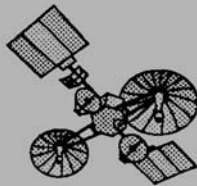$$\frac{1}{h^2}\left[E^2 - c^2p^2 - m^2c^4\right]\chi(P) = 0$$

Information Technology & People

Actor-network theory and information systems

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Actor-network theory and information systems

Guest Editors
Ole Hanseth, Margunn Aanestad and Marc Berg

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Actor-network theory and information systems. What's so special?

Ole Hanseth, Margunn Aanestad and Marc Berg

In this editorial introduction Allen Lee's definition of the information systems (IS) field is taken as the starting point: "Research in the information systems field examines more than just the technological system, or just the social system, or even the two systems side by side; in addition, it investigates the phenomena that emerge when the two interact" (Lee, A. "Editorial", *MISQ*, Vol. 25, No. 1, 2001, p. iii). By emphasizing the last part of this, it is argued that actor-network theory (ANT) can provide IS research with unique and very powerful tools to help us overcome the current poor understanding of the information technology (IT) artifact (Orlikowski, W. and Iacono, S., "Research commentary: desperately seeking the 'IT' in IT research – a call for theorizing the IT artifact", *Information Systems Research*, Vol. 10 No. 2, 2001, pp. 121-34). These tools include a broad range of concepts describing the interwoven relationships between the social.

Tracing the trajectories of issues, and their democratic deficits, on the Web: the case of the Development Gateway and its doubles

Noortje Marres

This article explores the ways in which actor-network theory (ANT) invites an alternative account of democratic process, namely in terms of issue-formation, which is particularly well suited to the study of democratic practices facilitated by information and communication technologies (ICT). Engaging with arguments that have been made in political theory in favor of the re-invigoration of institutional and extra-institutional forms of democratic debate, this article argues that a re-valuation of issue-politics is more than timely. In this respect, actor-network theory is a particularly fruitful approach, since it provides the conceptual and methodological equipment to account for democracy in terms of processes of issue formation. Such an account of democracy, it is argued, is particularly appropriate to the study of ICT-based democratic processes, since in the context of ICT distributed networks that configure around particular issues can be seen to emerge as the carriers of democratic process. Moreover, ANT provides the conceptual and methodological tools for the development of a research practice of tracing public controversies as they are enacted in such networks on the Web. In tracing a particular controversy on the Web, around the Development Gateway, a portal for development information set up by the World Bank, one begins to articulate an alternative understanding of the significance of ICT for institutional as well as extra-institutional forms of democracy. A number of requirements on effective democratic action, as facilitated by ICT, are derived from the case study, which move beyond the requirement of social networking, i.e. the building of partnerships, and informational networking, i.e. the exchange of knowledge and opinion. Issue-networking here comes to the fore as indispensable to democratic politics.

The nature of the Net: constructing reliability of health information on the Web

Samantha Adams and Marc Berg

This article juxtaposes the history of the book to the current discussions about lay health information on the Internet in order to thoroughly open up the notion of "reliability"

that underlies these discussions. It uses the parallels between the two media to improve understanding of what actors are involved and what issues are at stake, as well as how this is consequential for the reliability that is constructed.

Redefining the network: enrollment strategies in the PDA industry

Jonathan P. Allen

Theories of sociotechnical change seek to understand technology as both material and social artifacts. Actor-network theory (ANT) offers an approach to sociotechnical change that has been criticized for emphasizing a micro-level analysis of political strategies at the expense of larger social and cultural processes. This paper presents an approach to sociotechnical change that links the enrollment process of ANT with broader social practices, through the concept of inclusion in multiple technological frames. Inclusion in different technological frames is used to explain the sources of enrollment strategies in the early personal digital assistant (PDA) industry. Two case studies of PDA evolution (Psion, led by David Potter, and Palm, led by Jeff Hawkins) are used to illustrate the link between enrollment strategies and inclusion.

Contested artifact: technology sensemaking, actor networks, and the shaping of the Web browser

Samer Faraj, Dowan Kwon and Stephanie Watts

Much of IT research focuses on issues of adoption and adaptation of established technology artifacts by users and organizations and has neglected issues of how new technologies come into existence and evolve. To fill this gap, this paper depicts a complex picture of technology evolution to illustrate the development of Web browser technology. Building on actor-network theory as a basis for studying complex technology evolution processes, it explores the emergence of the browser using content analysis techniques on archival data from 1993-1998. Identifies three processes of inscribing, translating, and framing that clarify how actors acted and reacted to each other and to the emergent technological definition of the browser. This spiral development pattern incorporates complex interplay between base beliefs about what a browser is, artifacts that are the instantiation of those beliefs, evaluation routines that compare the evolving artifact to collective expectations, and strategic moves that attempt to skew the development process to someone's advantage. This approach clarifies the complex interdependence of disparate elements that over time produced the Web browser as it is known today.

Trojan actor-networks and swift translation: bringing actor-network theory to IT project escalation studies

Magnus Mähring, Jonny Holmström, Mark Keil and Ramiro Montealegre

This study investigates the potential of actor-network theory (ANT) for theory development on information technology project escalation, a pervasive problem in contemporary organizations. In so doing, the study aims to contribute to the current dialogue on the potential of ANT in the information systems field. While escalation theory has been used to study "runaway" IT projects, two distinct limitations suggest a potential of using ANT: First, there is a need for research that builds process theory on

escalation of IT projects. Second, the role of technology as an important factor (or actor) in the shaping of escalation has not been examined. This paper examines a well-known case study of an IT project disaster, the computerized baggage handling system at Denver International Airport, using both escalation theory and ANT. A theory-comparative analysis then shows how each analysis contributes differently to our knowledge about dysfunctional IT projects and how the differences between the analyses mirror characteristics of the two theories. ANT is found to offer a fruitful theoretical addition to escalation research and several conceptual extensions of ANT in the context of IT project escalation are proposed: embedded actor-networks, host actor-networks, swift translation and Trojan actor-networks.

Guest editors' introduction

Actor-network theory and information systems. What's so special?

Ole Hanseth

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Department of Social-Medical Sciences, Institute of Health Policy and
Management, Erasmus University, Rotterdam, The Netherlands

Abstract *In this editorial introduction Allen Lee's definition of the information systems (IS) field is taken as the starting point: "Research in the information systems field examines more than just the technological system, or just the social system, or even the two systems side by side; in addition, it investigates the phenomena that emerge when the two interact" (Lee, A. "Editorial", MISQ, Vol. 25, No. 1, 2001, p. iii). By emphasizing the last part of this, it is argued that actor-network theory (ANT) can provide IS research with unique and very powerful tools to help us overcome the current poor understanding of the information technology (IT) artifact (Orlikowski, W. and Iacono, S., "Research commentary: desperately seeking the 'IT' in IT research – a call for theorizing the IT artifact", Information Systems Research, Vol. 10 No. 2, 2001, pp. 121-34). These tools include a broad range of concepts describing the interwoven relationships between the social.*

Why make a special issue about actor-network theory (ANT) and information systems (IS)? What can ANT contribute to the IS field? What is its really unique contribution?

How to answer those questions depends – of course – on how we define the IS field. Recently there has been quite an intense debate about the core and identity of the IS field. Benbasat and Zmud (2003) calls for a stronger focus on the information technology (IT) artifact, a view also Robey (2003) subscribes to, although he is skeptical about the arguments for a dominating paradigm and the strong policing of the boundary of the IS field Zmud and Benbasat deliver. Allen Lee's (2001, p. iii) proposes the following definition: "Research in the information systems field examines more than just the technological system, or just the social system, or even the two systems side by side; in addition, it investigates the phenomena that emerge when the two interact."

This definition is also subscribed to by Baskerville and Myers (2002), when they argue that IS now has reached a maturity level where it should aim at being a reference discipline for others just as much as other disciplines contribute to IS. We also subscribe to this. We will, however, emphasize the last part of Lee's definition, i.e. the interaction between the social and the technical systems. This is what makes IS different from, let's say, computer science on the one hand, and organization studies on the other. At the same time we see this as the weak spot in IS. As beautifully illustrated

by Orlikowski and Iacono (2001) in their survey of ten volumes of ISR searching for theoretical conceptions of IT – without finding it! What they argue should be the core of the IS discipline – a theoretical understanding of the key object (if not the constituting object) of our field is virtually nonexistent. Based on this finding they conclude that research aiming at developing such theories is "desperately" needed. Accordingly, if ANT is supposed to make a significant contribution to IS research, it should help us theorize the IT artifact, or in Lee's terms: help us get a better understanding of the interaction between the social and the technical system. And the good news is, then, that it is exactly this borderline between the social and the technical that ANT has been developed to help us analyze and understand.

In our discussion of ANT's (potential) contribution, we will see it as a social theory of technology and discuss its (unique) contribution in relation to other social theories applied in IS research in order to get a better understanding of the social context of the development, implementation and use of IS. A long stream of social theories have been picked up and applied for this purpose. Among the early ones we find Marxist theories of the role of technology in social change. Braverman's (1974) deskilling hypothesis was in particular used to described rather deterministic processes where managers applied information technology as a tool to increase organizational effectiveness by controlling their workforce partly aimed at deskilling and partly had deskilling as a consequence (Noble, 1986; Greenbaum, 1995). Later studies showed that the effects of particular technologies were far from that deterministic, which again triggered the growth of constructivist approaches to the studies of technology. In the IS field this change was manifested in the growing popularity of Giddens' (1984) structuration theory (Orlikowski, 1992; Walsham, 1993), and to some extent "new insitutionalism" (Avgerou, 2002; Hasselbladh and Kallinikos, 2000).The structuration theory approach has been picked up by a vast number of scholars and a wide range of studies have been carried out. These studies have given us many valuable insights into the social processes related to the adoption and use of IS. There is one aspect of these studies that is of crucial importance here. That relates to the role of technology in these studies as well as the theories they are based on. These go equally well (or more precisely, badly) for both structuration theory and institutionalism. The studies of IS based on these theories do not address the role of technology in a proper way. This fact is largely a consequence of the fact that both these theories totally ignore technology. This makes ANT – and the technology studies part of the STS field – different. And in this respect ANT offers some unique and very important contributions to IS.

The early studies applying structuration theory interpreted technology as structure enabling and/or constraining certain human actions (Orlikowski, 1992; Walsham, 1993; DeSanctis and Poole, 1994) This idea certainly helped highlight various issues related to how a specific technology was used in an organization. But it also had its limits. This relates in particular to a richer understanding of the technology seen in a social context. On the one hand the notion of seeing technology as structure in line with social structures that enable and/or constrain is a rather poor conception of technology. On the other this idea is problematic because it directly contradicts Giddens' concept of structures by saying that they are only traces of the mind and have no material existence whatsoever. This fact is acknowledged by Orlikowski (2000) in her most recent writings on the issue. She tries to overcome this problem by means of a dual concept of technology: Technological artifact and technology-in-practice. The first

"appears in our lives as a specific machines, technique, appliance, device, or gadget. At the same time, use of the technology involves a repeatedly experienced, personally ordered and edited version of the technological artifact, being experienced differently by different individuals and differently by the same individual depending on the time or circumstance. In this aspect in might be termed a technology-in-practice, to refer to the specific structure routinely enacted as we use the specific machine, technique, device, or gadget in recurrent ways in our everyday activities" (Orlikowski, 2000, p. 408). Orlikowski says that this distinction is analytical, not ontological. She says that she believes this distinction between technologies as artifacts and the use of such artifacts is "an especially useful one in both empirical research and everyday usage" (Orlikowski, 2000, note 4, p. 425). She expresses this belief without any further argument supporting it and at the same time as she accepts Grint and Woolgar's (1995, p. 289) claim that "technology exists only in and through our descriptions and practices, and hence it is never available in a raw, untainted state."

On this point we disagree with Orlikowski. If we want to understand technology in a social context, it is exactly the relationship between what she calls the technological artifact and the technology-in-practice we need to understand. By staying close to Giddens' original presentation of structuration theory, she addresses only the technology-in-practice, and can say nothing about the relationship between the two – for instance how the technology-in-practice is actually shaped by the technological artifact. It is this relationship we see as what should be at the center of the field according to Allen Lee's definition presented above as well as Orlikowski and Iacono's call for the "desperate" need for theorizing the IT artifact. And as already said, it is exactly this relationship ANT is designed to help us analyze and understand.

To understand this relationship ANT offers us a rather rich set of concepts. We will briefly describe some of them here. The most basic one is that of an actor network, which is a network where elements of any kind may be included: humans, technological artifacts, organizations, institutions, etc. ANT does not distinguish between or define a priori any kind of elements. They are just called actants. Further, with its interest in the heterogeneous and socio-technical world, ANT assumes that all networks are heterogeneous or socio-technical. There are no networks that consist of only humans or only of technological components. All networks contains elements of both. And a socio-technical network is the smallest unit. If we open a box in one network and looks at what is inside, it is always a heterogeneous network. This means that what Orlikowski calls a technological artifact is a network which also includes humans or organizations. It is a heterogeneous network just as a technology-in-practice. The network constituting a technological artifact includes its designers and their social context. When it is used in an organization, some elements of this network are removed and others are included. Some elements are included in both cases, but they are also changing because they are parts of different networks.

ANT is sometimes criticized for claiming (or assuming) that humans and technologies are essentially the same. This is, in our view, an unfounded claim. It is true in the sense that ANT assumes everything to be an actor-network. And accordingly so are both humans and technologies. But all networks are also different. So are different technological artifacts and so are different humans, at least in terms of the roles they are playing in organizations and social life. These differences are constituted by different actor networks. The networks are becoming different by

translating and linking different elements (or more precisely: networks). Through this process various programs-of-action are inscribed into the network, or roles, competencies, and responsibilities are delegated.

An actor is also a network, whether this actor is a human carrying out an acted using some tools or instruments, or it is a technology supported by an organization (like telecommunication infrastructures). Various concepts are used to describe actors like hybrid objects, collectives, hybrid collectives, The French term is here used also in English. configurations, associations, technological systems, techno-science, etc. More recently, some ANT researchers like John Law and Annemarie Mol have zoomed in even more closely on the relationship between the social and technical. To them the concept of network is not fine grained enough to describe the complexity and nuances of this relationship. They find that the relation is better seen as larger regions where the social and the technical are tightly woven together, often inseparable like when we mix together fluids.

A central idea and motivation behind ANT is to study the construction of things normally taken for granted. The border between the social and the technical is one such. The border between design and use is another. This distinction is also assumed constructed. ANT sees both as negotiation processes where various networks are linked and transforming each other.

ANT may contribute to the IS field not only by means of its conceptual vocabulary. Various ANT inspired case studies from the STS field can also tell us a lot about the design and use of technologies which is of huge significance for the IS field. We will here mention just one: Thomas P. Hughes' *Networks of Power*, where he analyzed the development and use of electricity from 1880 to 1930 (Hughes, 1983). Here he describes this process as the development of a technological system (which is indeed socio-technical in this case) and develops a set of more aggregated concepts, like reverse salients and technological momentum, which we find to be of relevance for IS now when information systems have evolved into large scale, complex, integrated, global structures. Hughes' developed his concept mostly in parallel with the development of the core concepts of ANT. For this reason they were for quite some time seen as rather different. The concept of momentum, for instance, was interpreted as a concept of rather deterministic flavor – something which ANT was developed to prove wrong. Over time, however, his concepts have been interpreted differently, and much more in line with ANT (Hughes, 1987,Callon, 1991). Latour (1999, p. 204), for instance, describes the technological system of electricity networks as "a 'seamless web' of social and technical factors so beautifully traced by Hughes."

