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Method for Analyzing Individual Differences in Idea Evaluation and Interpretation

Masakazu Kobayashi and Masatake Higashi
Toyota Technological Institute, Japan

Abstract. In the previous paper, we focused on individual differences among designers, especially differences in their idea evaluation and interpretation during collaborative creative activities and proposed the method for analyzing results of designers' evaluation and interpretation in order to indicate the potentially fruitful directions for further idea explorations. Detailed analysis of experimental results conducted in the previous paper showed the effectiveness of the method, but also showed that there is a room to reconsider the procedure of semantic interpretation. Therefore, in this paper, we propose a modified procedure of semantic interpretation in order to improve the effectiveness of the previous method.

Keywords: Design engineering, Product innocation, Collaborative creative design, Creativity support, Analysis of individual differences

1 Introduction

Collaboration is a process where the efforts of a group of participants are facilitated by sharing information, expertise, ideas, resources or responsibilities (Chiu, 2002). The advantage of collaboration is the increased ability to achieve complex large-scale and multidisciplinary problems, which no man can achieve alone. In addition to such advantage, collaboration offers an additional potential benefit in terms of enhancing group members' creativity. During the collaboration processes, group members cooperate by exchanging ideas, opinions and various information, which can stimulate their creativity and increase their chances of generating new ideas (Yoshimura and Yoshikawa, 1998). The importance of collaboration is gradually recognized in these days and we often hear the word "collaboration " in a variety of media.

Collaboration has been an important research subject for many years and various support methods or systems were developed. However, the main concern of these researches is, for example, communication support, knowledge management and distributed design environments and there are not many researches that focus on the creative side of collaboration.

Against these backgrounds, we focused on the creative side of collaboration and proposed methods for supporting interactive communication among designers (Kobayashi et al., 2003, 2004) and for analyzing obtained ideas based on Data Envelopment Analysis (Kobayashi, Higashi and Yoshimura, 2007) in order to enhance designers' creativity during collaborative design activities. In the previous paper (Kobayashi and Higashi, 2009), we then focused on individual differences among designers and proposed the method for analyzing them. In the case where a group of designers cooperatively explores new ideas, a designer who comes up with a new idea usually proposes it in the form of several words or a short sentence and the other designers hear it and interpret to a concrete image in their mind. However, it is highly possible that there are differences in what designers concretely imagine from the presented words or short sentence. In addition, when designers evaluate presented ideas, it is also highly possible that results of their evaluation are different due to the difference in idea interpretation described above and the difference in evaluation viewpoint and measure. While it's apparently believed that such differences are considered undesirable in most cases, several researchers stated that diversity of group members has a positive effect on performance of the group productivity and creativity in their papers (Okada and Simon, 1997, Ueda and Okada, 2000, Paulus and Nijstad, 2003, Miura and Hida, 2004). We thought they have a huge potential for leading new ideas during creative collaboration activities and proposed the method that analyzes the results of designers' idea interpretation and evaluation and boosts their further idea explanations based on the analytical results.

In this paper, we discuss the modification of the previous method. This is because detailed analysis of experimental results conducted in the previous paper shows that there is a room to reconsider the procedure of semantic interpretation. When the subjects interpreted obtained ideas to formulaic representations during the experiment, some subjects tended to interpret ideas from the viewpoint of their "principle or structure" and others tended to interpret them from the viewpoint of their "effect or outcome". Such differences make a consistency analysis of semantic interpretation inaccurate which degrades the effectiveness of the method. Therefore, we modify the procedure of semantic interpretation in order not only to avoid such negative effect but also to utilize two viewpoints for further idea exploration.

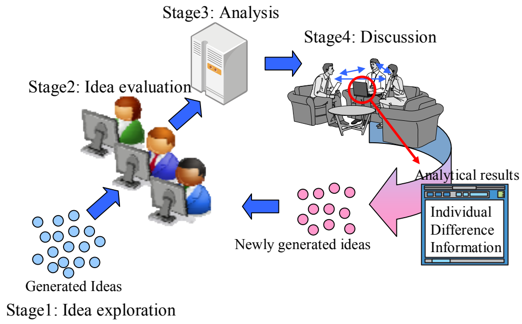


Fig.1 Overview of the method

2 Method for Analyzing Individual Differences

What are newly proposed in this paper are only procedures relating to semantic interpretation and the overall flow differs little from the previous method. However, in order to make the overview of the method easily understood, the following sections explain the entire method including the parts that are not different from the previous version.

