The combination of User Centered Design and Industrial design
-Balance between subjective and objective design

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***Abstract*—Traditional Industrial Design has been an important aspect in the New Product Development process within the last decades. User centered design is a growing research field for product innovation which needs support from both design knowledge and research methodologies. Both TID and UCD focus on user's perspective when doing multi-disciplinary work. They take care of style, usability, and balancing the users need and reality. The skills from TID help design expression and realization to communicate efficiently with other participants by informative images and real prototypes. The methods from UCD help the idea generation and opportunity discoveries by facilitating workshops and conducting interview with participants. TID and UCD represent different perspectives of the subjective and the objective respectively.**

Keywords-component; UCD; Industrial Design, Product development

I. INTRODUCTION

At the same time, the knowledge of UCD and Traditional Industrial Design (TID) gives a designer abundance of methodologies and skills to research, organize, create, reflect, design, and communicate. All the abilities are mixed together, which confuse a designer when choosing and applying the abilities in his arsenal, which can match any given situation. To get a better insight into how and where to apply the knowledge from UCD and TID we will describe and analyze the two fields, and present our case studies.

UCD and TID are necessary to an innovative project which known as a process of New Product Development (NPD). In this paper we will present our understanding and experience of using the methods and skills from UCD and TID in NPD projects. We will discuss the feedback and reflection from the customers and development groups. To figure out the role and contribution of UCD and TID, we list the following points that are fundamental of the incorporation between TID and UCD.

A. Innovation and dynamic

The innovativeness is one of the essential properties to a NPD project, and there is a trend to directly integrate customers in the development process and to enhance the aspect of multidisciplinary. [4] That developer has to do abundance of research and investigation on a new topic which few people are familiar with. This innovative property leads projects and has higher risk by lots of complex and uncertainty. [7] Mathiassen and Stage discussed this issue and propose to use experimental method to solve uncertainty and to use an analytical way to reduce complexity. [7] In his book, Larman suggested that to use agile and iterative method to plan and carry out an innovative project dynamically. [6] For solving uncertainty and complexity, UCD and TID provide the methodologeis of analytical and experimental respectively. And follow the principles of planning based on iterative process.

B. Multiple-disciplinary

In the NPD projects that we have participated in, there are mixed variety of disciplines, which include industrial design, mechanical design, marketing, electronics, software development and advertisement. They could be put in to three categories: Technical, Marketing, and Design. Comparing with the other two aspects, the most of our colleagues agree that the contribution of design is to guide projects and involve plenty of user's perspective and turn their needs to real and practical solutions. At the same time, for a more successful and meaningful product solution, the TID needs technical engineers to tell the realization possibilities and market specialist to evaluate the market scale. These points also fit the principles of UCD that needs to involve all project participants. When a project involves UCD, all members need basic training of UCD, and participate in the workshop together to generate ideas and make decisions.

C. Emotion and reason

User research contributes to the development of methods target at the identification and recognition of user needs and its use in the concepts generation. [10][9] This process leads

to a more considerable role of emotion aspects in the context of user behavior. There is thus a need for methods that acknowledge both reason and emotion in decision-making processes, and enable user to represent their emotions, feelings and experiences towards products. [10][8] TID has a fundamental theory that is product design should be a balance between emotion and reason. As the Bauhaus's slogan said "Art and Technology - a New Unity" [11] At this point UCD is a balance between user need and practical product. It is not only follow user's wishes, but find out the most practical and efficient design opportunity.

D. Reflection

The iterative process needs the reflection from phase to phase. Schön mentioned that the practitioner get reflection-in-action, and get reflection–on-action afterwards. [12] Especially to the designers, the reflection is a basic power for practitioner to undertake next action in a process. According to the context, developers need to change, choose, and even develop the right methodologies, to design an effective process or research, and to optimize the next process by reflecting on previous project. [5] The theory of TID includes design process and design methodology, which can be seen as a cycle and can evolve through the reflection. In this process, UCD collect the feedback from user in every step, it can be seen as a reflection-on-action from user. UCD give user a space and time to tell their dynamic feeling and experience in the process.

II. THE NECESSARY OF TID

A. TID provides creativity

From our previous projects, we feel that in a user-driven project, TID helps to define the direction of the project from the start of a project. [1] For not limit the possibility of the end product, it needs strong creativity and large space to imagine and to make connection between design materials. [2][3] Even in a technical driven project, TID provide creativity to help developer escape from the limitation by focusing on the final goal and by thinking about alternative solution.

The basic purpose of applying TID is to execute a design solution by using a specific approach for realization. But the effect of TID can be larger and influence the whole process and project direction. Especially, when development team meets an abstruse problem or an accidental matter, the way of design thinking could avoid going on the difficult way. From design perspective, industrial designers could foresee the degree of difficulty and the level of meaning of the product definition. They also always provide several design concepts as backup solution to reduce the risk of a 'one way' plan.