Within the IS field, Kling and Scacchi's (1982) web models of computer systems was a very important precursor, as the ideas underlying these models were very close to the basic tenets of the actor-network approach. Within the IS field, however, actor-network theory seems often to have been used merely as a methodology for description; as a way to perform a stakeholder analysis, describing and labeling the different actors, identifying interests, phases of alignment, obligatory passage points, etc. It may be discussed to which degree the deeper ontological tenets have been understood and taken seriously. This may lead us to ask whether ANT itself has become "translated" when moving into the pragmatic and non-theoretical IS world. How has the enrolling of ICT technologies reshaped the ANT actor-network? Will IS researchers' demands of a theory be different from those of social scientists attempting to understand the

workings of the social world without "discriminating against technology?" We will briefly discuss a few points related to this. While not presuming to address these issues in depth, we believe that the papers included in this special issue touch upon several of them.

Information and communication technologies are becoming more complex, interlinked and more deeply interwoven into the fabric of society. This implies an unprecedented degree of complexity for systems development. When it comes, for example, to global information systems, their scale, complexity and the interdependencies between systems may give rise to unexpected side effects that give the impression of a technology beyond rational control. Issues that previously could be assigned to either "micro" or "macro" dimensions and handled separately, turn out to be closely interrelated and connected in unexpected ways. Actor-network theory ignores the micro-macro dichotomy and includes all relevant entities irrespective of their "size". Despite this, we may ask how well suited ANT is when studying new phenomena in a networked, global setting. Is its insistence on the empirical contrary to the need to go beyond the local setting? John Urry (2003), however, has demonstrated in a very nice way how ANT can be combined with others into a powerful approach to the studies of "global complexities."

The classic "laboratory studies" focused on the practices around scientific knowledge production and analyzed processes of fact stabilization and closure through the creation of successfully aligned networks. Studies of commercially driven innovation networks do not abound, but may be more relevant when it comes to understanding the emergence and use of information and communication technologies.

After the initial call for papers in the summer of 2002, we received 33 abstracts, and in the next round 20 full papers. Of these five were selected, and we have the pleasure to present the following papers:

(1) Noortje Marres: "Tracing the trajectories of issues, and their democratic deficits, on the Web: the case of the Development Gateway and its doubles". Marres has studied a dispute around The Development Gateway, a Web portal for development information. Originally it was set up by the World Bank, but subsequently appeared to sever its ties to the bank. The following dispute within the development community was centered on whether this was more than a cosmetic move. In discussing this controversy and the alliances that were formed, Marres shows how neglecting traditional analytic boundaries (i.e. deploying the ANT approach) helps in identifying real effects from the somewhat discredited "issue politics", and argues that this approach may challenge existing conceptualization of what democratic action related to the Internet means.

(2) Samantha Adams and Marc Berg: "The nature of the Net: constructing reliability of health information on the Web". Through opening the "black box" of our historically negotiated trust in printed matter (e.g. books), Adams and Berg's paper illuminates how reliability of health information sites on the Internet is currently being negotiated. The paper describes some of the central actors and initiatives, including certification schemes, portals, and rating systems, and attempts to analyze which issues are at stake, and what reliability in this novel setting ultimately comes to mean.

(3) Jonathan P. Allen: "Redefining the network: enrollment strategies in the PDA industry". The empirical material in this paper is concerned with the different development trajectories for two PDA devices, the Psion and the Palm. In order to understand the broader context that was influencing these development trajectories, Allen introduces Bijker's concepts of inclusion into technological frames. These concepts are used to discuss how the individuals behind these PDA initiatives were relating to and partaking in larger communities and activities.

(4) Samer Faraj, Dowan Kwon and Stephanie Watts: "Contested artifact: technology sensemaking, actor networks and the shaping of the Web browser". The paper describes the evolution of the Web browser technology in the context of commercial actor-networks of innovation, a topic that has not frequently been analyzed in ANT studies. Other attempts at explaining or describing technology development often distinguishes between the developers beliefs and the evolving artifact(s), while the authors of this paper attempt to take the actor network as a unit of analysis and thus reject the subject-object distinction. Through a detailed study of events between 1993 and 1998 the paper analyses significant events, not just within, but across organizations and communities, of what has become today a widely spread and crucial technology.

(5) Magnus Mähring, Jonny Holmström, Mark Keil and Ramiro Montealegre: "Trojan actor-networks and swift translation: bringing actor-network theory to IT project escalation studies". The authors contrast actor-network theory with escalation theory in reviewing the case of the computerized baggage handling system at the Denver International Airport in 1993-1994. In analyzing this case of a project escalation, the authors suggest to expand the vocabulary with some empirically grounded analytic concepts: those of "host networks" versus "embedded (or "trojan") networks", and the phenomenon of swift translations of such embedded networks.

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Tracing the trajectories of issues, and their democratic deficits, on the Web

The case of the Development Gateway and its doubles

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Abstract *This article explores the ways in which actor-network theory (ANT) invites an alternative account of democratic process, namely in terms of issue-formation, which is particularly well suited to the study of democratic practices facilitated by information and communication technologies (ICT). Engaging with arguments that have been made in political theory in favor of the re-invigoration of institutional and extra-institutional forms of democratic debate, this article argues that a re-valuation of issue-politics is more than timely. In this respect, actor-network theory is a particularly fruitful approach, since it provides the conceptual and methodological equipment to account for democracy in terms of processes of issue formation. Such an account of democracy, it is argued, is particularly appropriate to the study of ICT-based democratic processes, since in the context of ICT distributed networks that configure around particular issues can be seen to emerge as the carriers of democratic process. Moreover, ANT provides the conceptual and methodological tools for the development of a research practice of tracing public controversies as they are enacted in such networks on the Web. In tracing a particular controversy on the Web, around the Development Gateway, a portal for development information set up by the World Bank, one begins to articulate an alternative understanding of the significance of ICT for institutional as well as extra-institutional forms of democracy. A number of requirements on effective democratic action, as facilitated by ICT, are derived from the case study, which move beyond the requirement of social networking, i.e. the building of partnerships, and informational networking, i.e. the exchange of knowledge and opinion. Issue-networking here comes to the fore as indispensable to democratic politics.*

Introduction

In the spring of 2002, my colleague rather unexpectedly received an e-mail from the World Bank (see Figure 1). The message had been forwarded to him by Oneworld, the organisation that hosts the Web crawling software we use in our research. The week before, I had been collecting data on the Web, using this software, about the controversy surrounding the Development Gateway, a portal for development
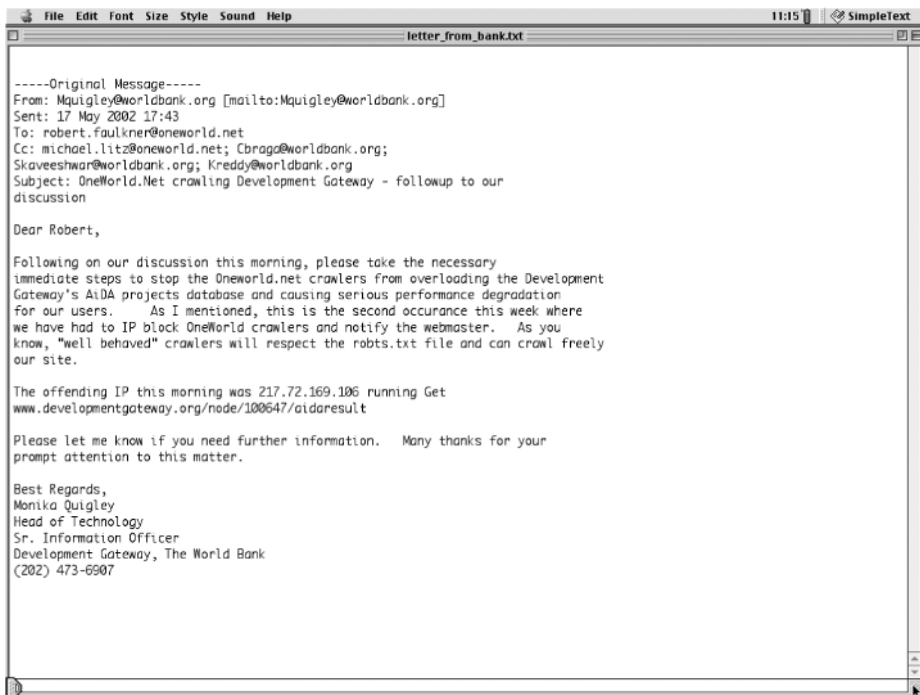
Figure 1.
The e-mail from the
"Development Gateway,
The Worldbank"

information originally set up by the World Bank. Now the World Bank had sent us a message that our crawling software clogs the Development Gateway Web site. According to the Bank, our software ignored the robot files of the Gateway, lines of code with "do's and don'ts" that visiting crawlers encounter on the Gateway site. If we did not stop the crawler from visiting the site, they wrote, they would block it. Now, the "cease and desist" e-mail we thus received from the Bank, could lead us to pose all sorts of questions, for example, about the inevitable involvement of Internet researchers in the phenomenon studied (the anthropologist's problem of "meshing with the natives"). It equally raises questions about the sophistication, technical and otherwise, that may be required if we are to successfully undertake social research on the Internet. However, at the time, the most interesting fact about the e-mail for us was the signature at the bottom: "Development Gateway, The World Bank".

In our research, we had found that one of the points of contention in the controversy around the Development Gateway was the independence of the initiative. According to the Gateway Web site, the portal is a project of a non-profit organisation called the Development Gateway Foundation. But judging from the criticisms of the initiative that can be found on the Web sites of non-governmental organisations (NGOs), the Gateway is really still governed by the World Bank. The e-mail from the World Bank now seemed to prove the critics right. It provided a pretty solid indication, that the story told by the Gateway Web site about its "independence" comes down to a public relations move. While this fact is perhaps little surprising in itself, it may shed a different light on the public controversies that the World Bank and its policies have

given rise to over the last decade or so[1]. In these controversies, which thematized the Bank's involvement in the deforestation of the Amazon, and its national debt-repayment policies with respect to developing countries, the NGOs and social movements that criticize the Bank often appear to be engaging in quite superficial forms of politics. They organize street protests, such as the demonstration in Washington DC in March 2002, and publicize critical documents on the Web and elsewhere. But in most cases they do not seem to succeed in producing a tenable accusation against the Bank, let alone a tenable alternative for the institutional arrangement it represents[2]. However, as we find that the Bank too, can be considered guilty of pursuing a rather superficial kind of politics, – that of "re-branding" the Development Gateway, while not making the correlating institutional changes – the charge of engaging in merely cosmetic, ineffective action, might be just as applicable to the institution itself. As we shall see, such a finding may lead us to re-open the debate on the type of politics pursued by NGOs and social movements, on the Web and perhaps also beyond it: the politics of issues.

During the nineties, the politics that social movements and NGOs engaged in was often characterized as "issue-politics". This type of politics never had a very good name, and the term "single-issue movement" is often used in a pejorative sense. The politics of issues is rarely taken serious as a form of politics. However, from the standpoint of actor-network theory (ANT), the issues around which public controversies revolve appear as a particularly fruitful entry point in the study of politics. This approach has become famous for its analysis of social processes of articulation in which socio-technical entities acquire a definition, from the vaccine to the computer user (Latour, 1988; Bardini and Horvath, 1995). When it comes to grasping political process, actor-network theory invites us to focus on the processes in which issues come to be defined as objects of public contestation. Such an ANT-informed approach to the study of political process is especially fruitful, I want to argue, if we want to account for the interrelations between democracy and information and communication technology (ICT). In recent work on this subject, much attention has been paid to the opportunities the Internet offers to institutions as a platform for deliberative processes and consultation procedures. Another often recurring theme is the possibilities that the Internet offers to NGOs and social movements for partnership-building and information-exchange. However, from the vantage point of an ANT-informed analysis of political process, both as it is supported by ICT and in as far as it has ICT as its object, these features turn out to be insufficient conditions for democracy. Neither the implementation of ICT-supported consultation procedures by institutions, nor the networking activities of civil society organisations, can assure that a democratic process is indeed taking place. From the standpoint of ANT, whether a political process counts as democratic or not, depends on the continuities and discontinuities among the different articulations of a given issue, as they are produced in networks of both civil and institutional actors.

This paper presents a theoretical discussion, notably of actor-network theory, that leads onto the argument that issue-politics must be taken seriously in the account of democracy, especially in relation to ICT. In making this argument, we take up the proposal of Doolin and Lowe (2002), who suggested that ANT provides a particularly fruitful approach for critical research on information systems, and more broadly the integration of ICT in organisational life. The value of ANT, they argued, resides in the

way in which its empirical accounts of practices unsettle predominant assumptions about the organisation of social life. In taking up their argument, this article zooms in on the more particular question of how ANT may be taken up to account for democratic processes facilitated by ICT. As such, it makes the argument that ANT provides such a fruitful approach to the study of democracy and ICT, not just because of its empirical method, but because of the conceptualization of democratic practice it makes possible. ANT invites us to account of democratic process as a process of issue formation, as opposed to more structuralist accounts, and as such it is particular useful for research into ICT-facilitated (non-)democracy. This article further explores this proposition in a case study, a Web-based ethnography of a public controversy around the Development Gateway, the portal for development information set up by the World Bank. Taking the approach of actor-network theory to the Internet, as a site of research, the case study brings into view a trajectory of issue formation, in which both civil and institutional actors contribute to successive articulations of the object of contention, "the Development Gateway". As such, it draws attention to a number of requirements on democratic action in the context of ICT, that move beyond the celebration of the opportunities provided by ICT for the implementation of deliberative procedures in institutions, and partnership-building among civil society organisations. The politics of issues here comes to the fore as a form of politics that must be taken seriously, by institutional and civil actors alike, if ICT are indeed to serve as a vector of democratization.

After the crisis of political institutions, the unfortunate fate of issue-politics

Actor-network theory invites us to approach democratic process (and its failure) as a process of issue formation, and, I hope to show, it provides us with the conceptual tools to do so. When it comes to questions relating to democracy and information and communication technology (ICT), this approach may shed new light on the socio-technical conditions for democratic action. It shows that on-line discussion and information-exchange in themselves cannot assure that democratic process is indeed taking place. Much depends, instead, on the contributions of both institutional and civil actors to processes of issue formation. However, to tell the story of issue-politics as a suitable concept to study democratic process (and its absence) in the context of ICT, we must begin somewhere else: in political theory. Incentives to pay special attention to the issues, in the account of democracy, abound in recent political theory. However, to my knowledge, political theory has as yet failed to develop the notion of issue-politics into a constructive concept for the study of democratic process. If we are to account for democratic politics in terms of issue formation, with respect to ICT, we thus first have to engage with and elaborate concepts of issue-politics (guided by work already undertaken in actor-network theory). Also in as far as work in the area of democracy and ICT has tended to derive its conceptualizations of democracy from political theory rather unquestioningly, we do well to evaluate the incomplete argumentative movement in political theory explicitly. In work on ICT and democracy, the theory of deliberative democracy put forward by Jürgen Habermas has served as the main source for the conceptualization of democracy (Varey *et al.*, 2002). Also in criticism of this approach to democracy and ICT, researchers have made critiques of the Habermasian approach which had previously been articulated in political theory:

Habermas's concept of democracy as rational debate among equal subjects fails to adress satisfactorily the complications of gender inequality and the assymmetry of power relations that risk to make democracy impossible (Adam, 2002). In this respect, it has been insufficiently appreciated, I would say, that research into the practices of doing democracy with ICT may compel and inspire shifts in the conceptualization of democratic process itself. More specifically, if we are right to recognize in processes of issue formation a crucial vector of democratic process, as it unfolds in ICT-related practices, then a critical re-consideration of the arguments put forward in political theory becomes crucial: political theory itself has gone only halfway in the conceptualization of democratic process as a process of issue formation. Exploring how the concept of democratic process can be further developed along these lines, we may begin to make clear in what ways work in the area of democracy and information and communication technology, inspired by ANT, could add to the conceptualization and empirical study of democratic process.

