Modeling of collaboration in design process Based on Channel Theory

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Abstract

Collaboration is one of the effective approaches that help us to share knowledge together and exchange ideas within a team member. Sometimes, new helpful knowledge that is not held by the members emerges as a result of the collaboration. Such knowledge often contributes to get prime solutions during collaboration process. However, the way to generate such new knowledge is implicit. In this paper, a method of creating a model, which represents effects of collaboration in design process is proposed. By using this scheme, we can illustrate what new knowledge can be gotten from a collaboration and we can know the effect of the collaboration.

Keywords: Collaboration, Channel Theory, design process, synergetic effects

1. Introduction

Collaboration is one of the effective approaches that help us to share knowledge together and exchange ideas within a team member. It is a communication process in which two or more people from different disciplines participate in knowledge transfer to achieving a goal of team [1]. During collaboration process, synergetic effects among a team member may contribute to generate novel knowledge. Thus, effective collaborations are expected in a team.

In design area, viewpoints of designers play an important role to bring about a novel design idea [2]. Different experiences and knowledge cause different viewpoints [3]. Designers can share their viewpoints through collaboration process. Thus, collaboration is a promising method, which assists the designer to create more outstanding design and increase ability to fulfill client's requirement more perfectly. However, the way to generate new knowledge is implicit. Thus, this study aims to represent the process of generating such knowledge by using mathematical model.

As a result of synergetic effects, new knowledge is produced within in collaboration process. To investigate effective collaboration, a representation model of collaboration mechanism is proposed. Channel Theory

[4] is introduced to create the model. Moreover, Chu space [5], that is a mathematical construction, which represents scheme of infomorphism, is adopted to account for the new knowledge in collaboration system.

2. Literature reviews

2.1. *Related works*

There are many researches have applied Channel Theory to study about communication system. For example, Suto et al. have proposed a representation model for communication medium with Channel Theory [6]. This model could describe the semantic information flow, which is corresponding to a kind of medium. Kawakami et al. have proposed a modeling system framework that involves diversity and context dependencies base on Channel Theory [7]. It has the potential to model diversity using the arbitrariness of information flows, Schorlemmer [8] proposed a formalization of knowledge sharing scenarios by using diagram in the Chu category, etc. In this section, Channel Theory and Chu spaces are introduced briefly.

2.2. *Channel Theory*

Channel Theory provides a mathematical framework of qualitative theory of information. The basic concepts of Channel Theory consist of classification, local logic, infomorphism, and information channel.

A classification $\boldsymbol{A} = \langle \boldsymbol{tok}(\boldsymbol{A}), \boldsymbol{typ}(\boldsymbol{A}), \models_{\boldsymbol{A}} \rangle$ consists of

(i) a set, $tok(A)$, of objects to be classified, called the "*tokens of A*,"

(ii) a set, $typ(A)$, of objects used to classify the tokens, called the "*types of A*," and

(iii) a binary relation, $\models_{\boldsymbol{A}}$, between $tok(A)$ and $typ(A)$.

A classification is represented with indicating the types to which tokens to be classified.

Given a classification A, a pair $\langle \Gamma, \Delta \rangle$ of subsets of $typ(A)$ is called a "*sequent of A*." A token $a \in tok(A)$ satisfies $\langle \Gamma, \Delta \rangle$ if a is of type α for $\forall_\alpha \in \Gamma$ then a is of type β for $\exists_\beta \in \Delta$. If every token $a \in A$ satisfies $\langle \Gamma, \Delta \rangle$, say $\Gamma \vdash_A \Delta$, and $\langle \Gamma, \Delta \rangle$ is called a "*constraint*" supported by A.

A local logic $\mathcal{L} = \langle A, \vdash_{\mathcal{L}}, N_{\mathcal{L}} \rangle$ consists of a classification A, a set $\vdash_{\mathcal{L}}$ of sequents of A called the constraints of $\mathcal{L}$, and a set $N_{\mathcal{L}} \subseteq tok(A)$ of tokens called the normal token of $\mathcal{L}$, which satisfy all the constraints of $\mathcal{L}$.

