Computer Supported Cooperative Work (2006)
DOI 10.1007/s10606-006-9014-3

Information Infrastructures for Distributed Collective Practices

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1. Introduction

The history of this special issue of the CSCW Journal goes back to 1997 and a book entitled ''Social Science, Technical Systems and Cooperative Work: Beyond the Great Divide'' (Bowker et al., 1997). The book concluded that an increasing number of researchers were electing to take up residence in the great divide in order to produce systems which were organizationally and socially sensitive. After more than two decades of effort, the early war stories of CSCW pitting the human, emotion-laden, contingent context of cooperative work (CW) against the formal, rational and potentially universal character of computer support (CS) were losing their appeal. Social scientists (primarily from sociology and anthropology; and attached either to research laboratories like PARC or universities) and computer and information scientists (primarily from software development, requirements engineering and artificial intelligence) had created a new form of partnership. Three conditions were evoked in order to explain the emergence of this new partnership (Turner, 1997).

The first was that the CSCW community had largely moved away from a concern with normative social scientific questions. For example, efforts aimed at understanding how human and technical systems come together in computing systems were, in the 1960s, strongly anchored in concerns about automation (e.g., ''deskilling,'' stratification and job loss) but, by the middle of the 1990s, this concern had become a plank of accepted CSCW practice. No member of the CSCW community now doubts that the goal of in-depth investigations of the workplace is to develop easier-to-use systems that enhance working conditions rather than impoverishing them. To the

contrary, a discipline-building consensus has been forged around the idea that sociotechnical systems are inherently plastic in nature; that they can be socially shaped through an adjustment process which will fine-tune their design to meet the cognitive and social information processing requirements of a given work situation. A contributing argument to this consensus comes from actor-network theory (Callon, 1986; Latour, 1987; Latour, 2005). According to this theory, cooperation takes shape and becomes meaningful because of the work done to build locally coherent sociotechnical systems. People might have different ideas about the ethical, moral, political, economic or social basis on which coherence should be based, but normative questions of this kind cannot be successfully addressed by an outside observer. The mystery of cooperative work – the fact that despite their differences, people are actually able to build things together (programs, machines, strategies, society, etc.) – has to be formulated in another way. The focus is on procedures through which groups achieve a relative autonomy with respect to their environment and, at the same time, develop the necessary economic, social and political skills needed to defend this autonomy. How are stable systems achieved? Cooperative work is looked upon as being more of an engineering problem than one that raises the theoretical issues of normative social science. The final structure of an engineered system is determined much less by the intentions, worldviews, and fundamental motivations of designers than by their concrete decisions to incorporate specific elements into the system, to link them together in a specific way, and to codify interactions by a given set of rules and procedures.

The second condition for installing a new partnership between social, computer and information scientists was seen to lie in a more comfortable, less aggressive attitude towards disciplinary differences. At times, these differences have been described in a caricatured form with the humane, soft-headed social scientists seeing contingency everywhere while impersonal technocratic developers and computer scientists seek only to produce working systems for managing information flows. But by the mid 1990s, the CSCW research community had gone reflexive. A second consensus was emerging around the idea that the expression of conflicting points of view is both good and desirable for the vitality of on-going research as long as they remain focused on cognitive issues and don't degenerate into name-calling and other forms of highly unpleasant interpersonal relationships. Thought was being given to ways of capitalizing on case studies in order to build a common working culture spanning the great divide. The CSCW community was evolving techniques for conflict management. For example, given that people from different disciplines generally have different points of view on what is important and what isn't for doing things together, creating ''negotiation spaces'' to work out these differences was seen as being an appropriate procedure. Wagner describes the type of negotiation space that

she observed when studying multidisciplinary design. According to her, design options become reality by adjusting conflicting points of view about subject-oriented as opposed to process-oriented design; ''workable'' as opposed to ''true'' representations of requirements; conditions for confidence building over disciplinary boundaries; and, finally, borderline questions concerning the respective limits of human and machine autonomy in their ongoing interactions (Wagner, 1997). Bannon's work goes further suggesting how the dynamics of change in these negotiation spaces can be managed using simple list management techniques for providing a constantly updated overview of the boundary objects emerging in these arenas (Bannon, 1997). Boundary objects are used in situations of conflict to measure disagreement and keep people at arm's length in ways that avoid disagreeable, emotionally intense interpersonal relationships (Hewitt, 1985). The concept recognizes the fundamental ambiguity of objects (an idea taken directly from the Pragmatist notion that meaning is given in use, not in antecedent characteristics) and the durability of arrangements to manage that ambiguity in cooperative ventures (Star and Griesemer, 1989). Bannon's suggestion that CSCW should develop boundary object management procedures implies the need of defining conventional or routine ways of working with ambiguity. The fact that those conventions themselves may be seen as data structures from a design point of view, as material structures from an organizational point of view, or as working treaties from a political point of view opens up common ground for working together over the great divide.

