Industrial designers and engineering designers; causes of conflicts, resolving strategies, and perceived image of each other

KwanMyung Kim, School of Design and Human Engineering, UNIST
Kun-pyo Lee, Industrial Design Department, KAIST

Abstract

What causes the conflicts between industrial designers and engineering designers? How do they resolve these conflicts? Furthermore, what viewpoint does each group form toward the other from their dynamic interaction? This study explores a consumer product company to answer these questions. Three industrial designers and three engineering designers working on the same product development were interviewed. As a result, this paper presents the causes of conflicts, conflict resolution strategies, and perceived image of each group. Two types of conflict causes, direct causes and basic causes, are reported. The direct causes are related to tasks in the design process, and the basic causes are structural, underlying the direct causes. The strategies to resolve the causes are also identified. Engineering designers appear to use ‘persuading’ strategy more. It seems that engineering designers prefer to ‘yield’ strategy in most cases and industrial designers use ‘insisting’ strategy more. Each group’s perceived image to the other group has also been investigated. Industrial designers view engineering designers as uncreative, conservative and unadventurous. Engineering designers say industrial designers are inflexible, acquisitive, bossy, and dismissive. Finally, a better way of collaborating between the two groups is discussed, and future research directions are proposed.

Keywords

Industrial design; engineering design; conflict; resolution strategy; perceived image

What causes the conflicts between industrial designers and engineering designers? How do they resolve these conflicts? Furthermore, what viewpoint does each group form toward the other from their dynamic interaction? These are interesting and important issues, because the two kinds of experts are core elements in a product development team (Roozenburg & Eekels, 1995; Ulrich & Eppinger, 2012). Some researchers have explored the types of problems and conflicts inherent in the interdisciplinary work of industrial designers and engineering designers (Pei, 2009; Persson, 2005; Saucken, Schroer & Lindemann, 2011). Problems raised between them are caused by the differences between these two groups and conflicts in value and principles. The industrial designers’ role is developing the outside shape and interface of a product, enhancing user experience (Ulrich & Eppinger, 2012). Their knowledge and skills are oriented in aesthetics and ergonomics (Eder, 2012; Pahl, Wallace & Blessing, 2007). In contrast, engineering designers work on implementation of the concept which industrial designers developed (Persson & Warell, 2003), focusing on functionality, reliability, and manufacturing (Pahl et al., 2007; Hubka & Eder, 1996). Their different working principles and styles, resulting from education differences, seem to cause problematic situations in communication and collaboration. The different representation methods in the design process also cause conflict situations, preventing smooth, cooperative teamwork (Pei, 2009).

Conflict among groups and in inter-personal relationships have been studied a lot in the management and psychology fields (Thomas, 1992). Group conflicts are generally
categorized into relationship, task, and process conflicts that result from interpersonal incompatibilities, different viewpoints, and disagreement between groups (Jehn & Mannix, 2001). According to taxonomy in conflicts, uncooperative and cooperative dimensions are identified in conflict handling which are again sub-categorized into avoiding, competing, compromising, collaborating, and accommodating (Kilmann & Thomas, 1977).

Research related to conflicts or collaboration in product design and development has been performed toward establishing efficiency among product development teams. An effective communication tool for industrial designers and engineering designers through sharing the way of visual representation was developed (Pei, Campbell & Evans, 2009), and methods for better communication between the two groups have been proposed (Persson & Warel, 2003). Also, an integrated and collaborative design process with industrial design and engineering design at the school level was tested by harmonizing and balancing their different characteristics and aspects through product design phases (Hosnedl, Sr & Dvorak, 2008). As such the importance of collaborative works has been emphasized, and research has dealt more with curing the symptoms rather than understanding the phenomenon itself. This seems to be especially true when we think about industrial design and engineering design in a whole product design context.

