, this research proposes a design methodology that can comprehensively improve the customer experience by considering the customers’ activities of using products as well as experiencing services.

1.2 Research Objective and Method

Customers have experience with products and services through the activities of using them. Accordingly, the methods of how to use the products and services from the viewpoint of customers’ activities must be analyzed. Also, designs that amplify synergy by strengthening the connection between products and services must be discussed to satisfy customer expectations. The service blueprint and customer journey map can be regarded as representative methods of PSS from the customer activities perspective, but the rough functions of products and services and interaction about path to use of customers are mainly dealt with. The detailed parts, including the order of their behaviors, duration time of the activities, and usability that is produced by customer experience, are not sufficiently discussed. In addition, as customers’ satisfaction differs according to the degree of their expectations about PSS or types of perspectives, such as emotional and rational perspectives, it is necessary to determine how experiences are influenced by expectation, which can be considered a pre-experience. Hence, this research focuses on discovering a relationship between the properties of expectation and those of the experience and design of concrete activities. This research approach is as follows: first, the application of unitizing the concepts
regarding activities, experiences, and expectation; second, the identification of the relationship among each unitized factor; lastly, the suggestion of a design method for systematic orders and order of property. It is assumed that this design method can improve the quality of the PSS design and help construct methods for developing a new emotional design.

2. DEFINITION OF PSS AND LIMIT OF PSS METHOD

2.1 Previous Research of Definition of PSS and PSS Methods

The definition of PSS was first introduced by Goedkoop et al. (1999). Goedkoop et al. defined the PSS as a “combination of products and services to satisfy customer needs” [9]. Mont (2001) insisted that it is a designed product with stronger competitiveness than existing products and with less harmful effects on the environment. In addition, he mentioned that it is a system of products, services, and socioeconomic infrastructure [13]. Baines (2007) understood the Product-Service System as a specific case of servitization [2]. Thus, it can be said that the methods for deriving a Product-Service System have been actively discussed, but the methods for integrated service are not constructed [19].

On the other hand, Shostack (1993) suggested a service blueprint that explains the service activities occurring between the service providers and customers as a flow of successive behaviors. Boughnim (2005) proposed a PSS blueprint method that was concerned with various stakeholders and expressed the usage environment and functions that are provided through a combination of products and services [4]. Also, Sakao (2007) defined service as a “receiver state parameter (RSP)” and suggested a design methodology using a service explorer [17]. However, these methodologies seem to be focused on the service and not the product. In other words, they consider that a product is one factor in the process of providing service and give weight to defining the concept of service. Therefore, the development of a balanced design with products and services is required. Furthermore, from the viewpoint of the convergence of products and services, they do not seem to consider the synergy effect and focus on the detailed parts of products and services. In short, although the convergence of products and services has been considered in both practical and academic fields, there is not a standardized framework that can be applied to the diverse concepts of the combined products and services [16].

2.2 Limits of Service Design Methods Considering Customer Activities

The Nielsen Norman Group proposed that the user experience research method must be subdivided into behavioral, attitudinal, qualitative, and quantitative methods [22]. However, it focused on the user interaction experience and did not sufficiently deal with the service design method; for example, the customer journey map (see Figure 1).

The double diamond design process, which was developed by the Design Council of the UK in 2005, is a representative model of service design. It explains that the design process is divided into four phases: Discover, Define, Develop, and Deliver, and the convergence and divergence of the design process are repeated. This diagram shows the categorization of useful methods in each stage, but it focuses on the service design. Therefore, it has a limited comprehension of the detailed parts of a product. On the other hand, it suggests the customer journey map as a significant method that can be extensively used in the stages.

Yu and Kim (2012) organized major service design methods into 33 methods by researching the literature and previous studies. They also classified them into seven groups by carrying out qualitative and quantitative approaches. According to the evaluation of their importance, customer observation (4.9/5.0), customer in-depth interview (4.8/5.0), rapid ethnography (4.8/5.0), and customer journey map (4.8/5.0) were highly evaluated [12].

Although the customer journey map is a crucial method, it has a limit in its application to the PSS design: that is, even if it is strongly related to customer activity, it mainly...
measures customers’ emotional level at each stage. Hence, it seems to be difficult to determine the detailed factors and experiences that the customers receive from physical space, products and services.