Building conventional ways of working with the ambiguity of boundary objects requires paying specific attention to the role of semiotic systems in overcoming that ambiguity. By the mid 1990s, CSCW research had gone a long way towards incorporating into its program some of the basic assumptions from semiotics about how things (objects, texts, artefacts,...) become meaningful (Goguen, 1997; Keller, 1997; Taylor et al., 1997; Yoneyama, 1997). And this was seen as being the third condition for building a new partnership between social, computer and information scientists. Work was being developed to capitalize on the results of case studies and models of ''negotiation spaces'' and ''boundary objects'' were being forged to guide that work, however, at the same time, the influence of semiotic systems on the outcome of these modelling exercises was starting to be recognized. Semiotic systems structure our understanding of the experienced world. They define the cultural values and outlooks that individuals generally admit without question, given the processes of socialization at work in a vast range of institutions from the family, to school, and the workplace. So it is important to understand how the constitutive order of semiotic systems impinges on the CSCW community's capacity to represent collective sense making activities.

In 1999 Geoffrey Bowker and Susan Leigh Star published their book entitled, ''Sorting Things Out: Classification and its Consequences'' (Bowker

and Star, 1999). For those of us building computer support systems for collective activities the message was clear: these systems are what the two authors called working infrastructures. Technically their construction demands an elaborate system of formal categories and standards which allow people to use their computer, connect it to Internet, retrieve email and browse the Web using their cell phones or interactively using their televisions. Socially their construction demands a set of clearly demarcated bins into which things represented symbolically in the system will neatly and uniquely fit. These bins can be organized hierarchically, as independent elements in a sequentially constructed list, or according to some logical function. Their very existence contributes to sowing into the social fabric a standardized representation of just about everything: animals, human races, books, pharmaceutical products, taxes, jobs and diseases. As Bowker and Star say, these categories take on life in the daily practices of industry, medicine, science, education and government. They work (to paraphrase the remark of Max Weber) as the "iron cage of bureaucracy" hemming in the lives of people in the modern world. When information infrastructures are seen in this way, their role in knitting together the social and technical dimensions of a collective activity needs to be treated with caution. And perhaps even more importantly, the move away from normative questions that seemed to characterize CSCW research in the mid 1990s needs to be seriously questioned. Despite the claim by Clay Shirkey (http://www.shirky.com/writings/ontology_overrated.html) that classification and ontology are overrated, and that 'folksonomies' and 'tagging' will win the day, it is clear that the complex new electronic infrastructures that are being built – cyberinfrastructure in the USA and e-science in the rest of the world – rely heavily on sharable ontologies predicated on ongoing classification work. It is also clear that these latter remain value laden and normative – from broad examples such as the filtering of the Internet by Microsoft, Yahoo and Google to specific organizational cases such as the development of cross-disciplinary platforms for working scientists (Bowker and Star, 2002)

This then is why we became interested in the general theme of building information infrastructures for distributed collective practices. We have used it over the past six years to look critically at the conditions of a partnership between the social, computer and information sciences. How is this partnership struck and consolidated when the goal is infrastructural inversion? This concept has been used by Bowker and Star to bring normative questions back to the table. It suggests that the objective of CSCW research should be less that of providing designers with blueprints for engineering locally coherent sociotechnical systems, but more that of providing system users with the power of constantly reconfiguring them in order to build for themselves roomier, more comfortable milieux in which to carry out their collective activity. What methods exist for building these milieux? We talked

above about managing ambiguity, but how should procedures of negotiation and boundary object management be set up and played out when collective activities are distributed geographically, economically, socially and culturally? Finally, the semiotics of the Web is an open area of study: what exactly is being sown into the social fabric of daily life through the adoption of information infrastructures? In 2000, a first Workshop was organized in Paris to look at these types of questions, and it was followed by two other workshops in San Diego in 2002 and Chicago in 2004. In addition, the French National Research Council (CNRS) sponsored a series of meetings between French researchers on the subject.[1] That said, the papers presented in what follows fall very much into the bin of "research in progress".