To pinpoint the particular moment in which the politics of issues became an object of special concern in the study of democracy is of course an artificial operation, but the recent emergence of the diagnosis of the crisis of political institutions, can be classified as one of those moments. Especially since the mid-eighties, the claim that the institutions of national representative democracy are under pressure has been widely embraced. It was notably the rise of environmental, humanitarian, health and women's issues, that was singled out as the prime symptom of this rather abstract problem. The sociologist Ulrich Beck, in his famous theory of the rise of the risk society, made much of the fact that the German government initially failed to respond effectively to the environmental problems that social movements and NGOs brought to their attention. He presents it as one of the more important pieces of evidence for his claim that national governmental institutions have lost their political efficacy, and ultimately, their legitimacy (Beck, 1986, 1997). Theories of globalization, as developed for example by the political scientist Held (1999), equally present the unmanageability of issues as proof of a crisis of political institutions. According to Held, the emergence of environmental, humanitarian and economic issues that transcend national boundaries signals the crisis of nation-state-based forms of governance, and democracy. Conceptualising this situation in philosophical terms, the political philosopher William Connolly, has come up with the term "generalized contingency", to capture the phenomenon of the disintegration of frameworks of manageability, both in institutions and in the home (Connolly, 1995). According to Connolly, social, technological, environmental and economic complications have ceased to respect a number of crucial premises built into the frameworks on which institutions and individuals rely in acknowledging and resolving such problems, such as the containment of issues within the boundaries of nation-states and the reliability of knowledge and information. However, whereas "the rise of issues" for these authors brings home the point of the crisis of political institutions, issues and their politics play far from a major role in the remedies they propose.

It is true that it is often acknowledged, also by the above authors, that issues will increasingly play a decisive role in the organisation of politics in the future, more so than before, or at least more ostensibly so. David Held claims that in the context of globalization, the borders and constitution of political communities will vary according to the issue at hand. While some issues can be treated perfectly well within the

arrangements of national, regional and local representative democracy, other issues can only be effectively taken up by a different kind of political community, which he calls "cosmopolitan", involving actors from a variety of organisational backgrounds (Held, 2000). William Connolly argues that in the light of the rise of global contingencies, issues come to serve as crucial coordinates of public spheres. As the issues defy institutional arrangements grounded in the nation-state, they are first and foremost taken up by actors that are not tied by these arrangements, notably social movements and NGOs. These actors, in their turn, will come to recognize the issues as crucial points of reference in the otherwise amorphous transnational political spaces in which they are active. These authors thus to a degree recognize the issues as an important organising principle of politics. However, in their formulation of actual remedies for the crisis of political institutions, they refrain from granting the issues a role. When it comes to the solutions for "institutional deficits", the above political theorists shift the analysis to a more structural level, that of underlying political arrangements. The remedies they propose target on the one hand the design of political institutions, and on the other hand, the architecture of what they call a global public sphere. With regard to the design of institutions, David Held refers to intergovernmental organisations like the EU and the Bretton Woods Institutions (the Worldbank, the IMF), and makes a plea for the establishment of more democratic versions of this type of institutions, which would then provide a platform for the cosmopolitan communities mentioned above. For Held, these institutional efforts are to be combined with the project to assure a vibrant culture of political engagement outside of the institutions. This allows the issues to be observed when they emerge, and to be brought to the attention of the relevant institutions (Held, 2000). Connolly (1995) equally makes the distinction between on the one hand legislative and administrative institutions of democracy, which assure the issues will actually be dealt with, and on the other hand, a global public sphere which allows for the observation and articulation of issues.

In this shift to the level of underlying political arrangements, the issues as an organising principle of politics to a large degree disappear from view. The mobilization of actors around issues, indeed the process of their articulation, inevitably begins to take on the appearance of a "surface activity", that relies on the presence of more fundamental political architectures. A second reason that issue-politics disappears from view, is a move made by the above authors which we may call, in taking up another term of William Connoly, "the disaggregation of democracy" (Connolly, 1995). That is, the above authors argue for a two-track approach to democracy, sharply distinguishing the project of institutional re-design, from the project of invigorating extra-institutional democracy, as embodied in a global public sphere, or as is increasingly pointed out, as enacted by global civil society. This analytical move of splitting democracy into an extra-institutional versus an institutional, statist arrangement, is deeply ingrained in political theory[3]. Indeed, that a distinction must be made between the public sphere, or civil society, on the one hand, and the administrative and legislative institutions of democracy on the other, is for most purposes self-evident. However, the definition of democracy in terms of such a bi-partite arrangement has substantial limitations, when it comes to the evaluation of democratic processes in the context of the rise of issues (and especially when it comes to democratic processes as enacted with the aid of ICT). As I will show in the following,

processes of the definition of issues involve both extra-institutional and institutional actors, plus hosts of actors that are more difficult to position according to this distinction, as they serve as interfaces between these constituencies. Moreover, these processes are spread out in time as well as in space, among more or less professional non-governmental organisations, and more or less "governmental" organisations, acting in many more or less "institutional" settings. As long as the disaggregation of democracy is respected, however, such distributed processes of issue formation, which cut across the boundary between institutional and extra-institutional arrangements of democracy, are likely to go unscrutinized.

Much research in the area of democracy and information and communication technology, tends to respect the rule of the "disaggregation of democracy". Most studies on this topic treat as two separate questions, the potential of ICT in supporting institutional democratic procedures, such as deliberation and consultation, on the one hand (Coleman and Gøtze, 2001; Ward and Gibson, 2000) and the importance of ICT to the democratic activities of civil society, on the other hand (Sassen, 1998; Naughton, 2001; Warkentin, 2001). Work in this area treats either one of these questions, and when treating both, the strict distinction between the two tends to be carefully maintained (Wilhelm, 2000). Actor-network theory (ANT), on the other hand, leads to scepticism with respect to the disaggregation of democracy, as well as with respect to "the crisis of political institutions". ANT in this respect invites a reconceptualization of democratic process. As I'll turn to now, ANT invites us to re-conceptualize democracy as a process of issue formation, that continuously transgresses the boundaries between "extra-institutional" and "institutional" sites of the articulation of issues. As I'll come to later, because ANT leads to scepticism with respect to the disaggregation of democracy, it invites us to develop an alternative approach to questions relating to democracy and information and communication technology.

ANT and the study of democratic politics in times of "crisis"

The approach of actor-network theory (ANT) is particularly well-suited to the study of democracy in the context in which political issues increasingly seem to unsettle existing democratic arrangements. The approach, originally developed by Bruno Latour and Michel Callon for the social study of scientific and technological practices, has become well-known especially for the concept of co-construction that it proposes. Rejecting both technological and social determinism in the study of science, technology and society, ANT focuses on the ways in which science and technology as well as society are re-configured in scientific and technological practices (Latour, 1993; Callon, 1986). It posits that both techno-scientific products and the roles of social actors acquire new definitions in the process of the integration of these new techno-scientific products in society. In order to understand the roles played by science and technology in society, ANT argues, one must zoom in on this process of the genesis and social integration of science and technology, and document how scientific and technological products as well as the roles of social actors both come to be re-defined in the process. When it comes to the study of democratic politics, in the context of "the rise of issues", this approach may prove particularly fruitful on a number of accounts. Firstly, ANT invites us to resist the claim that the inability of democratic arrangements to effectively process many contemporary issues is pathological, i.e. indicative of crisis. ANT has documented how practices in science and technology, as a matter of course, do not

respect formal institutional arrangements, such as the established separation between science and society, As such, ANT leads us to wonder whether the disrespect of current practices of issue-politics for formal institutional arrangements of democracy is in any way exceptional. Moreover, the empirical method developed by ANT, to follow through processes of the genesis and social integration of new entities in society, is well-suited to be adapted to the study of democratic practices in the context of "the rise of issues". As we shall see, ANT researchers have started to explore the possibility to account for democratic politics as a process in which issues are progressively articulated as political in nature, in a variety of settings by a variety of actors[4].

To begin with the negative critique of the thesis of the crisis of political institutions, ANT leads us to ask whether it is perhaps first and foremost concepts of democracy, and not necessarily political practices, that are "in crisis". The thesis of the crisis of political institutions posits that established definitions of democracy have today come under pressure. But from the standpoint of actor-network theory, the fact that practices fail to comply with official definitions of the functioning of institutions, does not necessarily imply that either these practices or these institutions are "in crisis". ANT holds open the possibility that the failure to respect formal arrangements could turn out to be a condition of success for practices. Thus, in his famous study of the discovery of the vaccine by Louis Pasteur, Bruno Latour has shown how this achievement depended on the fact that Pasteur, as part of his project, actively negated the formal distinction between science on the one hand, and society on the other. The vaccine could come into being, Latour argues, precisely because Louis Pasteur continuously transgressed the boundaries between his laboratory (science) and the world outside (society) (Latour, 1988, 1999). As part of his scientific project, Pasteur actively went out to meet social actors, from farmers, vetenaries to hygienists, so as to implicate them in this project, and the vaccine only could be said to work properly, and thus exists as a vaccine, once it could be successfully inserted in social practices[5]. The active negation of the formal arrangement of the separation between knowledge-production and societal processes, Latour argues, is part and parcel of scientific practice. Drawing on the methodological and conceptual commitment of Bruno Latour, to follow practices also where this means that formal arrangements are actively negated, Gomart and Hajer (2002) have questioned the thesis of the crisis of political institutions. Building on actor-network theory, these authors suggest that the worrying diagnosis of the state of contemporary democratic institutions may change quite drastically, as we move on to study politics ethnographically. In their case study of a public controversy surrounding a regional planning proposal for the Hoeksche Waard, a region in the South of The Netherlands, they suggest that the success of democratic practices may precisely depend on a healthy disrespect of actors as to what are the appropriate sites and forms of democratic debate. They show how in the controversy on the regional planning proposal for the Hoeksche Waard, citizens were only effectively drawn into the controversy, when it was taken up by a group of architects of Rotterdam, as the subject of a cultural event. Drawing on this case study, the authors claim that what appears a chronic failure of existing political arrangements when approaching politics from the side of formal definitions, turns out to be a less pathological situation, or at least a situation that must be deemed pathological on very different counts, if these notions are momentarily left aside[6]. While democratic practices might fail to comply with the prescriptions of the "classico-modern tradition",

they might be alive and kicking in different guises. Gomart and Hajer propose that politics may instead be going on in other locations that those conventionally favoured by democratic theory. Democratic politics, they suggest, goes on in the in-between, "next to or across institutionalised political orders", and that this may very well be its *modus vivendi*[7].

If actor-network-theory, as taken up by Emilie Gomart and Maarten Hajer, leads to a refusal of the diagnosis of structural institutional failure, and indeed to a momentary disregard of formal institutional arrangements, what then, serves as ANT's "lead" in the study of politics? The answer is given only implicitly by Gomart and Hajer, but in their account of the public controversy surrounding the regional planning proposal for the Hoeksche Waard, they elevate the object of public controversy to the focal point of democratic politics. In their description of the controversy, the authors follow the process in which the regional planning proposal is successively taken up in a variety of settings, from the offices of the policy-makers at the House of the Province of South-Holland, to the public event organised by architects of the city of Rotterdam. They describes how the issue at stake is increasingly politicized, as it subsequently takes the center of attention in the policy-makers practices, and those of the architects of Rotterdam. That is to say, the case study of Gomart and Hajer can be read as a proposal to account for democracy as a process of issue formation. This proposal can also be found in the work of the British sociologist Andrew Barry, who equally draws on ANT in the study of politics (Barry, 2001, 2002). In his case study on anti-road protests in Southern England at the end of the nineties, Barry explicitly proposes to attribute a leading role to the object of controversy in our understanding of democratic politics (Barry, 2001). In making this proposal, he starts with the observation that the environmental protest he studied, can impossibly be accounted for in terms of political representation as it is conventionally understood, in terms of the representation of actors opinions or positions. Barry points out that the activities involved in setting up a roadblock cannot be reduced to the presentation of a "position" on the particular issue of road-building in Britain. The anti-road protestors are not taking an ecological, romantic, conservative or anarchist standpoint on the matter: their backgrounds are too diverse and their slogans too inconsistent for that. Instead, Barry argues, the demonstration is about placing a specific object at the center of public attention, and making it visible. The site at which the protest takes place, the location of a future road, "the Newbury by-pass", is mobilized to publicize the issue: the trees and the birds and the coffee-tent at the protest site are made to tell the story of the contestable future of this particular land slot. According to Barry, the protest revolved principally around the question of what will happen to this land slot, and perhaps too, those other land slots on the point of turning into roads, or shopping malls, that this particular land slot may stand in for. That is, in Barry's account protest stands in the service of the transformation of the "projected by-pass" into an object of politics, i.e. an political issue.

Importantly, especially for our purposes, Gomart and Hajer as well as Barry do not conceive of issue-making as an isolated, "local" event. As they work with actor-network theory, they conceptualize the process of politicization in terms of the circulation of the object of politics among settings. Bruno Latour and Michel Callon, as part of their argument that the analysis of science and society must zoom in on the process of the genesis and social integration of scientific and technological products,

put forward the methodological precept to follow a given techno-scientific entity, along trajectories of articulation across social practices. Thus, in his study of Pasteur's discovery of the vaccine, Bruno Latour conceptualized this process as one of the circulation of this entity, in both its material and discursive guises, among the laboratory, the farms where it was put to work, the studies of the hygienists, who were studying epidemical solutions, and the popular press. The vaccine acquired its definition, as the effective answer to the anthrax epidemic, Latour argued, along these paths of circulation (Latour, 1999). Gomart and Hajer and Barry adopt this approach, as they account for the emergence of politics in terms of the circulation of a particular issue among various sites. In their ANT-inspired ethnographies of democratic politics, the circulation of a political object comes to the fore as constitutive of politics. As Gomart and Hajer follow the process in which the "regional planning proposal for the Hoeksche Waard" is provided with alternative definitions in the offices of the policy-makers over at the Province of South-Holland, and during the public event staged by the architects of Rotterdam, they develop the argument that the process of politicization of the proposal, must be located in the deviations from previous stagings the issue. Gomart and Hajer argue that it is in the shifting of the stagings of the issue, by the policy-makers, and after that, during the cultural event, that the design for the Hoeksche Waard becomes politicized. In Barry's account, the notion that the circulation of the issue is constitutive of politics also returns, albeit more implicitly. In his account, mass mediatization of the protest is part and parcel of this political event. He describes how the anti-road protest was formatted explicitly for distribution by news channels. The politics of setting, where the trees and the birds and the coffee-tent at the protest site are made to tell the story of resistance against the projected Newbury by-pass, are particularly well attuned to visual media. The wider circulation of the issue thus comes to the fore as crucial to its politicization here too. At this point, it may become clear why ICT presents such a crucial context for the study of democracy, as informed by actor-network theory.