The causes of conflicts between industrial designers and engineering designers are not well known, even though it is generally acknowledged that the two groups are deeply divided. Little knowledge has been collected empirically about what causes conflicts beyond the explanation of difference in education and working style. For this study, it was assumed that particular aspects in the design process, more than just group differences, probably led to structural conflicts. The rationale behind this assumption is that the two groups take different roles with different working styles toward one target in a certain procedural working flow, which may accordingly cause unavoidable tension between them. With this concept, the causes of conflicts and resolving strategies they adopted were explored. Evidence specified in a product design context was collected, which describes the conflicts and the designers’ resolving behaviors. Moreover, each group’s viewpoint toward the other party was investigated by describing their characteristics. It was assumed that a particular perceived image toward the other group would be formed through the inter-dynamics between them experiencing collaboration and conflicts.

For the last two years the inter-dynamics between the two expert groups of six companies have been explored with qualitative research methods. The large amount of transcribed data is currently being analyzing. This paper reports a small part of the findings from the recently analyzed results of one company, focusing on conflicts, conflict handling strategies, and perceived image of the other group. In-depth interviews were conducted with three industrial designers and three engineering designers who worked closely together on a product development team, and the transcribed interview data was analyzed. Coding schemes were used with causes of conflicts, resolution strategies, and perceived image of the other party.

The following section discusses the nature and the relationship of industrial design and engineering design. After that, the research method section provides detail procedures for the in-depth interview and coding method, which are followed by analysis and results. As the result of the study, we will discuss a better way of collaborating between the two design groups.

1. Industrial Design and Engineering Design

Industrial design originated from art, and engineering design from mechanical design. Industrial designers and engineering designers are frequently described as product designers. Some researchers describe product design as engineering design (Haik & Shahin, 2010; Pugh & Clauing, 1996), others view it as industrial design (Lorenz, 1986;
Tjalve, 1979), and others use it to mean product development itself (Roozenburg & Eekels, 1995; Ulrich & Eppinger, 2012). Generally, product design can be viewed as the area where industrial designers and engineering designers work together in the product development process.

The role of engineering designers in product design is to solve technical problems of product functionality with technical factors (Pahl et al., 2007; Hubka & Eder, 1996). They focus on the functional performance of a product, integrating and testing components. As product development team members, they arrange functional components inside of a product, which is called ‘layout design’ (Ulrich & Eppinger, 2012).

Industrial designers are often viewed as experts on aesthetics and ergonomics in product design. They are known to have sensitive minds that can develop subtle emotional feeling for a product. Thus, their role is aligned in improving the user’s experience around the product (Ulrich & Eppinger, 2012). In this way, they serve as a creator of the meaning of the product for the user from a personal and even social perspective.

The product design process is slightly different from the industrial design and engineering design perspectives. Engineering design describes it as the iterative process in which form is determined by layout design (Ullman, 2009; Haik & Shahin, 2010; Pahl et al., 2007; Dym, 1994). This matches with the old statement that ‘form follows function’, which in engineering design is called inside-out approach, while the industrial designers’ design approach is described as outside-in (Hubka & Eder, 1996; Pahl et al., 2007). This implies that the possibility of structural conflicts arises from different design approaches and the need to reach a consensus through negotiation.

In this overall perspective, then, it can be assumed that their values on product design may overlap and the extent of their roles will be adjusted in the design process according to product types. Designing industrial equipment requires more engineering function, while designing crafted objects needs a more industrial design function. Nowadays, under severe global competition, consumer products require a significant contribution from both industrial designers and engineering designers (Cross & Cross, 2000). A product which functions well but is ugly, or which is stylish but not well engineered, will not survive in the market. Comparing a technology-driven product design situation where the industrial designers’ role is limited to the packaging of the product, market-driven consumer products are developed through industrial designers’ substantial involvement throughout the design process (Ulrich & Eppinger, 2012). With this regard, a consumer product development situation was investigated to explore the designers’ interactions in a real world context.