In our research, we focus on the differences in designers' idea interpretation and evaluation and propose an analytical method for enhancing the effect of creative collaboration by revealing such differences. The processes which the proposed method supports are ones where designers cooperatively explore new ideas for achieving given target goals. The number of target goals can be more than one. The ideas which the proposed method assumes are ones represented by several words or a short sentence. The proposed method consists of the following four stages:

Stage1: Exploration of ideas
Stage2: Evaluation and interpretation of ideas by designers
Stage3: Analysis of differences in designers' evaluation and interpretation
Stage4: Discussion of ideas by designers

Stage1 is a conventional collaborative task for exploring new ideas. Stage2, 3 are analytical tasks newly proposed in our research. Fig.1 shows the overview of the proposed method. The following sections explain the details of each stage.

2.1 Stage1: Exploration of ideas

In the first stage, designers cooperatively explore as many ideas as possible. In our method, ideas are supposed to be represented by several words or a short sentence. This stage is usual collaborative activity and various support methods such as brainstorming can be used.

2.2 Stage2: Evaluation of ideas by designers

In the second stage, designers individually evaluate the ideas obtained in stage 1 from the following two viewpoints.

(1) Numerical performance evaluation
The performance of the idea is defined as the degree of contribution to the achievement of the given design goal when it is practically adopted to the design object. Designers individually grade all ideas on a scale of 1 to 10 from the viewpoint of how each idea can achieve each design goal. The degree of contribution needs to be evaluated for each design goal and for each idea, so the total number of evaluations executed by each designer equals to the total number of ideas multiplied by the total number of given design goals.

(2) Semantic interpretation
Procedure of semantic interpretation is modified from the previous method in order to reveal the differences in designers' interpretation of ideas more clearly. The details are shown as follows.

When a designer presents a new idea using several words or a short sentence, the other designers hear it and imagine the concrete image of the idea, such as its mechanism, structure, material, effect, etc., from the presented words in their mind. However, there is no guarantee that what designers imagine in their mind is identical.

To reveal such differences, the proposed method asks designers to individually interpret ideas to formulaic representations. Specifically, designers interpret an idea and describe its “Principle” and “Effect” by selecting from the list of verbs and objectives. “Principle” represents why and how the idea brings in the desirable effects, whereas “Effect” represents the desirable effect or outcome brought by the idea. If what designers imagine in their mind is different, the results of semantic interpretation are not identical. Therefore by comparing selected verbs and objectives, the degree of differences in semantic interpretation among designers can be revealed. Fig.2 shows the concept of formulaic semantic interpretation.

For appropriate semantic interpretation, preparation of the list of verbs and objectives that are closely matched for the design object is important, so the list should be prepared in each case.

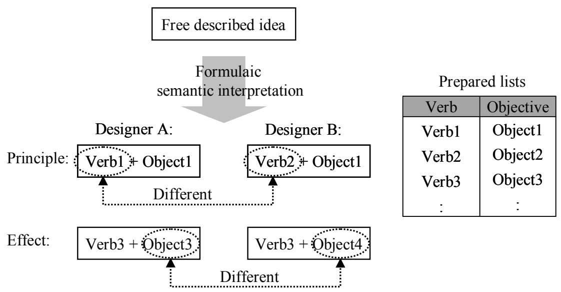


Fig.2 Formulaic semantic interpretation

2.3 Stage3: Analysis of differences in designers’ evaluation and interpreation

In the third stage, individual differences are analyzed based on the results of designers’ evaluation carried out in the second stage. In this stage, the results of numerical performance evaluations and semantic interpretations are individually analyzed and then these analytical results are combined into a single scatter diagram.