Catching up on the trajectories of issues on the World Wide Web

Actor-network theory, as it invites an account of democratic politics in terms of issue formation, implies a critique of the assumption of the disaggregation of democracy, which studies of ICT and democracy tend to subscribe to. In this sense, ANT is not only an empiricist approach which can be opposed to more rationalist and structuralist approaches to communication that is predominant in work in this area (Doolin and Lowe, 2002). More in particular, it invites a reconceptualization of democratic process, as it is facilitated by information and communication technology. But before addressing the approach to democracy and ICT that can be derived from ANT-informed accounts of political practices, it must first be recognized that ICT presents ANT with a new site of research. The prime relevance of the social domestication of information and communication technologies, it has been argued by Bruno Latour and also by Madeleine Akrich, is that they provide ANT with an especially fertile research field (Latour, 1998). Perhaps surprisingly, the argument that Latour makes is not that ICT and ANT make for a happy marriage because they share the concept of the network. The fact that ANT has described the genesis and social integration of scientific and technological products in terms of the configuration of networks of actors, certainly makes this approach especially adaptable to ICT-based

research, as we'll come to. But Latour prefers to emphasize that ANT in its empirical studies has always been obsessed with informational traces, According to him, it is first and foremost the careful documentation of such traces which allows ANT researchers to describe social realities without having to resort to the formal definitions as to what constitutes a particular practice (i.e. science). ICT, Latour stresses, provide previously unheard of possibilities when it comes to the traceability of social interaction: the most ephemeral social phenomena, like conversation and the circulation of rumors, are documented and archived, as ICT serve increasingly as their platform. Now this claim can be extended to political practices. The minutes of a meeting of an expert committee, the plans of an activist group, fresh scientific data, that is, many of the snippets of information that might at some moment, in some location, feed into an issue, can be found online. The Net can be regarded as a practically limitless storage space of issues-in-the-making. As such, it appears as a particularly fruitful site of research for empirical inquiry into distributed processes of issue formation.

The Internet, as a platform where different actors engage, more or less simultaneously, in the performance of issues, on Web sites and discussion lists, seems particularly well-adapted to the project of tracing "the shiftings of the stagings" of politics[8]. In line with Latour's emphasis on the traceability of social interaction facilitated by ICT, we can say that in its capacity of an infra-medium[9] of politics, that is, as a medium embedded in political practices, the Internet, is one of those locations where the circulations of an political issue throughout a whole stock of media – other electronic and print media, and live mediations, e.g. discussions – get collected and archived. As such, the Net can facilitate an empirical operationalization of the conceptual point that the circulation of an issue among sites allows for the transformation of a given object into a political matter. A web-based ethnography of the circulation of issues on the Web, may make it possible to bring into view the politicization of issues, as it happens, as Emilie Gomart and Maarten Hajer suggest, in the "in between", between formally distinct settings of politics. While actor-network theorists, at least to my knowledge, still have largely to develop a research practice that effectively harnesses the Internet for the ethnographic study of such distributed practices, in the broader field of the anthropology of technology this possibility is now beginning to be explored. Thus, the anthropologist Christine Hine (2000) argues in her introduction to the fresh discipline of virtual ethnography, that the Internet is particularly suitable for doing multi-sited ethnography (Appadurai, 1999), – an ethnography, she stresses, that cares particularly for the constitution of objects in processes of mediation across sites. When approaching the Internet as an site of ethnographic research, as Hine (2000) puts it, "connections take precedence over location, and the pursuit of a mobile ethnographic object takes over from the attempt to map a culture". For our purposes, we can derive from Hines more programmatic claims the particular proposition that the Internet, with its evolving architectures of hyper-reference among sites, appears to be a most suitable site of research for studying issue formation as a distributed process, in which different sets of actors, located in different settings, participate in the formation of issues. As Barry, Gomart and Hajer provide accounts of the situated articulation of issues, in local settings, an ethnographic account of issue-politics on the Web is rather more suited to bring into

view how an issue is formed and formatted in distributed practices, giving rise to what could be called trajectories of politicization among settings.

In exploring such an ethnography of issue-politics on the Internet, and most notably the Worldwide Web, we will take up the classic commitment of actor-network theory to the notion of the configuration of networks, as the preferred mode of description of social, and in our case, political, process. As was already briefly referred to above, actor-network theory classically conceptualizes the process of the genesis and social integration of scientific and technological products in terms of the configuration of actors in socio-technical networks. As part of its resistance to both social and technological determinism, the notion of the network made it possible for ANT to marginalize the distinction between the social and the technical in its analysis. The network is at once social and technological, and it produces articulations of social and technological entities in tandem. Thus, in his study of the discovery of the vaccine by Louis Pasteur, Bruno Latour describes the configuration of a network that connects Pasteur's lab in Paris, the hygienists in their studies, the farms in the French countryside, and the statistical institutes of France, showing how it is at once technical and social, in the sense that both the vaccine as well as the social interests in the vaccine circulate in this network. Morover, it is from this network that the scientific fact that the vaccine effectively combats the epidemic emerges, as well as the social fact that French society is reconfigured now that farming entered into a relation of dependency with laboratory science, among others. It probably needs little argument that the Worldwide Web provides a particularly fruitful site of research when it comes to the empirical study of network configuration. When it comes to the study of the processes of issue formation, more particularly, the Web allows us to trace the formation of hyper-link networks around issues. As such, it offers a particularly clear-cut way to capture empirically the political process that we conceptualized as the successive articulation of issues in distributed practices. The particular methods adhered to in this research practice will be discussed as part of the case study presented here below, on the public controversy around the Development Gateway, the portal for development information set up by the Worldbank.

When it comes to the conceptual commitment of our analysis, it proposes an understanding of the relevance of ICT for the enactment of democracy that does away with the assumption of the disaggregation of democracy that tends to be assumed in research in this area. As such, our argument is close to the proposition made by Doolin and Lowe (2002), who present ANT as a viable alternative for critical research in information systems, which is more conventionally informed by Habermasian critical theory. ANT is well-suited to this task, they argue, because of its empirical commitment to account for practices not in terms of a priori concepts of social structure and rational forms of communication, but in terms of the idiosyncratic and particular relations that hold them together. As such, they argue, ANT makes possible a de-familiarizing account of practice, which unsettles established understandings. To the more general proposition of Doolin and Lowe, we here add the specific claim that ANT invites an alternative account of democratic process, namely in terms of issue formation, which is particularly fruitful for research into ICT-based democratic practices. But our argument is in line with theirs, as it rejects the disaggregation of democracy, which is precisely an effect of structuralist approaches to democracy. ANT-informed research on the Web suggests that we may only be able to assess the

success or failure of the mobilization of the Internet in doing democracy, if we take into account the trajectories of issues among various settings inside and outside political institutions. As our commitment is to follow issues through along their trajectories of politicization among distributed settings, we must be prepared to disrespect the analytic separation between different sites and forms of democracy, when the issues turn out to do so. When trajectories of issue formation cut across the distinction between institutional and extra-institutional forms of democracy, between on the one hand, state-based and -affiliated institutions, and on the other hand, civil society, then our account of political process must do so too. But in disrespecting the distinction of the disaggregation of democracy, we also get into view the limitations of this distinction. As suggested the empirical findings presented here below, the distinction may actually make it impossible to grasp and evaluate democratic process, as it can followed on the Internet, and as it revolves around ICT-related issues. Our case study provides further indications, following the case study done by Emilie Gomart and Maarten Hajer on the controversy around the Hoeksche Waard, that it is precisely in the translation of issues among different settings of democratic practice, that the issues are politicized, and as such, may become the objects of democratic process. From this vantage point, as we'll come to, the democratic nature of processes of issue-formation must be understood in terms of continuities and discontinuities between issue definitions along these trajectories. The degree to which successive articulations of issues get picked up in the following, further down on the trajectory, will be crucial for our answer to the question whether a given process of issue formation, counts as democratic, or not. As long as the disaggregation of democracy is respected, however, such an evaluation is unlikely to be undertaken.

The Development Gateway and its shadows: on opposing interpretations on what it means to restore a severed public relation

For a initial exploration of the trajectories of issues as they can be traced on the Worldwide Web, we'll follow the controversy around the Development Gateway, the portal for development information on the Web initially set up by the World Bank. The Web is arguabliy one of the prime contemporary platforms for political controversy (Sassen, 1998), and it certainly served this role in the controversy over the Development Gateway – which is perhaps not surprising for an "ICT issue". By way of introduction, the Development Gateway is "an interactive portal for information and knowledge sharing on sustainable development and poverty reduction", or conversely "a vast new web initiative, which aims to be a supersite on all development issues", depending where you get your information, on the Gateway's Web site itself, or on the site of an organisation monitoring the initiative, the Bretton Woods Project. As to the organisational history of the project, the Gateway site presents the portal as "one of the key programs of the Development Gateway Foundation, a not-for profit organization based in Washington, DC". But, according to an origin myth circulating among NGOs, the Gateway is the offspring of a conversation between James Wolfensohn, President of the World Bank, and Bill Gates, CEO of Microsoft, which took place on the backseat of a taxi, during the WTO meeting in Seattle in 1999[10]. The myth has it that, while outside masses of protestors chanted against neo-liberal globalisation in the streets of Seattle, Gates offered Wolfensohn "a portal". As we shall see, it was precisely the

institutional history and organisational status of the Gateway that were at stake in the controversy it gave rise to, so it seems best to say no more about it now.

Taking to the Web to trace the issue, and ideally, its evolution, I had the luck of having immediate access to two actors who had been actively involved in the controversy. As we all participated in the workshop in which much of the research presented here was done[11], I was in the fortunate circumstance to be sitting next to one of the actors as she went through the list returned by the search engine Google, for "Development Gateway". Guiding me through the engine return list, she effortlessly identified the crucial sites that the dispute had called at, taking me to the initial report that the World Bank Institute had commissioned from the Costa Ricean Fundación Acceso, released in March 2000, which recommended that the Bank consult with civil society on the project of building the Gateway[12]. From there on, she took me to the site that hosted the consultation on the Gateway with civil society, a discussion list maintained by the Canadian NGO Bellanet[13]. We finally ended up at the definitive report on the consultation process published by the EDC (the Education Development Center) in February 2001[14]. With the aid of the search engine return list, this actor thus traced a series of displacements among sites, from Acceso in Costa Rica, to Bellanet in Canada, to EDC in Washington D.C., which each at one point in time had been central to the debate on the Development Gateway. However, while this actor could point out the virtual locations that at some point had been central to the controversy, we as yet had no picture of the actors involved in it, nor of the shifts in the definition of the issue. We therefore proceeded to map the networks that have configured around the Development Gateway on the Web.

Is the Gateway the Bank?
On the Web, we find, a network has configured around the Development Gateway. With the aid of a piece of software, IssueCrawler, we locate a set of interlinked Web sites that refer to, introduce or discuss the Development Gateway. This network consists mainly of NGO Web sites that comment critically on the Gateway, and on the initiator of the project, the World Bank[15]. The center of the network, however, is occupied by the World Bank, with the Gateway site to be found more towards the margins of the network. Visiting the sites in the network, it quickly becomes obvious that we are dealing here with an "issue-network", The notion of issue-network serves to distinguish a network on the Web which is geared towards the articulation of an issue, as opposed to a network which is constituted principally by social relations among actors, which for the purposes of this article may be called an actor-network[16]. Thus, in the case of the first Gateway-network we found on the Web, the Web sites that constitute it, in many cases cannot easily be reduced to "actor positions". For example, we find worldbankboycott.org, an anti-Bank campaign site, and whirledbank.org, an imposter of the World Bank site. With some effort, these sites can be traced back to organisations behind it, more precisely, to the site of the US Network for Global Economic Justice and that of The Institute of Equity, Ecology, Humor and Art, based in San Francisco. But it is not these organisations, as organisations, but the campaign and the spoof that made it into the network. Secondly, the issue-network can not be said to consist of social relations, in the narrow sense of the word, of relations between actors. The network contains many deep links, pointing to specific documents related to the Gateway and the Bank. This network thus presents us with a configuration of

organisations, articles, discussions, reports et cetera, which all in one way or other represent the Bank or the Gateway, rather than with a purely social configuration. Thirdly, we find documents circulating in this network: they appear on multiple pages in the network. For example, many of the sites offer critical reviews of the Gateway by Alex Wilks, from the Bretton Woods Project, the organisation mentioned above that monitors the World Bank and the IMF. As these files make the rounds of the network, we tentatively conclude that the cohesion of the network derives also from the passage across sites of these documents, not just from the actor-relations that are likely to sustain it too.

If we now pose the question, what is at stake in the controversy around the Gateway, we find a first clue when we disentangle the network of the critics of the project from the network of its affiliates. We take as our points of departure two different sets of starting points, one consisting of sites that are critical of the Gateway, the other of sites that present themselves as partners of the Gateway. In this way, we arrive at two networks which are almost completely distinct (see Figures 2 and 3). The network of critics of the Gateway is made up mainly of NGOs satelliting around the Bank, while the affiliate network consists of Gateway partner organisations, principally intergovernmental institutes, but not the World Bank. That is to say, the World Bank takes up the center of the critics' network, while it is entirely absent from the network of the Gateway's affiliates. (This absence, it should be noted, is collectively produced by the affiliates: it is on the basis of the hyperlinks going out from a set of partner sites, that IssueCrawler has located this network.) The juxtaposition of the critics' and the affiliates' network thus yields a critical question that seems likely to have played a part in the controversy: is the Gateway the World Bank? But before we

critics of the gateway (2)

Author: Noortje Marres
Email: marres@dds.nl

Crawl start: 2002-05-17 14:12:02+01
Crawl end: 2002-05-17 14:12:38+01
Depth: 1
Iterations: 1
Analysis mode: page
Authority: 2

brettonwoodsproject.org (11)   bicusa.org (6)

twnside.org.sg (14)   bellanet.org (5)

indymedia.org (2)   bankwatch.org (3)

corpwatch.org (3)   aidc.org.za (3)

oneworld.org (5)   whirledbank.org (3)

worldbank.org (31)   globalexchange.org (2)

developmentgateway.org (12)   50years.org (3)

focusweb.org (4)   imf.org (6)

oneworld.net (4)
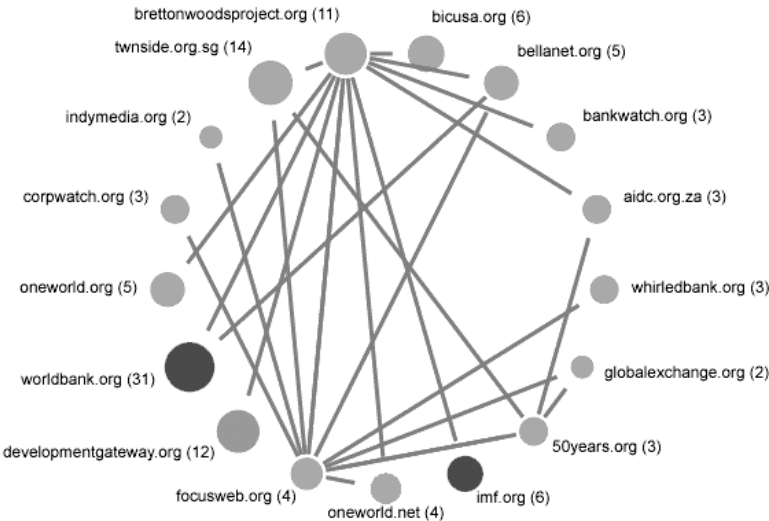
Figure 2.
Hyperlink-network on the Web, disclosed by the critics of the Development Gateway

gateway affiliates network (1)

Author: Noortje Marres
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Crawl start: 2002-05-17 16:59:02+01
Crawl end: 2002-05-17 16:59:27+01
Depth: 1
Iterations: 1
Analysis mode: page
Authority: 2

undefined
GOV
COM
CA
ORG

uneca.org (3)
col.org (2)
undp.org (6)
bellanet.org (6)
iicd.org (6)
idrc.ca (7)
dgfoundation.org (43)
iadb.org (4)
infodev.org (7)
usaid.gov (3)
dgmarket.com (40)

move on to see how this question arose over the course of the controversy, two other
disparities between the critics and the affiliate network can be observed, that may
provide some indications as to the forms of politics that emerge from these networks on
the Web. The first is that the affiliate network does present us with an actor-network,
while the critics disclose an issue-network. That is to say, the affiliate network is made
up entirely of homepages of organisations, and contains no deep links. As a network on
the Web, the collective of affiliates thus does little to specify the issue. We can add that
this actor-network contains only links of alliances, and no critical links, which,
unsurprisingly, can be found a plenty in the critics' network. The second asymmetry
between the critics and the affiliates is that the critics network engages a number of
actors that must be counted among the Gateway's partners – the IMF, and the Bank,
while the reverse is not really the case. No civil society representatives can be found in
the affiliate network, with the possible exception of Bellanet, the Canadian NGO, which
organised the consultations on the Gateway for the Bank, which was mentioned before.
The critics thus openly engage with some of the affiliates of the Gateway, but not the
other way around.