2. Research approach

Empirical design research in an industrial context generally employs research methods from social science which are commonly known as observation, interview, and document analysis (Ahmed, 2007). To investigate conflicts, resolution strategies and perceived image of each other, data needed to be collected throughout the product development process. The observation method is not appropriate and feasible in this sense, as researchers could not observe multiple designers and design activities for a long period of time in a company context. In contrast, interviews are beneficial to explore cases and to collect explicit knowledge that participants are able to articulate (Ahmed, 2007). A company was selected for a case study, and three industrial designers and three engineering designers working on the same product development team were interviewed to study their perceived views and knowledge about processes.
2.1 Selection of a case
A case was selected with a criterion-based selection method (Merriam, 1998). The selection criteria were 1) a company producing mid-complex engineered consumer products with its own brand, 2) a company with independent industrial design and engineering design departments, and 3) a medium size company was preferable to a large company, because the latter tends to generally have several functionally specified organizations even within a design department. The first criterion was set to search for a company where industrial design and engineering design have balanced functions. The complexity of the product was also carefully considered. If a product is too complex, like a car, the engineering function would surely overwhelm the industrial design. Thus it was thought that the type of company would determine the two experts' roles and functions.

The top brand consumer product companies in Korea were listed, and contacted through phone calls. One company accepted being a case. The company is a producer of home appliances including water purifiers, humidifiers, and so on. They have been a market leader in Korea. The company has separate industrial and engineering design teams. In terms of size, it has about 200 office workers including marketing, design, R&D and so on, and around 2,000 employees including manufacturing labor. The product design team has 20 industrial designers and the R&D center has about 150 engineers and engineering designers, including mechanical, electrical, and test engineers, purchasing specialists, and so on. The industrial design team and engineering design team are located at different facilities within 30 minutes distance by car.

2.2 In-depth interviews
Three industrial designers and three engineering designers were recruited as interviewees. All had at least 3 years of work experience in their field (Table 1).

<table>
<thead>
<tr>
<th>Industrial designers</th>
<th>Work experience (years)</th>
<th>Interview time (minutes)</th>
<th>Engineering designers</th>
<th>Work experience (years)</th>
<th>Interview time (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID-1</td>
<td>9</td>
<td>73</td>
<td>ED-1</td>
<td>11</td>
<td>80</td>
</tr>
<tr>
<td>ID-2</td>
<td>10</td>
<td>84</td>
<td>ED-2</td>
<td>9</td>
<td>81</td>
</tr>
<tr>
<td>ID-3</td>
<td>8</td>
<td>73</td>
<td>ED-3</td>
<td>3</td>
<td>75</td>
</tr>
</tbody>
</table>

Table 1. Information about the Interviewees

The interviews were conducted in calm meeting rooms in the company. A semi-structured interview method was used, in which the interviewer asked situated questions based on an interviewee’s response to a few main questions (Seidman, 2012; Ahmed, 2007). The framed questions were 1) what is your experience in the product design process, 2) what is your role in it, 3) what conflicts did you have with industrial designers or engineering designers and how did you solve them, and 4) what would be an ideal product design process in your mind. Other open questions were asked during the interview focusing on their interaction with the other partners. All dialogues were audio-recorded and transcribed afterward. The average interview time was 77 minutes (see Table 1).
2.3 Coding and Analysis

A coding scheme was developed based on the research questions. The coding categories are ‘causes of conflicts’, ‘conflict resolution strategy’ and ‘perceived image’. The transcribed data was read through several times before the first level coding started. It was performed by picking up matching sentences or phrases with the definitions of the coding schemes from transcribed data. All related text references were collected into the three code categories, and then the collected references within each category were sub-categorized. For example, subject ED-2’s mention of “at first, I attempted to persuade them to some extent. Talking a lot to convince them.” is coded into ‘conflict resolution strategy’ and again sub-categorized into ‘persuading’. Some coding references have lengthier words than others because meaningful words were picked-up rather than coding line-by-line. To achieve intra-coder reliability, we used a test-retest method by re-coding three months after the first coding (Leedy & Ormrod, 2012).

3. Results

There are 145 coding references collected for all code categories; 70 from the industrial designers’ interview data, and 75 from the engineering designers’. Among them, 85 references fall into ‘causes of conflicts’, 41 are ‘resolution strategy’, and 20 are from ‘perceived image’ (see Table 2). Each code has sub-code categories.

