

Action Context and Target Context Representations: A Case Study on Collaborative Design Learning

Henrik Artman

Dept. for Numerical Analysis
and Computer Science
The Royal Institute of Technology, Sweden
artman@nada.kth.se

Robert Ramberg, Hillevi Sundholm,

Teresa Cerratto-Pargman
Dept. of Computer- and Systems Sciences
Stockholm University, Sweden
{robban, hillevi, tetsy}@dsv.su.se

Abstract. This paper focuses on the concept of representations produced in the context of collaborative design. More specifically, on the interplay between collaborative creation of sketches (design proposals), and argumentation and negotiation processes taking place in the design activity. The question raised in this paper is how sketches produced during a design session reflect and mediate dialogues and argumentation in the design activity and how the sketches feed into an envisioned use context or vice versa. The concepts of *action context*- and *target context representations* are introduced and used to illustrate shifts of focus during a design session. We have studied a group of students working on a design task in an interactive space for two weeks. The purpose of the study was to investigate how an environment meant to support collaborative work and learning support collaborative and creative learning of interaction design. The results indicate that students attending a course on interaction design did not pay enough attention to target representations. Furthermore the results suggest that “action context representations” to a large extent occupy student activities as a result of either complex technology or as a result of the students thrust to do something instrumental. We suggest that pedagogical programs for collaborative learning of design may relieve some of the mapping, or interplay, of design proposals and the target context representation.

Keywords: Design, Communication, Interactive Spaces, Learning, Representation

REPRESENTATIONS AS RESOURCES FOR ACTION

Collaborative design can be viewed as an activity driven by communicative practices and representations for mediating ideas. In domains such as design, and interaction design in particular, learning goals are often difficult (if not impossible) to define in a precise manner. In this sense, design, interaction design and learning of these domains is often ambiguous and evolving rather than pre-defined. The need to propose, discuss and evaluate different ideas, design proposals, etc. is therefore crucial to learning and practice of design. In professional design, negotiation is a crucial part of the design situation and the student has to appropriate such knowledge to be prepared for this. Designers must learn not only the skill to design visual design, and design that is in line with some general aesthetic principle but also to learn how to negotiate the relation or the interplay between some actual system design and design of use (Arvola & Larsson 2004). Especially, in the conceptual stages of design, negotiations between different designers (system architecture, database designers, interaction design) are important, but also when integrating designs it is important, particularly if the general design concept has not been agreed upon or not been dealt with thoroughly to negotiate and mend the design proposal. In this paper we pose the question of relations between physical sketches and conceptual design imperatives.

In the study of complex situations the concept of *representations for action* has been suggested (Weill-Fassina, 1993; Rabardel and Dubois, 1993). Representations for action refer to the representations that people have of the situation they are part of and focuses on people’s actions, how people act in relation to what others’ do and say with or without artefacts. The temporality of the situation is very much dependent upon the communicative acts that people do, for example one might refer to the immediate context or to future or historical situations. Design as an activity is often directed towards the future in that the designed system will be used in some situation apart from the one the designer is in – that is the designer representation for action is, or should be, oriented towards the future. To learn to design is as much of building and communicating a repertoire of motivations for the future use-context as it is to actually build something that fulfils more immediate construction. Interaction designers must have some understanding, or representation if you like, of the interactions that the users will do. Thus the problem a team of designers who design a common object face is on the one hand to coordinate a common representation of the future use situation, and on the other hand a smooth mapping of mediated representations for actions within the context of design activities. We call these contexts *target context* and *action context* respectively.

Sketching, drawing, thus representing design ideas and learning to represent ideas have been found to be crucial to the design process and also to development of design ability (Löwgren & Stolterman, 1998). This is what the general design research has focussed on and what we call action context representations, i.e. the use of supportive tools within the design environment and those skills a designer must have in order to make good design proposals in action (Gedenryd, 1998; Lawson, 1997; diSessa & Cobb, 2004). Generally, the arguments are focused on the solitary designer with much creativity and talent, rather than collaborative efforts and accomplishments within designer teams. We will instead focus on communicative practices which designers use in order to convey ideas and negotiate design (see Sundholm, Artman, Ramberg, 2004; Sundholm, Ramberg, Artman, 2004 where we have discussed creativity in collaborative design). This means that we do not focus on some general mental mechanism, talent or other trait, but rather how team members communicate and negotiate different solutions to an envisioned use situation. We are in this paper especially interested in describing how design can be viewed upon as an oscillation between different forms of design contexts, and how different forms of representations support or undermine collaborative design activities. This motivates a focus on the interplay between collaborative creation of sketches (design proposals), argumentation and negotiation, and how sketches that are created mediate discussions and argumentation and feed into new ones, and to what degree characteristics of artefacts in the environment that are used in the process permit coming to discussions of the target use situation.