2. Distributed collective practices

Distributed Collective Practice (DCP) is used to signify collective activity mediated through geographical and conceptual distances, time, collective resources, and heterogeneous perspectives or experiences. Often DCP is carried out through information infrastructures and technologies such as collaboratories, organizational memories, digital libraries, multi-agent systems, community networks, scientific data repositories, chat rooms, multiplayer games, distance education environments. The concept invokes the infrastructure which today has inserted itself between human and human in a huge range of collective activity. The movement toward DCP is as old as human history – key points along the way have been the invention of writing (Goody, 1986; Schmandt-Besserat, 1992); the development of a trust in writing over public witness (a huge sociotechnical achievement – (Clanchy, 1993; Geary, 1994)); the invention of the printing press (Eisenstein, 1979); and the development over the past 200 years (we are wrong to see this as a feature of computers and the last 50 years) of a radically new information and communication infrastructure (Graham and Marvin, 2001; Bowker, 2006).

The rapidly solidifying Global Information Infrastructure (GII) – the Internet, the World Wide Web and the extended global wireless, mobile, satellite telecommunications system – is a major socio-technical substrate for DCP. The GII is by nature diffuse – there is no central control, no central locus for technical and interactional innovations, no central arbiter of ethics, meaning, or representation, and no central awareness of its implications, so configuration choices are tremendously hard to anchor in existing practice, philosophy, or economics. And yet decisions on how to configure the GII in technical, social, cultural, legal, and economic senses are being made daily and will be hard to reverse (Callon, 1991). Because of this, we critically need to learn how to describe and build DCP infrastructures that recognize and foreground the issues of heterogeneity and uncertainty in continuing cycles of

understanding and management, rather than trying to relegate them to the 'too hard', 'self-correcting', or simply 'invisible' bins.

Efforts aimed at foregrounding problems of heterogeneity and uncertainty have often used *a priori* distinctions. For example, sociologists have compared computer-mediated and face-to-face interactions in order to better understand the opportunities and limitations of technology for forging social ties and building social identities (Hinds and Kiesler, 2002). Economists distinguish between information which exists as a set of formal, explicit proposals which can be reproduced without cost and disseminated without loss and knowledge which, to the contrary, refers to the cognitive capacity of an individual or group to use that information (Dasgupta and David, 1994). Knowledge engineers build domain specific ontologies and specify inference rules for reducing the cognitive workload of users carrying out tasks in those domains (the nec plus ultra being the overweening Cyc project – http://www.cyc.com). Computer scientists are designing information systems using a constantly improved understanding of interaction-based coordination practices which are driven by collective conventions and standards, mediated through speech acts, cognitive artefacts and classification systems, or which emerge out of on-going negotiation and mechanisms of collective storytelling (Ishida et al., 2005). In other words, a large number of options are available which offer analytical and interpretative categories for dealing with the heterogeneity and uncertainty inherent in building DCP infrastructures. However, one can ask if these *a priori* distinctions hold up in the face of computer-mediated practices of social criticism.

Goody (1986) made the point: New cognitive technologies tend to encourage social practices of criticism. These in turn constantly call into question the legitimacy of recognized sources of authority – moral, institutional, organizational or consensual. On this view, the dense GII infrastructure may be opening Pandora's box. The goal of harnessing technology to the yoke of collective action might destroy the capacity of social groups to work within strategic frames of reference. It is possible that forms of social solidarity become so transmogrified that they break down. We can grasp what is at stake if we look at a variety of different behaviour patterns that are emerging with the spread of new information and communication technologies.

Take the emergence of a new cultural phenomenon that Licoppe has called the "always on" culture (Licoppe, 2000). Peoples' cell-phones are generally always on and if not, they can be contacted rapidly by using their personal digital assistants or by leaving a message in their Email box. The variety of digital communication channels is making it less difficult to contact people than it is to attract and keep their attention. Organizations are faced with this problem when distributing the work of their members across different geographical locations. In this context, the growing "always on" culture is