The following sections describe the details of each code.

<table>
<thead>
<tr>
<th>Code category</th>
<th>ID</th>
<th>ED</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes of conflicts</td>
<td>43</td>
<td>42</td>
<td>85</td>
</tr>
<tr>
<td>Resolution strategy</td>
<td>17</td>
<td>23</td>
<td>41</td>
</tr>
<tr>
<td>Perceived image</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>70</td>
<td>75</td>
<td>145</td>
</tr>
</tbody>
</table>

Table 2. Coding results

3.1 Causes of conflicts

There are basically two types of causes of conflict between industrial designers and engineering designers. Direct causes are factors directly related to the tasks that the two experts cover together. Thus all of them come from the design process. Basic causes are ones which underlie the direct causes. They seem to exist structurally through the organization structure, management style, and nature of design process. There are more direct causes than basic causes. Industrial designers identified more direct causes while engineering designers did more basic causes (see Table 3).

<table>
<thead>
<tr>
<th>Code category</th>
<th>ID</th>
<th>ED</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Causes of Conflicts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Direct causes</td>
<td>36</td>
<td>14</td>
<td>50</td>
</tr>
<tr>
<td>Basic causes</td>
<td>7</td>
<td>28</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>43</td>
<td>42</td>
<td>85</td>
</tr>
</tbody>
</table>

Table 3. Coding results in ‘causes of conflicts’
**Direct causes of conflicts**

The direct causes of conflicts are categorized into six groups (see Figure 1): schedule, material cost, quality, specification, concept change, and design change by engineering designers. These are all directly related to aspects of the design process. Interestingly, industrial designers provide more information in this category, which implies that they are more sensitive to those factors.

![Figure 1. Coding results in 'direct causes of conflicts' (left) and comparison of them (right)](image)

**Schedule:** The conflict situations related to schedule can be summarized by two situations. The first situation is when the designers are pressed to meet a launching time while they are struggling with their own task. Many conflicts happen because the preceding team spent more time than that given to it, which consequently squeezes the following team’s time to meet the fixed deadline. It seems that industrial designers and engineering designers meet this kind of situation frequently in the design process, and they push each other to hurry to accomplish the task so that they can secure more time. The second situation happens when engineering designers could not develop functional performance because of a tight schedule. Engineering designers said they didn’t have enough time to review and test their ideas, and accordingly could not try to implement a novel concept even when industrial designers proposed it.

**Material cost:** There is a fixed ‘target material cost’ in a specification document when a design project starts. Both industrial designers and engineering designers feel that the target material cost is too low, and it doesn’t count in costs related to industrial design at the starting point. The teams are continuously pressed to decrease material cost and to increase quality beyond that of competitors. The final material cost after completing the design phases generally increases from the initial target cost. Engineering designers frequently blame industrial designers for that, but industrial designers complain that the material cost related to industrial design, such as surface finishing, glossy coating, and so on, is not counted from the beginning. From a holistic point of view, engineering designers want to keep the target material cost constant, while industrial designers want to have a showy surface, thereby increasing the cost.

**Quality:** There are disputes to secure the aesthetic quality by the industrial designers and the performance quality by the engineering designers. Most disputable quality issues are related to manufacturing methods. They are also connected to issues in ‘schedule’ and ‘material cost.’ Looking at the details, industrial designers usually want to apply an exotic or glossy color to the product surface to enhance the aesthetics, but engineering
designers want to use the material’s own color, in order to keep to the target material cost. Even requests to change the material's own color by industrial designers after making molds often requires manufacturing new molds, because there may be a physical property change of the material with the color change. These all lead to large problems between the two groups.

Sometimes, engineering designers change the shape of an outer part for manufacturability, which creates the wrong aesthetic. When engineering designers anticipate that the product could not pass the reliability test with new shape requested by industrial designers, a problematic situation occurs. In order to avoid failing the test, they need more time to review the industrial design concept. However, in reality, time is limited and that leads them to give up the aesthetic concept.

