Paper title:
Ambiguous problem-solving in the product development process: Japanese practices

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Keywords: Hiding hand effect, ambiguous problem-solving, innovation,

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Introduction

In this work-in-progress paper we argue the role that ambiguity works in the product development process using the example of a Japanese industrial company case. We focused our attention on an ambiguous problem-solving process that suppliers do against the request of the buying company. This ambiguity makes a developer use trial-and-error in the product development process. When we say ambiguity we are referring to several aspects. Literally, ambiguity is defined as the state of having more than one possibility. In management studies, Cohen, March and Olsen (1972) called decision-making in highly ambiguous settings “organised anarchies”. This model is called the “garbage can model”. This model was largely a reaction to the rational and political process models of decision-making. They believed there was a lack of sufficient sensitivity in the decision-making process.

In this paper, ambiguity is referred to as the “variety of circumstances”. So, it is defined as the situation being difficult to interpret or explain, because there are many different aspects to it. For instance, some product development projects may be launched even though the developers do not have any technical problem-solving ideas. Furthermore, the goal may be redefined by the developers. In some studies of joint product development it was found that one of the key factors for success is to identify the managerial task. For example, some researchers have suggested the importance of this. “Significant problems arise when the manufacturer fails to communicate clearly to suppliers what it expects from them, especially in terms of development responsibility for the products they produce. This leads to suppliers forming inaccurate assumptions as to what this responsibility may be, possibly even basing strategies and investments on those incorrect assumptions. The lack of clear project plans and work-packages and the absence of agreements regarding the basic principles of the collaboration leave room for diverging interpretations (Wynstra et al. 2001, p.159)”.

In our research, we have found an unusual case which was not suited to the theoretical perspectives. By using the ambiguity concept, we will develop an analytical framework to interpret Japanese joint product development practices. Antecedents tell us that a joint product development begins when a specific goal has been established. However, Japanese companies sometimes tend to start their joint product development projects before the goal has been clearly defined. We will explore how Japanese companies drive their problem-solving, and how they come to a consensus on the goal of product development under ambiguous conditions.

To understand this unusual phenomena, we will organise this paper as follows. First, we will briefly review some previous research on innovation and uncertainty. Through this process, we may confirm that some ambiguous conditions lead to innovative problem-solving in the product development process. Second, we will specify our research question. Third, we will refer to our case studies on procurement of materials and joint product development projects in Japanese companies. Fourth, we will develop our conceptual framework based on the linguistic communication model. This model may give us some interesting perspectives against the orthodox product development models.

Previous Studies on Ambiguity and Uncertainty as Innovation Drivers

In economics, the ambiguity concept always plays a crucial role in the decision-making theory (Ellsberg, 1961). Ellsberg (1961) defined ambiguity as “a quality depending on the amount, type, reliability, and ‘unanimity’ of information, giving rise to one’s degree of ‘confidence’ in an estimate of relative likelihood” of the future events. He revealed that people's choices violate the expected utility hypothesis. Ambiguity sometimes distorted people’s expected behaviours, people may react to ambiguity in creative ways. In this paper, we will describe how Japanese companies start their product development projects under ambiguious situations.

We, however, will focus upon unanticipated behaviours which are influenced by ambiguity. These unanticipated behaviours sometimes may lead to breakthroughs or innovations. As for innovation research, Abernathy, Clark, and Kantrow (1983) emphasized the importance of uncertainty based on thier observation of innovation process in automobile industry. They suggested that diversity on both the demand and supply sides led us to try new technologies. The demand side of the market will require the satisfaction of a new cluster of needs and preference; the supply side will experiment with new dimensions of performance and value. As a result, this mutual search process will make techonology more visible, more valuable, and more diverse.(Abernathy et al.(1983), p.99)

Ambiguity does not have the same meaning as uncertainty. Uncertainty is defined in several ways. In economics, it was defined as possible outcomes under various circumstances (Perloff, 1999, p.620). North (2005) defined it as a condition in which no probability distribution existed. In management study, it sometimes was defined as a level of forecasting capability at a given point in time (Pfeffer and Salancik, 1978, p.p.67-68). Although the variety of definitions that have appeared have various details and concerns, all these are related to future forecasting. In an uncertainty condition, since there is a lack of full knowledge, it is impossible to describe the existing state or future outcome exactly. In other words, all the descriptions are just possible estimations. In this meaning, ambiguity has a functionally similar role to uncertainty; it hides some details of future occurrences. By definition, “uncertainty” may not be completely equal to “ambiguity”, however in this paper we will treat these two concepts as having the same functionality.