Did the Gateway become the Gateway?
Taking up the question of the disputed identity of the Gateway, we move back in time
to get into view the Gateway as it was presented before it became the subject of
controversy on the Web[17]. The critical or even scandalizing reviews of the Gateway
that circulate in the critics network, were all published after March 2001, and as the
actors that were present in the lab where this research was done were quick to note,
they were published after the release of the EDC report in February 2001. This report,
according to them, significantly failed to integrate the recommendations made by civil
society organisations during the discussions hosted by Bellanet and EDC. We
tentatively put down the publication of the EDC report as the turning point of the

controversy. Around this point, the controversy may have transformed from a "debate" between the Bank and civil society organisations, into a dispute between the camp of critics of the Bank and a camp of partners of the Gateway. In principle, we could now move on to trace the shifts in the location of the issue: probably from discussion fora, to the publication-oriented Web sites of the critical NGOs, such as Bankwatch and the Bretton Woods project, on the one hand, and, the "promotion" sites of the Development Gateway partners, on other. In this way, we could begin to document the likely transformation of the issue, progressing from a "debate" to a "scandal" (raised by the critics' network), and a product (advertised by the partners network). We know from previous research that debate-networks, scandal-networks and product-networks may show distinct types of configurations – debates often exhibit wide-ranged cross-organisational networking; scandals tend to display a small circle of protagonists, with media sites hooking into this core network; products are often represented on the Web by producers, disclosed by various distributors of the product (Marres and Rogers, 2000; Marres, 2002). But, because we arrived too late at this controversy, we must contend ourselves in this case to map the contours of the affiliate network as it had configured on the Web before the turning point. In this way, we may at least find out whether the polarization between critics and affiliates is as recent as we hypothesized.

As it turns out, the World Bank was still firmly entrenched in this past network of affiliates. Most partners that now make up the affiliate network, still linked to the Bank before February 2001. The affiliate network thus has quite drastically reconfigured over the course of the controversy. Moreover, calling up the Gateway's homepages of the World Bank and the Gateway site as they first appeared on the Web in the Internet archive, we find references to the World Bank on both pages (see Figure 4). If we now return to the current homepage of the Gateway, and notice the absence of all reference to the Bank on this page, at least one shift this issue has passed through comes clearly
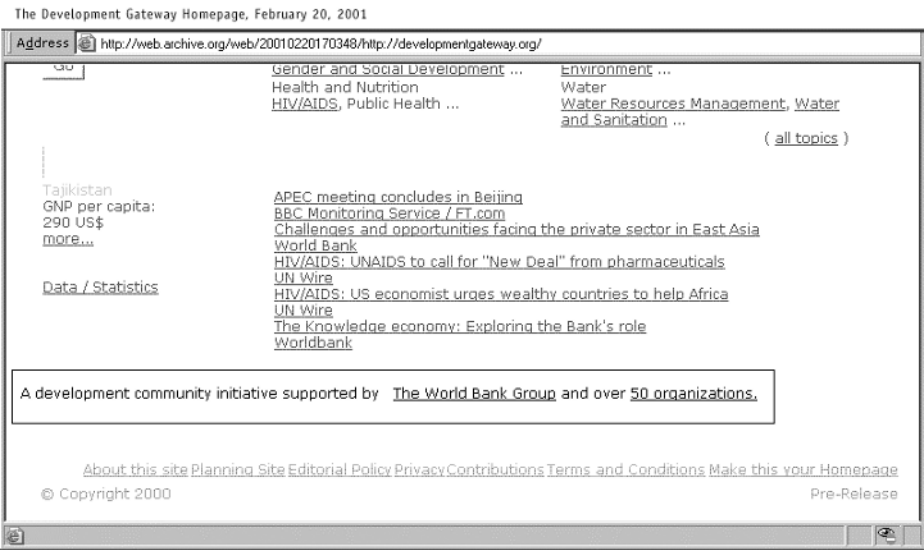
Figure 4.
The homepage of the Development Gateway Web site, January 2001: the Internet archive

into view. While the World Bank once served as the principal actor in the Gateway network, the affiliate network now presents the Gateway as an initiative of the Gateway foundation. The World Bank has left the network. From an intergovernmental project, the Gateway has turned into something that almost looks like a civil society initiative, governed by a non-profit organization[18]. Thus we fill in: the Gateway is the Gateway, and no longer the Bank, or at least this is how the initiative is presented by the affiliate network.

The Gateway is the Bank

Various interpretations of the reconfiguration of the affiliate network, and its juxtaposition with the critics network, are of course possible. One could very well argue that the Gateway initiative simply has reached maturity, and that the ties with the institution that initially nurtured the project, are broken accordingly. Or one could speculate that the composite actor Gateway/World Bank has simply responded to its critics by severing the critical link between the portal and the mega-institution, after all it was the World Bank's involvement in the Gateway for which it was most heavily criticized. According to this interpretation, the critics network on the Web would be put down as a "remnant of the past", together with so many other Web projects. The allegation it produces – the Gateway is the Bank – might have been valid a year ago, but not anymore. (The Gateway Foundation, we read on its site, was established in August 2001.) This interpretation would also provide an explanation for the affiliates' failure to engage the critics in the Gateway network: the latter's claim is simply no longer relevant. Indeed, most of the documents circulating in the critics network where released before the beginning of 2002. We woud then conclude that the controversy has longtime shifted away from the critics' network, even if this network is still in place. In fact, there is no longer any controversy at all: the issue has been settled. But the course of events led us to give precedence to a third interpretation.

A few days after we had run the crawls of the affiliates' and critics' networks, we received an e-mail from the World Bank that our crawler clogged the Gateway Web site. As was mentioned in the introduction, this message allowed us to settle some of our questions. The letter was signed by the Senior Information Officer of The Development Gateway, The World Bank (see Figure 1). We tentatively concluded that the severing of the relation between the Gateway and the Bank, as it appears from the evolution of the issue- and actor-networks we traced, can be understood as a public relations move only. (This has been already suggested before, by one of the actors present. As she surfed the Gateway Foundation's "About us" section, she pointed out the number of listed members of the Gateway's board of directors with a World Bank affiliation, either working or having worked there previously. She also pointed out the absence of civil society representatives on this board.) In this context, the persistence of the critics' Gateway-network on the Web turns out to be more than a testimony to a debate long extinguished. It may serve as a critical reminder of the ties between the Gateway and the Bank, which have effectively been "airbrushed" out of the picture of the Gateway as it emerges from the network of its affiliates, as well as on the Gateway and World Bank Web sites. As the critics network points at the Bank, the Foundation and the IMF as actors caught up in the Gateway, it thereby invites a critical examination of the apparent independence of the initiative. From the Gateway-networks located on the Web, we thus derive the following narrative: after

the criticisms of the Gateway had been published on the Web (and elsewhere?), the affiliates of the Gateway attempted to restore its credibility by putting in place a public image of independence for the Gateway. The critics network, however, continues to bear witness to the critical link between Gateway and Bank. This network in this way makes clear what is demanded from the Gateway and the Bank, before the initiative can effectively be attributed credibility by civil society: it requires not just a public image, but a governance structure that assures its independence.

Conclusion: from issue-politics as merely "cosmetic", to an inquiry into its make-up

Our small case study of the controversy around the Development Gateway on the Web, provides only small glimpses of an issue trajectory. Hyperlink configurations served as our main indicators of the respective states and shapes of the issue, and a much more extensive study of the development of these configurations over time, as well as a more precise account of the "mise-en-forme" of the issue, in the organisation of material on individual Web sites, and in the wider issue- en actor-networks, would be needed to capture the political process of the articulation of the issue. Nevertheless a few tentative conclusions can be drawn from this case study. These conclusions displace some of the reservations that issue-politics has encountered, as concerns its alleged "superficiality" as a way of doing politics. They equally provide suggestions as to alternative requirements on effective democratic politics, as they come to the fore on the Web, which deviate from more conventional proposals in the area of ICT and democracy. Our case study on the controversy around the Development Gateway presented us with a failed democratic process, which would been likely to have appeared as a successful democratic process, if we had respected the usual two-track approach to democracy, separating the questions of institutional and extra-institutional forms of politics. As such, our case study provides indications as to what is demanded from both institutional actors and their extra-institutional critics for their encounter to be successful, on the Web, and perhaps also beyond.

Firstly, the sequence of events that makes up the controversy around the Development Gateway, as it came to the fore in our study, unsettles the opposition between the effectiveness of intervention on the institutional level versus the superficiality of mobilization around single issues. After all, in our study, it became clear that the charge of "superficiality" applied most forcefully to the institutional (quasi-)solutions implemented by the World Bank. The report about the civil society consultation on the Gateway by the EDC, was criticized on the count that it only symbolically and not effectively incorporated "the voices of civil society" into its recommendations. The modification of the Gateway's governance structure, which should have assured its independence, was equally exposed as a mere public relations manoeuvre, which left the actual practice of governance largely untouched. Of course it would be ridiculous to simply shift the charge of cosmetic action to the opposite side in the controversy, and put the institutional approach to political innovation in the dock of the accused. Ostensibly, the politics of issues pursued by the critics of the Gateway, cannot be freed from the charge of ineffectiveness either: their project of assuring an independent Gateway equally failed. But the notion that recourse must be taken to the "institutional level" in order to assure an effective re-invention of politics does come out of this small study weakened. The "procedural solution" implemented by the Bank (the

consultation hosted by Bellanet), and the "institutional solution" it subsequently came up with (the establishment of the Gateway foundation), were exposed as mere "symbolic" forms of action. The Bank's formal engagement in consultations with NGOs, and the modification of the Gateways formal institutional status, must be put down as cosmetic interventions, as they acknowledged the demands from critical NGOs and social movements only in name.

Secondly, our case study of the Gateway controversy brought into view a democratic, or rather, a non-democratic process, which would have been far more likely to have escaped our attention if we had respected the strict separation between institutional democracy on the one hand, and civil society or the public sphere on the other. When considered in isolation, the Bank's project to run consultation procedures, as well as its "response" to civil society actors' demands for an independent Gateway, may appear as fairly democratic gestures. Taking into account the broader trajectory of the issue, however, it turned out that these democratic gestures have to be regarded as inconsequential. They must be put down as merely superficial. Similarly, if we had considered in isolation the activities that social movements and NGOs deploy on the Web, we might have been tempted to draw the conclusion that civil society, or perhaps more generally, the public sphere, is thriving on the Web. After all, these extra-institutional actors can be seen to be building plenty of alliances and sharing plenty of information on the Web. However, if we take into account whether the demands formulated by civil society organisations about the re-organisation of the Development Gateway were in fact taken up in the decisions that were subsequently made on the governance structure of the Gateway, we get a very different picture. To put it briefly, civil society organisations were networking and sharing like mad, but it didn't get them very far, at least in the case of the Gateway. From the vantage point of our small case study, two often heard descriptions of democratic use of the Internet, the implementation of consultation procedures on the Internet, and network building and information sharing among civil actors, come to the fore as insufficient requirements on democratic action. However, our exploratory findings also provide indications as to alternative requirements.

The case study of the Gateway controversy unsettles the assumption that the democratic potential of the Internet for civil society resides in the opportunities it offers for the building of alliances among actors. Much of the literature on the Internet and civil society focuses precisely on the opportunities that the Internet offers for actor-networking. But from the vantage point of our case study, the distinguishing characteristic of civil society mobilization on the Net is the formation of issue-networks. The Gateway case study brings into view a mode of association, particular to critical NGOs and social movements, in which not the establishment of partnerships, but the articulation of an issue comes to the fore as an important organising or mobilizing principle. The NGOs that criticize and scandalize the Gateway on the Web, disclose an issue-network in which this project is made controversial. Through the association of actors that are critical of the Bank, through the linkage and circulation of critical documents, and the identification of the actors to be held accountable, the Development Gateway is turned into an issue. The specific techniques for the "formatting" of issues these agents develop in the process, as well as the process itself, must still be accounted for in detail. But our exploratory study does suggest that actor-networking, the mode of association facilitated by the Web where

organisations link to other organisations homepages, in some cases may represent the failure to act politically. The network of affiliates of the World Bank disclosed a network of alliances among institutions, and as such, it offered little to nothing in disclosing what the controversy of the Gateway is about. To the degree that practices of "partnership building" substitute for specific engagement with particular issues online, they may indicate a "democratic deficit". Thus, in as far as the significance of the Internet for civil society is understood in terms of "connecting the actors", it misjudges the conditions of politicization in the virtual domain. Not actor-networking in itself, but issue-networking signals politicization.

In a similar vein, from our case study on the Development Gateway the implementation of consultation procedures on the Web, in itself, comes to the fore as an insufficiently rigorous form of democracy. As was the case with Gateway, such an event is located within a larger trajectory of the articulation of an issue. The absence of continuities between on the one hand, the event of consultation and the definitions of the issue that emerge from it, and on the other hand, subsequent events and the issue-definitions they provide, equally point to a democratic deficit. More generally, our case study on the Gateway points to an alternative approach to the organisation of such democratic events. In the literature on online consultations, a model of democratic procedures is often imported from political theory, e.g. the theory of deliberative democracy, which, it is then proposed, are to be implemented on the Internet (Coleman, 2000). However, following the trajectories of issues, we shift attention, with regard to this question, from the implementation of procedures, to the visualisation and framing of emergent political processes already underway on the Web. If the point is to put the Web in service of democracy, the first question here becomes what distributed efforts at issue formation are already being undertaken in the medium. In its capacity of live archive, the Web offers great opportunities to frame, capture and visualize political processes already set in motion by institutional and extra-institutional actors themselves. Online events of democracy could accordingly be conceptualised as extensions of such previous involvements with and articulations of issues. In doing so, a "bottom-up" approach to online democracy would come to replace the "top-down" approach that is implicitly embraced when "ready-made" procedures of democracy are imported from elsewhere.

A Web-based ethnography of issue-politics may allow us to grasp the "shifting of the stagings" of distributed politics[19]. In the case study of the Gateway controversy, we tentatively identified the moment in which the issue transformed from a debate into a scandal and a product – which looking back, might have been one of the decisive moments of politicization of the Gateway. Neither the debate on the Gateway, nor the scandal it was turned into by NGOs and social movements, nor the product that the partners of the Gateway presented on the Web, could be located on any one site in particular on the Web. The forms of the political, just as the shifts between them, as they can be traced on the Web, emerge from distributed practices. Theorists of global civil society have pointed out that the politics of non-governmental organisations is essentially one of mediation. As Craig Warkentin (2001) puts it, the politics of civil society consists essentially of indirect action, as social actors are "forced to work through mediators in their efforts to realize institutional objectives". I doubt whether the objectives of NGOs, let alone those of social movements, in all cases are really all that institutional. But judging from our small study of the controversy surrounding

the Development Gateway, Warkentin's observation must be extended to the politics pursued by political institutions, in their encounter with NGOs and social movements. The modest example of a web-based ethnography of issue-politics presented here, begins to unsettle the asymmetry between the politics of extra-institutional and institutional actors that is often assumed, when it comes to their "mediatedness". As it becomes clear that "institutional politics", the "other" of media-based politics, cannot provide a definitive escape from the messy, mediated, encounters of issue-politics, we must return to the scene of these messy encounters if we want to grasp the political. Whether the mediated politics that issue-politics inevitably comes down to, might indeed count as "real politics", remains to be seen. But it is clear that an answer to this question not only has consequences for the politics of NGOs and social movements. The success of the encounter between political institutions and their critics, depends on it.

