ORIGINAL ARTICLES

INTERDISCIPLINARY WORKGROUP METHODOLOGY BASED ON INTUITION
Application to a communication tool design based on Kansei information approach

Pierre LÉVY*, Toshimasa YAMANAKA**

* Graduate School of Human Comprehensive Sciences, University of Tsukuba, Tsukuba-shi, Ibaraki-ken, JAPAN
** Institute of Art and Design, University of Tsukuba, Tsukuba-shi, Ibaraki-ken, JAPAN

Abstract: The artifact is a complex element. Besides its elementary dimensions (material, functional and formal), the artifact is composed of much more dimensions: ergonomic, emotional, cultural, and even ethologic or theological. To take into account this great quantity and diversity of dimensions, the designer’s work has to be widened out. Necessarily, this goes through an interdisciplinary approach, i.e. through an interdisciplinary workgroup activity. Nevertheless, this brings issues, notably concerning knowledge communication and sharing. For each variety of knowledge (tacit, prescriptive and descriptive), interdisciplinary activity provokes issues either because of disciplinary ontology differences, or because of human subjective understanding differences.

Intuition is a mental process which is able to minimize these issue effects. We then propose a methodology based on intuition, structured on the theory of Ba, on the SECI Model, which an evoked metaphor (EM) is added to. Through the EM, each member of the workgroup is able to participate to every steps of the design process and to communicate with other members, thanks to an intuitive understanding permanently validated by involved disciplines. This creates an efficient interdisciplinary dynamics and the realization of fully interdisciplinary projects. To illustrate this methodology, the design of MATiK is introduced as an example. MATiK is an original workgroup communication system based on a Kansei information approach. In order to understand the expected functionalities of MATiK and to design it, the EM is set up. Considering basic aspects of an extensive workgroup operative process, the Loft is defined as an EM. The Loft offers an opportunity to understand MATiK’s original functionalities, MATiK’s design, and MATiK’s functional and technical requirements intuitively. This methodology, based on the EM, asserts its relevancy for interdisciplinary design. Its strength comes from the fact that the EM links all the levels of the design process (the idea/concept level, the reality level, and the technical level) and makes their understanding accessible to all members thanks to intuition.

Keywords: Intuition, Interdisciplinary workgroup, Design, Communication, Knowledge sharing.

1. INTRODUCTION

Considering the complexity of the artifact¹, i.e. the great quantity of dimensions characterizing the artifact, design process improvement can succeed thanks to an interdisciplinary approach. However, how can designers adopt an interdisciplinary behavior, whereas interdisciplinary knowledge sharing encounters many issues due to disciplinary ontology and human subjective understanding?

This paper focuses on the knowledge sharing issues related with interdisciplinary workgroup communication and intends to propose a methodological solution, based on intuition.

2. INTERDISCIPLINARY DESIGN

2.1. Dimensions of the artifact

When an artifact is described, whatever it is, it is of use to evoke first its functional, formal, structural or material aspects. These are immediate aspects of the artifact. Recently (relative to the history of industrial design), the influence of the artifact on the five senses has been considered [1]. To this are often added aspects either more specific or more general aspects. Thus, one speaks about the ergonomics aspect and the emotional aspect of artifacts [2].

But beyond these immediate aspects of the artifact, there is a great quantity of other factors, which give meaning and identity to the artifact. An artifact can be separated neither from its design, nor from its manufacture, nor from its use, nor from its disuse. It is thus inherently related to history, to society, to mankind (represented by its users, its designers and its producers). The artifact also has many dimensions of cultural nature (dimensions related to the religion, the practice, the mood, the culture and human knowledge), historical nature (the artifact is inherently bound to the historical and temporal context in which it is conceived), and technological nature (related to the state of the art of technologies).

The connection between the human being and the artifact is fundamental for both. There is a permanent relation between the history of both [3]. This is all the more significant since the users ascribe to certain artifacts a sentimental value, a value of regard and characters similar to those which they can ascribe to their counterpart [4]. Actually, a strong emotional connection between the user and the artifact can exist. Often, identity and meaning based on social standards

¹ ‘Artifact’ means here human construction, to be opposed with the Nature construction. It gathers objects, processes, services and their systems.
are associated with the artifact. It is thus possible to consider factors of value, identity, and symbol. These are the stakes and the consequences of the connection between the artifact and the society (or context), which emphasize the symbolic, social, anthropological, and even ethologic aspects of the artifact.