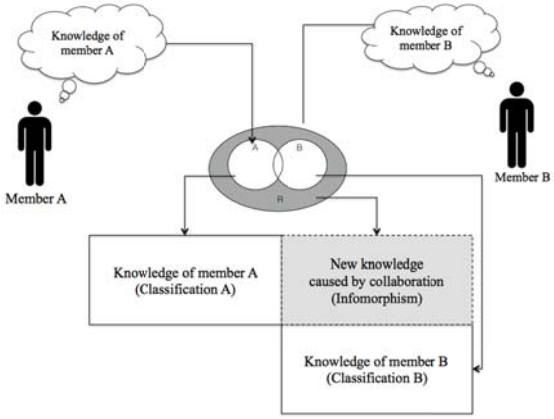

Fig. 1. A framework of collaboration mechanism represented by using Channel Theory

An infomorphism is important relationship between two classifications and provides a way of moving information back and forth between them. Infomorphism $\langle f^\wedge, f^\vee \rangle$ is a pair of functions, in which $f^\wedge$ is a function from the types of one of these classifications to the types of the other, and $f^\vee$ is a function from the tokens of one of these classifications to the tokens of the other. Given two classifications, A and B, an infomorphism from A to B written as $A \rightleftarrows B$ satisfies the following Fundamental Property of Infomorphisms:

$$f^\vee(b) \models_A \alpha \text{ iff } b \models_B f^\wedge(\alpha) \qquad (1)$$

for each token $b \in tok(B)$ and each type $\alpha \in typ(A)$.

An channel C is an indexed family $\{f_i : A_i \rightleftarrows C\}_{i \in I}$ of infomorphisms with a commom codomain C, called the "*core of* C." I is an index set.

3. Proposed model and examples

3.1. *A model of collaboration mechanism*

The framework of proposed model is shown in Fig. 1. Each circle indicates a set of knowledge held by a member. Due to synergetic effects in collaboration, team performance cannot be calculated as simple union of the

abilities of each member. Possibility domain of collaboration can be described as $R-(A \cup B)$. This situation can be represented by using classification of Channel Theory as shown below the circles in the figure. Here, we can deduce the knowledge, which can be obtained from synergetic effects by using infomorphism.

By using this scheme, we can demonstrate effective collaboration by representing how new reachable design solution broadens. To verify potential of the proposed framework, example of collaboration in webpage design is used to be a case study.

3.2. *Example: Layout designer and Color designer*

A collaboration between designer A, who is practiced on

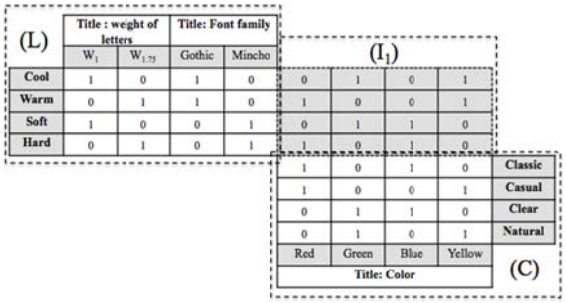

Fig. 2. A model of collaboration in webpage design between layout designer and color design

layout design and designer B, who is proficient on color design is considered as an example. This situation can be represented as matrices shown in Fig. 2 by using the proposed method. In this case, the model consists of three classifications, i.e. L, C, and I_1.

Classification of layout design knowledge (L): The classification of layout design knowledge is shown in Fig. 3 (L). Here, each token stands for impression and each type stands for layout item, font weight or font style. For example, when font weight is thin and the style is Mincho (Japanese Serif style), it gives cool impression to the observers. Such knowledge can be described as a classification as following:

$$tok(L) = \{Cool, Warm, Soft, Hard\}$$
$$typ(L) = \{W_1, W_{1.75}, Gothic, Mincho\}$$
$$Cool \vDash_L W_1, \quad Cool \vDash_L Gothic, \quad Warm \vDash_L W_{1.75},$$
$$Warm \vDash_L Gothic, \quad Soft \vDash_L W_1, \quad Soft \vDash_L Mincho,$$
$$Hard \vDash_L W_{1.75}, \quad Hard \vDash_L Mincho$$

Types W_1 and $W_{1.75}$ mean weights of letters, which define as normal and bold respectively. Types Gothic and Mincho mean font styles of letters in title part, which define as Gothic and Mincho styles respectively.

Classification of color design knowledge (C): The classification of color design knowledge is shown in Fig. 3 (C). Here, each token stands for an image and each type stands for color decorating. For example, when webpage is decorated with Red and Blue, it gives classic image to the observers. Such knowledge can be described as a classification as following:

$$tok(C) = \{Classic, Casual, Clear, Natural\}$$
$$typ(C) = \{Red, Green, Blue, Yellow\}$$
$$Classic \vDash_C Red, \quad Classic \vDash_C Blue, \quad Casual \vDash_C Red$$
$$Casual \vDash_C Yellow, \quad Clear \vDash_C Green, \quad Clear \vDash_C Blue,$$
$$Natural \vDash_C Green, \quad Natural \vDash_C Yellow$$

