

Diagrammatic Expression as a Practical Framework in Interpretive IS Research

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Abstract

Interpretivism has been recognized as a discipline in the research of information systems, and several theoretical frameworks have been identified for the research. However there is no data showing the increased use of the research papers by IS practitioners. By using Activity Theory we will reveal an ever-lasting structural problem that researchers continue to produce text-centered papers not used by practitioners. Based on the discussion we will articulate the needs for a practical framework. In the 1990s cognitive research intensively studied the effectiveness of diagrammatic expression in problem solving and finding. We will examine the notion of diagrammatic expression as a practical framework in both IS research activity and the use activity of the research results, and propose that the adoption of diagrammatic expression as a practical framework moderates the structural problem. With the discussion we will open up an avenue to the development and use of diagrams as a research domain in interpretive IS research.

Keywords

Information systems, interpretive research, practical framework, diagrammatic expression, activity theory

INTRODUCTION

Interpretive IS research has established its domain in the IS research field. The outcome of the research is knowledge as a text or a narrative instead of propositional knowledge in positivism. It tends to be of a long text, so that it is not aimed at busy practitioners. There is no data showing an increased use of research results by practitioners the same as in the age when positivistic research dominated IS field. Thus the gap or distance between the research and practice has not shortened.

What cannot be overlooked out behind the gap is the fact that it is also difficult even for many less-experienced IS researchers to produce interpretive texts based solely on theories such as phenomenology, hermeneutics and critical theory. The difficulty is mentioned by Lyytinen (1999) as "Anything that really addresses relevant concerns is beyond the scope of a single Ph.D. study."

Knowledge has been regarded as what is produced by a limited number of professionals. In the age of knowledge creation, however, learning by reflecting on own experiences and creating knowledge by oneself are considered important as well as acquiring universal knowledge from outside. Practitioners are required to create a text or a narrative as knowledge. However, they do not have concrete methods as pointed by Davenport et al. (1998, p.175) who mention "Not every engineer can or will do a good job at writing down what he or she knows. Every person should reflect on life, but not everyone can write narratives about their musings." Interpretive IS study is open only to some limited number of researchers.

There have been tools such as an instrument or concepts out behind the progress of culture or civilization (Vygotsky, 1978). The difficult situation surrounding interpretivism suggests the lack of tools. Theoretical frameworks such as Actor Network Theory and Structuration theory have been identified for IS study, but tools for understanding and creating knowledge do not exist. We see the absence of practical frameworks in contrast to the existence of theoretical frameworks.

Recently in cognitive science there has been intensive studies showing the effectiveness of diagrammatic expression in problem solving and finding. It is considered that diagrammatic expression as a tool has some potential to improve these situations in interpretive IS research.

Thus, our research interests are to reveal the nature of the continuing reproduction of the gap between research and practice, to show the necessity of practical frameworks to bridge the gap, and then to present the feasibility of diagrams as a practical framework by referring to the outcome of recent cognitive research, triggered by Larkin and Simon (1987), into diagrams for problem solving and finding.

The next section shows that little research has been made about a practical framework in interpretive IS research. Then we will introduce the notion of a tool and Activity Theory as a research methodology, reveal a continuing

gap or structural problem between the researchers and the practitioners with the research methodology, and show the needs for practical frameworks to dissolve the gap. Then we will review the effectiveness of diagrammatic expression in problem solving and finding shown by recent cognitive science. Finally, we will introduce the notion of diagrammatic expression as a practical framework to the interpretive IS study, and show it has a potential to resolve the non-diminishing structural problem.

LITERATURE REVIEW

The interpretivism here is dialectical or critical hermeneutics (Myers, 1995). The research environment of interpretive study has been developing in both perspectives and principles. For a basic perspective, it is made clear what dialectical/ critical hermeneutics is in IS research. Myers (1995) showed that the primary focus is totality of meanings, social reality, and intended and unintended results, and that the descriptions are interpretive and critical, subjective and objective, and historical.

A set of principles for conducting interpretive studies in IS are articulated by Klein et al. (1999) and made a progress in this field. In the set of principles the hermeneutic circle is the fundamental principle with six more specific principles including that of contextualization, interaction between the researchers and the subjects, dialogical reasoning, multiple interpretations and others.