Therefore, the artifact appears as an entity whose great complexity is due to its integration in human society. That is what the designer has to face. The designer must take this variety of dimensions of the artifact into account, and collect them together in order to design the artifact. But this point of view is theoretical. Either way the designer is alone or within a design team, so it is not realistic to expect that he would be able to take all these factors into account during their work. These factors can be gathered in three different factorial categories:

- The elementary factors are currently regarded as fundamental for the industrial design. These factors are consciously taken into account for each design. For instance, the functional, formal, anthropometric aspects of the artifact can be regarded as elementary factors.
- The complementary factors are recognized by the designer as significant concerns to the design work. However, these factors are placed on a second level compared to the elementary factors. The environmental and emotional aspects of the artifact are included in this category.
- The induced factors are not consciously studied by the designer. Because of his human nature, the designer chooses solutions intuitively. The suggested solutions ensue primarily (not to say completely) from his own experience (cultural, historical or identical experience, etc…). These solutions are exceptionally validated. Moreover, their relevance and their evolution are often hazardous. Theological or ethologic dimensions of the artifact are induced factors in the majority of the designs of artifacts, since even if the designer does not take them into account consciously, the artifact cannot free itself from them [5].

2.2. **Interdisciplinary and design**

The development of knowledge was carried out with the profit of disciplinary specialization, and vice versa. During the last century, the progression of knowledge was slowed down by the limits of each individual, reduced to his own specialization. This dam was to be exceeded with the crossing of this knowledge. Interdisciplinary research seemed to be a need, as a prolongation of specializations (and not as a substitution) [6].

This approach allows taking all the measurements of the interest of the interdisciplinary in design. The designer does not acquire too much knowledge, which he could not fully use. A design-centered interdisciplinary structure can be created to permit to choose judiciously new solutions for the design of industrial artifacts. The "interdisciplinary" solutions create (or emphasize) one (or several) solution for one of the factorial categories of the artifact. These dimensions are complementary from the artifact elementary dimensions. This complementary is not distinctive: all these dimensions interact of course between themselves. The principal mission of the designer is to coordinate them in order to extract some new artifacts, which improve in their social and human dimensions without disturbing formal, functional and emotional qualities of the artifact [7].

---

![Figure 1: Artifact dimensions](image1.png)

One of the first issues, which come to the interdisciplinary design, is the identification of the disciplines to be integrated. Love [8] proposes a framework to identify the relationship between design and other disciplines. It can be used to determine the disciplines that could be relevant in an interdisciplinary design process. This framework is based on three **key elements of designing**: 'humans', 'artifacts' and 'contexts', and is extended by their relationships (materialized in the triangle by the sides and the inside lines (cf. Figure 2)). This framework is then composed of nine areas that are **identifying the relationships between theories about designing and designs and theories of other disciplines**. Thus, Love proposes a list of disciplines that can be in close relationship with the design process, and therefore these are a priori relevant to interdisciplinary design.

---

![Figure 2: The three key elements of designing](image2.png)
Table 1: Fields of theories [8]

<table>
<thead>
<tr>
<th>Area of theory about designing and designs</th>
<th>Disciplines that address this area of theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behavior of individual humans</td>
<td>Biology, Psychology, Anthropology, research into designing, History…</td>
</tr>
<tr>
<td>Behavior of contexts</td>
<td>Environmental Studies, Geography, History, Physics, Social Psychology, Sociology, Management, Business Studies, Systems…</td>
</tr>
<tr>
<td>Behavior of artifacts</td>
<td>Engineering, Natural Sciences, History…</td>
</tr>
<tr>
<td>Human to human interactions</td>
<td>Psychology, research into designing, Sociology, Anthropology, Social Psychology, History, Management, Soft Systems…</td>
</tr>
<tr>
<td>Artifact to artifact interactions</td>
<td>Engineering, Natural Sciences…</td>
</tr>
<tr>
<td>Human and artifact interactions</td>
<td>Æsthetics, Ergonomics, Philosophy, Psychology, research into designing, research into designs, Social Psychology…</td>
</tr>
<tr>
<td>Human and context interactions</td>
<td>Æsthetics, Ergonomics, Psychology, History, Geography, Philosophy, Social Sciences, Anthropology…</td>
</tr>
<tr>
<td>Artifact and context interactions</td>
<td>Engineering, Natural Sciences…</td>
</tr>
<tr>
<td>Interactions involving human(s), artifact(s) and contexts</td>
<td>Æsthetics, Biology, Engineering, Environmental Studies, Ergonomics, Philosophy, Psychology, together Natural Sciences, research into designing, research into designs…</td>
</tr>
</tbody>
</table>

3. METHOD PROBLEMATIC

Another important concern encountered by interdisciplinary is the communication between the disciplines (their vocabulary and their visions). This concern is the problem of the present paper. Whereas an "interdisciplinary translation" is necessary, it can be in the meantime the reason of failure of an interdisciplinary project. A translation provokes a mandatory loss of information, which can be fatal. However, as it remains inevitable, the interdisciplinary team has to assume this limit and cannot be released from it. The success of these translations will appear in the relevance of the results and in the consensus inside the interdisciplinary team. Vera Vidal does not define this consensus as 'the result of a synthesis, but of a new meaning which emerged from the collective work, which was "co-produced", which derives from the new system of knowledge founded by the interdisciplinary practice' [6].