Notes

1. World Bank projects have been the subject of public controversies at least since the mid-eighties, when the Brazilian Polonoroeste Amazon Road Project was taken up by non-governmental organisations and social movements as a paradigm case of the Bank's complicity in rainforest destruction (Fox and Brown, 1998).

2. The word "tenable" here is used in the sociological sense of the term. That is to say, the accusations of critical NGOs and social movements against the World Bank have as of yet not reached the wide acceptance (or at least aren't seen to have reached it), that seems required for their claims to be no longer ignored by the institution in question.

3. The distinction can be traced back to Hegel's introduction of the concept of civil society in political theory (Wagner, 1996).

4. It can be argued that actor-network theory has been in the business of doing ethnographies of politics for a very long time already. After all, ANT is often held responsible for approaching all other social practices as if they were political in nature – Bruno Latours famous variation on the Clausowitz principle, "science is politics by other means" (Latour, 1998), being the favoured piece of evidence for this. However, as Gomart and Hajer (2002) argue, ANT has tended to economize on the question of the social labour that goes into the explication of practices as political in nature. When it comes to the explication of the political dimensions of social practices, ANT has tended to draw from imported, "ready-made" models of (participatory) democracy from political theory.

5. Latour's argument in *The Pasteurization of France* is far more interesting than I can make clear here. His conception of the "displacement accross boundaries" of techno-scientific entities, in this case, the vaccine, as the movement that is constitutive of scientific practice, is especially relevant when it comes to the conceptualization of politics (Latour, 1988).

6. Their argument could have been inspired by Mary Douglas's (1986) characterization of the "crisis of the institutions". She sees in this slogan a legitimacy tool. According to her, the diagnosis of crisis thrives on nostalgia for a time in which "the institutions were still well respected", and implicitly presupposes an institutional arrangement that is not called into question as the ideal situation, to which we must return (Douglas, 1986).

7. The argument by Gomart and Hajer (2002) risks being interpreted as a dismissal of pathologies of current institutional political arrangements. While this interpretation might be to some degree intended by the authors, it has unfortunate relativistic implications, as if a switch of perspective to ethnography might suffice for legitimacy problems to dissolve. Moreover, the authors hereby fail to appreciate the social and political practices of

articulating institutional crises. I would rather argue that from an ethnographic vantage point, institutional political practices appear pathological on different counts (see Conclusion section).

8. Of course, to put issues on the foreground as crucial carriers of the political, already means to smuggle in an informational notion of politics. To foreground the politics of issues, is to zoom in on the distributed processes in which virtual entities are produced. These processes, leaving telepathy out of account, are obviously media-based. The notion that issues emerge from "passages across settings", can be regarded as an economical way of saying that for their emergence, issues depend crucially on circulation as facilitated by media – in their various, print, electronic and digital guises.

9. The name meta-medium has been made up to stress the fact that ICT, in particular the Web, often serve to distribute content from other media (Agre, 1998). However, the Internet is perhaps better understood, in analogy with Michel Foucault's notion of infra-power (Foucault, 1980), as providing a platform for social practices "from the inside out". In as far as the Internet can be regarded as a socially domesticated medium, it must be located within social practices, as opposed to a conceptualisation of the Internet as "imposed" on them from the outside.

10. Personal communication, Anriette Esterhuysen.

11. "The Social Life of Issues 6: The Network Effects of Civil Society (Politics)", C3, Budapest, May 15-21, 2002, a workshop organised by govcom.org and supported by the Open Society Institute, Budapest (see www.govcom.org).

12. The report was entitled "Global Development Gateway Needs Assessment Report for Civil Society Organizations" (available at: www.acceso.or.cr).

13. The discussion was conducted under the title GDG principles (GDG for Global Development Gateway, as the project was called at its inception), and involved a significant number of NGOs, including the two organisations for which my fellow issue-ethnographers work.

14. Final Report: Global Knowledge for Development, Forum on the Global Development Gateway, submitted by the Education Development Center, Inc., February 2001 (available at: www.edc.org/GLG/GDGreport/final.htm).

15. The IssueCrawler is a piece of software that locates networks on the Web through co-link analysis, i.e. who's linked to whom. For a site to be part of the network, it must be sufficiently linked by sites in the even broader network treating the issue on the Web. The IssueCrawler was developed by govcom.org Foundation and OneWorld International (see www.govcom.org).

16. When it comes to the notion of the network as applied to politics in the context of the Internet, it often becomes associated with a rather narrow definition of social interaction, that of "connecting people" or "connecting institutions". We hope to be excused to use the term actor-networking in this article for this type of all too "social" concepts of the network.

17. There are a number of places on the Web where one can visit the Web's past, notably, the Internet archive, and its searchable data-base, the Waybackmachine (see www.archive.org). Unfortunately, however, the IssueCrawler in its current layout is not equipped to locate networks preserved in the Internet archive. The crawler is build to record only external links, and the links within the archive would appear to it as internal ones, that is, as referring within the same domain space.

18. Another much more speculative indication of this can be found if one types the words "civil society" into the search engine Google. The single sponsored link returned for this query is that of the Gateway.

19. To single out the Web as a crucial site of issue-politics, inevitably brings along risks and dangers. Firstly, a web-based ethnography of issue-politics risks to get fixated on the "PR version of things", while the real issues are actually being settled elsewhere, off the Web. However, this pitfall only appears as unavoidable when offline politics are considered to be irrevocably inaccessible via the Web. However, issue-politics can be said to come down precisely to the daily labour of forcing leakages between the semi-public domain of the Web and elsewhere, and whatever closed worlds lay beyond. Secondly, to single out the Web as a crucial site of (issue-) politics poses the risk of reïfication. In a web-based ethnography, the situated practices that sustain the issue-politics pursued there, to a degree disappear from view. As a consequence, the abstractions (issues) that only exist by virtue of being grounded in these practices, might easily be mistaken for self-sustaining realities. This danger is now so widely recognized among social theorists of information technology that it might almost be said that a moratorium on the definition of the Internet as a space onto itself, is now effectively in place (Woolgar, 2002) But the taboo on reïfication brings along its own risks and dangers. When the reïfication of media is too readily dismissed, the practices of reïfication for which the Internet provide a platform, equally risk to disappear from view. Especially when it comes to the politics pursued on the Net, reïfication is precisely one of the important tasks to be fulfilled. The collective work of providing the informational entities called issues with a stronger claim to existence than they currently have, this is exactly what is demanded from a politics of issues. In this light, the failure to appreciate reïfication, is the failure to appreciate the politics of virtuality, as it is pursued in the context of the Internet. Of course, there can be no question of confining an issue to its online existence, this must obviously be counted as a failure of issue-politics too: it means that the work of issue making remains without effects beyond the media. While indeed a Web-based ethnography of issues might at some point have to follow the issues through all the way into the actually situated practices that sustain them, at the same time it can conceive of informational practices as producing political events in the virtual domain, precisely because it keeps into view the emergence of virtual objects from these distributed practices.

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The nature of the Net: constructing reliability of health information on the Web

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Abstract *This article juxtaposes the history of the book to the current discussions about lay health information on the Internet in order to thoroughly open up the notion of "reliability" that underlies these discussions. It uses the parallels between the two media to improve understanding of what actors are involved and what issues are at stake, as well as how this is consequential for the reliability that is constructed.*

Introduction

> If an early modern reader picked up a printed book – De Natura Libri, perhaps – then he or she could not be immediately certain that it was what it claimed to be, and its proper use might not be so self-evident . . . illicit uses of the press threatened the credibility of all printed products. More broadly, ideas about the correct ways to make and use books varied markedly from place to place and time to time (Johns, 1998).

The World Wide Web, now approaching its second lustrum as a public medium, has seen so many fluctuations that a four year existence has been said to indicate the seniority of a Web site (Lundberg, 1999). Accompanying the innumerable changes of the previous years is a wealth of literature regarding the presence and potential staying power of health care information on the World Wide Web. Acknowledging possibilities related to the availability of such information results in both enthusiasm and skepticism, as existing information is considered to be able either to help those searching for health care information by empowering them with knowledge, or to hurt them by subjecting them to fraud and "quackery" (Eysenbach and Diepgen, 1998; Gottlieb, 2000; Kiley, 2000.). In 1995, individuals, governments, professional groups and non-profit organizations in both Europe and the USA began calling for action to ensure the reliability of information on the Internet. These players sought the establishment, by an authoritative institution, of mechanisms that would enable those who were accessing this type of information to assess the quality of what they found. Furthermore, they hoped for tools that would also enable users to apply the information they found. Eight years and at least 98 instruments later (Gagliardi and Jadad, 2002), the discussion about reliability problems continues.

The Internet is often referred to as "revolutionary" and "unprecedented" in its potential role in society, a stance that is no different in medical literature. With respect to "quality" of information, the pages of the Web are often compared, or rather, contrasted, with newspapers, journals, and books, with especially the latter frequently being depicted as bastions of trustworthiness in contrast to the renegade nature of the Web. This is a familiar dichotomy: "scientific" publications, such as books (and journal articles), because they are time-tested and peer-reviewed, are typified as exemplary of

"reliable", "usable" information, whereas the Internet, which is still new and frequently changing, is presented as a chaotic assemblage of questionable material. In medical literature, for example, Eysenbach and Diepgen (1998) list "why Internet information is different from printed information", citing characteristics such as lack of quality control, anonymity, and unclear markers to indicate for whom a document is published. Additionally, they compare the "quality control" in "traditional" publishing with current Internet publishing, criticizing the latter process for absence of elements that are present in the former. The result of this line of argumentation is a contrast between a new, unstable medium and one that already has a stronghold, one that has been "black-boxed"[1].

Studies of science and technology have revealed that reopening of the history of a fact or an object can sometimes be surprising in that we come to see that certain components, which would now be considered obvious (sometimes to the point of being taken for granted), were not so obvious in the making. The opening quotation from Adrian Johns's (1998) The Nature of the Book alludes to this very idea with regard to the book as a reliable source of information. A familiar Latourian argument is that we do not want to analyze the final state of things (for purposes of this paper, the reliability of printed texts or the unequivocalness of authorship), but we must return to a point before that state of being – we must reopen its history. He states, "I want to situate myself at the stage before we can clearly delineate subject and objects, goals and functions, form and matter . . . Full-fledged human subjects and respectable objects out there in the world cannot be my starting point; they may be my point of arrival" (Latour, 1999, p. 182, original emphasis). In the same vein, Madeleine Akrich (1992, p. 211), in discussing descriptions of technical objects and the role of mediators, differentiates situations where technologies are stabilized and those where they are not: "The situation is quite different when we are confronted with stabilized technologies that have been 'black-boxed'. Here the innovator is no longer present, and study of the ordinary user is not very useful because he or she has already taken on board the prescriptions implied in interaction with the machine . . . Alternatively, we may study disputes, look at what happens when devices go wrong, or follow the device as it moves into countries that are culturally or historically different from its place of origin".

The work of Adrian Johns aligns with these and other works in science and technology studies. As is further explained in the following section, this work revisits previous chronicles of the history of the book in order to re-open the history of printing, print culture and printed works. Johns asserts the need for understanding the complex processes involved in producing and using books in society: "In the first place, a large number of people, machines and materials must converge and act together for it to come into existence at all. How exactly they do so will inevitably affect its finished character in a number of ways. In that sense a book is the material embodiment of, if not a consensus, then at least a collective consent" (Johns, 1998, p. 3)

In contending that the identity of the book can be understood in terms of intricate processes, Johns leads the reader to question his/her own understanding of the book – what it is, where it came from, and why it seems so secure. To fully appreciate the significance, he states, echoing ideas from the above statement from Akrich, there are two options – looking at different places at the same time (cultural differences) or looking at one place during different times (historical differences) – and he opts for the

latter. By opening many of the black-boxed components of print (reliability, for one; the idea of the "print culture" for another), Johns demonstrates that quality and reliability of information were not unproblematic concepts. Furthermore, much like now, the actual meaning of words such as quality and reliability was not clear – they were defined differently in different times and places and there was often disagreement about the definitions. Additionally, reaching the point where they became obviously connected with the book, to the point of being taken for granted even, ultimately took several centuries.

His print history of the sixteenth century reveals important parallels, such that we already see that concerns over reliability of information are neither new nor specifically connected to the technology of the Internet.

In this paper, we juxtapose this history of the book to the current discussions on the reliability of lay health information on the Internet[2]. Our purpose in doing so is to thoroughly open up the notion of "reliability" that underlies these discussions. In revisiting the history of the book, we are confronted with striking parallels that we can draw upon to better understand how reliability is now constructed and seen as so crucial. Importantly, we do not suggest strong parallels in the developmental trajectories that the book and now the Internet take. Nor do we suggest that the history of the book has any predictive value for the future developments around the Net. All we suggest is that drawing these parallels may enrich our understanding of current developments – by confronting us, through contrast, with what we take for granted.

Our aim is, then, not so much to show that reliability is constructed. That would not be a very surprising message for the readership of this journal. Of course it takes much work, resources and time to build up the working routines, institutions, artifacts and cultural expectations that all come together in the term "reliability". What is more interesting is how reliability is constructed: what actors are involved, what drives them, what issues are at stake? Finally, our core aim is to investigate what reliability is constructed. The most important yet the hardest thing to grasp is that the very concept of "reliability" can take many different (and highly consequential) shapes.

Opening the black box of the "reliable book"
The commercialization of print, through the use of the printing press, has often been referred to as revolutionary because it supposedly enabled, as never before, the transcendence of context. Dispersal of printed reproductions of works would enhance communication – connecting the producer with others in distant places (multiple copies could be distributed among many different regions) and removing certain temporal constraints in the exchange of information – one did not have to be present at the revelation of a work, but could read a copy of it later. More importantly, Westman (1980) acknowledges that the conditions for collecting, storing, promoting and reviewing information began to change, with implications for the relationships between producers of information, consumers and middlemen.

Johns's summary of the contemporary approach to printed materials, reveals that, in modern definitions of print, reliability is so deeply ingrained, that the two are intertwined in a tautology: we know that printed pieces are reliable because they are printed[3], before calling this idea into question by revisiting history. He traces a history that begins in the late sixteenth/early-seventeenth centuries, in various parts of

Europe[4]. Tycho Brahe, Galileo Galilei and their contemporaries were producing printed versions of the results of their "scientific" work, and distributing them "as gifts to patrons at courts and universities" (Johns, 1998, p. 14)[5]. We must keep in mind that publication at that time was different than we currently understand it – and even then, it was also changing (Westman, 1980).

Reference to courts and universities gives us cause to consider their role in the printing of books at that time and to think about the changes that were occurring in who was printing, what they were printing, how they were printing and the regulation of this printing. Prior to the printing press, the control over printing was largely in the hands of the church and/or state[6]. Levinson (see footnote 2) argues that both the church and the state had their own ideologies of what should be printed – based, actually, on conceptions of what should not be printed (of what should be kept from the public) or of the fate of texts (how to preserve them, where and when to disperse them, etc.). If we consider printing in the period before the printing press, we see, for example that the primary agenda of those producing scribal reproductions of scripture was to reproduce, ideally without distortion, and to preserve ancient texts. In so doing, these texts remained primarily in the hands of the church, enabling the church to remain in control not only over the quality of texts, but also over what ideas were brought to the public. Even after the printing press and the beginning of mass productions of the Bible, Levinson argues, the (Catholic) church continued to exercise this control in order to stifle opinions that were in contrasts to its teachings. One example of this would be the First Index of prohibited books, which was issued by the Congregation of the Inquisition in 1557. In 1571, this became a continuously revised list that served either to completely prohibit books, or to control revision of certain material before they were returned to circulation (Goodman and Russell, 1991).