They serve as a helpful guide for researchers to understand the basic thought of hermeneutics, phenomenology and critical theory, and constitute the basic part of theoretical frameworks.

There have emerged research papers (ex., Orlikowski, 1991; Monteiro et al., 1996) which use Structuration theory and Actor network theory as a theoretical framework. These theories are used as a "sensitizing device" (Giddens, 1984, p.326) to capture the situations.

In the case of the natural reality and its related disciplines, we see engineering between science and practice. Practitioners are involved in their fields with the engineering methods not directly using theories derived from science.

The perspectives and the principles for interpretive research mentioned above are comparable to physics in Science, and are not on the level of engineering. As Klein et al. (1999) point out that the application of one or more of principles requires considerable creative thought, the principles do not reach the level of practical frameworks with which most of researchers can begin specific researches. Only for those people who already have rich understanding of phenomenology, hermeneutics and critical theory, they are useful principles to do research.

Thus, we can see a situation where theoretical frameworks are identified, but practical frameworks are not developed yet. The absence of practical frameworks is thought to prevent the spread of interpretive research into practice.

This situation is also pointed out by IFIP WG8.2 panel (Myers et al., 1998) where Sauer argued; "Theory is actually of little value to practitioners. Academic researchers in IS have too often unquestioningly adopted the belief that 'There is nothing so practical as a good theory.'" Walsham at the panel argued: "Theoretical frameworks such as actor-network theory or structuration theory can be valuable sensitizing devices for the researcher, or practitioner, but they clearly do not provide simple prescriptive guides to action, and there remains a challenge for academics to make the conceptual ideas and insights in these theories more accessible to thoughtful practitioners."

Because of the little use by practitioners, the relevance of interpretive research papers has been discussed mostly in terms of a class discussion case for students who are expected as a future reflective practitioner (Davenport and Markus, 1999; Lyytinen, 1999).

In brief, there remain difficulties for researchers to do a concrete study and for practitioners to use interpretive research results. It is still at the theoretical stage that fundamental perspectives and principles have been identified. Few tools as a practical framework are developed in general. The notion of diagrammatic expression as a practical framework in particular has not been discussed well in prior research (Kosaka, 2002).

RESEARCH METHODOLOGY

We will use the concept of a tool and Activity Theory (Engeström, 1999) as a research methodology. From the perspective of a tool and Activity Theory, we will shed light on the seriousness of the situation, and point out the needs to have a new tool to resolve the difficult situation.

Humans have been using a tool developed in a history when he or she works with an object. In other words there has been always a tool out behind the progress of a culture or a civilization.

The tool is used not only to recognize or transform an object but also has a role of helping a human to control his or her behavior, thereby serves to mediate between a subject (actor) and the object of doing (Vygotsky, 1978, p.40). As a tool, there are instruments for transformation of objects as well as concepts or models for capturing objects.

The tool is at the same time both enabling and limiting. "The tool empowers the subject in the transformation process with the historically collected experience and skill 'crystallized' to it, but it also restricts the interaction to be from the perspective of that particular tool or instrument..." Kuutti (1996).

The use of a tool facilitates the understanding of the object but also has a demerit that it make a human have only a limited view of the object. For example, the positivistic research approach makes a researcher avoid noise, at the same time it constraints the understanding of the reality as a whole.