3.1. Preamble: variety of knowledge

Knowledge is composed of three kinds: descriptive, prescriptive and tacit [9,10]:

Descriptive knowledge (DK) represents statements of facts, such as technical information, quantitative data or artifact properties. It approaches an approximation of the formal knowledge of a "discipline" since it describes things as they are, it can be in the form of rules, abstract concepts and general principles, and it often has a consistent and comprehensible structure.

Prescriptive knowledge (PK) results from the successive efforts to achieve greater effectiveness, such as improved procedures or operations, and is altered and added to as greater experience is gained. PK generated through experimentation, trial-and-error, and testing is used in specific ways to make predictions at a pre-theoretical level [11]. This is because PK is less wedded to scientific principles and law. However, and because it is an outgrowth of specific application, it is not easily codified in a general form, and therefore it is less amenable to the formulation of instructional generalizations that go beyond a particular activity. The easier knowledge is codified, the easier it can be transmitted [12].

Tacit knowledge (TK) is implicit. It is largely the outcome of individual judgment, skill or practice. It cannot be perfectly or formally expressed. Supportive elements, such as diagrams or pictures can only partially explain TK. Moreover, they largely result from individual practice and experience. TK is close to PK in the way that both are procedural [9]. TK is personal, subjective, and immediate.

Each cognitive activity, and each reaction, involves necessarily these three varieties of knowledge. One’s experience (related to TK) is influencing one on the motivation to focus and remember DK or PK, such as a mathematics demonstration. Also, DK may help to deal with one’s feelings and to elaborate an appropriate behavior (e.g. National laws to prevent personal revenge as a justice). In a real context, these three varieties of knowledge cannot be distinct.

3.2. Communication issue

Communication is one of the fundamental tasks in group constitution and operation (cf. Chapter 2.2). Intrinsically, a group cannot exist without communication. The specificity of interdisciplinary groups is that the communication is not based on a single ontology2, but on as many ontologies as the number of disciplines gathering in the group. This specificity affects both tacit and explicit knowledge.

The specificity affects TK and PK directly related with Kansei, since each discipliner’s experience is partly coming from the activity in the discipline. As ontology also gathers links between artifacts, and rules and actions being performed in the activity, it influences the way the activity is performed and tacitly understood. That is all the more important that explanations and trials aiming at resolving any issues related with TK cannot directly be

2 Here, the meaning of ontology is the one used in Knowledge Representation. It is a specification of a domain, of all that ‘exists’ in a domain, including terms, concepts, entities, axioms, theorems, laws, rules, and actions that can be performed on everything within the domain as well as how to reason about the domain.
expressed explicitly, whereas conflict can occur because direct experience conflict.

Interdisciplinary sharing affects explicit knowledge since it involves concepts or methods that may be defined differently for each ontology (i.e. the same word may mean different things in different disciplines). Communication on concepts or methods defined specifically to each discipline is a barrier for the interdisciplinary group communication process. Indeed, divergence of definition for a similar concept or method can lead easily to misunderstandings and frustrations between members. This issue is independent from the kinds of interdisciplinary groups and from the involved disciplines.

Figure 3 illustrates how previously presented issues can affect the communication, and then knowledge sharing. On the transmitter side, the required involvement of the transmitter’s knowledge (noted DK, PK, and TK) affects necessarily the formulation process, and thus the information to be encoded. On the receiver side, the understanding process is also requiring receiver’s knowledge (noted DK’, PK’, and TK’). Yet, both processes are affected by these knowledge-sharing issues.

Figure 3: Kansei aspects in communication process

So considered, pointing out a major issue of knowledge sharing, we aim at searching for a methodology which is able to minimize the influence of such an issue. Intuition is a mental process that appears to solve the current problem.