B. TID connects concept to actuality

From our experience, there are two typical scenarios in the design process that leads to low user satisfaction. One of the scenarios is a clients'-driven process: At the beginning of a design project, the clients define the concept of the product, and they require the designer to work out and realize the concluded product form and function. Then they control any changes of the design concept through the whole project, and insist on their feeling and vision for the product. The clients may collect users' and customers' thought, and turn part of their ideas into the design concept. However the problem is many of this kind of clients normally accept less advice from designers and develop teams. Because they feel the user research and marketing investigation are enough to define the product concept.

To deal with the issue in this scenario, TID is aiming to balance the emotion and reason, and bridging user and technology. In practice, an industrial designer at least needs to work with a mechanical designer. They discuss the possibility of form and style, and feed into some new and useful function. Industrial designers are not end users, but they think from the users' perspective. Mechanical designers are not manufactures, but they carry out engineering files that can be produced directly. These two roles reduce the gap between the user and the product. But there must be some fall between user's imaginary and technology limitation.

III. INDUCTING UCD

A. UCD and participatory innovation

Another scenario is the developer-driven process: In this case developer-driven means a closed development environment which developers accept less advice from clients, users, and customers. Some of these kinds of projects start by the clients who define the design concept, and in the later stages, developer group decides the design decision. The final result may still be in the range of the project specification but it reduces or has a lower users' satisfaction.

Because the NPD process is a cooperation of multiple-disciplines, it needs some knowledge and methods to balance different inputs that are originated from multiple-disciplinary knowledge and real-life experience. Basically there is three groups giving the inputs: the clients, the developer, and the user. Each of the groups has their own vision to the design. Some are clear and some are vague. We should respect these design visions, considerate them together to balance these input.

To facilitate the balance, the developers need to get the training to study and to practice this balance in design process. Participatory Design and UCD involve all stakeholders into the project, and make them speak out their feeling and suggestion, and allow them participate into the decision making process. It is a process management method and system to ensure the development cycle is healthy and balanced.

B. *UCD is a dynamic reflection*

Normally, in a NPD process, UCD is aiming for the step that just before TID. To compare with TID, UCD is focusing more on field investigation, user research, user reflection, organizing participants, and the management of development process. Depending on context of each project, the developer needs to make a niche targeting plan, to design the process, and to choose the methodology for user research. Especially in the later iterative step in the process cycle that got a turn of user's feedback, UCD facilitator needs to adjust method or redesign the UCD plan, which forms a dynamic process. This feature make UCD follow the theory that reflection on action, which fit the needs of NPD and will improve its quality.

IV. SUBJECTIVE AND OBJECTIVE IN NPD

A. *TID and the subjective*

NPD is a process that needs to combine both subjective thinking and objective thinking. To fulfill the goal of NPD project, the research of market trend and target users' context will tell you the design opportunity and guide the project direction. The investigation of current practical technology, which is available on the market, will put the project practical and cut impossible ideas or give more space to new ideas.

Based on the research and the investigation, TID has ability to translate users' expectation to a design concept, and has ability to know and study the application and integration of a technology to a project goal. After the analysis of objective information, TID undertake a subjective design behavior to create and build design concept to surprise user, and improve user experience.

B. *UCD and the objective*

However the subjective design behavior is not the exclusive and only step for designing concept. UCD is also taking charge of the integration of the users' and participants' ideas into a product by objective methodologies and principles. NPD process is not a process to create an artwork. The developer should not just follow the feeling and flow of artistic and subjective expression. There is risk if only follow the subjective thinking, because a basic part of the knowledge and education in TID has come from the art field. To an industrial designer, the type of ideation and the way of solving problems follow the principle that combing the emotional and rational ways. Depends on scenarios, topic, and issues the industrial designer could choose either a user-based or tech-based principle to make the product have a particular feature. A designer can also explore value from artistic perspective or from functional perspective to increase the competency of the final product.

C. *Uncertainty and complexity*

Furthermore, as we mentioned in the beginning, NPD is a highly innovative process that includes mass uncertainty and complexity. As Mathiassen analyzed, this two issues are mixed together and they needs experimental method and analytical method respectively to solve. [7] But when people solve them, the countermeasure for each one would increase the issue for another. Plenty of research and analysis would be helpful for complexity issues, and a variety of experiments and prototypes would take valuable knowledge for the unpredictable issues. [7]

UCD takes analytical method into this process of problem solving with objective perspective. It performs subjective research and investigation to collect information for later analysis that includes both qualitative and quantitative method. This work resolves complex issues in to small segments, and puts them into clear category, and then carries out a framework to put segments into it. This framework works as a plan but not too detailed, because it can be adjust in later iteration dynamically.