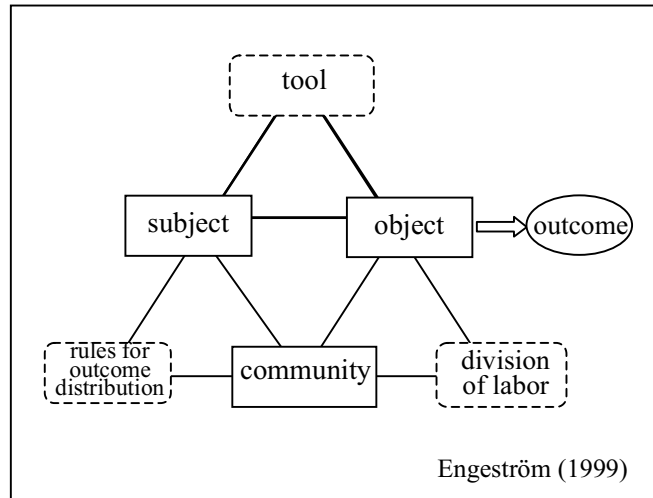


Fig.1 Activity

Activity Theory captures the context where a tool is used. The theory is exceptionally equipped with a diagrammatic expression. It is primarily based on and an expansion of Vygotsky's (1978) idea that the relation between an actor and the object is not direct but mediated by a tool, and places an individual action within an activity practiced by a community which shares the same object. Two new relationships are then formed: subject-community and community-object. They are also mediated, The former is the rules for outcome distribution and the later is division of labor as shown in Fig.1.

A STRUCTURAL PROBLEM BETWEEN THE RESEARCH AND THE PRACTICE

Here we will make it clear that there is a structural gap between the research and the practice, which is a problem that does not accept an easy solution. By using the diagrammatic framework of Activity Theory we will depict the difficult situation between the interpretive research activity and the IS practitioners' activity. Then we will show a possibility that a tool mitigates the problem by mediating between the two.

The activity of researchers

The first one is an activity practiced by the community of researchers. A Researcher is evaluated by the publication of his research outcomes. The object of his research must belong to the current object domain which is considered worth addressing by the community. At the same time, the production manner of the paper must conform to the customs shared by the community, otherwise the paper is seldom accepted by a journal. It means that, in "the division of labor" (mediation), a researcher plays a certain role in producing the journal.

His paper is not necessarily published even if the research domain of the paper is the same as that of the community and also his research manner confirms to the production of the community. In the community each researcher is exposed to implicit and explicit evaluation rules, which is "rules for outcome distribution" (mediation). His paper is published only if it further satisfies that the representatives of the community consider it as a good job.

The fundamental "tools" (mediation) currently applied in dialectical hermeneutics are phenomenology, hermeneutics, critical theory, and a set of principles based on these disciplines. The outcome is a long text there.

These three mediations control researcher's action. Thus an individual action is forced to conform to the customs reproduced by the community. As a result, the action continues to result in the production of a text-centered paper that is expected to be an ethnographic or case paper mostly with no diagrams.

What we have to pay attention to is that there is no practitioner's perspective in the papers produced. The community is comprised of researchers most of whom advocate theoretical frameworks. As a result, a paper for practitioners or a practical framework is seldom published.

Walsham (1995) mentioned the inerratic reproduction of journal articles as a "machine" by borrowing an idea from Actor Network Theory. Here we have elucidated that an ever-lasting mechanism is reproduced by the three mediations.