Engeström & Escalante (1996) presented a case where the designers fell in love with their design, the action context representations they created. The design became an idealistic vision, supported by suggestive design proposals and argumentation, which resulted in neglecting practicalities of use. A hypothesis is that inexperienced interaction designers may be immersed in *action context representations* resulting in that *target context representations* are not attended to or even ignored. Ideally, a design environment should support designers and design activities to focus on target context representations.

ILOUNGE – AN INTERACTIVE SPACE

At the Royal Institute of Technology in Kista, Sweden, there is an interactive space called the iLounge designed and built to support collaborative work and learning. The room has two large touch-sensitive displays known as Smart boards built into a wall. In front of this wall there is a table with a horizontally embedded touch sensitive plasma screen. This interactive table is large enough for 6 to 8 people to sit around. In one of the corners of the room a smaller table and three chairs are placed in front of a wall-mounted plasma display, enabling a part of the group to work separately. In short, iLounge supports collaboration through; *Large* screens that can show material that can be viewed and discussed by a whole group of people; The contents of the screens can be *shared* by the participants – documents can be edited by the participants; The screens are *interactive* – the participants can edit material on the shared screens through their own keyboards or directly using the touch screens; *Multiple screens*: several wall screens and a large horizontally embedded plasma screen (a table) are used instead of just one permitting the participants to work in more flexible ways, e.g., the participants can easily shift between working in groups or working individually on a subtask; *Multiple computers*: apart from the computers in the room, people can also bring their lap-tops and connect to a wireless LAN. This allows for flexibility (bringing documents and other work related information) and the possibility to work on a familiar platform. Also, more people can actively contribute to the ongoing work rather than having one person taking control of events. Figure 1 shows a plan of the room. The room has a wireless network and keyboards and mice in the room are also wireless, using Bluetooth technique.

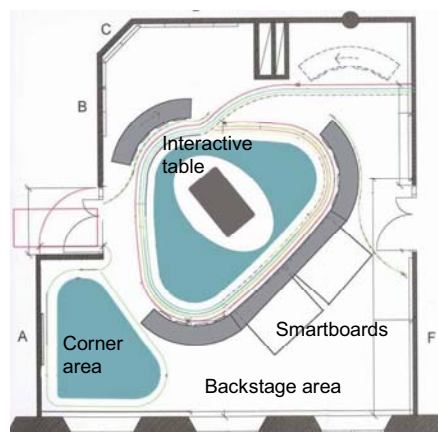


Figure 1. Plan of the room. The working areas are shadowed.

To facilitate and support work in the iLounge, services that help and support the user to move data between the devices present in the room have been developed. The services include Tipple¹ (allows users to open files on another computer), Multibrowse (allow to move web content on different displays) and PointRight² (allow one pointing device on several computers). PointRight together with iClipboard makes it possible for the user to cut or copy text between computers in the space. The text is placed on a clipboard that is shared by the computers running the service.

Finally, the iLounge contains high quality audio and video equipment that for instance can be used when having videoconferences, or during user studies.

METHOD AND DATA COLLECTION

Five female and four male students in the ages of 21 to 45, divided in two groups, participated in the study. One group consisted of three men and one woman, and the other group of one man and four women. Some of the students in the groups knew each other from before. The students attended a course in design of interactive systems. The students' task was to design a digital, multimedia guide for an exhibition "4, 5 Billion Years - The History of Earth and Life" at the Swedish Museum of Natural History. The two groups were responsible for designing the multimedia guide describing "from Big bang to first life", and "pre-historical mammals". The target group was children about twelve years old. We followed the students during the conceptual design phase of their assignment. The conceptual design phase lasted two weeks and consisted of brainstorming, sketching of scenarios and the multimedia product, and information search. During this time the groups had four and five sessions, respectively, in the iLounge. Prior to this, they received an introduction to the environment and the specific services introduced in the section "iLounge" above.