Infomorphisms from L to C (I_1): Each line in the (I_1) means a combination between a token in classification L and a token in classification C. For instance, Cool in (L) is combined with the Natural in (C) because the first line of (I_1) has the same element of the fourth line of (C). While, each column in the (I_1) means a combination between a type in classification L and a type in classification C. For instance, Red in (C) is combined with $W_{1.75}$ in (L) because the leftmost column

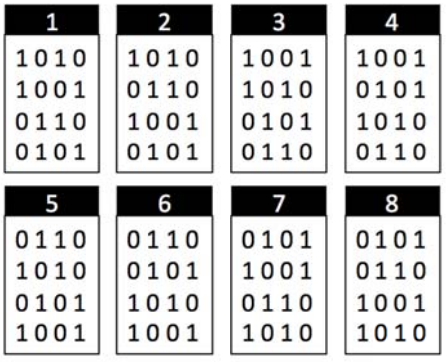

Fig. 3. Infomorphisms from layout design knowledge to color design knowledge

of (I_1) has the same element of the second column from the left in (L).

In this case, infomorphisms are established from "classification of layout design knowledge" to "classification of color design knowledge." Eight infomorphisms have been obtained as shown in Fig. 3. It means there are eight situations that may occur when layout designer and color designer collaborate in a design process. Each situation explains new knowledge, which layout designer and color designer obtained from cooperation in the design process. However, all possible situations are derived with the proposed method. Thus, we cannot say that all situations are proper understanding in the context. For example, in Fig. 3., infomorphism 1 shows that

$$f\hat{}(Cool) = Classic, \qquad f\hat{}(Warm) = Casual,$$
$$f\hat{}(Soft) = Clear, \qquad f\hat{}(Hard) = Natural$$

From this infomorphism, a designer can understand that the design, which has cool imoression, is corresponding with classic image, while warm impression is corresponding with casual image. Moreover, soft impression is corresponding with clear image and hard impression is corresponding with natural image. It can say that this new knowledge is possible to be true because this knowledge is consistent in semantics. Meanwhile, infomorphism 2 shows that

$$f\hat{}(Cool) = Classic, \qquad f\hat{}(Warm) = Clear,$$
$$f\hat{}(Soft) = Casual, \qquad f\hat{}(Hard) = Natural$$

From this infomorphism, cool impression and hard impression can be implied as same as infomorphism 1. But soft impression is corresponding to casual image and warm impression is corresponding to clear image. It must be misunderstanding because warm impression is conflict with clear image according to the theory of science of color [9].

4. Conclusion

A modeling method of collaboration mechanism is proposed based on Channel Theory. An example of webpage design case was shown as case studies. The example is illustrated the situation that two designers who have different knowledge, collaborated in a webpage design process. In the example, designer A is practiced on layout design whereas designer B is proficient on layout design. They could have several possible knowledge as a result of the collaboration.

We can say that the proposed model can explicitly represent the situation, which possible to occur in collaboration in a webpage design process. However, we cannot say that all situations are correct understanding because all possible situations are derived with the proposed method. Nevertheless, with using the proposed model, we can illustrate potential of collaboration by representing how new reachable design solution broadens.

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References

1. G.W. Dickson and G. DeSanctis, *Information Technology and the Future Enterprise: New Models for Managers*, 1st edn. (Prentice Hall PTR Upper Saddle River, NJ, USA, 2000).
2. H. Suto, P. Patitad and N. Kang, A collaboration Support Tool for Multi-cultural Design Team Based on Extended ADT Model, in *Proc. HCI Conf.* (Crete, Greece, 2014), pp. 548-557.
3. F. DeALtienne, Viewpoints in co-design: a field study in concurrent engineering, *DES STUD.* **26**(3) (2005) 215-241.
4. J. Barwise and J. Seligman, *Information Flow: The Logic of Distributed Systems* (Cambridge Univ. Press, 1997).
5. M. Barr, *-Autonomous Categories*, LECT NOTES MATH **752**. (Springer-Verlag, Berlin, 1979).
6. H. Suto, T. Taniguchi and H. Kawakami, A Study of Communication Scheme for Media Biotope, in *Proc. SICE Annu. Conf.* (Tokyo, Japan, 2011), pp. 206-209.
7. H. Kawakami, T. Hattori, T. Shiose and O. Katai, Modeling of System Diversity Based on Qualitative Information Theory, *WSEAS Trans. Syst.* **10**(5) (2006) 2411-2417.
8. M. Schorlemmer, Duality in Knowledge Sharing (The university of Edinburgh, UK, 2002).
9. S. Kobayashi, *A book of colors: matching colors, combining colors, color designing, color decoration*, (Kodansha, USA, 1987).