TID takes experimental method into the process of problem solving with subjective attitude. It undertakes objective creation by reflection in action to produce design concept for later experimental by prototype test. This work deals with uncertainty issues by trying some ideas and concepts, of which the method includes suppose, inference, and establish connection. Then designer gives evaluation, and test to these concepts to reduce the uncertainty and filter out the possible directions. This is a subjective process through an individual design action.

To demonstrate how we apply these knowledge and analysis in real project we will show a real project in the next part.

V. CASE STUDY:USER SYSTEM DESIGN

To practice the reflection and analysis we got from above chapter, we tried to combine user centered design and traditional industrial design in a balanced way for our projects. One of our projects is to design an electronic ticket for Denmark train bureau (DSB). Possessing knowledge and skills of UCD and TID, our design principle can be exended to a system level. To design an electronic ticket is not foucs on the ticket itself, but think and plan through the whole train system.

I undertook a User System Design project in a design team setting for a company called Focon, which is a company developing electronic devices for trains. The goal of the project was to analyze and design a series of products that would help the train journey of the general train traveler. We separated our team in two groups, one was the 'outside group' that was working with the user, and the other was the 'inside group' working on organization research at Focon. I was in the 'outside group' with another product designer, a

modern language graduate, an engineer and a communication designer. We set a frame for the user study. We defined three categories for our research: the train, the ticket, and train station. Because we believed they were the three basic steps the user needs to go through on a train travel. From my personal experience as a train traveler I had a bad memory from a train station, which I will talk about later in the paper, while others my have problems with a confusing ticket or got on the wrong train. The team used different methods to do the user study, including a questionnaire, interviews, and video shadowing method. We got rich user study materials in different formats, with all the team members participating in a workshop to analysis the material, and finding out the appropriate design opportunities. The analysis methods included the use of A-frames, which is a frame for putting keywords, main story, and a photo on a folded paper [19]. Personas (see figure 3) that are basically making fictional characters based on the true feedback from a user study, they are not real people but give insight into a real users life or problems [20]. Another analyses method used was so called Story cards, which asks the participants to read a story of a card and write down their feelings on the piece of card. Participants exchange cards therefore giving their feedback based on the feedback on the cards given by former readers. The thinking process within our group got deeper and deeper. After the analysis workshop we turned to a brainstorming session. The previous analysis outcome showed us the most interesting converging points of the user study

Figure 3 — An example of one of our Personas

During the brainstorming session, we keeps you confident got many ideas and wrote them visibly on the wall (see figure 4). One is my train late? Could I still get a coffee? Did they change the platform again? Is this my wagon? Of the designers drew a series of scenarios to help the team think how the ideas would work in a real situation. After we had gone through a filtering face, where ideas were dropped due to certain criteria's, such as too expensive, too futuristic or not within Focon's interest we started an election for the remaining ideas. During the idea election, the engineer worked as a leader and all other participants voted for the ideas. Finally we thought an e-ticket design (see figure 5) is our strongest solution and the most efficient. I and another designer made the draft sketches together and got feedback the other participants.

Figure 4 – Our ideas written on the glass wall.

At the end of this project, we had an exhibition, which we invited some users, among them experts of UCD and the people from Focon. Some of the feedback included that the users hoped that the ticket would be more colorful, and they wanted to interact with the ticket. The UCD experts questioned our process and methodology as they argued it was not objective. And the people from Focon thought our idea was simply too imaginary and the research was hard to facilitate in the real development for now. This case is a practice of combination of UCD and TID.

This combination provides a possibility of think through the whole train service system. Subjective and objective thinking support developer to get a boarder overview and to put their work on user's real scenario.

VI. Conclusion

As an industrial designer and a user centered designer, we are clear about our capability and competency in a NPD project. Basically industrial design grants us design expression skills that include sketching, concept prototyping, concept generation, 2D drawing, and 3D modeling. User-centered design grants us the abilities of

interviewing, qualitative and quantitative researching, and organizing meetings and workshops.

Figure 5 -Conceptual poster of the E-card design

Whatever kind of work designers get, these skills and abilities provide designers strong competences. In many situations, an active designer needs to have the ability to handle a dialogue to present reasonable methods or express ideas by sketching fast and directly. These skills work as designers' second nature after they got them.

Whenever we reflect on methodologies and principles of TID and UCD, we can see the differences are subjective and objective. TID makes design concept from the designer himself directly. UCD collects the user's innovation and creation directly, and turn it into design concept. TID will provide the surprise and amazement to the users when they using the product. And that is contributed by designer's subjective creativeness. UCD will provide the facts of users' expectation and improve users' satisfaction. And that is contributed by user's objective feedback.

TID and UCD take charge of different balances. TID balances the art and technology, style and function, user expectations and reality in a subjective perspective. UCD balances the inputs from all stakeholders and participants, and balances between the reliable plan and dynamic changes, and designer's vision and user's vision. These balances could make up the obvious failure in a product.

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