Data were collected through observations, pre- and post-study questionnaires, and ended with semi structured group interviews. Both the work sessions and the interviews were video taped. The recordings consist of four angles to cover the whole workspace (see figure 2), and one channel for sound. Altogether the data material consists of 21, 5 hours of video data. As a tool for our analysis we have used interaction analysis (Jordan & Henderson, 1995), and more specifically, certain foci for analysis, namely spatial organization of activity, participation structures, artefacts and documents, turn-taking, and trouble and repair.



Figure 2. The view of the video recordings with four angles

THE INTERPLAY BETWEEN TARGET REPRESENTATIONS AND ACTION REPRESENTATIONS

As pointed out by Löwgren & Stolterman (1998), representing design ideas and learning to represent ideas through sketching and drawing have been found to be crucial to the design process and also to development of design ability. In the case accounted for here however, instead of using paper and pencil to sketch the participants worked on one of the two interactive screens for making sketches or for showing information found at the Internet to each other. While producing a sketch, one of the group members usually stood in front of the

¹ Tipple is developed by the FUSE group, Stockholm University/ Royal Institute of Technology, and can be downloaded at <http://www.dsv.su.se/fuse/downloads.htm>

² Multibrowse, Pointright and iClipboard are part of the iWork package and are developed by the Interactive Workspaces at Stanford University. The iWork services can be downloaded at <http://iwork.stanford.edu/download.shtml>.

screen, and the other participants were sitting around the table. The person in charge of drawing the sketches alternated. For instance, one participant could be using the touch functionality of one of the screens, another using the keyboard and mouse working on the same document, and a third using PointRight and iClipboard to insert a piece of text, and together they created a sketch.

Excerpt 1 illustrates that although the group had become acquainted with and used the interactive screens during the first session they still felt somewhat uncomfortable in using these during the second session.

Excerpt 1. Group 2, session 2. Using the interactive screens to sketch³

Time 0.12.55	Person	Transcript of interaction	Characteristic of action
1	#3	"We can also put some pictures here [in the Notebook]".	Sits down. Looks at the right interactive screen
2	#1	"You mean, when we draw the proposals we can do it with the interacti..."	Looks at #3 sitting next to #1.
3	#3	"Mmm, but we can draw now. We have written down some things about what we want. I don't know exactly what we are going to do now."	Looks at the right interactive screen
4	#1	"Mmm... We can do that."	Looks at #3.

An obvious drawback in using the interactive screens to sketch is that the interactive screens and the tools that support sketching and drawing makes very raw and clumsy sketches as compared to using paper and pencil. A positive outcome is that discussing around the interactive Smartboard is a collective act directed towards the team and put issues up front.

In the above excerpt, line 1, person #3, starts the episode with drawing attention to the use of pictures in order to start the design, which person #1 quickly follows with a question of how to use the interactive screens. Then in line 3 #3 is referring to a target representation of the use situation, but at the same time he is articulating his hesitation towards how clear this representation is for making a design proposal. Person #1's response is focused on doing something by using the representational means i.e. the interactive screens. The two team members seem not to be synchronized in their endeavor to articulate visions and means. This kind of discussion is of course to be expected and in a sense constitutes a fruitful oscillation between the different forms of constraints to the design proposal. At the same time it may not be fruitful since the unfocussed discussion might stand for an anxiety of articulating either means or goals. However, the communication serves as a driving force for the team – each communicative initiative directs the team to consider new aspects of the design.

Interesting to note is also the transition between private and public, where drawing and sketching on a piece of paper followed by an attempt to translate or copy that onto the interactive screens allow the rest of the group members to see and react on the design ideas. In Excerpt 2, the continuation of the previous excerpt, we will see how going public and exposing ones sketches to the rest of the group produces dissatisfaction. This directs the communication and the actions towards the appearance of the *action context representations* they are creating.

Excerpt 2. Group 2. Continuation of excerpt 1.