Specification: Interestingly, references in this category are only found in the industrial designers’ data. Conflicts over specifications usually occur in the concept design phase where industrial designers are mainly involved. When a design project starts, the engineering design team sends an undetailed, preliminary layout to the industrial designers, which is 2D or 3D CAD data containing the arrangement of the internal components, without the exact specifications. With this rough direction, engineering designers leave a relatively spacious envelope to avoid future problems. When industrial designers check the data at first, they feel that the overall size can be more compact by narrowing down the inside space. However for the engineering designers’ perspective this could yield a critical failure situation later in the detail design phase, for example, if the outside envelope defined by the industrial designers could not accommodate all inside components, or the product could not pass the test. Let’s look at a reference below.

ID-2: “originally 1mm is better. But, 0.5mm has no problems and 1mm is just safer for them. Then, they decided it has to be 1mm. but we want to have it 0.5mm…”

Their tug-of-war handling of this situation occurs in the very first phase, because part of the industrial designers’ role is determining the size of the product to be designed.

‘Concept change’ and ‘design change by ED’: The last two categories, with a small number of references, are ‘concept change’ and ‘design change by ED’. Very rarely, a design concept defined by the marketing team at the starting point of the product development project is revised in the middle of the design process, reflecting the fast-changing market. Even with a trivial change, both experts are asked to change some parts within a limited time, which definitely creates tensions between them.

The last issue raised by an industrial designer, ‘design change by ED’, is the case where engineering designers change the outer shape after approving it through the design mock-up evaluation event. This means that engineering designers didn’t check the design mock-up thoroughly at the event, or unanticipated factors came into the in-detail design process.

Basic causes of conflicts
This category describes basic and structural causes behind the direct conflicts. They give insight about why the two groups cannot help doing things in particular ways, for example, why they conflict with the ‘schedule’ issue. We collected more references from the engineering designers’ data in this category (Table 4). This implies that engineering designers feel more systematic problems than direct problems on tasks.

- Basic causes indicated by industrial designers

Responsibility and evaluation: Industrial designers have their own interpretation about why engineering designers are not pursuing new concepts, and why they frequently say ‘no’ for this and that. The company evaluates each person’s performance every year.
<table>
<thead>
<tr>
<th>ID/ED</th>
<th>Category</th>
<th># of Coding reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Responsibility and evaluation</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Disposition difference</td>
<td>2</td>
</tr>
<tr>
<td>ED</td>
<td>Uncompleted layout and specification</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Industrial designer’s lack of knowledge</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Difference in core value</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Difference in working style</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Responsibility and evaluation</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4. Coding results in ‘basic causes of conflicts’

If engineering designers go over time implementing a design concept developed by industrial designers, this gives rise to bad effects for them in their evaluation. This seems to make them select the safer, more conservative options.

Disposition difference: Industrial designers mentioned that the two groups had basically different inclinations. Industrial designers pursue new ideas despite the risks, while engineering designers want to go the safer route.

- **Basic causes indicated by engineering designers**

  **Uncompleted layout and specification:** The number of references in this category is outstanding. Industrial design starts by receiving an incomplete preliminary layout. While industrial designers develop an outside shape with the layout, engineering designers also develop it to the final layout through detailing product specifications. For industrial designers, the preliminary layout is the reference for developing the outer shape, but when they finish their job, the reference has been updated by the engineering designers, which produces a problematic situation if the two groups don’t work closely, interactively, and continuously during this phase. The product design process is described as the development of form and layout iteratively (Pahl et al., 2007). Thus, the conflicts occurring in this category may be inherent in the process. They can be managed, but not removed in the current design process.

  **Industrial designer’s lack of knowledge:** Engineering designers mention that industrial designers are less knowledgeable about implementing the design concepts they developed. Few industrial designers know about construction structure, manufacturing methods, mold structure, and so on, as these are up to engineering designers. In this context, industrial designers can often seem to harass the engineering designers to do things that can’t be done. The following references show the evidence.