generally perceived favourably, however, it has its limits. Empirical research has shown that people working at a distance are able to manage the borderline between public and private time easier than when they are co-located; they have greater leeway for shutting off connections when they do not want to be disturbed. So what happens in situations where the organizational constraint of being available doesn't apply? For example, what happens when people have an idea for a project but have not yet marshalled the necessary support to structure it? This has long been a central problem in the social-economics of science: How do you interest people and gain their support for something which is new and innovative? This something has to be exported out of the local context in which it was created, it has to put in the marketplace of competing proposals, it has to be made visible and convincing, it has to attract and interest. What scenarios are available for developing innovations over Internet? To what extent is the 'always on' culture a help or a hindrance? We would expect a relationship between newness and noise as people faced with a constant flow of incoming information are likely to experience difficulty in perceiving what is relevant and what is not. Cognitive overload takes on new proportions in the open spaces of Internet. One way to manage it is to shut down connections with the outside world: Being available means being selective in engaging in cognitive and social relationships. So the problem becomes that of knowing if the densification of the GII is propitious to building support networks for constantly redefining existing organizations. Before new forms of activity take hold, existing social and cognitive structures have to be called into question (David, 1985). As is increasingly apparent today, technologies which beckon fair to produce free, open interchange (Yahoo, Google) can become tools of a totalizing state (the United States, China, Iran): technology is never liberatory per se, this is the domain of sociotechnical clusters. The attention paid in this volume to the way in which open source software communities function collectively can in part be explained by an interest for these types of questions. Is there an underlying innovation scenario at work in these communities that accounts for the influence of the always on culture on the on-going collective design of distributed collective practices?

The need to establish foundations for a GII innovation scenario can be highlighted in another way by considering how ordinary people are investing the communication and information spaces of Internet. Ordinary people come from a wide variety of backgrounds, work in different contexts, are generally not computer skilled, have different ages, experiences, occupations and capabilities. And whereas computing for industry and for research can use a general understanding of market mechanisms, work practices or the social system of science to build infrastructures, it remains an open question as to the background knowledge needed to compute for ordinary people. This is all the more the case because ordinary citizens are proving themselves

to be largely undisciplined in their use of the GII. For example, from a political science perspective, their behaviour is calling into question the role of spokespeople in organizational decision-making. As people are becoming more highly educated they are also becoming increasingly reluctant to let others speak for them. This is particularly evident with the irruption of non-experts in scientific debates. Expert opinion on how best to stock nuclear wastes, or combat the mad-cow disease, or experiment genetically modified organisms is openly being contested. And in the economic sphere, the power of Internet has clearly been shown in mobilizing opposition against the institutions of the global economy. And so, can we change perspectives? Can we assume, for example, that before people are experts, professionals or ''actors'', they are first and foremost ordinary citizens concerned about the quality of the life they lead and what the future will hold for themselves and their children? Would this lead us to start thinking about designing infra-structures for collective practices differently, in ways that would help citizens better engage in the economic, political and social processes that shape their lives?

A third need for a foundation for GII innovation lies in the thorny issue of what Licoppe refers to as the distribution of morality (in this volume). We see this problem in our daily lives – a package doesn't arrive when it's supposed to, and tracking down the cause can lead to an endless series of phone calls in which no one person takes moral responsibility for getting the package to you (indeed King refers to the problem of *prosumerism*, where the consumer has to accept the responsibility which service providers do not). There is no doubt that in a world characterised by a wild proliferation of distributed collective practices we need to inject value sensitive design right into the basis of our infrastructure.

In addressing these types of questions in this special issue of the JCSCW, we hope to clarify the relationships each of the three terms making up the notion of distributed collective practice has with the general problem of designing infrastructures for supporting cognitive and social innovations.

3. What is a collective?

Asking this question raises what economists of innovation have referred to as the framing problem. What population is likely to be concerned by an innovation? In fact, there is no simple answer to this question as Michel Callon has shown in his work on externalities (Callon, 1998). When a group A, B, C initiates a project, it will take decisions that will have positive or negative effects on another set of actors X, Y, Z who were not initially consulted before the project began, either because they were not considered stakeholders or because they had not expressed any desire to take part in the decision-making process. It's only after a project is underway that members

of the X, Y, Z set are able to perceive and evaluate how the innovation is likely to affect their interests. In the open world of design, people who are identified as potential users of an application are not usually the only stakeholders that need to be consulted. The fundamental uncertainty of any design process lies in the trade-offs needed to resolve this framing problem. A design process has to be kept open to the outside world but at the same time, and symmetrically, opening it to newcomers implies constantly modifying the blueprint for design. So how open should a design project be?