Time 0.21.05	Person	Transcript of interaction	Characteristic of action
5	#3	"But if one draws something under here [shows with the pointer]. Or to make some more space."	Points with the pointer in the Notebook, on the right interactive screen.
6	#4	"Hm..."	Looks at the right interactive screen.
7	#3	"Some screens or something or... [refers to the design of the multimedia guide]"	Looks at the Notebook.
8	#4	"Yes. Is anybody good at this, to draw?"	Looks at #3.
9	#3	"I am very bad..."	Works with the Notebook.
10	#5	"So am I."	Looks at a Word document on the left interactive screen.
11	#4	"There are others..."	Looks at #3.
12	#1	"On where? There? [points to the right interactive screen] It is just to go there and draw with the hand."	Points at the right interactive screen.
13	#4	"Yeah, right! If... Is there anybody with some talent of drawing?"	Looks at #3.
14	#5	"We don't care about what the animals look like"	Looks first at #3, then at the left interactive screen. Talks simultaneously to #1, line 12.
15	#5	"What are we supposed to draw?"	Looks at #2 and #3. Talks simultaneously to #3, line 13.

³ The transcriptions below are divided with resemblance to the work of Pomerantz & Fehr (1997). But in our case "Characteristic of action" describes the actor's action, not the abstraction of the utterances.

16	#2	"Draw pictures of a screen with all the animals, maybe. It is just to make some dots."	Looks at #5.
17	#4	"Someone with some talent of drawing?"	Talks at the same time as #2, line 16. Talks to #1.

Here the interactive screens seem to be more inhibiting, than supporting coming to creative expressions. In line 14 person #5 tries to redirect the discussion away from the appearance of the design proposal that they are to create, but the team is stuck on the appearance and holds on to the discussion. We interpret this as person #5 is trying to include the issue that the appearance is mainly of interest when they have an idea of the use of the system. That is, person #5 tries to direct the issue of target context- rather than the action context representation. In line 16 person #2 seems to adhere to this shift in focus in pointing out that they simply have to "make some dots". Still, as the target context representation is not clearly articulated and shared the issue is dragged back to an issue of the here and now of making design sketches, where the focus is shifted again towards a more instrumental action context perspective. Although it seems that no one is willing to take on this instrumental perspective and actually do something. The problem was resolved by ripping pictures from the Internet and by using simple representations such as squares and circles, to signify animals. This was done using two interactive screens in parallel, one for using the Internet and one for using the drawing program. This is interesting since it illustrates the interdependence of two seemingly independent processes, and the relation of how the workspace layout is supporting creative solutions and creative use of representations in collaborative activities. Internet becomes an important source for them not to get stuck in the design process and action context representations. And also, the digital representations give the users the chance to re-negotiate and re-represent the design proposals. This discussion is facilitated by an easy access to the Internet, digital representations of animals as well as a shared surface for projection. This creative use of the artifacts gives an opportunity for the team members to re-focus on the use of the multimedia guide. It is a good example of the oscillation between action context discussions and target context discussions as well as of how technology can and should support these oscillations. More experienced designers often have learned different repertoires of design solutions to test and choose among that can help accomplish smooth oscillation, while inexperienced designers seem to need transparent and ready-to-hand support to be able to do this. However, as Lawson (1997) has shown, such design repertoires are very fragile and may easily break down when facing new use situations, which require new design solutions. Therefore we think that design studios should be designed with both action context- and target context representations in mind.

RE-INTERPRETING AN IDEA COLLABORATIVELY

The interactive screens were mainly used in two different ways. Mostly to present rudimentary sketches, often visual, to other team members as illustrated in figure 3. Individual sketches on paper sometimes preceded this. The other way to use the screens was to present web pages from the Internet, in order to discuss the information that was found, the design or other issues coupled to the project. In both cases the goal was to make information available to others in order to discuss (which makes it open for re-interpretation or disputing of the idea). In this way the team gets the "raw" information, rather than some pre-processed summary prepared by another team member.

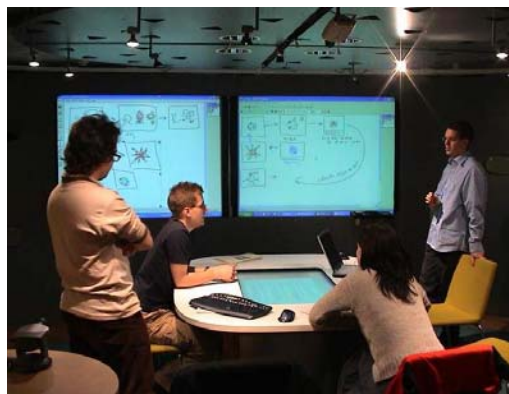


Figure 3. A group discussion regarding design sketches

Excerpt 3 shows how the interactive screen is used to present an idea. The excerpt is taken from an early part of session 3, where the group still has not decided or agreed on the concept of the multimedia guide. Before the excerpt below begins the members of the group have discussed what children would like to know, and how deeply they should go in to particular details. While other group members try to solve some practical issues, #1

stands up, and starts to make a sketch of a proposal of a game on the left screen. The theme is a competition, “like a boxing game”, between animals.