4. METHOD PROPOSAL

4.1. Intuition

Concisely, the term of intuition would be defined as the ability to understand or know something immediately, without conscious reasoning [13]. But this simplistic definition does not clarify the way intuition works. The Oxford Companion to Philosophy explains it more in detail:

Intuition. Originally an alleged direct relation, analogeous to visual seeing, between the mind and something abstract and so not accessible to the senses. What are intuited (which can be derivatively called ‘intuitions’) may be abstract objects, like numbers or properties, or certain truths regarded as not accessible to investigation through the senses or calculation; the mere short-circuiting of such processes in 'bank managers intuition’ would not count as intuition for philosophy. Kant talks of our intuiting space and time, in a way which is direct and entirely free from any mediation by the intellect - but this must be distinguished from an alleged pure reception of ’raw data’ from the senses; the intuiting is presupposed by, and so cannot depend upon, sensory experience [14, p 415].

Considering the philosophy of Kant, the crucial question is not how we can get to understand the world, but how the world comes to be understood by us. Then, one of his main philosophical works, the Critique of the Pure Reason [15], aims at showing how reason determines the conditions under which experience and knowledge are possible. Instead of making our concepts match the nature of objects, we must allow the structure of our concepts shape our experience of objects. This turn of mind helps a lot to understand the way intuition works and the purpose of it.

According to David L. Thompson [16], ‘Intuition’ relies on a notion of presence which is abstracted from time and so is available only to either a timeless God (Cartesian philosophy) or an instantaneous ego stripped of all historicity (Husserlian philosophy). When it comes to real spatio-temporal knower who lives in the hic et nunc, we must substitute for absolute presence the embodied temporal process of making sense of the world. Absolute seeing is an illusionary product, an product generated by the processes of our bodies which structure our experience, integrating both objects and conscious selves over space and time.

Both Kant’s philosophy and Thompson’s remarks on Cartesian and Husserlian philosophy point out main important notions related with intuition, which will be explicated later in this chapter. The intuition is the human primary understanding of the environment. So it is highly related with our own experience, integrating both objects and consciousness over space and time. It is the way we can perceive and conceptualize the world without required prior knowledge, well explained by the works of Antoine de La Garanderie [17].

4.1.1. Intuition and perception

When one calls up objects visually, auditory or verbally³, this categorization of calling up does not divide people distinctly since anybody is potentially able to understand and uses another mode of understanding.

³ In this section, ‘Object’ gathers here human and Nature construction.

⁴ Words and sounds are called up as auditory in their tonality, whereas verbally, the subject tells or sings what he/she hears or sees.
than the one he/she is used to, even though it could cause communication and appreciation issues.

By the analysis of perceptive activity and its modalities, differences of understanding processes may be pointed out. There are two ways for observing an object: by visual evocations or auditory/verbal evocations (further explanation on this topic is illustrated in Figure 4). In order not to confuse the reader in this chapter, the difference between the mental evocation and the nature of the perceived object has to be cleared. For example, an auditory stimulus (auditory perceived object) can be mentally evoked visually, and vice versa. Many people could understand this concept while listening to The Four Seasons from Antonio Vivaldi. In this purpose of clarifying, Antoine de La Garanderie [17] is recalling the words from Napoleon: Let do so that, when I have heard you, I think of having seen.

In the case of visual evocation, the project is to give oneself a global image of the object. The observation starts by the creation of an image (different from a simple impression) being able to be filled up by the following perceptions evocating details of the object. Once the global image is filled up by perceived details, following perceptions will cause confrontation refining an ‘expert’ judgments. Evocations are carried out by visual expressions. Thus, when using visual evocations for a perceptive activity, the meaning of the perceived object is got in the space and by the spatial dimensions: in the filling up of an evoked global image. It is important to notice that the global image created in the first place does not generate the meaning of the perceived object. It is only a way to obtain the meaning. As it is filled up, the intuitive meaning of the object is being cleared. The perceptive activity needs to be indorsed on a global image to input into it further evocations of the perceived object. This global image furnishes then the material for the meaning’s intuition: the space. The left side of the Figure 4 resumes graphically the intuitive understanding of perceived object’s meaning by visual evocation.

For the same reason than the visually perception, the auditory or verbally one needs a material to give meaning to the perceived object. In this case, the material is the time and the project be executed thanks to a work of meaning discovering: it will be in following a path, i.e. in a temporal context. At the starting point, an indistinct idea or feeling will serve as a project of meaning and will drive the perceiving activity towards other ideas or feelings received by further observations. This path is heading toward a more precise feeling, becoming the observer’s one. It is similar with the dialectical scheme introduced for the visual modality, in the relationship between the starting evoked concept and the following ones. The auditory or verbally modal perceptive activity is based on a path in which details of the perceived objects will gather in an indispensable temporal order, heading to intuition of meaning. Thus, the project has time as material for the meaning’s intuition. The right side of the Figure 4 resumes graphically the intuitive understanding of perceived object’s meaning by auditory and verbal evocation.