John King looks at this question in the first chapter of this volume. He argues that the measure of an infrastructure's success lies in the capacity of a service provider to shift the burden of controlling the cognitive and social functions of the system to the end user. His example is taken from an historical study showing how the transport infrastructure has progressively come to depend upon information and communication technologies. For a variety of reasons outlined in his text, we learn that by the 1970's the traditional solution to traffic congestion in the United States – namely, densifying the infrastructure by building more roads and airports – was increasingly called into question by coalitions of sociologists, ecologists, geographers and members of the atmospheric chemistry and life science communities. A new strategy was adopted which aimed at allowing the end-user to operate the transport system. One of King's examples concerns air travel and the fact that now most airlines encourage their users to book and reserve via the World Wide Web, issue electronic boarding passes and are experimenting the idea of having passengers self-scan their boarding passes prior to boarding. Users operate the system to meet their schedule-sensitive or low-cost travel needs and, at the same time, receive such things as frequent flyer mileage as an incentive for doing so. The infrastructure is highly complex but operates efficiently on a very wide scale to distribute individual activity. In the United States alone the scheduling, timing and logistics of some 600,000 passenger trips are annually organized using it. However, putting the power over the infrastructure into the hands of the user could be going too far as King suggests in his discussion of the September 11, 2001 terrorist attack on New York. The infrastructure was used by individuals who were intent upon perpetrating criminal acts. The frame of reference has now changed and the infrastructure is being redesigned.

The shift in control from service providers to end-users is a measure of infrastructure success and a common goal of DCP design, but end-users are individuals while the idea of collective practice generally implies some form of social interaction. So is it legitimate to speak here about support systems for collective practices? King's point is that before interacting, there is all the social and cognitive overhead that goes into preparing the interaction. We know that we have a meeting to attend, a family reunion to organize or the need to limit road traffic in order to cut down on city pollution. By binding

together shared expertise, technology and social conventions in addition to ownership and regulatory structures, infrastructures can be developed which allow individuals to act largely on their own recognizance in order to accomplish these larger, collective objectives. Stabilized formats of information dissemination and access permit individuals to schedule their travel or to decide when not to take their car into the city. DCP infrastructures allow distributed individuals to act independently but in a highly coordinated manner in order to make their own arrangements for doing things together. The overhead formerly placed on each individual participant to stay in close contact to achieve such coordination is absorbed by the infrastructure.

4. What is distributed activity?

Often in the literature, distributed activity is contrasted to co-located activity in order to focus attention on the specificity of technologically mediated interactions as opposed to face-to-face interactions (Kiesler and Cummings, 2002). It points to the problem of organizing these interactions when working across time and space. Another use of the concept is made in connection with the distributed cognition paradigm which holds that our environment can be structured in ways that greatly simplify the problem of knowing what to do in a particular situation. In traditional cognitive science, this ability is generally associated with an information processing capacity. However, collecting, evaluating, analyzing and interpreting information implies high-cost intellectual investments. People use a wide variety of techniques for reducing these costs, one of them being to transform the cognitively intensive information processing problem into a much more simply resolved perception problem. By putting a mark on their speedometer, pilots know at what speed they have to open their aircraft's landing flaps. People place objects in their environment in ways which remind them of what they have to do and when. The question of how an environment is pre-formatted for reducing the cognitive workload associated with information processing is central to the distributed cognition concept (Hutchins, 1995). However, as Christian Licoppe points out in the second paper in this volume, pre-formatting an environment is possible when that environment is stable. But what happens when it is undergoing constant change? How is an environment stabilized to the extent needed for successfully anticipating on how to act appropriately in a given situation? Know-how isn't given; it depends upon how heterogeneity and uncertainty are made tractable in a given situation. DCP research uses the distributed concept in a third way: it focuses attention on mechanisms for making things calculable in the context of building something new and innovative. Distribution is a conceptual device serving to link calculability, the framing problem and on-going social practices of criticism and negotiation.