Although the court was not considered to be a "scientific" establishment (existing rather to represent royal power), endorsement by the court was crucial for aspiring scientists and philosophers (Biagioli, 1990). Patrons of the court were influential on the politics of the state, and subsequent control over dispersal of printed presentations enabled the strategies of both the patrons and the rulers. "The tendency of governments to reign by reining in decentralizing media was already apparent in the attempts of monarchs to control the first printers". (Levinson, 2001, p. 86) Controlling the flow of information to the public was essential, in Levinson's terms, to ensuring the power of the monarch.

Regardless of developments for tighter control, en masse publication was accompanied by new problems, most noticeably increased possibilities for errors and increasing cases of piracy and imitation. Johns writes that the early printers identified scribal reproductions (supposedly precisely preserving ancient texts) as corrupt and full of errors (such as spelling). Printers further used this point to argue that it was the press that actually enabled preservation. However, Johns notes the contrary in demonstrating that these problems presented even in the case of reproductions of the Bible, despite close monitoring by the church and even later under the tight control of the state: "There were, it has been estimated, some twenty-four thousand variations in the text of the King James Bible between its first printing[7] and the 1830s" (Johns, 1998, p. 91).

Searching for new solutions
In England, Francis Bacon expressed his opinion that the press was "a device discovered by chance and by disorganized artisans" (Johns, 1998, p. 50). Also, he felt, it encouraged dangerous ambitions. He was displeased by the devolution of content control to actors "independent of the state's bureaucracy" (Johns, 1998, , p. 50). That is, "... he certainly did not recommend unrestricted publication of knowledge, urging rather its retention within a tiny community of royal licentiates" (Johns, 1998, pp. 49-50). Bacon was known, and saw himself, primarily as a statesman and royal counselor and he used this position to champion his own cause – natural philosophy. In regard to printing, he saw outsiders as dangerous and attacked the rights of those not in courtly circles to openly profess knowledge. Therefore, Bacon advocated the implementation by the state of an administrative mechanism that would best serve to advance the interests of the crown (and its state officials). However, other individuals and small groups were also attempting to create their own methods for addressing the same issues that Bacon raised when expressing his vision of official licensing by the court and centralized (elite) approval of all publications. These individuals and groups were not always in accordance with one another, resulting in a stream of new, slightly different methods, each considered to be the "unified answer", at least in the opinion of those providing it.

What is noticeable in looking at how changes in publication practices led to concerns about rightful control, is that the idea of authorship became important. Who had written a piece? Was the work really the production of the name that was attached to it?

Before the press, authorship was a relatively minor issue, but once the church and courts were no longer the only locales for the production of "knowledge", as it were, the name attached to a publication was crucial. Establishing one's name as an author – of having the authority to distribute a work in print (or as Bacon had said, the "right to profess knowledge" (Johns, 1998, p. 50) – was therefore important and authors assumed the task of simultaneously forging the reliability of their personal names and that of their work. Authorship in that time period entailed the anxieties of gaining and holding attention and out-competing rivals for a new market of reward and prestige (Westman, 1980).

Authors could play upon these concerns regarding authorship to levy criticisms against their opponents. Rather than attacking the content of a criticism, characteristics of the criticizing author were called into question. Especially in cases where criticism was offered anonymously, the lack of name was an important factor in questioning credibility.

"Licensing" was increasingly supported as the answer to regulating works and ensuring credibility, but even this licensing was variable. Johns traces a period of just over a century, in which some form of licensing was in force for almost the entire time, even though there were some periods when licenses were ineffective. Such a licensing system generally required that any text to be published must be read and approved beforehand by one of a small number of authorized officials. Licensers were expected to be knowledgeable in fields over which they were to hold jurisdiction, but they had to develop individual manners for reading in order to stay within the parameters of existing protocols. "In theory, [licensers] had at first been ecclesiastical officers

appointed by the church. Before the Civil War, however, a remarkable variety of individuals, clerical and lay, felt authorized to sign imprimaturs" (Johns, 1998, p. 239).

Because the notion of licenser as a figure of credit within a particular province prevailed, Johns asserts, licensers could not be seen as holding a neutral position. "Licensing was another connected response to a print culture characterized by endemic distrust. It was machinery for producing credit. Books bearing a license, defenders of the practice often claimed, were 'distinguish'd like Money by a Royal Stamp'. Would-be readers would know before purchasing it that a licensed book was no counterfeit and, moreover, 'that there is no Poison in the Composition'" (Johns, 1998, p. 263). A license was interpreted as a badge of distinction or "a public demarcation of knowledge from error" (Johns, 1998, p. 263).

Licensing, even though it changed over time, gradually developed into a complex regulatory system, upon which authors increasingly became dependent. The relationship between authors and those affording the licenses was crucial and the process was often used to suppress any text of which the state disapproved. In each city the regimes were different, and a work had to be licensed where it was published. Galileo's work is perhaps infamous for the "failure" of the licensing process. Galileo published a piece in support of Copernican postulations regarding the Earth's revolution around the sun – an opinion refuted by the church. Even though the piece in question was certified by five different licensing groups and in both cities of its release (Florence and Rome), its release was considered scandalous. Levinson discusses how the church bullied Galileo into recanting this position, which he did in Rome, although in other cities his original work continued to be publicly distributed. "Orders were given for the suspension of sales and confiscation of stock; it was too late, all copies were in circulation" (Levinson, 2001, p. 112)

In later years, much of the work to solidify the reliability of printed work, in England at least, continued through the Royal Society of London. Despite its higher profile role, and the changes that resulted from its "aggressive intervention" into scientific publishing (Johns, 1998, p. 44), Johns refers to the Royal Society's achievements as, "consequently but one element in a continuing history of attempts to discipline print and render it a sound platform . . ." (Johns, 1998, p. 49). He further demonstrates that once the control over printing diffused from the church or the state, there was no way to return it to them. "Courtly aspirations notwithstanding, in England there would always be other printers, booksellers, writers, and readers at work. The fact was that book dispersal did not operate entirely through diplomatic and courtly channels. There was a national and international book trade and before long even books directed at restricted audiences . . . participated in it" (Johns, 1998, p. 51).

We halt the historical scenario at this point, as it has already set the stage for thinking about reliability issues in relationship to the Internet. In re-visiting accounts of the history of the book, we see that reliability and truthfulness of works are not implicit in print. We have not discussed this history in some detail in order to make any detailed historical claims. Rather, we see this analysis as a useful tool to examine the issue of reliability work in relation to the Internet. It enables us to formulate new questions in the midst of the Web's continual development, while there are still many options for how the trajectory that arrives at reliable information will evolve.

The open controversy: "reliability" and the Internet

Early on, the "everyone is a publisher" idea that was coupled with the World Wide Web was considered to be an asset and the Internet was extolled for all the revolutionary changes it would bring in the nature of health care delivery. There was much published speculation about the advent of a communications revolution, the possible "death" of academic journals, the breaking down of geographical borders and the subsequent ease of transferring expertise in real time across great distances. The Web and Internet technologies were considered to be unprecedented for all the different types of changes they would bring.

The most significant concern at that time regarded a potential overabundance of information, but it was expected that the "nature of science" and the "nature of the Internet" would correct for this – sub-standard information would be indicated as poor and would be pulled from the pages of the Web. However, opinions changed as the authors voicing these concerns began to realize that the Internet was gradually growing out of the domains of academia (Pluscauskas, 1996). Publishing was indeed changing and opinions regarding Internet potential rather quickly dissolved from excitement into unease as the realization set in that the "nature of the Web" and the "nature of science" did not correct for the problem of placing medical information on the Web for public consumption without peer review. Medical informatics experts meeting in Geneva in 1995 raised concerns about the abundance of information that could be accessed and the lack of any guarantee that this information could be trusted for accuracy[8].

The types of publication changes that subsequently have taken place during the last decade with respect to the Internet are leading not only to redefinitions of what it is to publish, to be an author, to be a reader, or to play a mediating role, but also to the search for and creation of mechanisms for the distribution of reliable information to the public. And thus, just as the early modern reader questioned sources of information, so too does the present day user of health care Web sites. Or, at least he or she should be questioning the available information, according to certain health professionals (Eysenbach, 2000).

A communication from the Commission of the European Communities (2002) categorizes the existing international reliability initiatives into five incremental levels, beginning with simple codes of conduct, and proceeding to the self applied code of conduct or quality label, user guidance tools, filtering tools, and third party quality and accreditation labels. Such a list already begins to black box components of the technological developments at hand. It is important for our understanding of the reliability problematic that we approach it from a prior time period. We must question how such a list came to be – an exercise in revisiting how publication again changes, the locations where the major players have assembled during the last eight years, and the work being done to regulate publication, as well as attempting to understand the role of the gatekeeping ideology in shaping the initiatives that they develop.

At the time of the 1995 conference in Geneva, the World Wide Web had been available for public use for just over two years[9]. A range of different types of authors, primarily from the USA and Europe, were placing various types and levels of information on the pages of their Web sites. Concurrent with the changes in publication types and sources was an increase in consumer warnings instructing users to be wary of the information found on the existing Web sites of the time, which possibly came not

from medical professionals, but rather from big businesses (Keating, 1997)[10]. Increasing scrutiny of medical Web sites was reflected in concerns expressed in medical circles about the "everyone is an author" (or editor or publisher) phenomenon. In contrast to the concern about commercial enterprise, which was considered to be intentional non-disclosure, the prevalent theme of this discourse was concern about unintentional omissions that came through ignorance and bias (Wyatt, 1997). More concern derived from existing ambiguity about who was doing what, how and from where – on both the production side and the reception side – and even more concern about how to adequately measure this. And notably, there was consternation about the conspicuous absence of health care professionals on many levels.

Significant challenges facing those seeking to counter the problem of proposed unreliability of information were those of jurisdiction and enforcement. How far was the reach of any individual or body working to improve the quality of information and how effective would any effort be? In the USA, the statement was made within government[11] that it was time to bring the Internet back into the proper hands – yet, whose hands this might be and how this was to be accomplished was unclear. Equally puzzling was the question from whom, precisely, did the Internet need to be "regained"?

Authorship and publication consequently became topics that were also wide open. Randale Sechrest, addressing doctors about e-Health in 2000 discussed the presence of patients in Internet space, in absence of professionals there to meet them, and the subsequent "vacuum" that resulted from this imbalance. He further discussed how "non-traditional" players were filling the gap that the professionals had left. Who were these so-called non-traditional players that were filling the open space and how were they answering patients' requests for information? The answer to this is variable – as is stated above, there were all types of new authors – and for many, there was a general feeling that the exponential increase of medical Web sites by unknown sources was a problem that was quickly growing beyond any or all control.

Codes and seals
The aforementioned 1995 conference in Geneva provided a venue for discussion of these issues and participants questioned how to reach global agreement on evaluation, how to maintain a server with which real, accurate and up-to-date data could constantly be delivered, and how to keep control over medical information in the hands of the professionals. Participants resolved to coordinate an international effort (assembling representatives from what they identified as the three main world areas – the USA, the European Union and Asia) and to create a Foundation, now known as Health on the Net (HON), which would be centrally located in Geneva, in close proximity to the academic hospital. The Foundation sought to create and maintain a server with real, accurate and up-to-date information.

In the immediate aftermath of the conference, HON became much more than just a catalogue of sites. It responded to the above "authorship" problem by proposing that anyone responsible for a Web page containing medical information follow a specific set of "ethical guidelines" (the HON Code)[12]. Sites that agreed to adhere to these principles and were approved of during a HON review were then enabled with a hyper-linked icon, which was to be placed on the Web site. Users could click on this

icon to travel to the HON site, for the purpose of either verifying proper use of the icon or attaining additional information about the organization providing the Web site[13].

Criticisms that were levied against HON and similar organizations contributing to what Risk and Dzenowagis (2001) from the World Health Organization identified as "the burgeoning output of codes of conduct from numerous organizations trying to address quality of health information" were three-fold. Firstly, there was the concern that codes alone were unenforceable and that breaking them was inconsequent (Rigby and Forsstrom, 2000; Wilson, 2002; Meric, 2002). Secondly, there was concern that codes in combination with, for example, icons, though somewhat more complex were still equally ineffective, as they were of little meaning to users. Thirdly, questions abounded (and still regularly surface) regarding the quality and reliability of the practices behind the initiatives themselves (Gagliardi and Jadad, 2002; Stanberry, 2002).

In March of 2000, Gunther Eysenbach published an opinion piece on the home page of his own Journal of Medical Internet Research (Eysenbach, 2000). Eysenbach identified four pillars that he believes support "quality management of health information on the Internet": educating consumers, encouraging self-regulation, evaluating information by third parties and enforcement in cases of fraudulent or positively harmful information. Under the second of these pillars, Eysenbach extended this criticism by stating that the efforts of specific initiatives were "problematic, perhaps even counter-productive", and suggested the need for a more sophisticated system.

In this editorial, Eysenbach introduced the MedCERTAIN initiative, a third-party rating system that was funded by the EU under the "Action plan on promoting safer use of the Internet by combating illegal and harmful content on global networks"[14]. He described the project as one that "follows up the idea that the quality of health information and interactive applications can not and should not be controlled by a central body or authority, but instead information and applications must be evaluated and labeled in a decentralized and distributed way". Eysenbach (2000) defined labeling as the provision of meta-information, which provides additional description or evaluation for existing information. MedCERTAIN, planned to use PICS (platform for Internet content selection) – a technical development from the W3 Consortium. Individuals, organizations, and associations, among others could digitally label (rate, evaluate[15], peer-review, give quality seals to . . .) online published health information using labels consisting of a standard computer-readable vocabulary (meta-information). Eysenbach (2000) also identified different levels of certification that MedCERTAIN would give "ranging from simple quality seals indicating the 'good standing' of the site to 'gold' quality seals indicating that the site has been peer-reviewed externally".

Concurrent with these two European level developments, individual countries also have implemented various initiatives, many citing the need for own-language initiatives. One example is a collaborative effort from Spanish health care professionals led to the development of a nationally recognized seal (the Seal of Calidad[16]) to place on Spanish-language Web sites. Another example is in the Netherlands, where the Ministry of Health established a national health information portal (www.gezondheidskiosk.nl) and TNO (a Dutch Research and Development organization) created a recognizable trust mark (QMIC) for Dutch-language Web sites.

Portals and domains

The Dutch Ministry of Health's Gezondheidskiosk is exemplary of a different approach to the reliability question – assembling a portal site for approved information. One of the longest standing national health portals is healthfinder.gov, developed in 1996 by the US Department of Health and Human Services, out of an existing service from the Office of Disease Prevention and Health Promotion (ODPHP). The ODPHP had been active since 1979 in assembling information to which they could refer the public. They used existing guidelines for selecting information as a basis for judging quality and reliability. Coupling these with the newly formulated HON standards, and in collaboration with other divisions within the Department of Health, the healthfinder.gov steering committee created a new Web-based selection policy. However, this effort was not in absence of difficulties, attributed to internal disagreement about what should and should not be included. It is important that the healthfinder.gov portal was never intended as a primary end-result; rather, it was established as part of larger educational programs administered by the Department of Health and Human Services. Those involved in setting up the portal saw this new creation as a chance to take advantage of the new Internet technologies as one more medium to reach their intended public.

Although healthfinder.gov was the official US government portal, it was not the only federal initiative that was developing. Just as experts were discovering that they were unable to control who was providing information in the domain of health care, they also discovered that they could not control who was retrieving it from Web sites. The National Library of Medicine discovered that it was not only scientists, students and doctors who were using its Medline database of articles (freely available through their Web site since 1997) but also that many lay persons were searching the Web site for health care information. Through continued study of Web logs in combination with focus group research and evaluation, the library modified the services it offered, leading for example to the creation of medlineplus and other public-oriented Web-based resources starting in 1998.