The perceptive activity is thus the phenomenological analysis of attention. The perceptive activity aims at obtaining a meaning for the perceived object. In this target, it takes the project to evocate the perceived object and its aspects that can help to provide a meaning. This is done by the observation of aspects gathering thanks to the support by the material for the meaning intuition: the space in case of visual evocations, and time in case of auditory or verbal evocations. This process will have, as first effect, to precise the meaning of the perceived object, and then by further observations, to comfort, correct or modify this meaning.

Perceptive activity brings the ability to grasp meaning relations between objects and beings (for example, the ground is all wet because the rain drops down). Perceptive activity reaches its goal to understand objects only if it is driven by the thought that aims at evocating their composition. In the project of giving meaning to the perceived object, elements are set against each other recursively, requiring recursive evocations to be processed. This enables the project to progress to a new understanding state of the object. In the case of visual modal evocations, this process is based on a global image in which evoked elements are input to fulfill the objective. In the case of auditory or verbal modal evocations, this process is based on a self given speech telling a feeling or an idea about the evoked elements. This speech will then served as constant support for temporal placement of following evocations. Considering this process, it is immediate how perceptive activity can shift to a conceptual activity.

4.1.2. Intuition and conceptualization

Whereas perceptive activity has the project to determine a meaning for the perceived object, conceptual activity aims at determining by comparison differences and similitude of visual, auditory or verbal evocations. Concerning perceptive activity, a sequence of linked events in a common situation occurs. Evoked aspects are linked to each other, sometimes showing out cause and effect relationships. It may also happen that previously acquired evocation is recalled because of the close similarity with the currently perceived object. Still this is not conceptual activity since the rapprochement is sensitive related, whereas conceptual activity aims at comparing elements in order to perceive intellectually similarities and differences.

In the case of visual modality, space is the meaning material. It provides then an homogeneity of site, assuming a form of generality. In the case of auditory/verbal modality, time is regarded as the meaning material, providing heterogeneity of moments, assuming a form of abstraction. Thus, the target for meaning can be generalization (generality of the homogeneity of site), or abstraction (abstraction of the heterogeneity of time). Actually, the one who has visual evocations gives oneself the mean to abstract, and vice versa for auditory/verbal evocations. In the first case, the beginning of the project is to consider the set of the object, in a generalized space. Then, following steps (or evocations) will be to let into this space details (always from the most general to the most detailed element, i.e.
the elements that take the most room to the one that takes the least room in the space). Generalization is the guide of this mental progression. In the second case, the first step is to abstract a meaning of the object (generally an emotion or a sensation). Then following evocations will serve to go on the investigation, but this time with the firstly acquired abstract meaning, in order to look for other elements confirming the first perceived meaning. This is a generalizing process. The problem posed by Henri Bergson [18] about the interweaving between abstraction and generalization is here split into two processes according to the project and the material of meaning: one subject targets generality and intuition comes from space, and the other one target an abstraction and intuition comes from time.

Perception

![Intuitive meaning - Perception](image)

**Figure 4: Intuition perception process**

Perception and conceptualization are similar and may present continuity because they use space or time as meaning material to reach the intuition of meaning. Nevertheless, perception activity has the project to input in space or time elements that come directly from objects in contact with one’s sense. In this case, intuition is inside the perceptive activity and is exclusively targeting the meaning of the observed object. In psychology, the intelligence used for perceptive activity is called direct intelligence. Conceptualization activity uses indirect intelligence. It uses space or time to feed it with elements that are not perceived but that are picked up in order to be compared and to determine similarities and differences. In the case of the visual modal conceptualization, space is used to gather schemes or sketches representing global structures of the objects (visual representation of the concepts). In case of the time modal one, descriptions are based on words gathered on the time scale. Such descriptions are compared, and similarities and differences are output on a temporal structure [17].

In the case of visual evocations, words are used to communicate or express the image or the scheme. They are signifier, i.e. a convention. The meaning is in the signified, i.e. the image which is the intelligibility itself. Ferdinand de Saussure explains that words are used to communicate with others, but they don’t have any direct role in the meaning construction. In contrast, ’Emile Beveniste’ thinks that words are the bearer of the meaning. Drawings used to express one’s thoughts are only an intermediate for the communication of the meaning beard by the words. For people like Ferdinand de Saussure, the signifier is the word and the signified the image, and vice versa for people like Emile Beveniste.