When users of an innovation are viewed through the lens of the framing problem it is more appropriate to refer to them as stakeholders in the design process. As a project develops, positive and negative externalities are identified and new actors come on stage. The problem of organizing airplane travel is seen differently since the September 11 terrorist attacks on New York. Consumers concerned for their health have severely criticized the one-sidedness of the discourse about the potential benefits deriving from genetically modifying living organisms. The criticism has been more than just verbal; in France, for example, the movement has taken the form a civil disobedience movement with more than 50 people now facing prison terms for having voluntarily destroyed crops planted to experiment genetically modified plants. Using the stakeholder concept seeks to capture the dramatic content of an actor's irruption on stage. As one can readily see, the question addressed here is clearly not that of identifying a user population in the way market studies seek to identify a representative sample of potential clients for a given product or service. Nor is it that of obtaining rapid user feedback on a design concept though cooperative prototyping types of techniques. Instead the perspective is more that of event management where the events imply deep emotional involvement, not only on the part of outsiders who suddenly realize that a project has been launched which will affect their well-being but also on the part of designers who recognize that the engagement of these outsiders in an emerging collective activity constitutes a potential menace for their innovation. Just as in the distributed cognition model, the ''gut reaction'' implies a perceptual reaction to the event; people don't need explications in order to understand what is at stake. No costly information processing is needed in order to determine the meaning of what is taking place. The event announces the existence of a problem and people on both sides of the divide have no trouble representing what will happen if they don't react: a return on investment which is positively evaluated in material, human, social or symbolic terms by the promoters of a project has to be weighed against the potential harm done to the well-being of its detractors. Event management refers to the different mechanisms used to carry out these extremely sensitive and highly political evaluations which necessarily accompany the development of all innovation scenarios, and which determine the conditions of their implementation.

Distributed cognition research looks at how objects and artefacts are used by actors to create perceptually rich environments in which they are able to act without having to pay the high-costs of engaging cognitively complex tasks of information processing and representation. It provides us with an understanding of how people set up routines for reducing the social and cognitive workloads associated with doing things together. DCP research tends to look at the opposite question. Routines are constantly called into

question by the arrival on stage of stakeholders whose interests are at odds with a specific design. Designers manage events of this kind by recomposing their discourse in ways which serve either to keep outsiders at a distance or to enrich perceptions of what is at stake in the design process. DCP research looks at the dynamics of putting into words emotionally-laden behaviour. It looks at how groups organize themselves to make sense out of the events which disrupt their routines.

Christian Licoppe's paper illustrates event management in a DCP context by looking at the evolving infrastructure of a helpline service. He uses the concept of "distributed listening" to analyse the interactions which take place between three types of stakeholders: the callers, the listeners and the helpline organization itself. The events which structure their interactions are the calls of distress put to the helpline. Listeners are expected to know what to do in order to alleviate distress, not only because they share a common humanity with callers and are consequently able to understand suffering, be compassionate and help in finding the words to express the anguish of a highly emotional experience, but also because individual listening is rooted in teamwork. Listeners who are constantly confronted with the distress of others are able to obtain support from their team in formulating what has troubled them personally. The goal is to keep the public at a distance. Events are reconstructed collectively in ways which enable listeners to remain open to the suffering of others while avoiding the risk of being too open and only hearing in what is said that which resonates with their own particular worries and concerns. On-going group discussion and reinterpretation of highly charged emotional events stabilize the way in which these events are collectively perceived and managed. Of particular interest in Licoppe's paper is his analysis of the way in which the concept of distributed listening was affected by the adoption of E-mail technology in 2001. Members of the helpline teams were at first tempted to apply information processing and representational techniques to deal with this new material, but they then reverted back to presenting it orally in order to better identify a listener's feelings when confronted with suffering. Helpline volunteers had developed their skills for recognizing emotion during telephone listening and it appeared to them just as important to deal with this subjective content of messages as it was to deal with their explicit, Email recorded information content. Reading Emails out loud proved to be a way of socializing Email listening by giving voice to written exchanges. It focused the dynamics of social criticism on how to incorporate a listener's experience into the collective practice of dealing with suffering and thereby avoided the danger inherent in working with written material, that of multiplying subjective, individual interpretations of Email messages precluding all possibility of stabilizing a collective activity.

5. What is practice?

Different forms of collective practice depend upon the techniques which are used to stabilize the reading of a given situation. As we saw above, this idea raises several fundamental questions because no situation is given; it is constantly being recomposed to accommodate the arrival on stage of actors whose interests are at odds with a particular plan or project. So what level of analysis is appropriate for adequately dealing methodologically with this framing problem? Should we focus on interpersonal interactions, the way in which people attract interest and attention for the ideas they place in the marketplace of competing proposals? Licoppe's example of how listeners socialize their individual solutions for dealing with suffering is a good example of this approach. One can conclude from his paper that designing infrastructures for supporting on-going collective practices lies in better understanding the dynamics of interacting at a distance: Not distance in the sense of being physically distant as opposed to being co-located in close proximity, but distance in the sense of being emotionally challenged by the position taken by another and requiring breathing room in order to be able to continue to perform independently in a capable manner.