  **ED-3:** “then, we spend several days, the draft problem, which occurred last time. Needed this type of container, the unmatched draft makes this part thickened on the upper side. I told him this is difficult. The designer asked me ‘why it is difficult, do it as it is, you can do it’. Wasted more than one week persuading him.

  **The difference of core values:** Industrial designers stress on aesthetics values and the engineering focus on function and performance, which determine their ways of designing. Industrial designers use an outside-in approach, while engineering designers adopt an inside-out approach (Hubka & Eder, 1996). They clash at certain overlapped areas.

  **The difference of working style:** Industrial designers rely on their feelings and senses. Engineering designers work with dimensions and tolerance. When engineering designers receive 3D data containing an outer shape, some dimensions appear incomprehensible or
useless to their eyes. Industrial designers don’t allow any modifications of the dimensions without their permission, even in a tiny change that could not be recognizable physically.

Responsibility and evaluation: Only one reference was collected. It seems that engineering designers are not very sensitive to this issue considering the fact that industrial designers mentioned more about it.

3.2 Resolution Strategy

Five categories were developed to determine how industrial designers and engineering designers resolve conflict situations. They seem to be linked to stages. For example, they first start with persuasion of the other party, insisting on their opinion if it is important to them. Next, they go to negotiation. If this fails, they dump the issue on the boss or the CEO. This is different from the general model of conflict handling strategy (Thomas, 1992) that doesn’t describe an inter-relationship among the strategies. This is also interesting, because it appears to reflect the characteristics of the design process that is either iterative and linear, or spiral (Roozenburg & Cross, 1991).

Regarding the total number of references, both are similar. In detail, engineering designers mention more ‘persuading’, whereas industrial designers mention ‘insisting’ more. This doesn’t directly mean that engineering designers use the persuading approach more often or that industrial designers insist more in conflict situations. However, they give insight into how the two groups perceive their approaches. With the contents of the coding references, it was concluded that engineering designers attempt more persuasion and compromising, and industrial designers are more likely to use an insisting approach (see Figure 2).

The detailed investigation is described below.

<table>
<thead>
<tr>
<th>Persuading</th>
<th>Insisting</th>
<th>Compromising</th>
<th>Handing on to CEO</th>
<th>Handing on to team boss</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>ED</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>8</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

Figure 2. Coding results in ‘conflict resolution strategy’ (left) and comparison of them (right)

Persuading: When the two groups clash with different ideas, they attempt to convince the other. They frequently employ CAD data, design artifacts, exemplary cases, and prototypes to support their argument.

ID-2: “The spec. came to me in a huge size. I just cannot accept this huge size. No matter what I told them, they said it was the minimum. So, I made a dummy model cutting soft

ID-2: “The spec. came to me in a huge size. I just cannot accept this huge size. No matter what I told them, they said it was the minimum. So, I made a dummy model cutting soft
material. It took three or four days. Three or four days are very critical in the design period. Nevertheless I had to do so to show it to them.”

ED-2: “At first, I tried to meet the designers’ requests. When we cannot agree anymore, we show a few alternative cases. Ask them to select one saying ‘I cannot do anymore’.”

Insisting: Sometimes industrial designers and engineering designers confront each other. Industrial designers report more cases of this, which seems to reflect their disposition for handling subjective and emotional matters.

ID-3: “the extruded feature would be better if it goes around in this way, but this is short and this is long in a tilted and rhombus shape. That was really wrong. So I said, ‘No, this is not the case’. But he said that was the only solution. ‘I cannot accept this, I cannot move forward at all’. Eventually they developed a new module.”

In the above situation, the designer could not logically describe why the shape was wrong. Moreover, there was no functional problem. When industrial designers handle conflicts related to aesthetic value, they seem to use this approach. On the other hand, engineering designers employ this strategy when they anticipate unavoidable failure in function.

ED-2: “When we anticipate that we cannot achieve the functional performance, we press them to choose either stopping the project or accepting our idea.”