Our Research Question and Method

In this section, we will state our research question and methods. We have confirmed that ambiguity (i.e. Unpredictability in the future) sometimes leads us to unexpected behaviours. As the background of our research question, another function of ambiguity that Hirschman discussed in 1976, is important. So before we mention our research question, we have to introduce it briefly.

Hirschman (1967) reported several cases in which ambiguous conditions led to “creative responses”. He stated the common structure of cases of international projects in which ambiguous conditions brought “creative responses”. The common structure that Hirschman stated can be formulated as follows:

1. If the project planners had known in advance all the difficulties and troubles that were lying in store for the project, they probably would never have touched it. As a gloomy view would have been taken of the country's ability to overcome these difficulties by calling into play political,

administrative, or technical creativity. Saying in our words, that is, for those project planners, there are too many uncertainities to make a rational decision, so they use their images about a certain country or other factors (such as political consideration etc.) to help them to make decision.

2. In some, though not all, of these cases advance knowledge of these difficulties would therefore have been unfortunate, for the difficulties and the ensuing search for solutions set in motion a train of events that not only rescued the project but often made it particularly valuable.

According to Hirschman (1967), creativity always comes as a surprise to us. Therefore we can never count on it and we dare not to believe it until the surprise has happened. Hence, the only way in which we can bring our creative resources fully into play is by misjudging the nature of the task, by presenting it to ourselves as more routine, simple and undemanding of genuine creativity than it will turn out to be.

Since we necessarily underestimate our creativity, it is natural to underestimate the difficulties of the tasks that we are faced with. Tricked by these two offsetting underestimations, tasks are undertaken bravely. Without them we would be far more hesitant to do so. Hirschman (1967) called these underestimations that beneficially hide difficulties from us the “Hiding Hand”.
In general, when we use language to communicate with others, every word we receive does not necessarily have a single meaning. When the meaning is not unique, it is possible to get confused about how to respond at the next step. Then if we want to keep the conversation going on, we have to decide the meaning temporarily. That is to exclude all meanings but choose one for communication. This process of choosing meaning is what Hirschman’s “Hiding Hand” metaphor meant.

Hirschman (1967)’s “hiding hand” concept is somewhat similar to Marx's famous sentence "Mankind always takes up only such problems as it can solve". He modified its wording slightly, but had changed its meaning fundamentally, to read: "Mankind always takes up only such problems as it thinks it can solve". Addition of the words “it thinks” blurs the neat determinacy of Marx's original statement. For, with Hirschman (1967)’s version, it is possible that, as a result of various misconceptions about its problem-solving ability, "mankind" will take up either more or fewer problems than it actually can solve at the moment it takes them up. Up to a point, the “Hiding Hand” can help to accelerate the rate at which "mankind" engages successfully in problem-solving. People take up problems that they think they can solve, but find they are more diffcult than originally expected. Then being stuck with them try to surmount the unsuspected difficulties and sometimes even succeed.

Using Hirshcman’s model we can understand why people would try to do something even if the conditions are ambiguous. However, if we look into the development projects, no matter the economic development projects or business ones, this description still can not explain why under ambiguous conditions, different people with different logic could reach the same goal. To put it back to an industrial business context, our research question can be stated as follows. In an industrial product development project, why do both supplier and buyer reach the same final outcome, even when both of them interpret each others actions by their own logic and some differences exist

between them.

We will use case studies as our main method in the research. Using case studies is a common method for business and management research, since it allows for a processual and contextual analysis (Yin 1991). According to our research question, what we want to explain is the gap that existed between the rational theory and the real phenomenon. Using case studies is appropriate for understanding the dynamics of the phenomenon (Bonoma 1985). Our aim is to understand the dynamics of how suppliers and buying-companies reach the same goal, starting from different understandings on the goal of the joint project. This is why we chose this method.

The Case

Sumitomo Light Material (SLM, hereafter) is one of the material suppliers to DENSO, who are one of the biggest parts suppliers to TOYOTA. In this case, we will discuss the clad aluminium sheets that SLM offers to DENSO. In this case study, we interviewed the product manager of SLM to understand the whole procress that occurred between SLM and Denso, between 2000 and 2001.

In general, the main tasks that maunfacurers ask for material suppilers to fulfill are lower price or steady product quality. However one of the players in this case, DENSO, required SLM to provide the highest quality products. Therefore, when SLM offers its aluminium sheets to DENSO, the quality is the most important task.