Even though the customer journey map is useful as a communication tool and also effective for finding problems in the services from the customer experience perspective, the problem is that it is conducted as a design workshop without customers’ agreement. As a result, a more objective and formulaic method is required [21]. Interaction between service providers and customers, which is a strength of the customer journey map, must have a stronger focus. At the same time, the combination of products and services must also be compensated for from the viewpoint of the detailed activity analysis dealing with PSS design. If so, it is expected that this method will become more useful as a method of PSS design.

2.3 Need for a Specific Approach to PSS Customer Activity

The design process consists of formative research, which pursues early confirmation and the solution of problem, and summative research, which is to interpret the output of the investigation process [14]. The investigation of user activity is prominent because it links these two types of research and implies the reason for researching user activity for PSS (see Figure 2).

Besides, PSS design must be concerned with how to converge products and services from the customer’s perspective, which is not an approach that is overly weighted toward products or services. Furthermore, as the self-service system has rapidly expanded, particular attention must be paid to customers’ activities. Therefore, this research aims to focus on the development of a PSS activity design method that is specialized from the customer’s stance and proposes a new approach embracing concepts of both products and services.

3. FRAMEWORK OF SOLVING PROBLEMS

3.1 Expectation and Experience Focused on Customer Activity

1) Customer Activity Experience

Activity is an expression of customer desire, an external attempt to communicate by internal motives, and a means to get what the customer wants. Activity indicates a change of state of the entire human body and is observed as a set of “actions,” which are “movements,” or physical motions of the human body. Additionally, the concept of “behavior” seems to be considerably similar, but it is a set of continuous activities with purpose. Therefore, it can be regarded as a pattern of activities rather than activity itself [18].

On the other hand, an experience is a reaction to a stimulus. Specifically, it arises after a stimulus is delivered to the sensory system and passes through a thought process. In a similar vein, Dewey (1958) regarded an experience activity as an activity pattern of the human body that happens in relationship with nature and the environment [6]. The experience can be divided into external and internal aspects: external experience is shown as an activity of the human body, or “action”; internal experience is an activity of the mind, or “thinking” or “reflection.”

Customer activity is a crucial object of observation because it can be clearly watched. In other words, since emotion and thoughts, which are internal factors, are difficult to observe and objectify, this research focused on activity, an external experience, rather than internal factors (see Figure 3).

2) Extension of Customer Experience

Customer experience is divided into pre-experience, the experience, and post-experience as time changes [5] (see Figure 4).

Pre-experience gives information or warning before the experience, so it influences the experience directly.
The experience is a customer’s real experience, and post-experience is a memory process of the result of the experience.

In order to understand PSS experience formation, one needs to identify not only customers’ experiences while using products or services, but also their experiences before and after the experience. Expectation is a significant factor in understanding pre-experience. Hence, to improve the level of PSS design, it is necessary to figure out how the experience correlates with PSS expectations through the formation process and structure of the PSS expectations. The reason is that PSS design means design activity that can create an experience of using products and services in the customer journey and touchpoints that are intended to induce activity and thoughts and to find out what the customers want. Until now, the factors of the experience have been emphasized. However, experiences have to be researched synthetically, including the conditions of pre-experience and expectation.

3) Customer Activity Expectation

Customer expectation, as a consumer’s pretrial belief of service performance, is becoming a standard or a reference to evaluate real service performance. Parasuraman, Zeithaml, and Berry (1988) divided customer service expectations into desired service, adequate service, and zone of tolerance and considered that the process of perceiving service quality is determined by the gap between result and expectation (see Figure 5).

Analysis of customers’ expectations before an activity as well as their experiences after it will improve the level of PSS design. Therefore, this research concentrates on the relationship between expectation and experience, investigating how to improve an experience that does not meet expectations and how to design concrete activities.

3.2 Solution for the Gap between Expectation and Experience

Parasuraman’s model compares total amount of experience after experience and does not cover journey and inconstant interaction between service and product. In addition, the customer journey map mainly shows experience level. If PSS experience and expectation level are added according to the flow of time, utilization can be higher (see Figure 6).

In this method, the flow of successive units of activity is indicated, and the gap between the experience and expectation of each activity is measured. Since the advantage of this map is that the gap can be captured more clearly than with other methods, it is effective for seeking strategies to improve customers’ experiences.