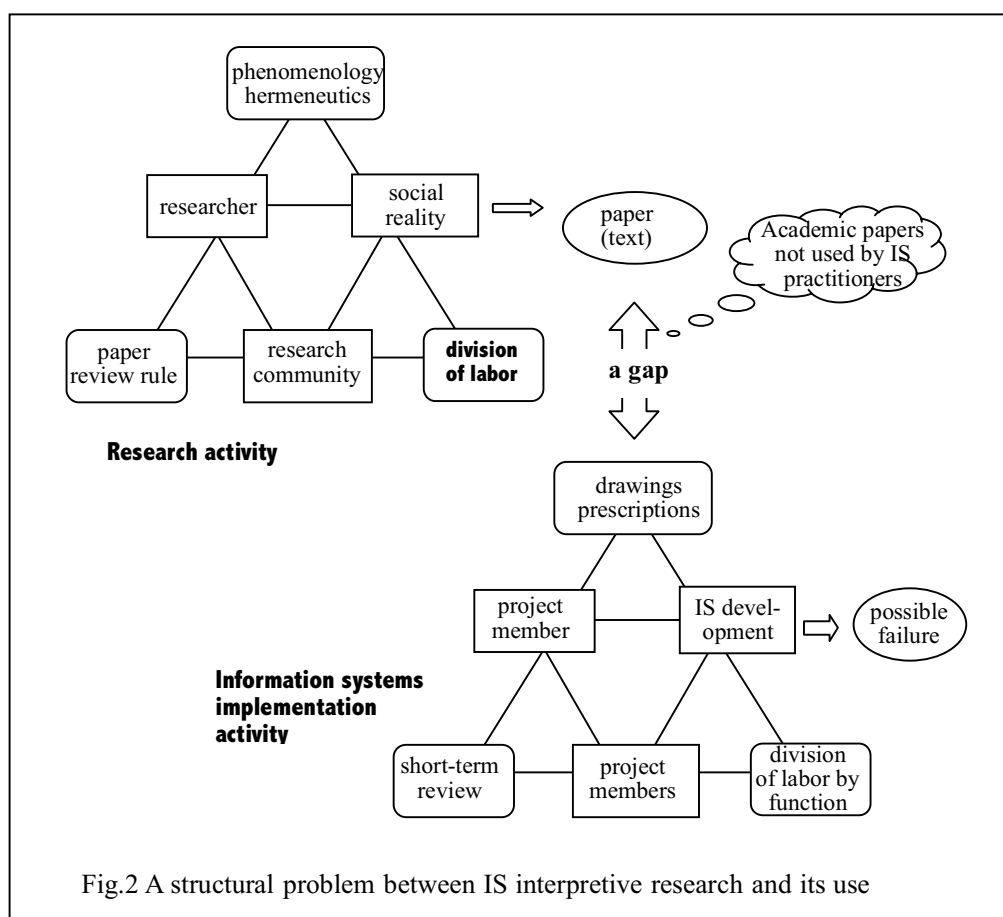
The activity of IS practitioners

The second one is an activity of IS practitioners including busy managers. Their work is characterized by frequent interruptions of time. The interruptions are intensifying as changes of environments increase these days.

The size of most IS is large at present so that "the division of labor" (mediation) is followed in general. IS development is usually performed function by function. The context in which IS will be placed is destined to be considered less important than the functions being currently developed. As a result, information systems tend to be considered a technical system rather than a social system.

The evaluation of project members or "outcome distribution" (mediation) among them under the division of labor is usually made at the end of each phase prior to the end of the project as a whole. It means that the evaluation is performed based on short-term outcomes. Project members and managers become more concerned with functions of IS than the context of IS.

Methods or "tools" (mediation) used in IS development activity are primarily related to hard system thinking (Checkland, 1984). They belong to an engineering methodology, where approachable prescriptions and drawings are used. By using the methods or tools people can develop IS of a certain quality. Furthermore, CASE tools provides an environment where IS is produced semi-automatically to some extent by following the procedures provided. Efficient development with tools facilitates the dependence on tools among people.



An IS manager or a project manager should cooperate with the project members. What is necessary in an organization is a good story or narrative (Weick, 1995, p.61). However, the three current mediations in the IS development activity do not allow stories or narratives to be appropriated in the organization. Knowledge such as best practices and prescriptions instead prevails over stories or narratives there, although research shows that knowledge is communicated most effectively through a convincing narrative that is delivered with formal elegance and passion (Davenport et al., 1998, p.81).

A structural problem between the two activities

As a result, knowledge used in practice is prescriptions and drawings which include little contextual information. In contrast, knowledge produced by interpretive researchers continues to be of a text-centered long paper which includes rich contextual information.

Therefore, a gap continues to exist between the production and the consumption as shown in fig.2, as is the case in the age of positivism. Academic research papers are not used by practitioners. This situation emerges due to the different strategy adopted by each person to survive in his community, it being an unintended consequence.

Acknowledging this situation, a few researchers say that interpretive papers are not directed toward practitioners but toward future reflective practitioners who are currently students, and therefore the papers are valuable as materials for class discussion (Davenport and Markus, 1999; Lyytinen, 1999). For example, Lyytinen (1999) says "Our research findings are appropriate in practice - through our teaching. Textbooks have an immensely important role in shaping the minds of future generations." Davenport et al. (1999) also say "Our undergraduate and masters students are important research consumers. We should aim to produce practical research that is consumable by current students, thereby increasing the audience of reflective practitioners."

A practical framework mediating the two activities

We have revealed a structural mismatch why interpretive research papers are not transferred from researchers to practitioners. The mismatch or gap is considered to continue to exist because of different survival kits or mediations.

When we look at natural science and its utilization, we see a discipline of engineering between physics as science and industrial production. In other words there is engineering to practical frameworks as science to theoretical frameworks. Practitioners usually apply practical frameworks to solve their problems not theoretical ones. Research of engineering is evaluated but differently from that of science.