Excerpt 3. Group 2, session 3. Presentation of ideas

Time 0.23.07	Person	Transcript of interaction	Characteristic of action
1	#2	“As one of the games, or...?”	Sits down. Looks at #1.
2	#1	“Yes, but you can..., like this [pointing]... eh, I mean to eat or to be eaten, but you can choose, so you in one way or another, or maybe not like this. But you present the information about them, and then you can... or even if one might go here. But maybe also like this. “	Stands in front of the left interactive screen. First looks and points at the sketch, then looks at the group around the table, and finally points at the sketch again.
3	#1	“You might go like this in the forest somewhere. Here you have...”	Opens a new page in the Notebook and starts to visualize how #1 thinks by drawing with the finger.
4	#3	“But if you think we are going to do this in a real way, then we need to know what they sound like, and how they use their body, and knock, and...”	Sits down. Looks at #1 and #5. #3 sits on the opposite side around the table.
5	#1	[Mumbles something inaudible]	Sketches in the Notebook. Nobody pays attention.
6	#5	“It is built upon research [inaudible]...”	Sits down. Looks at #3
7	#1	“Then you can have different animals.”	Looks at the interactive screen, and start to draw with the finger in the Notebook. Nobody listens.
8	#3	“Watch Jurassic Park [the movie].”	Looks at #5.
9	#1	[Mumbles something about “a cave”]	Sketches first, then turns around and looks at the group.
10	#5	“Mm...”	Looks at #3

As we can see the idea is forming as it is successively formulated and represented. The team members are partly open to the idea, partly developing the idea but also tend to take the idea to a practical level of implementing it. This is one of the few instances where we have found the team formulating and pursuing ideas about the target context, that is, where the discussion in the group is more about the use of the multimedia guide than of the technology and the representations surrounding them. It seems as if having come to the solution of ripping pictures from the Internet relieves the group from having to focus on graphical details but can concentrate on the use of the guide. This gives witness to the group having found a meaningful use of the interactive screens and their functionality resulting in a stronger focus on target context representations. Learners of interaction design need support that facilitates and highlights the important relation between immediate actions carried out in the environment and a vision of actions and use in the target environment. Another way to say this is that learners need a support that helps them to shift between action- and target context representations, respectively.

DISCUSSION

If tools are not appropriated both to individual and team needs these tools will be a nuisance rather than a support. The nuisance steals attention, concentration and energy from the individual and in turn from the team. The tools become present-at-hand rather than ready-at-hand. This may sound like a renaissance cognitive idea of a given mental capacity, but our argument is rather that the communication among the team members is directed away from target context representations to action context representations. We certainly see that students of Human-Computer Interaction in general and interaction design in particular, must have some training in attending to and creating target context representations, be visionary if you like, in order to proceed with becoming skilled designers. This repertoire should both include a repertoire of using different tools, but also an empathetic repertoire of high-lighting use situations. The latter is unfortunately often forgotten, ignored or plainly not seen as an important repertoire as it can be explored at hand or after the fact. Our understanding and belief is the opposite.

One known problem with supportive representational environments is that each and every representation on their own may be supportive but when something goes wrong, or when the different representations are not mapped, much of the users work is to match the representations by handling the mismatch manually (Garbis & Artman, 2004). In this study we have found that the students oscillate between action and target context representations but also that an unclear target context representation does not guide the process resulting in that mapping action context representations take over the design process. Problems with action context representations may further hinder to articulate such use contexts. This is very problematic if one considers