Can infrastructures be designed which allow people to see and better understand how they can work together to collectively open up and maintain a space with sufficient room so that they can be both distant – but not too distant so as to ignore one another – and close – but not too close so as to limit one's capacity for engaging in personal initiatives. The third paper in this volume by Gabriel Ripoche and Jean-Paul Sansonnet addresses this question using four categories from speech act theory to describe an event space in which people position themselves in more or less close proximity. Accepting the general idea of speech act theory that language is performative and structures on-going social and cognitive interactions, the two authors are developing automatic language processing techniques in order to explore how the combined use of assertive, commissive, expressive and directive speech acts either reduces the breathing space available for interpersonal interactions creating tension and conflicts or, to the contrary, makes the space roomier and more emotionally comfortable to be in. Of equal interest in their paper is the methodology they are developing for testing the contribution of their speech act approach to an understanding of on-going collective activity. They consider that an important issue for the future of DCP research lies in developing suitable computational tools for dealing with the wealth and richness of archives containing the traces of computer-mediated interactions. Their application area is the Mozilla Free/Open Source Software (FOSS) community, and more specifically the Bugzilla sub-group working at resolving bugs found in software developed by the

community. The Mozilla project counts hundreds of developers distributed around the world, and tens of thousands of participants (users, developers, testers, etc.) who have contributed to one of the 295,000 bug reports currently in Bugzilla, the community's problem management repository. These figures illustrate the magnitude of the task that Ripoche and Sansonnet have taken on; using such a huge archive for describing how event spaces are composed and evolve through linguistic interactions is a highly challenging methodological problem.

In the paper co-authored by Warren Sack, Françoise Détienne, Nicolas Ducheneaut, Jean-Marie Burkhardt, Dilan Mahendran and Flore Barcellini, the opposite approach is taken to the framing problem. Instead of focussing on interpersonal interactions, a methodology is proposed to identify and describe the structures shaping the development of the FOSS programming language Python and, more particularly, the design process called Python Enhancement Proposals (PEPs). The authors' represent this process as being one in which actors weave together a tapestry of heterogeneous components by interacting with and through three specific information spaces. In the Python discussion space, a variety of newsgroups and mailing lists are used to air PEP ideas, get feedback and engage in proposal rewriting and finalization before an official decision is taken on whether or not an idea should be accorded PEP status. The documentation space contains the archives of the Python community: draft proposals are maintained as text files which can be viewed in several ways by time, topic or thread, for example. Finally, the implementation space serves to store both the current version of the Python code and a record of changes made in that code over time together with the names of the people responsible for those changes. One of the conclusions drawn by the authors is very similar to the one drawn by John King in his discussion of transport infrastructures. By stabilizing the ecologies of their information spaces, the members of the Python programming community have been able to alleviate the cognitive and social workload of individually engaging in on-going collective interactions. The existence of these stabilized ecologies enable people to see how they can interact with others through code, Email exchanges, documentation archives, etc. They don't have to perpetually calculate what to do and when; they naturally engage in what the authors call a "hybridism of dialogue and code, where the dialogue is directly embedded in the code – and vice-versa". At the same time, and symmetrically, the fact that people can see how to position themselves with respect to others in on-going interactions ensures a distributed, collective evaluation of PEP ideas, thereby enabling an effective and efficient processing of a very rich and constant flow of potentially relevant information for design. As King points out in his paper, infrastructures work when they transfer the social and cognitive burden of controlling the quality of distributed information processing to the end user. The Python infrastructure works: The authors use

a methodological approach which combines qualitative and quantitative techniques including ethnography, discourse analysis, cognitive analysis of activity, social network analysis, and actor-network analysis to show why.