Compromising: Engineering designers produced overwhelmingly more references in this category. They are summarized as ‘yield’ and ‘give and take.’ Most references are in ‘yield’ (8 out 9), implying that engineering designers tend to accept the industrial designers’ stance as far as possible at the end. ‘Give and take’ has only two references; one from each side, so this seems to be the last strategy that they take.

ED-2: “at first, I attempt to persuade, talk as much as possible to convince them. They say there is a stressing point on a design. The designer doesn’t give up that point. We talk to a certain extent but if nothing is resolved, we moved forward to change our part in many cases.”

References from ‘Give and take:

ED-3: “sending section drawings and screen capture images, then designers say ‘it won’t work’ ‘too extruded’. In this way, after coming and going around, we make a compromise. ‘I will do this for you if you do that for me’.”

ID-3: “as the product is mechanical inside, the designed shape could be changed by the spec. Then, the designer goes to see what’s happening. At the meeting, ‘this should be extruded in this way, how could we do that?’ said the engineer. There could be several cases when the mechanical part cannot be changed; because of fixed schedule, because of common parts. Then, I have to negotiate reluctantly to some extent taking another from them, like, if I give you this, you give me that.”

The Give & Take strategy seems to be the last one that the two experts can take by themselves.

Handing on to CEO: When industrial designers and engineering designers fail to persuade or compromise, or when the issue is important enough to be reported to top management, they throw the issue to the CEO to judge. Both groups adopt this approach at a similar level. It is interesting that the CEO is used for handling conflicts, because studies from other disciplines don’t report this type of intervention (Ock & Han, 2003; Kilmann & Thomas, 1977). This may be because the product design context has more interactive and procedural relationships between the two groups than other construction projects or inter-personal relations, even though the two groups are commonly separated by function.

This approach takes relatively longer time than normal cases. However, they can acquire legitimacy and authority from the CEO’s decision, and they can be free from responsibility.
The last one, ‘handing on to the team boss’, has only one reference. Analysis of the other companies’ data is needed to see more rigid evidence, because it is estimated that project managers spend at least 20% of their times resolving conflicts and dealing with the consequences (Pinto & Kharbanda, 1995).

3.3 Perceived image to the other party

Each group has negative feelings about the other. Industrial designers think engineering designers are not creative and also are conservative and unadventurous. Industrial designers hear “impossible” from engineering designers, when they propose a new concept to them. They think engineering designers can do more. Regarding creativity, industrial designers said that engineering designers always want to keep the same assembly structure and use similar technology.

ID-3: “As they are not creative as I told you before, they always think rectangular developing inside component module and always use screws for fastening. Screws are the simplest way, no need to think out details further …”

The engineering designer’s image of industrial designers reflects what they meet in conflict situations. They say industrial designers are inflexible, acquisitive, bossy and dismissive. This seems to accord with the previous result that engineering designers take more ‘yield’ approaches. This also explains why engineering designers are ‘persuading’ and industrial designers are ‘insisting’ more.

ED-3: “some design concepts are not feasible in current mold technology. As per this, we say this is not possible then, they hate it. When they hear ‘impossible’ for their design, they really hate it. ‘Do this!’, ‘No impossible’, ‘why impossible?’, ‘cannot make molds’, then, they say ‘I cannot understand it, let me understand.’ Honestly it is difficult to understand a different domain that they are not familiar with even if we provide enough detailed explanation and drawings. Then, we waste several days.”

‘Acquisitive’ as an image of industrial design comes from the situation that industrial designers always pursue high surface quality over the initial product specification.

Finally, industrial designers are proud of their design, so they are sensitive about changing it and frequently reject engineering designers’ requests to change the outer shape of a product.

Figure 3. Industrial designers’ perceived image to engineering designers (left), Engineering designers’ perceived image to industrial designers (right)
4. Discussion and conclusion
To answer how industrial designers and engineering designers work together, qualitative research was conducted. Three industrial designers and three engineering designers working in a consumer product company were interviewed. Transcribed interview data were analyzed with a coding scheme. As a result, this paper presented the causes of conflicts, conflict resolution strategies, and perceived images of each group.