2.3.1 Analysis and visualization of numerical performance evaluation

Under the condition where n design goals are given, the results of numerical performance evaluations can be plotted on a n-dimensional space. Fig.3 shows the case of n = 3. This graph is drawn for each idea. Each vector shows the result of each designer’s evaluation. The coordinate of each vector equals to its values.

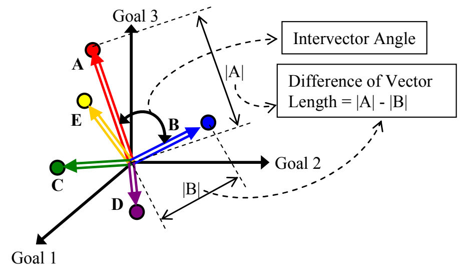


Fig.3 Two types of differences in numerical evaluation

Using this graph, the differences in designers’ numerical evaluations can be represented by the combination of the angular differences between vectors and the differences in the length of vectors. This method takes the meanings of these differences as follows. The former shows the individual differences concerning evaluation viewpoints and the latter shows the individual differences concerning estimation of the total performance of the idea.

For practical use, since only the values of angular and length differences are necessary for further discussions, a table shown in the bottom right of Fig.4(b) is drawn for each idea and displayed to designers instead of displaying the graph itself.

2.3.2 Visualization of semantic interpretation

As for the results of semantic interpretation, combinations of verbs and objectives selected by designers are visualized by directed graph form for each idea, as shown in the bottom left of Fig.4(b). Same verbs or objectives selected by several designers are merged into one node and each designer’s choice is described by an arrow. In the proposed method, since ideas are interpreted from the viewpoints of both their principle and effect, two sets of directed graphs are displayed for each idea.

2.3.3 Scatter diagram for designers’ discussion

Based on the above analyses, consistency indexes of both numerical performance evaluation and semantic interpretation are calculated for each idea and a scatter diagram shown in the left side of Fig.4(a) is then drawn. The scatter diagram is used for the further discussion in the next stage and helps designers to understand the relationships between the idea being focused now and the others. The detailed procedure of drawing the scatter diagram is as follows.

(1) Consistency index of numerical performance evaluation

Consistency means the degree of the difference in designers’ evaluation for the idea. Concerning the consistency of numerical performance evaluation, the index is calculated according to the following procedure.

Step1: Variance of designers' evaluated value is calculated for each design goal and for each idea.
Step2: Variances are then summed up for each idea.
Step3: Maximum value of summed variances is found.
Step4: Uncompensated index of each idea is calculated by subtracting summed variance of each idea from the largest summed variance.
Step5: The deviation of each uncompensated index is calculated and defined as the compensated index.

(2) Consistency index of semantic interpretation

When the results of interpretation of an idea made by two designers are compared, the pair can be classified into the following four cases: (a) Both the verbs and the objectives selected by two designers are same, (b) Only the verbs are same, (c) Only the objectives are same and (d) Both the verbs and the objectives are different. Based on the above classification, the index is calculated according to the following procedure.

Step1: If the pair is classified into the case (a), the pair is scored 1 and if the pair is classified into the case (b), (c) or (d), the pair is scored 0.8, 0.4 or 0 respectively. This rating is executed for every pair of designers and for every idea. In the proposed method, since ideas are interpreted from the viewpoints of both their principle and effect, this rating is applied to both interpretation results.
Step2: After rating all ideas, scores are summed up for each idea and the sum total is defined as the uncompensated index.
Step3: The deviation of each uncompensated index is calculated and defined as the compensated index.

(3) Scatter diagram

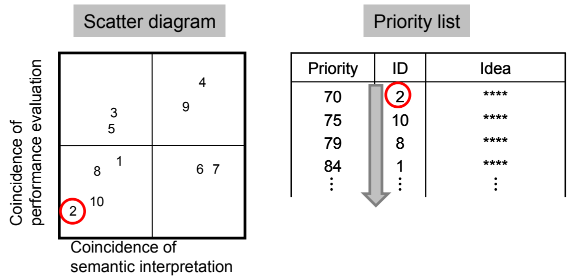
The scatter diagram is then drawn by plotting ideas based on the consistency index of performance evaluation as coordinated value of Y axis and the consistency index of semantic interpretation as coordinated value of X axis. Both indexes are deviation scores, so their averages equal to 50. The left side of Fig.4(a) shows its example.