The gap is divided into four types by two standards: confirmation / disconfirmation and positive / negative (see Figure 7). Among these types, the negative disconfirmation type is problematic. To be specific, the other three types, at least satisfy the customer’s expectations, whereas this type does not. However, it is also meaningful: it achieves satisfaction only because the customer’s expectation is low, and its problem is low experience level. Therefore, it is necessary to figure out the type of gap and importance of the units of customer activity and then seek a way to improve them.

3.3 Unitizing Activity

The concept of unitizing is used to break down customer activities that are continuously connected. Considering customer activity as a unitized system, an action consists of simple motions, whereas activity is thought of as a complicated pattern of actions [11]. Bobick classified behavior into movement, activity,
and action. He mentioned that movement as the most elemental, primitive, activity is "a sequence of movements" and action is "a larger-scale event" [3]. On the basis of his research, customer activity can be considered a sequence of primary units of movement, and application of a new template for customer activity design will be much easier (see Figure 8).

This research considers activity as a basic unit which constructs customer behavior and a continuous activity group as a sequence of customer behaviors.

### 3.4 Expansion of Unitizing and Consolidation of Connection System

In this research, the experience and expectations of customers’ activities using a PSS are broken down by using the concept of unitization to establish a system. First, products and services are broken down into units. Second, the service unit is divided into several service elements. Lastly, the service elements are linked with the product unit (see Figure 9).

As a result, it is anticipated that a hierarchy of the PSS will be constructed by connecting product units and service units, which are composed of smaller elements. At the same time, customer expectation units and experience units are also broken down into expectation elements and experience elements and then connected to activity elements based on the sequence of PSS activity [8].

### 3.5 Making New Activity Modeling through Related Theory

As an analysis of related theory needs to be conducted before establishing a new model of activity expectation and experience and proceeding with unitization, significant models are examined in this research.

Norman (1988) divided human action into execution and evaluation from a cognitive psychology perspective and insisted that there is a gulf between execution and evaluation (see Figure 10). The gulf of execution is the difference between the user’s intention of action to reach his/her goals and the actions allowed by the system. The gulf of evaluation refers to the difference between the actual result of the actions and the expectation. In addition, Norman presented seven stages of action through which the user interacts with the world. Stages 1 to 3 are about forming intentions and planning. Stage 4 is about executing the action, and stages 5 to 7 are about perceiving, interpreting, and evaluating the result of the actions [7]. That is, human actions are a series of 7 steps of execution and evaluation, including the formation of the goal. Hence, the gap between execution and evaluation needs to be closed for customer usability. However, since his model is mainly about interaction, it does not seem appropriate for application to the overall journey of PSS. That is because service, which consists of a phased order of action and activity is a flow of experiences and activities that are evaluated by the customer every moment.

On the contrary, behavioristic psychologists regard all actions as results of conditioning and believe the basic formula for understanding humanity is the stimulus-response, which is called S-R psychology. Woodworth (1928) inserted the organism into the stimulus-response formula and presented the S-O-R formula. Atkins and Birch (1970) suggested a new S-O-R paradigm that concentrated the functional significance of stimuli and responses related to action (see Figure 11). He noted that an action tendency becomes stronger by the stimuli with the passage of time and weaker by the responses so a change in the action can be induced [1].
4. SUGGESTION OF AN ACTIVITY-DRIVEN PSS DESIGN METHOD

4.1 Proposal for Customer Activity Modeling through Unitizing

This research breaks down expectations and experiences of customer activity into primitive units and proposes a new PSS customer activity model by connecting these units with a PSS system. Therefore, it is expected that this model can be used as a new analysis framework in which the product and service units of PSS correspond to the customer activity units. Besides, each activity unit is linked with expectation and experience units, which are regarded as an addition of an expectation line to the experience line in existing methods of service design (see Figure 12).

There are two ways to boost the flow of customer activity modeling: one is by activating the flow of activity units, which are related to the axis of the activity unit sequence: the other is by connecting expectations and experiences through interactions of PSS and touchpoints, and it is related to the axis of the expectation activity PSS experience. The purpose of the axis of the activity unit sequence is to make the experience smoother. That is, it is intended to find out how the customer acts without confusion when one function is over and the next function starts. On the other hand, the perspective of the axis of expectation activity PSS experience is about how long it takes the customer to use the PSS without a mistake or failure. This is considered usability in interaction design and touchpoint in service design.