interaction design to be the design of use, rather than product design. One crucial problem appears to be how to share and communicate one's idea of the target context as well as to keep it alive while attempting to formulate and represent the idea in the action context. In this study we have observed students performing a task in collaboration but without any larger chunks, or vivid discussions about the context of the future use of the artefact being designed. In spite of this, students managed to come to creative solutions in handling artefacts in the action context subsequently resulting in the students being able to focus more on target context representations. At the moment we are designing pedagogical programs that structure the students' work. The programme includes the division of labour into a design- and critique team. These teams work in parallel and meet on a continuous basis to discuss the design proposals from any angle. Our intention is to force the design learners to represent and motivate their design proposals to an outsider who is getting more and more involved in the design work. Furthermore, we are experimenting with design patterns in terms of user interface and task flows. One important intention with presenting design patterns, apart from providing students with concepts to practice on how to use, elaborate, etc., is to motivate the students to make conscious choices or combinations of alternatives as well as to relieve the students from only focussing on the action context representations and raise their perspective to the use situation i.e. the target representations. Learning the practice of interaction design includes much more than only making an appropriated design. It also involves practicing to make vivid presentations of the future use of the interactive system, thus training in attending to and creating target context representations. It is the use that should direct the design rather than design directing use, or is it not?

ACKNOWLEDGMENTS

This work was sponsored by the Wallenberg Global Learning Network through the iSpaces Project as well as the DeKaL-project (The Swedish Science Foundation). We would also like to thank Maria Croné and Johan Mattsson at DSV, who participated as systems designers and in conducting the study, and Ann Lantz for comments on an early draft of the paper.

REFERENCES

- Arvola, M., & Larsson, A., (2004). *Regulating Prominence: a design pattern for co-located collaboration*. In: Darses, F., Dieng, R., Simone, C., & Zacklad, M., (Eds.) *Cooperative systems design: Scenario-based design of collaborative systems*. IOS press, Amsterdam.
- diSessa, A., & Cobb, P., (2004). Ontological Innovation and the Role of Theory in Design Experiments. *The Journal of the Learning Sciences*, **13**(1), pp. 77-103. Lawrence Erlbaum Associates.
- Engeström, Y., Escalante, V. (1996). Mundane Tool or Object of Affection. The Rise and Fall of the Postal Buddy. In B. Nardi (Ed.), *Context and Consciousness - Activity Theory and Human-Computer Interaction*. Cambridge Massachusetts: MIT Press
- Garbis, C., & Artman, H. (2004). Team Situation Awareness as Communicative Practice. In S. Banbury and S. Tremblay (Eds.), *A Cognitive Approach to Situation Awareness: Theory and Application*. Aldershot, UK: Ashgate & Town.
- Gedenryd, H. (1998). *How Designers Work*. Thesis nr. 75. Lund University Cognitive Studies. Lund: Jabe Offset AB.
- Jordan, B. & Henderson A. (1995). Interaction Analysis: Foundations and Practice. *The Journal of the Learning Sciences* **4**(1). 39-103. Lawrence Erlbaum Associates, Inc., 1995
- Lawson, B. (1997). *How designers think*. Butterworth-Heinemann, UK.
- Löwgren, J. & Stolterman, E. (1998). Developing IT design ability through repertoires and contextual product semantics. *Digital Creativity* **9**(4), pp. 223-237.
- Pomerantz, A. & Fehr, B.J. (1997). Conversation Analysis: An Approach to the Study of Social Action as Sense Making Practices. In: van Dijk, T. A. (Ed) *Discourse as Social Interaction*. London: Sage Publications, pp. 64-91.
- Rabardel, P., & Dubois, D., (1993). Microgénése et fonctionnalité des représentations dans une activité avec instrument. In: Annie Weill-Fassina, Pierre Rabardel et Danièle Dubois (eds.) *Représentations pour l'action* Toulouse, Octarès Éditions, 1993.
- Sundholm, H., Artman, H., & Ramberg, R., (2004). *Backdoor Creativity: Collaborative Creativity in Technology Supported Teams*. In: Darses, F., Dieng, R., Simone, C., & Zacklad, M., (Eds.) *Cooperative systems design: Scenario-based design of collaborative systems*. IOS press, Amsterdam.
- Sundholm, H., Ramberg, R., & Artman, H., (2004). *Learning Conceptual Design: Activities with Electronic Whiteboards*. In: Proceedings of CADE04 (Computers in Art and Design Education).
- Weill-Fassina, A. (1993). Formes des représentations fonctionnelles et contrôles des actions dans le diagnostic de panne – In: Annie Weill-Fassina, Pierre Rabardel et Danièle Dubois (eds.) *Représentations pour l'action* . Toulouse, Octarès Éditions, 1993.