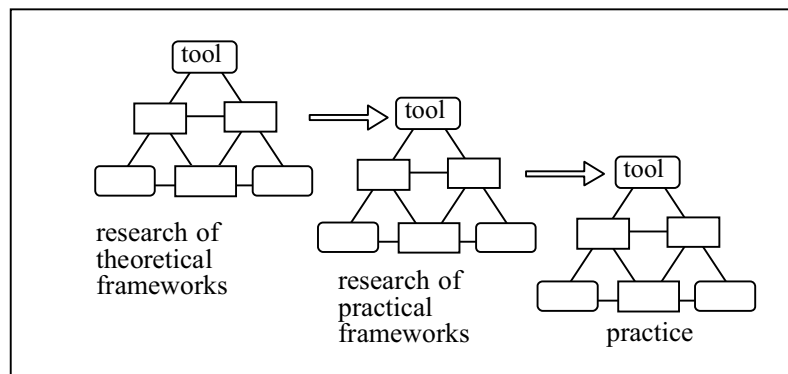


Fig.3 A research community of practical frameworks

Research of engineering is evaluated but differently from that of science.

In the age of knowledge creation, practitioners also have to create knowledge by reflecting on their own practices. They need practical frameworks not only for understanding the research results but also for their own knowledge creation.

Not every researcher has to create a theoretical framework. Some of researchers can contribute to make cases as most of ethnographers create an ethnographic text with the use of ethnographic methodologies or theories already established.

In order to promote IS research and the use of research results, there is a need for us to establish another research domain for practical frameworks in between the research community for theoretical frameworks and the community of practitioners (fig. 3).

In the next section we will examine the possibility of diagrammatic expression as a practical framework. The notion of diagrammatic expression is expected to bridge the gap.

DIAGRAMMATIC EXPRESSION AS A PRACTICAL FRAMEWORK

In this section we will discuss the notion of diagrammatic expression as a practical framework. We will not discuss the effectiveness of a specific diagram, but show the possibility that the general characteristics of diagrammatic expression moderate the problem concerned with research and practice.

IS practitioners and researchers acknowledge the importance of diagrams in systems development (Fowler, 2000, p.6). For example, UML has a variety of diagrams including a class diagram and a sequence diagram, which enable IS practitioners to develop a clear understanding of an organization, enable them to design IS, and further facilitate users' understanding of their own work.

However, diagrams and pictorial illustrations have been disdained in the Western education and research (Arnheim, 1989). It is known that papers and articles published in the West of phonogram are text-centered compared to those carrying lots of diagrams in the Far East of ideogram. Recently, cognitive science researchers have revealed the positive aspects of diagrammatic expression (Larkin and Simon, 1987; Cox and Brna, 1995; Stenning and Oberlander, 1995; Ueda, 1995; Suwa, 1999; Suzuki, 2001; Yamazaki and Miwa, 2001). We will adopt them to eliminate prejudices against diagrams. Diagrams have the following characteristics that were revealed by the mid-1990s.

- Compactness: Diagrams can group together all information that is used together, thus avoiding large amounts of search for the elements needed to make a problem-solving inference.
- Locality: Diagrams typically use location to group information about a single element, avoiding the need to match symbolic labels.
- Emergent Property: Diagrams automatically support a large number of perceptual inferences, which are extremely easy for humans.
- Specificity: Diagrams give shape to things by visualizing their location and size, thus sometimes restrict abstraction. Diagrams have a negative effect in this respect.

It is known that reduction in cognitive load is the primary effect of diagrams. For example, there is a study reporting that, in a world with interruptions, a text with diagrams supports knowledge workers working on complex symbolic problems more effectively than a text only does (Speier et al., 1997).

Since the mid-1990s, the effectiveness in problem solving and finding has also been examined by cognitive researchers. For example, Suwa (1999) demonstrated that a human goes through a process where he finds a new aspect of a problem by drawing and externalizing his idea inspired from the diagrams while he is illustrating them. Yamazaki et al. (2001) showed that diagrammatic expression works as an externalization resource of internal ideas and helps to find new solutions by facilitating the reflection on his own thought and experience. Meanwhile, Cox and Brna (1995) revealed that the use of multiple external representations (drawing) was associated with correct responding to a problem more often than was the case of single representation.