In summary, the purpose of this model is to improve PSS design based on the relationship between expectation and experience; for instance, by the addition of new activity and rearrangement and removal of existing activity.

4.2 Two Perspectives: Momentary and Durational Perspectives

1) Momentary Perspective

The momentary perspective seeks tuning to close the gap between activity expectation and experience and to develop a new PSS design. It is reflected by the axis of the expectation activity PSS experience, and its aim is to examine from various aspects the improvement of the touchpoint. Design that is derived from the activity that the customer expects, such as signifiers, can be a good example. In short, this perspective is suggested to minimize the gap between activity expectation and experience (see Figure 13).

2) Durational Perspective

The durational perspective is proposed to design customer activity by adjusting the activity unit sequence.
Activity combination, breakdown, switching, and development of functions and designs that can be used simultaneously with other activities are included (see Figure 14). Considering action, interaction and touchpoints have been dealt with as crucial topics in PSS design. On the contrary, the link between activity units is not focused on, even though it is an important concept that can provide consistency between connected functions and adjust the order of the activities. Hence, the action type for linking activity units, action direction, and action range for consistency and connection need to be researched. In addition, the durational perspective needs to be further discussed to construct a smooth activity sequence.

4.3 Activity Reconfiguration Template

“The Value Curve,” introduced by Kim and Mauborgne (2010), is a good guide to investigate activity design from both the momentary and durational perspectives.

As Figure 15 shows, Eliminate-Reduce-Raise-Create (ERRC) is included in the process of the Value Curve. This research modified ERRC by unitizing customer activity and proposing a template for creation, elimination, and reconfiguration of the activity (see Figure 16).

In comparison with Kim and Mauborgne’s Value Curve, the creation of new activity and the elimination of useless activity are maintained, but the rise and reduction are combined under the title “reconfiguration” to integrate other concepts, such as redistribution of activity order and combination.

By using this template, various scenarios can be created and visualized by connection, reconfiguration, and elimination of activities, and finally the development of new PSS design is possible.

4.4 Steps for Activity-Driven PSS Design

An Activity-Driven PSS design method is proposed to make activities flow smoothly and to minimize the gap between expectation and experience. That is, the Activity-Driven PSS design concentrates on breaking down activities into basic units and elements and investigating the features and weight of activities. Consequently, it seeks to create a new activity design from both momentary and durational perspectives and to upgrade products and services which match in this new design.

As Figure 17 demonstrates briefly, this research presents a guideline for a new Activity-Driven PSS design. It consists of seven steps, as follows:

1) Unitizing Activity Unit and Element
It is necessary to examine the activity units and elements of using PSS. This step is to understand changes of activities based on customer characteristics. At the same time, the motions and actions that construct the activity are important and also have to be inspected carefully.

2) Unitizing Features of Activity
Since activity has various features, such as type, direction, and strength, and each affects the next activity, the features of the activity need to be unitized.

3) Identifying Activity Weight
Due to the difference in degrees of difficulty of the activities, the influence and weight of each activity need to be considered. In addition, the sequence, structure, time, and importance of the activities have an effect on the activity, so they also need to be considered important factors.
4) Creating a Momentary Perspective
The point of this research is to minimize the gap between expectation and experience related to the expectation-activity-PSS-experience axis. Therefore, the functions of products and services must become more convenient to improve touchpoints, and affordance has to be introduced by using a signifier.

5) Creating a Durational Perspective
This study focuses on the improvement of customer activity flow by applying the activity unit axis. Activity units are connected in a single flow and become a new PSS experience. For the creation of a seamless flow, the connectivity between activity units has to be strengthened, and each activity unit should be consistent. However, in the case of seeking fun and attracting customers’ attention, this strategy may not be used.

6) Upgrading the Product
Details on the properties of the product need to be updated consistently by monitoring customers’ activity experiences.

7) Upgrading the Service
By considering the properties of products and services together, business applying the PSS has to be established and upgraded.