2.3.4 Discussion priority

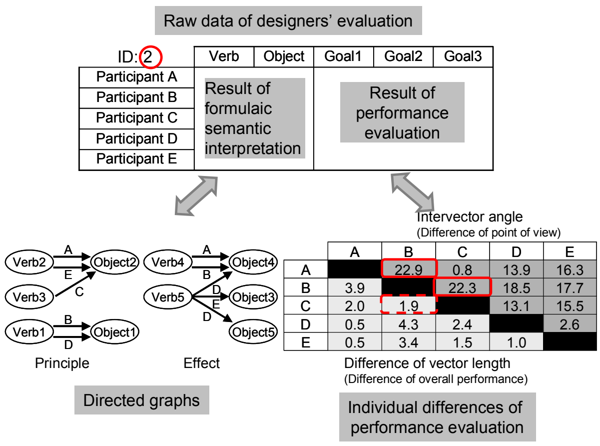
The discussion priority in the next stage is finally calculated by summing two indexes for each idea. Note that the idea with a little difference in designers' evaluation has a low priority, whereas the idea with a great difference has a high priority. This is because the ideas with a great difference have more information about the differences in designers' viewpoints and chances of further idea generations than ones with a little difference.

2.4 Stage4: Discussion of ideas

Fig.4 shows the overview of the results of analysis carried out in stage 3. Fig.4(a) shows information of all ideas, whereas Fig.4(b) shows information of one idea which designers focus on now. Using these figures, designers discuss individual differences according to the following procedure.



(a) Analytical results of all ideas



(b) Analytical results of the specified idea

Fig .4 Overview of the analytical results in Step3

Step1: Based on the calculated priority, designers decide from which idea they start discussion. In the case of Fig.4, discussion starts from the idea ID 2.
Step2: Next, designers focus on information of the targe ted idea displayed at Fig.4(b). Raw data of numerical performance evaluation and semantic interpretation and their visualized data are displayed here. Using these information, designers hold a discussion according to the following procedure.
(a) Concerning the differences in numerical performance evaluation, the pairs of designers whose angular difference is large discuss the reasons why

their evaluation viewpoints are so different. In the case of Fig.4, the pair of designer A and B whose angular difference is largest starts 1st discussion and the pair of designer B and C whose angular difference is second largest then starts 2nd discussion. During the discussion by the pair, it is advisable for the other designers to actively join in their discussion. Concerning the differences in length which show the differences in estimation of total performance, discussions are carried out in the same fashion.

(b) Concerning the differences in semantic interpretation, since the proposed method asks designers to interpret ideas from two viewpoints: "Principle" and "Effect", the results of designers' semantic interpretations can be classified into the following 4 patterns: (i) Designers' interpretations of the idea's principle and effect are nearly same, (ii) Only designers' interpretations of the idea's principle are same, (iii) Only ones of the idea's effect are same and (iv) Designers' interpretations of the idea's principle and effect are quite different. Based on the above classifications, designers discuss the reason why they select different words and what they think during interpretation using the directed graphs.

Step3: When new ideas are generated in the course of above discussions, newly generated ideas are recorded with the information about their source idea.

Step4: When designers agree that the targeted idea has been well discussed, they come back to step1 and select the next target. In the case of Fig.4, the idea ID10 is selected as the next target.

When designers agree that discussions are well carried out, stage 4 is finished at that point and they get back to stage 2 in order to analyze obtained ideas during stage 4.

3 Summary

In this paper, we propose a modified procedure of semantic interpretation in order to improve the effectiveness of the previous method. In the modified procedure, ideas are interpreted to formulaic representations from the viewpoints of their "Principle" and "Effect" and their differences are analyzed and discussed.

As for future research, we will implement the modified procedure of semantic interpretation to the computerized support system that was developed in the previous paper and conduct a new experiments in order to confirm the effectiveness of that modification. We will also discuss the list of verbs and objectives used for semantic interpretation.

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