Based on these findings we will discuss the notion of diagrammatic expression in interpretive research and practice.

The effectiveness for researchers

The characteristics of emergent property means that a big picture is inferred from a diagrammatic disposition of parts and then the big picture supports the re-interpretation of the parts. It corresponds to the hermeneutic circle, the main principle of interpretive study, so that diagrammatic expression can be regarded as a facilitator of the hermeneutic circle.

Recent cognitive science shows the effectiveness of diagrammatic expression in problem finding. It is still a future research topic to examine what exact relation exists between problem finding and the hermeneutic circle. However, since a problem-finding problem is a sort of a problem whose goal conditions in itself continue to be explored, it is possible to consider that the hermeneutic circle is closely related to problem finding.

As mentioned above, there are a few points that are considered the effectiveness of diagrammatic expression to facilitate the hermeneutic circle. A human finds a new aspect of a problem by drawing and externalizing his inspiration from the diagrams (Suwa, 1999). Diagrammatic expression as an externalization resource of internal ideas helps to find new solutions by facilitating the reflection on his own thought and experience (Yamazaki and Miwa, 2001). In short these points indicate the hermeneutic circle with the aid of diagrams is more effective than that without it.

Tools empower humans in the transformation process with the historically collected experiences and skills crystallized to them (Kuutti, 1996). Therefore, diagrammatic expression can become a practical framework or a tool in studying IS implementation. It is possible for researchers with less experience to begin IS study with the aid of diagrams and then to reflect on their own on-going research to understand the social reality further.

The effectiveness for practitioners

We can expect diagrammatic expression to reduce reader's cognitive load related to search. With diagrams readers are expected to get a big picture about a text with more ease and to associate the parts with the picture. IS practitioners also work in a world of interruptions. The cognitive load associated with the interruption can be

moderated by a text with diagrams (Speier et al., 1997). Readers are supposed to be able to understand a long text in aggregation of segmented time if the text carries diagrams that supplement it.

Like researchers in the interpretive study, practitioners do not merely accept the self-understanding of writers, but tries to seek total meanings that are suggestive to the improvement of his own situation. It means that there is a dialect between the text and the reader through the hermeneutic circle. Diagrams prepared by researchers can show a whole and their parts in a visual way. They are considered not only to reduce the cognitive load of the reader but also to facilitate his hermeneutic circle.

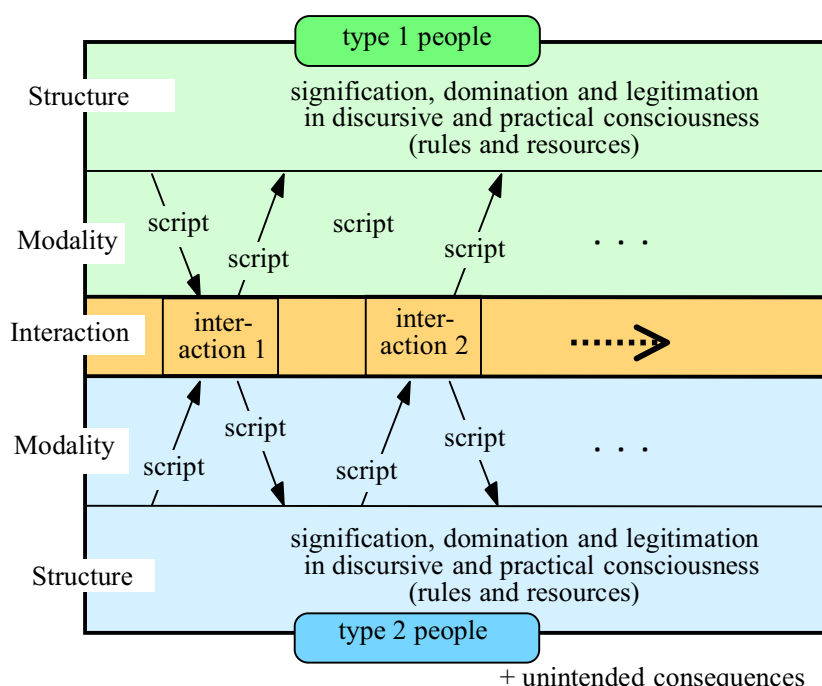
Diagrams can be used and prepared by researchers during the process of study as mentioned previously. The resultant diagrams accompanying the texts will, at the same time, have a role of facilitating the reading of the texts by IS practitioners. Thus, the adoption of diagrams in research will make mediation between the research activity and the practice one, and thereby the diagrams are expected to moderate the structural problem between them.