Under this quality task, a joint project between SLM and DENSO had started in 2000. The first time, the goal of the joint project was to reduce the size of the radiator for new models which would be produced in 2004. In other words, the joint project started 4 years before the product needed to be final. Since the goal was set in the future, there were many factors out of control at the time the project started. Also because of this uncontrollable situation, the ideal goal could easily be defined but the solutions could not be decided clearly. So the joint project started in an ambiguous atmosphere. Under this ambiguous sitution, the staff of SLM and DENSO conversed with each other to decide the specification of the new product. After several months of meeting, the specification of the new product was decided in the middle of 2000, and the project continued. However a serious problem occurred in January 2001. The aluminium sheets SLM offered to DENSO developed holes during the heating process.

In general, the manufacturing factory is full of dust. So was present during the manufacturing process of aluminium sheets. If the factory does not set any special cleaning systems or devices to reduce the dust, they can easily to stick on the products. Before DENSO pointed out the problem, the aluminium sheets that SLM offered up had some dust on them. In Fig. 1 we will show how the dust created holes in the sheets. The new sheets that SLM were producing were thinner than previous sheets, previously small holes that didn't go all the way through the sheets were created. However with the thinner sheets the holes went all the way through.

First, the parts of the radiators are composed by two different kinds of aluminiums. One of them has a higher melting point and the other a lower. The dust stuck on the lower melting point aluminium sheets and transfered to the high-melting point sheets through the first heating process. Then they

develop holes on the parts during the second heating process. (see Fig. 1)

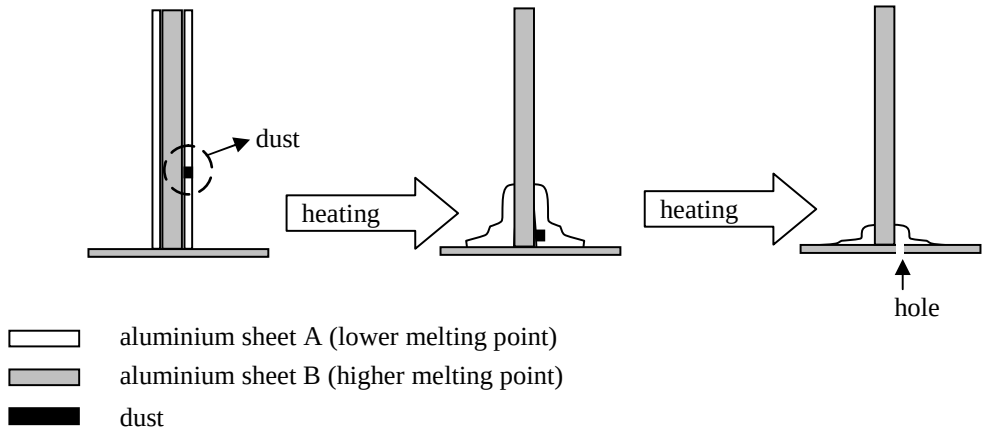

Fig. 1 Diagram of the occuring problem

When the problem occurred, in addition to the original task (down sizing), a new task had been created. That was to solve the hole-developing problem. The DENSO engineers' understood, that the reason was the sprinkled dust that stuck on the clad aluminium sheets. Specifically, a copper dust. So Denso engineers asked SLM engineers to remove all sprinkled dust on the aluminium sheets. That meant DENSO required SLM to supply perfectly clean aluminium sheets. However, to the SLM engineers, this requirement was far beyond their capabilties.

There were several solutions. In order to solve this problem perfectly, using a "clean room" was the best solution. This idea was neither realistic nor practical for both DENSO and SLM as the production costs would become extremely high. Adding a washing process into the production process was another solution, but this would also increase the costs. According to our interview, the product manager said, the "clean room" and "washing process" ideas were denied by the SLM engineers right away, even without evaluating the possibility or the real effect on profits that may come from the investments. However, the discussions between DENSO and SLM were on going. This fact tells us two important points. Firstly for some reason the SLM engineers were unwilling to use some rational options during the solution searching process. The other one is that DENSO and SLM had different ideas to solve the same problem. Even though their ideas are different, they kept the discussion going on.

Against this requirement, SLM engineers tried to find other solutions. First, they found the outbreak sources creating the copper dust that stuck to the surface of the aluminium sheets. The electric motors were the source. According to this finding, they wrapped these electric motors in plastic covers. This improvement reduced the amount of sprinkled dust to a tolerable range, however it did not remove all the sprinkled dust.

After this improvement, SLM engineers started to check the amount of dust stuck on the sheets that they made. The checks included the percentage of the dust in an area and the components of the dust. By checking these items, the SLM engineers established a quantitive standard to make improvements. This process influenced the engineers of DENSO in return. They changed their requirement from "no dust on the aluminium sheets" to "decreasing defective ratio of their radiators".