5. CASE STUDY TO VERIFY VALIDITY
In order to evaluate the validity of the proposed PSS design method, the way customers use a self-checkout system was observed in a market. In addition, to find out detailed elements of customers’ experiences, expectations, and feelings, their preference and correlation analyses were examined. The gap between customers’ expectations and experiences was identified through this examination, and the feasibility of the Activity-Driven PSS design method was considered by measuring the significance of the momentary and durational perspectives.

5.1 Target Setup
A self-checkout system is a representative item of PSS: it is made by many products for the function of collecting payment when a customer checks out after his/her shopping: it should provide different services depending on the individual purchases of each customer. For instance, some shoppers want to make a payment by credit card but some do not. In these cases, personalized information is transferred to the credit card company online during payment. Since it is created to replace the role of the checkout staff and checkout counter, the customer self-payment system can be mentioned as the most distinctive feature.

The use of self-servicing machines has increased recently, so establishment of a new role for the PSS is required. For example, a large market in Korea is increasing the installation of self-checkout machines with the purpose of maximizing economic effects and satisfying customers’ needs. However, a large number of shoppers do not seem to prefer using self-checkout machines. This is the reason that this research chose the self-checkout system as a research object.
5.2 Time-based Observation of Activities of Self-Checkout Users

According to the observations and interviews, customers tend to expect convenient and simple activities, a short process, and clear induction of activities. They become confused about what to do when the previous function is over and the next function is starting. They also feel stress when they have to change the type or direction of activity unexpectedly. These kinds of trouble were related to activity time. Therefore, customers became embarrassed when it took longer than they expected or the operation of the machine failed. However, two types of time-consuming process were distinguished: repetition of activity and difficulty of operation. For instance, scanning barcodes was not complicated but took a long time due to the repetitive action.

Considering payment, it is made up of activities related to cards, membership point cards, cash, coupons, and receipts. The payment process was complex, as the types of activity were different from the expectations and the layout was irregular. Customers preferred a shorter activity sequence. That is, the activity sequence had a significant effect on the duration of time.

Figure 19 shows different timelines of customers.
Customer 2 took a longer time to make a payment. This person experienced a problem using coupons and a membership point card. On the other hand, customer 7 spent time operating the touch screen. Customers 2 and 7 were not familiar with the self-checkout system because this was their first experience using this machine.

Customer 11 had a problem with credit card recognition. Customer 5 had to ask staff for help because the barcode of an item was not reading, and customer 8 made a mistake in scanning. In short, payment and scanning barcodes were recognized as prominent activities, and this implies that the level of importance and difficulty is different for each activity.

5.3 Data Collection and Analyzing Data

1) Collecting Data

In this research, two surveys were conducted to collect data. The first survey was carried out from September 10, 2015, to October 15, 2015, and the total number of respondents was 75. The main purpose of this survey was to organize and categorize the value factors of shopping and expectations of using the self-checkout system. Based on the result of the first survey, ideas for improving the self-checkout service by applying an Activity-Driven PSS design method were extracted.

The second survey was done from October 27, 2015, to December 15, 2015. This survey included 134 persons, who can be grouped by age as follows: 36 persons under age 25, 30 between age 26 and 35, 28 between age 36 and 45, 20 between age 46 and 55, 12 between age 56 and 65, and 6 over 66. Among them, 49 (36.6%) were men and 85 (63.4%) were female.

This research used IBM SPSS Statistics Version 23 as the data analysis tool, and frequency, factors, and regression were analyzed.

2) Analysis of Expectation and Experience

According to the data analysis, the level of expectation and the experience were different, as was predicted. The crucial point was not the degree of customer experience, but the gap between expectation and experience. For instance, although the experience level of the location of the market was relatively high, it was shown to be much lower than the expectation. On the contrary, the experience of the interior design was higher than expected, despite its relatively low experience level (see Figure 20).

As a result of the factor analysis of expectations of visiting the market, it was identified that the expectation factors were divided into core services and sub services (see Table 1).

3) Analysis of Activity Experience

The experience of phased actions of using the self-checkout system is lower overall than the expectations. However, the experience of asking staff for help is particularly high, so it is analyzed that the staff’s service is very helpful when using the self-checkout system (see Figure 22).