For the perceptive activity, we saw that space and time had the role of material of meaning for intuitive perception. This is also the case for intuitive conceptualization, but it is not the only role of time and space. Indeed, when space is used, the meaning is determined thanks to the position of the elements, by their relative size and by their possible interlocking. In the case of time, meaning is revealed thanks to articulations which link elements to each other. The meaning is determined thanks to the successive order of the elements.

### 4.2. Using intuition in interdisciplinary communication

The Chapter 3.2 was pointed out the difficulties of knowledge communication in interdisciplinary groups. These difficulties may concern descriptive and PK because of the ontologies proper to each discipline. They may also concern prescriptive and TK because humans are communicating.

The impact the perceptive or the conceptualizing intuitive process can have on communication and on explicit knowledge sharing is immediate. Indeed, as intuition is not based on prior explicit knowing, it does not require the use of disciplines’ ontology. If the transmitter’s formulation process output is such as receiver’s understanding process (cf. Figure 3) being based predominantly on intuition, then the discipline ontology issued cited previously is minimized.

---

5 Henri Bergson states that abstraction needs beforehand generalization and vice versa. This voluntary confusion can be explain by the Bergson’s theory knowledge evolution: in spontaneous cognitive activities, there would be captures of intuitive, implicit or resemblance nature, which would be already specifications. Bring to the level of reflection, these captures would become concepts thanks to settling words.

6 The analysis of Saussure's works reveal that he was certainly intuitively understanding thanks to visual modality.

7 who was certainly intuitively understanding thanks to verbal modality.
On the other hand, the way intuition process can help experience related knowledge-sharing issues (tacit or experienced related PK) is very different. Actually, intuition is the regular understanding process used to gain TK. TK and intuition work together. However, formulation can be processed such as receiver’s understanding process would be eased by favoring intuition. In other words, if one can explain one’s point of view in a way that others understand it well intuitively, then the knowledge sharing would be more successful.

To conclude, intuitive process can help the sharing of all varieties of knowledge. In order to reach this goal, it was shown that formulation has to be realized and structured for the understanding process to be highly intuitive. Structuring the knowledge-sharing process, based on intuition is then a solution for the problem focused by this paper. The communication process, based on the mechanism described in Figure 3, should be structured considering the intuitive mental process. From this consideration a proposal can be propounded.

4.3. Proposal: the Evoked Metaphor

We propose here to introduce intuition thanks to a concept called Evoked Metaphor (EM). As we are aiming at establishing a communication system for a specific content but based on intuition and its process, we propose the creation of an interaction place (based on the theory of Ba, including the SECI Model [19,20]) in which a metaphor related with the specific topic would be built. This metaphor has to be such that its understanding (and thus its explanation) is accessible by all, due to the intuition process. In other words, the EM is an image whereby the project, its context, and its problem can be expressed and studied by analogy. The definition and the construction of an EM are done by the two following aspects: a static aspect, structuring the analogical context, and the dynamic aspect, structuring the processes existing in this context. This induces attributes and constraints that have to be developed here (cf. Figure 5 illustrating following explanation).

Probably the most important aspect to be considered while setting up the EM is the analogy between the EM and each of the disciplines’ points of view involved in the workgroup. It is crucial that each discipline can validate in full the EM structure and processes. At each step of the process, any contradiction should be corrected in order to validate the EM completely by each single discipline.

The understanding of the EM, since it is based on intuition, should not require any specific disciplinary knowledge. Thus, we advise the set-up to be based on a very pragmatic concept that could be understood by everybody (even external to the workgroup), due to their own intuition or own experience.

The EM has to serve as the meeting point between the disciplines to share their own knowledge and methods, and to progress together. Then, each discipline should be able to translate both ways between its own disciplinary ontology and the EM. This would allow each discipline to participate to the project at each step, by understanding and validating each step (first way), and by instructing or implementing new elements to the project (second way). The project would be then totally interdisciplinary.

Finally, the EM should be able to support interdisciplinary communication. This means that each discipline should be able to use EM concepts to explain any problems raised by the disciplinary concept or to understand any other problems evoked during the process.

As spaces such as the EM are included in design skills, we consider that the field of design is in charge of elaborating the EM before it is validated by other disciplines [21].

The points hereinbefore show the strength of this methodology: Based on a four step cyclic process (socialization, externalization, combination, and internalization - cf. Figure 6), the theory of Ba and the SECI Model are well recognized for efficient information management in workgroups. The use of the EM reinforces the embodiment and body transcendence of knowledge, allowing better shift between tacit and explicit knowledge, better interaction between members, and thus better understanding and realization of the interdisciplinary project. It would result on interdisciplinary output, meeting the goal that interdisciplinary design intends to reach.