It was found that there are two types of conflict causes; direct causes and basic causes. The direct causes are related to tasks in the design process, and the basic causes are structural, underlying the direct causes. The strategies to resolve the causes are also identified. Engineering designers appear to use a ‘persuading’ strategy more. It seems that engineering designers prefer to ‘yield’ in most cases, while industrial designers use an ‘insisting’ strategy more than engineering designers.

Each group’s perceived image with the other group has also been investigated. Industrial designers said that engineering designers are not creative, and are conservative and unadventurous. Industrial designers are described with the words ‘inflexible,’ ‘acquisitive,’ ‘bossy,’ and ‘dismissive’ by engineering designers. Each group’s image has been formed through their interaction with the other group. Thus, each group’s behavior toward conflicts is in accordance with the perceived images.

Better collaboration should be approached from two directions. One is to remove the direct causes of conflict through better management. The other is to relieve and weaken the basic causes of conflicts through developing an effective and integrated product design process, and through educating designers with an integrated knowledge of both design and engineering.

Nowadays, industrial design is highlighted more than in the past, yet the majority of design research has been done in the engineering design field. There has been a perspective from engineering design that industrial design is regarded as an art-related area. As this study implies, industrial design function and coverage seems to be wider and more important in some areas, especially in the consumer product industry where global competition is cutthroat. Regardless of this, we have relatively little knowledge on how industrial designers work within a company. Moreover, studies on their interactive design behaviors with engineering designers have been little developed. Design research viewing the two groups’ collaborative work as a holistic design process is needed.

In this study, the stance of the product design has been kept as an integrated design activity of industrial design and engineering design. Some insights into their collaborative work were acquired. However there is no report about what we found beyond issues related to conflicts. There are many issues and topics on integrated design activities, such as the integrated design process, product development strategies and so on. As the team dynamics of only one company was presented in this paper, it is difficult to draw any definite conclusions, and a report on the rich findings and insights from analyzing the results of the six company cases will be forthcoming.

Acknowledgement
This work was supported by the National Research Foundation of Korea Grant funded by the Korean Government (NRF-2012S1A5A8024274)

References


Merriam, S. B. (1998). *Qualitative Research and Case Study Applications in Education. Revised and Expanded from" Case Study Research in Education.": ERIC*.


KwanMyung Kim
KwanMyung Kim is an assistant professor in the School of Design and Human Engineering at UNIST (Ulsan National Institute of Science and Technology) and the director of ‘Integration and Innovation Design Lab’. He received a B.Sc. and M.Sc. and completed a Ph.D. course in industrial design from Korea Advanced Institute of Science and Technology (KAIST) in 1992, 1994, and 2010 respectively. He has a strong practical background stretching from design to engineering to business, having been involved in developing products and machine systems for 13 years as a product designer and founder of a venture company. As a researcher and practitioner, he is interested in integrating design and engineering knowledge for design-driven product and product-service innovation.

Kun-pyo Lee
Kun-pyo Lee is the professor of the department of industrial design at KAIST and the director of its Human Centered Interaction Design Lab. He also serves as president of the International Association of Societies of Design Research. Dr. Lee was the executive vice president and head of the corporate design center for LG Electronics and has worked on various research projects with many of the world’s leading companies and organizations, such as LG Electronics, Samsung Electronics, Johnson and Johnson, and Volkswagen, as well as for governmental organizations. He has served on the advisory boards of several organizations and journals in Korea and abroad.

Dr. Lee has published widely (more than 350 articles, papers, books, and book chapters) both in Korea and abroad, has served on international juries, and has been an invited keynote speaker and lecturer at more than 150 conferences and institutions throughout the world. He holds a BFA in design from Joong Ang University in Korea, an MS in design from IIT Institute of Design in the US, and a PhD in design from the University of Tsukuba in Japan. His research interests include user experience design, human-centered design, design methodology and, more recently, open design with crowdsourcing.