A notable point is that customers confuse the types of actions when using self-checkout system. That is, they have difficulties in the process of the actions and the direction of the actions. In addition, they feel that the steps are too complicated and the number of the steps is too large (see Figure 23).
4) Analysis from the Momentary and Durational Perspectives

The factors of the activity experience of using the self-checkout system can be analyzed from both a momentary perspective and a durational perspective (see Figure 24).

As Figure 25 shows, confusion between the steps and mis-operation of the touch screen are the most concerning factors. Therefore, they must be discussed from the durational perspective.

In addition, considering ideas for improving the self-checkout service, the respondents prefer durational factors such as a simple use sequence and a scanner-attached shopping trolley that helps with using the self-checkout system rather than solving momentary problems (see Figure 26).
The ideas are analyzed as follows: first, from the durational perspective; second, from the momentary perspective; and lastly, from the perspective of using network technology. However, since using network technology is considered to have a low relationship with self-checkout system, it is not preferred. Therefore, it is excluded and the durational perspective and momentary perspective are identified as valid (see Table 3).

5) Findings and Discussion

To determine the correlation of the ideas for improving the self-checkout service from two perspectives, the results of factor analysis of expectations of the market and self-checkout were comprehensively researched. As a result, it was found that the expectations of incidental services are higher than those of core services of the market in terms of contribution to durational aspects. The contribution of rational expectations is also larger than the emotional expectation in the self-checkout system (see Table 4).

Considering the momentary aspect, the contribution of expectations of the non-core services of the self-checkout is high, which is no different from the durational aspect. However, the difference is that the emotional expectation is slightly higher (see Table 5).

To sum up, the concept of unitizing activity is identified as valid, and measuring the gap between the expectation and the experience of each action is significant. The expectation factors of shopping are divided into core factors and sub factors, and the expectation of self-checkout is analyzed from both the rational perspective and the emotional perspective. These two perspectives also have different effects on the ideas for improving the self-checkout. Hence, the Activity-Driven PSS design method can be adequately applied to emotional customer activity modeling of durational and momentary perspectives by understanding the expectations and experiences of activities.

6. CONCLUSION AND LIMITATION

In this study, an Activity-Driven PSS design method is proposed as a new integrated way to package functions to support products and services. And also, this method is suggested to determine problems of design through the relationship between the expectation and the experience of product design and service design from the aspect of user behavior.

Service is composed of activities, so products and services need to accord with customer behavior to create synergy between the product and the service. However, interaction and touchpoints have often been a research focus; on the contrary, the flow of activity in terms of a customer’s journey and the gap between expectation and experience have not been discussed actively.

In addition, in order to make the flow of activity smoother, the concept of activity unitizing is important due to its analog characteristics.

According to the survey, it is significant to measure the gap between the expectation and the experience of unitized activity. In addition, producing design ideas by dividing customers’ initial expectations into emotional and rational perspective based on the correlation of the momentary experience and durational experience is also crucial. Therefore, the Activity-Driven PSS design method is suggested based on how to design a sequence and context of activities by applying a unitizing concept, how to set up the scope of unitizing, and how to allocate elements of PSS.

Although deeper study based on the suggested design guidelines and other empirical processes needs to be accomplished, this method can be used as a new PSS Design Development Tool for application to emotional customer activity modeling. Therefore, this method can be considered a new approach that integrates expectation and experience.
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Eok KIM (Member)
Eok Kim is a Professor and chair of Design Department in Korea Polytechnic University. He is also a Ph.D. student of Industrial Design Department in Korea Advanced Institute of Science and Technology (KAIST). His interests are Kansei engineering and Product-Service System design.

Kun-Pyo LEE (Member)
Kun-Pyo Lee is a Professor and head of department of Industrial Design in Korea Advanced Institute of Science and Technology (KAIST). He also serves as president of IASDR (the International Association of Societies of Design Research). Lee was the executive vice president and head of the corporate design center for LG Electronics. His research interests include Human-Centered Design, User-Experience Design, and Design Methodology.

Ki-Young NAM (Non-member)
Dr. Ki-Young Nam is an Associate Professor of Industrial Design, Korea Advanced Institute of Science and Technology (KAIST). His research interests are in strategically integrating diverse design issues within and beyond the design process in corporate, social and political contexts, including strategic design innovation, service design, social innovation and design for public policies.