Figure 5: EM principles

Figure 6: EM process (in red) in SECI Model
5. DESIGN OF MATiK

In order to illustrate the point, this chapter introduces promptly an example of EM-based design. It consists in the currently in-process design of a Kansei information based communication tools called MATiK. This part had been presented at the Futureground Conference, Melbourne, in 2004 [22].

5.1. Introducing MATiK

MATiK is introduced as an original communication system designed for interdisciplinary workgroups to communicate on various topics, without limitation of space and time, providing each member the necessary information according to the consideration of individual specifications. This description presents some key aspects, which have to be analyzed in order to understand MATiK better. The aim is to design one interface that can be used by any of the group members, with geographical and time independency, spreading information in a selective and intelligent way based on personal user criteria (the aim is to split and structure information, and to provide only the interesting part if there is). Each of these criteria is important since they provide all together the possibility for a delocalized interdisciplinary group to communicate efficiently. MATiK can be seen as a communication tool for the cyberspace [23], able to filter and organize information flow intelligently, by taking the several human aspects into consideration for the profit of collective intelligence.

5.2. The EM: the Loft

In order to understand what MATiK is better, what its philosophy of operation, and what its originality is, an EM is introduced here: the Loft. The design of the EM starts from basic considerations concerning extensive interdisciplinary workgroups.

Extensive workgroup members very hardly work all together. For efficiency and organizational concerns, they split into little groups, enabling better discussions. However, these discussion groups are not physically real and one is not captive of the other group: one can jump from one group to another, and even can be part of a few groups at the same time. If the group communication system is well organized, then any member should be part of any relevant discussion group for her/his concern or any group she/he may help. From these simple considerations, we can describe once again the same workgroup considering a loft environment.

A loft is a big and unique room. In this space, a group of people is doing various activities (in a loft used as an apartment, people may cook, sleep, watch television, read, and so on...). As people are doing different things in different places, non-clearly delimited subgroups are formed. These subgroups may begin discussions, probably on a topic related with their activity. As the conversations are going on, it may happen that one or few individuals, initially not taking part in the conversation, get interested into it (by consequence of phenomena such as the ‘cocktail party phenomenon’ [24]). This interest may be converted into participation, into active listening, into the beginning of a talk with other people, or just into ignorance. Two critical points in these definitions: the unity of space and the multiplicity of activities. Both are the consequences of the loft structure.

The similarities between the interdisciplinary workgroup structure and interaction dynamics and the loft group ones are obvious. The entire group is split into a few subgroups in which interactions are intensive and discussion topics different from one subgroup to another. Yet, these interactions may jump out of a subgroup to attain other members which may enter the subgroup or not. In both case, these jumps are because of the concordance between the topic and some of the attained member personal criteria.

5.3. Using the Loft to design MATiK

MATiK intends to simulate the same environment of communication as the Loft within the interdisciplinary workgroup through IT. The basic functional process would be following such synopsis: the sender writes a message being part of already existing discussion or the starting point of a new discussion. In the second case, the sender would have to select desired receiver (with who she/he wish to start the discussion). This selection has the same intension as the three lines ‘To:’, ‘Cc:’ and ‘Bcc:’ of the email system. This selection should be limited and an exclusion list could be set up too (who the sender does not want to send the message to).

Then, MATiK analyzes the content of the message. According to each member’s specification (sender included), MATiK may add some of the other members to the receiver list to render the cocktail phenomenon events that could take place in the Loft. The result consists in a series of mails with complete (for full receivers), partial (for members which enter in the course of the conversation), or empty contents (some members may just notice that a conversation is going on, without getting the content, a kind of one girl call).

Finally, each member may react to pursue the conversation or not, or simply to listen to the on going discussion, to their own discretion. This gives MATiK the ability to go on, and improve dynamically the management of the conversations. The previous description gives a rough but correct idea of the operation of MATiK, as an original communication system used in the cyberspace proposed to interdisciplinary workgroups.

5.4. Functional requirements

To identify and specify functions of MATiK, the Loft is used as the base for the function-listing step. From different scenarios taking place into the Loft, and needs expressed by real workgroup experience, it is possible to determine functions relevant for MATiK.

Thanks to scenarios applied on the Loft, it is possible for any member of the MATiK design group to propose functions that can be intuitively understood and validated by all the members. These functions describe the operating system of the Loft. It is important that all the members can validate each of them. Then ‘Loft functions’ are translating to become ‘MATiK functions’. Thanks to the validation on the loft functions and the analogy between MATiK and its EM (the loft), MATiK
functions can be gathered to set the functional requirements.