Conclusion

We will now present some findings from the case. First, the specific goal that had been stated by DENSO, was “no sprinkled dust on the aluminium sheets”. This goal was not realistic or practical to SLM. However, SLM accepted the requirement and interpreted it as a challenge. According to this interpretation, SLM tried to find out the practical solutions, e.g. the ways to decrease dusts. We often assume that an objective selects the means, but this case seems not to follow this assumption. On the contrary, we might say the means influenced the objective.

In order to make sense on this perspective, let us think about our communication process. From a modern scientific communication veiw point, the communication process will be the model described in Fig. 2.

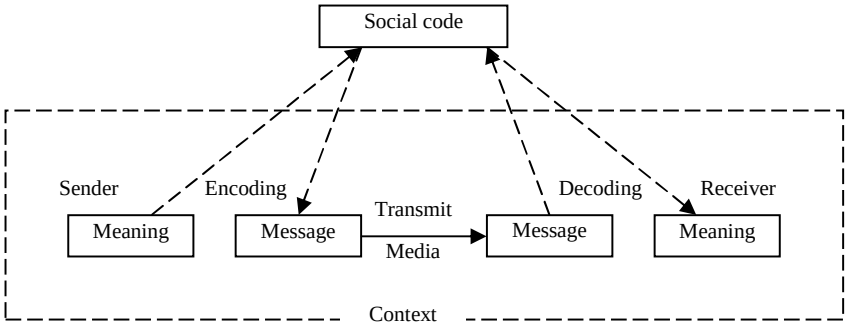

Fig 2. Message Transmission Model (Ikegami 1984) modified by author

However, if we consider our communication process more deeply, we find our interpreting is not always so clear or rational. For example, when we say “see you later”, nobody will confirm if we will meet again or not. Putting this back to our case study, when DENSO asked SLM engineers to reduce the dust stuck to the sheets to zero, no engineer in SLM thought it was possible, but they still tried. However, according to the product manager’s information, the understanding among the SLM engineers is different to the expection that DENSO has. In this instance, we would like to introduce another communication model that is based on linguistic theory. (see fig. 3)

If we apply this linguistic communication model to the SLM case, we have four findings from it.

1. People’s behaviour is effected by his/her interpretation. For example, the DENSO engineers found the sprinkled dust, then they asked for perfectly clean products from SLM because they thought removing all the dust was the only way to solve the problem. On the contrary, the SLM engineers interpreted it by different logic and took different reactions.

2. The interpretations between different people do not necessarily have to be the same. These different interpretations need only be familar or related. In our SLM case, the interpretations between DENSO and SLM engineers were not the same, but they can still discuss the project together. This character refers to the ambiguity in the decision making process.

3. According to point 2, we can say, people accept the different interpretations from others and that

then their communication keeps going on. It is when people refuse to accept the differences, the communication process will stop. This means, communication is based on the acceptance of differences.

4. The function of interpretation and acceptance of differences is to fix, or to define the meaning. That is exactly what Hirschman (1967)'s "Hiding Hand" concept refers to.