Diagrams are also helpful for practitioners to create their own knowledge by reflecting on their experiences.

DISCUSSION

As we have discussed the need and effectiveness of diagrammatic expression in general, we would like to suggest a few types of diagrams which need concrete development in the future. Mingers (2001) argues that multiple perspectives are necessary to understand a social reality. Cox and Brna (1995) also showed that the use of multiple external representations is more effective than that of a single one. We will show three types of possible diagrams, two of which are concerned with time, and one of which is not.

Fig. 4 The framework of dialectical structuration (Kosaka)



- Diagram at a particular time: This could be a diagram to capture a relation among actors and non-actors at a particular time over the trajectory of a social reality. For this type of diagrams, a basic framework may be provided by Actor-Network Theory, by which Latour (1999) and others try to capture actant-rhizome ontology inherent in the ever-changing social reality.

- Diagram for a trajectory: This could be a diagram to capture a trajectory of a social reality over time. There is an example for this type (Fig.4). Kosaka (2003) developed a diagrammatic framework that captures the trajectory by using Giddens' Structuration Theory and Bourdieu's sociology of class. In the diagram a researcher firstly depicts a time-series of facts (actions and events) between two or more different parties, ex. IS developers and users. He adds each party's discursive consciousness, reasons for each action, to the facts. Then, he writes the structure for each party, which is often conflicting each other. They are revealed and repeatedly modified through researcher's double hermeneutics while writing the diagram.

- Time-less Diagram: This could be a diagram to capture a timeless relation, for which Activity Theory may provide a basic framework. In this paper we used a diagram in Activity Theory to depict a structural problem between researchers and practitioners. Engeström (1999) has made efforts to represent the context for an action taken by an individual person in a community. The diagram for relations among adjacent activities such as in fig. 2 helps to represent, in a simple form, a complex context concerned with an individual action. For a practical framework based on Activity Theory in IS research and practice, Kosaka (2004) proposes a technique of sense-making which was developed by applying social semiotics to Activity Theory.

CONCLUSIONS

With the aid of Activity Theory we revealed that the gap between research and practice in interpretive IS field is lasting. We then gave an account of the fundamental reason of the needs for a practical framework to mediate the relation between the two.

In a positivistic term we further articulated a hypothesis that diagrammatic expression in general is a practical framework in supporting both IS research and practice. Our discussion is still conceptual. There are needs to develop specific diagrams and to test the hypothesis with them.

In this paper we have tried to open up an avenue for the development and use of diagrammatic expression, a practical framework, as a new research domain in interpretive IS research.