Some functions are requiring quantified information. For example, that is the case when MATiK needs to evaluate the potential interest of each user about receiving a specific message (in the Loft, this corresponds to the level of reaction in the cocktail party phenomenon event). Thus, an experiment is carried out currently in order to evaluate quantitatively these levels of interest. In order to stay close to the EM, the experiment is designed simulating the sound environment in the Loft. Evoked related potentials (ERP) are measured on subjects listening at a mix of five equally-tone conversations by surround system headphones after mood infusion [25-27]. Within these conversations, some events in their formal aspect (familiar voice or way of speaking) or content aspect (keywords) can be captured by stream segregation and may cause short high brain stress. ERP characterizes the level of brain stress, which is considered as the weighting for each message analysis criterion used by MATiK. Also a correlation correspondence with subject personality (based on the Five Factor Model OCEAN) is evaluated in order to design user-customized weightings in MATiK.

5.5. Technical requirements

Considering the design of MATiK using the Loft, it would be judicious to propose a technical solution being in accordance with this EM approach. However, multiagent technology abilities seem to be adapted to what Loft requires. An agent is an autonomous entity (a software in information technology), which is capable to act on itself and on its environment, which in a multiagent environment can communicate with other agents, and whose behavior is the consequence of its own observations, of its own knowledge and of interactions with other agents [28]. A multiagent system is an environment where at least three agents act and interact. As Loft operation is mainly based on individuals communicating between each other in a specific environment and acting in this environment, the multiagent system technology match totally Loft requirements, and thus MATiK ones.

According to the constraints and the characteristics of multiagent systems, recommendations for the data processing design of MATiK using multiagent technology can be set. Nevertheless, this point may not be gone into details since it is not the aim of the present paper.

This example showed how MATiK can be designed thanks to an EM (the Loft) keeping all the interdisciplinary aspects of workgroup and the project (at least design, psychology, management, brain science, information science are involved in this project).

6. CONCLUSION

We showed that design should be interested in interdisciplinary methodology in order to improve the concordance of artifacts with humanity and with the environment. This interest should be settled by designer’s behavior aiming at extending contact with other disciplines. The creation of interdisciplinary workgroups overtakes specialization limitations and maximizes the quantity of product dimensions taken into account in the design process. Nevertheless, we pointed out the knowledge sharing issues existing in interdisciplinary workgroups. They affect all the varieties of knowledge but can be minimized by intuition. From this statement, we proposed a methodology, based on the theory of Ba, on the Model SECI, and on an evoked metaphor (EM). This EM would allow group members to communicate and work together, minimizing disciplinary constraints and benefiting from all the strength of interdisciplinary context. Each member (regardless of the background) can understand and participate in all the steps of the design process, validating due to her/his own disciplinary ontology. We finally provided an example following this fully interdisciplinary methodology: the design of MATiK, an original workgroup communication system based on Kansei information.

Interdisciplinary issues are classic concerns in design. The methodology presented in this paper, based on intuition, assertively proposes a pragmatic solution to process interdisciplinary design and for interdisciplinary workgroups to communicate efficiently. The strength of this solution is that the EM can be used at each step in the design process, keeping the entire group working together on the design from the beginning to the end of the project. This is possible because the three main levels of the design process are considered and linked by the EM: the ideas/concepts level (including EM), the reality level (context related issues) and the technological level.

![Figure 7: the levels of the design process](image)

ACKNOWLEDGMENT

This research is part of the 21st Century COE program Promotion of Kansei Science for Understanding the Mechanism of Mind and Heart, sponsored by the Japanese Ministry of Education, Culture, Sports, Science and Technology.

REFERENCES

1. PSA; Les sens en éveil; Planète Groupe (Internal journal of PSA Peugeot Citroën); 25-29 (1999).
2. P.M.A.Desmet, P.Hekkert, J.J.Jacobs; When a car makes you smile: Development and application of an instrument to measure product emotions; Advances in Consumer Research; 27; 111-117 (2000).
3. W.Gilles; The context of Industrial Product Design; Carleton University (1999).
4. L.-E.Janlert; The character of things; Design Studies; 18; 297-314 (1997).
8. T.Love; Constructing a coherent cross-disciplinary body of theory about designing and designs: some philosophical issues, Design Studies; 23, 345-361 (2002).
15. I.Kant; Critique of pure reason; Palgrave Macmillan, Houndmills, New York, 681 (2003).
23. P.Lévy; L'Intelligence Collective: pour une anthropologie du cyberspace; La Decouverte/Poche, Paris, 247 (1997).