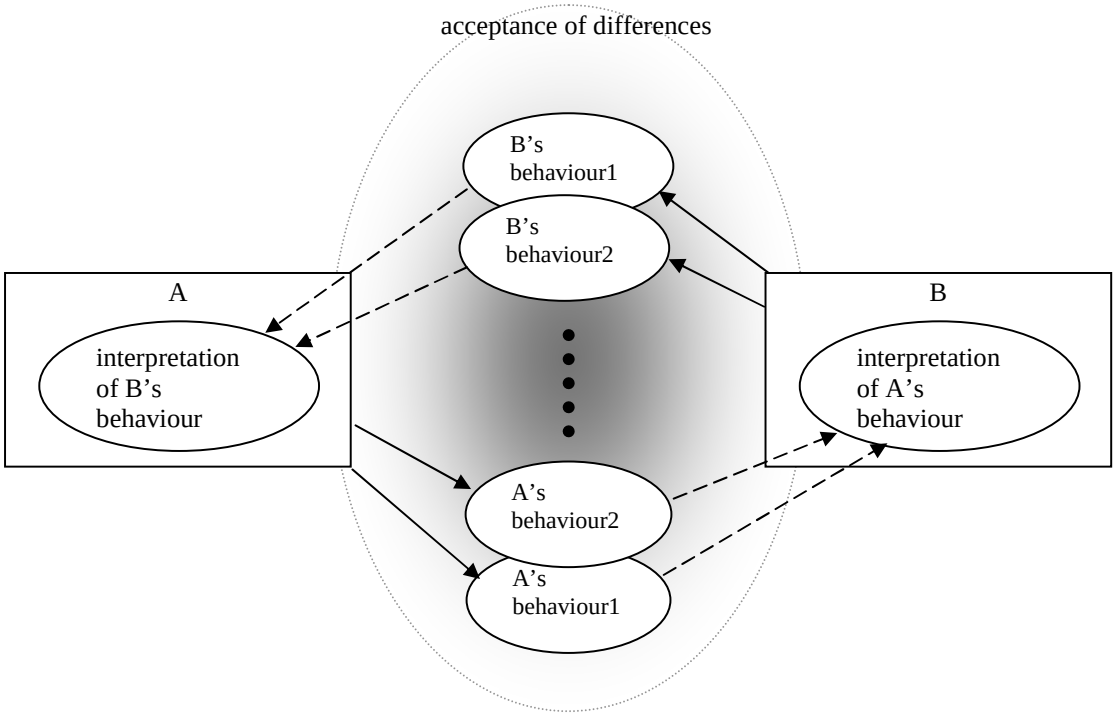

Fig. 3 communication model based on linguistic theory

Theoretical Contributions

We could claim that we found another side of supplier involvement. The earlier study found that early supplier involvement and a greater responsibility of the supplier for the development of its component did not lead to decreased costs or decreased development lead-time, nor to higher quality of the final product (Hartley et al., 1997; McCutcheon et al., 1997). As shown before in Wynstra et al. (2001)'s research the dominant perspective on joint product development referred to well-defined goals. Furthermore, they claimed in the unclearly defined product development process, "there are no clear ideas in what areas, when and how suppliers should be involved. This may lead to involving the wrong suppliers (Wynstra et al. 2001, p.160)". So they conclude "first of all, the necessary activities and processes with regard to managing supplier involvement in product development need to be identified (Wynstra et al. 2001, p.165)".

Based on our case study, the processes and tasks that needed to be carried out were not clear. Furthermore, even the goal of joint development was redefined after the development process had started. DENSO claimed the goal of the joint project was for there to be no sprinkled dust. However no engineers believed that "no sprinkled dust on the aluminium sheets" could be achieved. It was an unacceptable goal for SLM. On the other hand, DENSO was in no mood to compromise with SLM

on the goal. So, the project started in an ambiguous situation. The agreement on the project goal was set after the project had started. Eventually reducing sprinkled dust to an acceptable range was set as a goal. In the end, SLM made innovations in clad aluminium making processes. The ambiguity allowed SLM to use trial-and-error, allowing them to achieve innovation.

Managerial Contributions

In industrial product development, the goal is thought to be clear so that it is hard to feel any ambiguity on it. However, even if the goal has been defined clearly by the manufacturer, it is not necessary clear to the suppliers. In general, suppliers have their own logic based on their technological knowledge. So any clearly defined task may be redefined by the suppliers. Also by the supplier's logic, the way to achieve that task may not be the only one. In the SLM case, when DENSO asked SLM to remove every piece of sprinkled dust from its clad aluminium, no engineer in SLM thought the task was possible to achieve. Also no one knew a way it could be realistically achieved in a cost effective manner. For example, maybe they could build a clean room to keep all the sprinkled dust away from their products, but the costs would increase drastically. The task was impossible to achieve, but also impossible to ignore. So the engineers in SLM started to research the percentage of defective sheets, the components of the dust and the process. All these subjects are not related directly to the sprinkled dust removing task. In this situation, the engineers in SLM, tried to redefine the task that DENSO gave them, and according to their new definition find out the proper solution.

This fact presented us with two important managerial implications. The first one is redefinability of a joint project goal. If the goal that industrial companies have to achieve is clear, it is redefinable by the suppliers, meaning that the method to achieve it can be varied. Had SLM accepted the original task with no interpretation it would have resulted in a less effective solution. In order to find out a proper way to solve the problem, some ambiguity in the decision making process is necessary. Since ambiguity can boost the creativity of people to consider the possible solutions voluntarily. This solution finding ability may be one of the strengths of Japanse industrial companies.

The second implication is the consequences of adaptation. Discovering proper solutions voluntarily in an ambiguous situation is a characteristic style of Japanese industrial companies involved in product development projects. Here, we may call it "Japanese customer oriented adaption". However because of the ambiguous decision making process, the industrial product suppliers may adapt to their customers too much, meaning the operation efficiency is not so good. That is the reason why the Japanese industrial companies have strong competitive potentials but profitability is not good enough. So the suppliers engaged in "Japanese customer oriented adaption", like SLM in our case, could apply their innovation to other businesses someday. "Japanese customer oriented adaption" might not be efficient, but it could be an effective way to encourage innovation.

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