REFERENCES

- Arnheim, Rudolf (1989) *Visual Thinking*, University of California Press.
- Beyer, H. and Holtzblatt K. (1997) *Contextual Design: A Customer-Centered Approach to Systems Designs*, Morgan Kaufmann Publishers.
- Checkland, Peter (1984) *Systems Thinking, Systems Practice*, John Wiley & Sons.
- Cox, R. and P. Brna (1995) Supporting the Use of External Representations in Problem Solving, *Journal of Artificial Intelligence in Education*, 6 (2), 239-302.
- Davenport, T. H. and L. Prusak (1998) *Working Knowledge - How Organizations Manage What They Know* Harvard Business School Press.
- Davenport, T. H. and L. M. Markus (1999) Rigor vs. Relevance Revisited: Response to Benbasat and Zmud, *MIS Quarterly*, 23 (1), 19-23.
- Engeström, Y. (1999) *Learning by Expanding: An Activity Theoretical Approach to Developmental Research*, Shinyousha (in Japanese translation).
- Fowler, Martin (2000). *UML Distilled, 2nd Edition*, Shoeisha (in Japanese translation).
- Giddens, Anthony (1984) *The Constitution of Society*, Polity Press.
- Klein, Heinz, K., and M. D. Myers (1999) A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems, *MIS Quarterly*, 23 (1), 67-94.
- Kosaka, Takeshi (2002) The Notion of Diagrammatic Expression in Interpretive IS research, in *Proceedings of the Sixth Pacific Asia Conference on Information Systems*, 186-190.
- Kosaka, Takeshi (2003) An Approach to Graphical Representation in Interpretive Research of Information Systems: A Framework of Dialectical Structuration, *Journal of Japan Society of Management Information*, 12(2), 2003, 47-66 (in Japanese).
- Kosaka, Takeshi (2004) Social Semiotic Techniques of Sense Making using Activity Theory, in *Proceedings of the Eighth Pacific Asia Conference on Information Systems* (to appear).
- Kuutti, Kari (1996) Activity Theory as a Potential Framework for Human-Computer Interaction Research, in B. A. Nardi (ed.) *Context and Consciousness*, 17-44.
- Larkin, J. H. and H. A. Simon (1987) Why a Diagram is (Sometimes) Worth Ten Thousand Words, *Cognitive Science*, 11, 65-99.
- Latour, Bruno (1999) On Recalling ANT, in *Actor Network Theory and After*, Law, John and John Hassard (eds.), 15-25, Blackwell Publishers.
- Lyytinen, Kalle (1999) Empirical Research in Information Systems: On the Relevance of Practice in Thinking of IS Research, *MIS Quarterly*, 23 (1), 25-26.
- Mingers, John (2001) Combining IS Research Methods: Towards a Pluralist Methodology, *Information Systems Research*, 12 (3), 240-259.
- Monteiro, Eric and Ole Hanseth (1996) Social Shaping of Information Infrastructure: On Being Specific about the Technology, in W. J. Orlikowski, et al. (eds.) *Information Technology and Changes in Organizational Work*, Chapman & Hall, London, 325-343.
- Myers, Michael D. (1995) Dialectical Hermeneutics: A Theoretical Framework for the Implementation of

- Information Systems, *Information Systems Journal*, 5 (1), 51-70.
- Myers, M. D., D. Robey, C. Sauer, and J. Walsham (1998) Practical and Theoretical Frameworks: Valuable Aids or Seductive Traps? in T. J. Larsen, et al. (eds.) *Proceedings of IFIP WG 8.2 and 8.6 Joint Working Conference on Information Systems: Current Issues and Future Changes*, 303-305.
- Orlikowski, Wanda J. (1991) Integrated Information Environment or Matrix of Control? The Contradictory Implications of Information Technology, *Accounting, Management and Information Technologies*, 1 (1), 9-42.
- Speier, C., et al. (1997) The Effects of Task Interruption and Information Presentation on Individual Decision Making, in *Proceedings of the Eighteenth International Conference on Information Systems*, 21-35.
- Stenning, Keith and Jon Oberlander (1995) A Cognitive Theory of Graphical and Linguistic Reasoning: Logic and Implementation, *Cognitive Science*, 19, 97-140.
- Suwa, Masaki (1999). Visual Displays as Stimuli to Cognitive Processes, *The Journal of the Visualization Society of Japan*, 19 (72), 13-18 (in Japanese).
- Suzuki, Hiroaki (2001) In Search for Dynamic Nature of Thinking, *The Journal of Japanese Cognitive Science Society*, 8 (3), 1-13 (in Japanese).
- Ueda, Kazuhiro (1995) Problem Solving by Using Image-Schemas and its Facilitation, *The Journal of Japanese Cognitive Science Society*, 2 (4), 76-92 (in Japanese).
- Vygotsky, L. (1978) *Mind in Society*, Harvard University Press.
- Weick, Karl E. (1995) *Sensemaking in Organizations*, Sage Publications.
- Yamazaki, O. and K. Miwa (2001) A Study of Changes of Problems Solving Processes by Externalization, *The Journal of Japanese Cognitive Science Society*, 8 (1), 1-14 (in Japanese).
- Walsham, Geoff (1995) The Emergence of Interpretivism in IS Research, *Information Systems Research*, 6(4), 376-394.

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