The above discussion of the relationships between DCP research and the design of information infrastructures shows that information infrastructures will affect the way a given situation is read; they will influence how the opportunities and constraints of doing things together are perceived and evaluated. The reason lies in the fact that information infrastructures code and stabilize the use of perceptual cues which help people know what to say (and what not to say) and what to do (and what not to do) immediately, without having to calculate the consequences of their behaviour. People are in the world emotionally, cognitively and socially and because they are, they know how to be with others, but some more skillfully than others. The two FOSS papers presented in this volume are examples of DCP research aimed at understanding the foundations of this practical skill of being able to cooperate successfully with others. As we saw, the first paper aims at describing how different combinations of speech acts create (or not) the room needed for people to be emotionally comfortable together, without tension, on the basis of a mutual recognizance of knowledge and skills; the second paper aims more at reducing the cognitive and social workload of engaging interpersonal interactions in the first place. The two approaches are anchored in different representations of what it means to be skillfully in the world: the first stresses our common humanity with others as a source of our capacity to interpret what they say and do; the second is more anchored in the idea of rational action and the need to develop information processing skills if we want to meet our goals and objectives. They lead to two design strategies for infrastructure conception and implementation.

To conclude this special issue on Information Infrastructures for Distributed Collective Practices, two papers are presented which aim at adding Scientific Data Collections and the Semantic Web to FOSS studies as appropriate areas for DCP research. The point argued by Melissa Cragin and Kalpana Shankar is that most previous approaches to the study of shared data collections (SDC) and repositories have generally focused on technical micro-studies of particular architectures of data collections, or self-reports on the outcome of projects which happen to have a shared data system. Their approach is anchored in the concept of ''working infrastructures'' presented above. Rather than seeking to improve the design of future SDCs, Cragin and Shankar's objective is to better understand the dynamic nature of distributed scientific work. For this, they are developing conceptual tools and methods for analyzing how small (often local) data collections become more public or shared collections, how shared collections mature from prototype to fully working, successful SDCs, and how these SDCs become integrated as social and technical resources into the content and context of scientific

research. Their paper discusses an issue which is of central importance to DCP research: namely, the mechanisms at work in stabilizing the categories and standards which are sown into the social fabric of scientific practice.

The paper by Manuel Zacklad, which is the last paper in this volume, can be read as well as a contribution to understanding the same general question, however, his approach is less descriptive and more theoretical. His goal is to produce a theory of intellectual transactions suitable for managing the wide variety of document related collective practices encountered on the Web. He considers that these practices are materialized by the production and exchange of semiotic products and then goes on to use his theory of intellectual transactions in order to explain how and why these products become meaningful in the course of a collective activity. He argues that a theory of this nature will serve to reduce the high cognitive overhead associated with managing semiotic products on the Web. In order to illustrate his point, he discusses a process which he calls "documentarisation". It implies annotating a semiotic product in a way which will clarify for future use its specific contribution to an on-going, goal oriented collective activity. And it is precisely that act of annotation that Zacklad wants to theorize. His work is part of a long tradition of research in CSCW on the role of semiotic systems in modelling collective practices. Increasingly, these collective practices will be using the Semantic Web for their development. Will that change the way we need to think about managing semiotic products? Zacklad's answer is that it will.

In short, we believe that the study of DCP is central to the development of a rich understanding of the interplay of technology, organizational form and social and moral agendas. No one discipline can control this field – indeed the silo mentality of a variety of disciplines has made it hard to articulate this need. Programmers, information scientists, sociologists of technology, philosophers of ethics, members of the business community and ordinary people in all walks of life have a lot to talk about. With this volume, we seek to identify some of the issues and to sketch an agenda which we feel is not only an intellectual feast but also an urgent moral and political necessity. The authors in this volume speak from multiple perspectives but on the bases of DCP they speak collectively, in distributed fashion, with one voice.

Acknowledgements

Work on the general theme of Information Infrastructures for Distributed Collective Practices has been financed by the National Science Foundation and the French National Research Council (CNRS) through a Special Action supported by the Department "Science and Technologies of Information and Communication".We would particularly like to thank Claude Henry, Annie

Gentes, Jean-Paul Sansonnet, Jacques Perriault, Dominique Boullier, Gérard Sabah and Catherine Garbay for their help in launching this activity, and Denis Bayart, Bernard Conein, Bertrand David, Alain Derycke, Bernard Reber, Claire Brossaud, et Gregory Bourgain for their many hours of discussion about how to structure it. We would also like to thank the many people who have taken part in the three DCP Workshops in Paris (2000), San Diego (2002) and Chicago (2004).

Notes

1. Information on the content, the participants and the results of these workshops and meetings can be found at the following site: http://www.limsi.fr/Individu/turner/

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