Although there was much speculation early on about the possible adverse effects of the Internet on public health, leading to the creation of the aforementioned initiatives, there were few actual anecdotes providing a foundation for these concerns. That was, until 1997, when the first concrete adverse effects of the Internet's "open market" evidenced in an article in the *New England Journal of Medicine* and received international attention. "Poison on Line" discussed the case of a patient that was hospitalized after drinking essential oil of wormwood that he had purchased online (Weisbord *et al.*, 1997). It was unclear what information the patient had received when purchasing the product – was the mistake his own, or had the oil been sold as an ingestible potion? This was the first widely publicized case to lend support to concerns that had been voiced in the previous two years about the ability to receive via mail-order products from the Internet that crossed country borders[17].

During this time period, the first studies regarding quality of information were also carried out, with the results being published in major medical journals. There were three studies in particular that were noted and widely discussed within the professional community. Impicciatore *et al.* (1997) searched the Internet for sites with information regarding managing fever in children. They expected some inconsistency because of lack of consensus within professional communities. Out of the sites they

studied, the authors judged only one as dangerous and concluded that the problem of inconsistent information was not Web specific and that more research was needed. In the same vein, McClung *et al.* (1998) searched the Web to see how official AAP position papers were presented to the lay public. They found many informational errors on sites provided by universities and medical institutions, citing the problem as one of lack of peer review and oversight of submissions. They were concerned about the equal presentation of good and bad information. Sandvik (1999) published another similar study wherein he expressed concern about the fact that the information most often missing from sites (whether containing correct or incorrect information) was that of the author and source – this was especially true of sites that he identified as "commercial" sites.

These events and studies contributed to increasing concern that the threat of bad information alone would sabotage the purposes of good information providers, by creating a general loss of confidence among the public (Mitchell, 1999). Once again, there was a call for action among the professional community to evaluate the problem, propose solutions and attempt to design better mechanisms that would respond to consumer needs and be more effectively implemented on the Web (Eysenbach and Diepgen, 1998; Mitchell, 1999; Eysenbach *et al.*, 1999; Ostrom, 1999; Mandl *et al.*, 1998). However, the issue became one of more than just monitoring – how to enforce any initiative across state borders remains an unanswered question.

Risk and Dzenowagis (2001) contributed to the discussion by suggesting the need for global leadership: "The author believes that there is a need for clear leadership on a global scale to achieve the yet-unfulfilled promise of information and communication technologies of better health for all", identifying the potential role of the WHO in this process. "In line with the WHO's global role in setting norms and standards and assisting member states to implement these norms and standards, the organization has a crucial role to play in developing norms and standards for Internet health information quality".

One proposed solution stemming from this discussion is the creation of a ".health" domain that can only be used by those with express permission. Permission would of course come from the World Health Organization after careful review of sites.

Discussion
The above fragments of these two histories are extracted with the intent of illustrating the importance of breaking away from a frame of reference that contrasts a black-boxed technology with one that is still open. By reopening its history, we are forced to abandon the current understanding of the book as a homogeneous object with which we daily engage. From there we can use the book as a frame of reference for the Internet – not so much to demonstrate what the Internet is missing, or how it is different, as others have done, but to extract the components that are crucial to understanding how initiatives develop and take shape – what leads to the categorizations in the communication to the European Union and the creation of lists of initiatives lasting longer than four years, and so forth.

Just as the emergence of the printing press raised anxieties about the unrestrained diffusion of incontrollable writings, the rise of the Internet raises concerns about the dangers of uncontrolled and unreliable health information. The types of localized work by individuals or small groups that are described in both the history of the book and

the Internet initiatives discussed here are often referred to as "gatekeeping". Institutions filter information by deciding what to release to the public (and from which source), based on particular ideologies. These ideologies are variable across time, place, types of institutions and actors involved, and singular ideologies are themselves malleable. Yet, Levinson (2001, p. 125) identifies one characteristic common to all: "The logic of gatekeeping, whether by Church, national states, or the media themselves – is that information is like a food or drug, which, apropos the Pure Food and Drug Act of the USA and similar laws in most countries, requires inspection or certification before it can be made available to the public. To offer information unvetted is, on this reasoning, to risk poisoning the public, as it could be from spoiled food or bogus medication". Levinson then emphasizes that this mentality is never abandoned, but rather that it changes in regard to new media, new opportunities, new actors and new types of regimes. Although Borowitz and Wyatt (1998) discussed the absence of a governing body or authority that serves a gatekeeping function for Internet publications, we actually see that, just as it was voiced with the book, the same gatekeeping argumentation is being made by those who favor the filtering of Internet information and are working to create initiatives to execute this task.

As with the church and the state, the strong urge to develop some form of gatekeeping for health information is undoubtedly also due to a fear within health professions to lose their grip on their "public". Discussing the "imbalance" in cyberspace, and the danger that "non-traditional players fill up the vacuum left by professionals", for example, clearly plays upon the classic positioning of the profession fighting off attempts to intrude upon its sphere of professional jurisdiction (Abbott, 1998).

Driven by different yet deeply historically anchored motivations, then, we see a plethora of actors and institutions aiming to reinvent the classical licensing mechanisms for the Internet era. As in the history of the book, the reliability of the content of an Internet site is to be established through an independent, third party. Drawing upon mechanisms that are already historically available would lead one to expect that the construction of a similar mechanism for health information in the Internet era might be a relatively unequivocal affair. And indeed, many initiatives refer to the preferred example of scientific publishing, with its "objective" form of licensing based upon blind refereeing, journals run by established scientists, and so forth. Yet in the case of the book, the high reputation of the licensing official of body was to ensure a strengthening of the position of the book and its author. This historically specific form of "licensing" was tied to both the desire of established bodies (be it the state, government, or later scientific communities) to control the content of published work and to the desire of potential authors to solidify their name and work through the licenser's stamp. In the case of Internet health information, however, those establishing themselves as potential licensors cannot be said to be already "established" institutional bodies. In addition, Web authors use a wide array of other marketing and Web-design tools to enhance the visibility of and trust in their Web site (see, for example, Brown and Duguid, 2000; Sechrest, 2000; Introna and Nissenbaum, 2000).

Establishing one's role as "licenser", then, is difficult work. Every project is centered on the building of an extensive network of persons and computer programs, of collaborative groups and guidelines. Healthfinder.gov's steering committee is comprised of representatives from a number of government agencies. HON has an

international advisory board and site reviewers from different countries, enabling the review of pages in a diversity of languages. Development and expansion of these networks leads to changes – changes in composition of the claim to reliability and changes in the physical design of the technique(s) that represent this claim on the Internet[18]. Over the last eight years, Health on the Net has expanded from a database to a code of conduct with a hyperlink seal, to current developments underway regarding natural language search capabilities. In addition, their definition of what makes a reliable site has been modified more than once (the addition of two principles in the code of conduct, more elaborate descriptions of the policing process and responsibilities included therein, expanded guidelines for information providers, and a deepened understanding of user behavior, expectations, needs, etc.). By the time a project is presented, it is not just a Web site, a seal, a database, or a set of published guidelines – it is a conglomeration of definitions, actions, technical elements, etc., which all have resulted from real-time, hands on work done by the individuals involved[19]. "Reliable health information" is what emerges from that work: sites with HON's hyperlink seal, or a network of sites all linked to healthfinder.gov

As was stated earlier, in constructing these reliability networks, these initiatives draw upon traditional scientific publishing as the paradigmatic example that should be "reinvented" in the health information domain. Yet what is interesting is that there are many important differences between the individual initiatives. Diverse proposed "singular reliabilities" are emerging, each one different, each one proposing their own definition of "the problem" of health information reliability. Since each proposed problem definition or technical solution is "packaged" with a specific initiative and a specific licensing apparatus, the question of what "reliability" we will see emerge is very much tied to the question of which licenser will prevail. There are several, related differentiations here that are of interest[20].

First of all, much like in Johns's examples of the differences between streets and neighborhoods of London, the influence of the local cannot be ignored. With the Internet, the role of the local is still very much of consequence, although it may take the form of a geographical region, a bundle of dispersed institutions linked by some ideology, or a particular Web domain, rather than a street. We are reminded that, although popular thought tends to categorize it as such, the Internet was not the first technology to be labeled as a "border breaker". Further still, we are reminded that this label is not necessarily correct, Internet technologies can be viewed not only as not breaking borders, but also as actually creating new (types of) borders. Finally, as we have discussed elsewhere, with reliability work, there is also the active creation of new specific bordered spaces[20].

Regardless of how far the boundaries of an initiative currently extend, in how many circles it is recognized, or how large of a network it has built, the project is still centered in a specific location. Although many of the initiatives are collaborative efforts in geographically separated regions, there are identifiable, pocketed locations where the physical work of reviewing sites or updating portals is carried out. When we take a closer look at current initiatives, we see the local elements that are embedded in each. Furthermore, we see how these elements, in turn, return in the specific definition of "reliability" construed by these initiatives[21].

We see this in the case of new national initiatives, but also in more "international" or "collaborative" efforts, such as HON and MedCERTAIN. Although considered by

many to be a "European" initiative, and claiming itself to be an "international" initiative, the Health on the Net organization still holds very closely to its Geneva roots. Geneva, as the home of CERN, gives special significance to Internet-related work because of its centrality in the developmental history of the Web itself. More important still, HON is of the opinion that an organization carrying out this type of reliability work must be international, non-profit and neutral in order to successfully function as a symbol of reliability for health Internet users[22]. Its location in Geneva, the home of politically neutral inter-governmental and non-governmental organizations (itself located in the neutral territory of Switzerland), is crucial to building that outward image into its initiative. All this is physically illustrated in the organization's Web address, which keeps a Swiss domain ending, rather than a ".org" or other ending.

For others, this attempt at "universality" carries a much too strong, local tone. From a US perspective, this strong "Switzerland" heritage makes HON too European indeed. To the USA, it would be unthinkable that a Swiss organization would perform such an important "gatekeeper" function for their citizens; similarly, MedCERTAIN is obviously too "European" for many. Vice versa, European countries do not want simply to follow US-led initiatives – and "language issues" are in this case truly secondary issues.

Similarly, the locality of national initiatives comes clearly to the fore in their struggles about including non-national links. In The Netherlands, the national health information portal refers only to Dutch language sites from the participating organizations (physicians and pharmacists organizations, Dutch Quality Institute, and so forth). Doing so, of course, severely limits it relevance to a population whose Internet-users are very often well versed in (reading) English. After all, the amount of health information on the Web in Dutch is negligible to all the English language information that is available (and browsers can often even automatically translate to Dutch, if desired). In the USA, healthfinder.gov primarily endorses US government links or links that have already been endorsed by US government bodies. There as well, there are no links to information outside the USA. There are many Spanish Web sites – but all of them are of US-based health care organizations or institutions, often simply direct translations of the English resources.

In addition to these struggles about the locality and universality of the licenser, and its concurrent consequences for the kinds of reliability that are established, the very problem that the licenser is focused on addressing varies. Not all initiatives were established with the same intent of responding to a perceived "threat of bad information", although many were. Healthfinder.gov, for example, was considered to be an aid for patients who were unfamiliar with the Internet– a starting point to help them begin a search. It is also part of a larger public education program. One can also consider the National Library of Medicine, which was establishing a scientific database for a specific community (and not specifically looking to address issues of reliability) and only later realized that other communities (some of whom were looking for "reliable" information) were using it as well.

Related to this previous point, different groups envisioned projects that utilized various components of Internet technology. Early on, healthfinder.gov merely converted existing paper-based information into easy-to-access Web pages, whereas Quackwatch (see footnote 17) assumed a double task of converting existing resources into a Web site and assembling a new index of recommended (or non-recommended)

sites. HON wanted to design a more "open" technology, utilizing a specific mechanism of flexible design (an electronic "seal") that could be adjusted in response to alterations in other Web technologies. Other initiatives, such as MedCERTAIN, the QMIC and the Seal of Calidad, further built upon these ideas, adding different technical and conceptual layers.

Finally, just how the line is drawn between "reliable" and "non-reliable" can also be due to other reasons than a site's national background, its government endorsement, or its vision of patients as in need of either "protection" or "information". Differences also proliferate within medicine as well as within its potential "users". What counts as "reliable" for a strong Evidence Based Medicine believer, for example, might be far too limited for a more pragmatically inclined medical specialist or GP. What is posited as "well-established" information on the benefits of wine or the use of antibiotics in France, to use some common example, would abhor most Dutch physicians[23]. Likewise, it is evident that what would count as "reliable" or not will differ considerably, according to an individual user/patient's beliefs. A national portal would lead to general, basic information, whereas the criteria of an independent initiative, or perhaps even for a third party rating system, would be too restrictive. A fanatic chiropractic client would appreciate healthfinder.gov much more than Quackwatch, but would be ultimately disappointed with both.

Conclusion

Born from anxieties not unlike those calling for the "regulation" of the printing press several centuries ago, many initiatives have been developed during the last decade to "regulate" health information on the Internet. The discussion about health information reliability lends much attention to finding the one notion of reliability that answers the threat of misinformation on the Web and then establishing the ultimate gatekeeping method. This notion is one mirrored on the "ideal" image of scientific publishing, and the apparatus that ensures its objectivity and trustworthiness.

Yet as we have argued, this ideal-typed historical example is not easily transportable to the Internet of today. In addition to the impossible extent of the task of reviewing all relevant Web sites, the historical positioning of the "author" versus the "licenser" is different. Furthermore, the existing categorical definitions for these respective roles are not always applicable, as the persons attempting to fill them continues to change.

Creating "reliability", then, has become a difficult process of reinvention, involving much work – now, as much as it did several centuries ago. In addition, the different initiatives produce different reliabilities. We see differences in technical modes of operation: basically, two main competing forms (although within both types there is variation): the indicatory label and the separate domain of a Web portal. Also, we see different notions about what consumers need or require, and we see struggles and differences between locales that are remarkably resonant with the competition and differences between the Florence and London licensing bodies. Finally, we pointed at the differences within the medical content of the site: how alternative medicines were evaluated, for example, or which side of a current medical debate would be taken. Although those working to create reliability persist in the attempt to reach universality, each initiative remains tied to specific characteristics attributable to its respective local context.

For many reliability-seekers, this variety is offensive. It shows, after all, the failure to match the health information reliability quest to the scientific publishing example, and it stands in the way of an unequivocal defense-line against "bad" information (or a rallying point for "useful" information, depending on one's philosophy!). For us, however, this variety, although still limited because of this very attempt to "unify", is the only desirable situation imaginable. A deep fault of many current approaches is this underlying, sometimes implicit, ideal of the one system for "reliable health information'. Of course, all systems (quite openly) cover only a small fragment of what they would like to cover, but there is a clear desire to overcome that limitation – if not practically (providing a comprehensive response and reviewing all the existing medical Web sites), then conceptually (i.e. in defining the "best" system to ensure reliability).

Yet one comprehensive reliability model to which all sites and licensers must adhere is not only inherently doomed to fail, but it is also deeply undesirable. The diversity of options that the Internet offers is indeed exactly one of the components of its "nature" that has helped to create much enthusiasm, if not pure hype, about both its existence in general and its potential uses specifically within health care. A singular gatekeeping regime, if even possible to set firmly in place, would run the risk of stifling this, while not necessarily "solving" the suggested problems related to reliability. Thinking more in terms of feasibility than of medical ideal types, we can see that the co-existence of different systems actually serves as an avenue to reach different audiences, with different needs, and for that reason can be considered to be an asset, rather than a detriment.

Notes

1. For discussions about the concept of black boxing, see Latour and Woolgar (1986), Latour (1987) and Latour (1999).

2. Levinson (2001) has already made a partial comparison of media when interpreting the works of Marshall McLuhan in terms of the Internet. Within medical literature, two historical comparisons have been made. Both return to the respective introduction of a specific technology into society (and consequently, into medical care) and, in so doing, refer to the controversies that arose around these technologies. Spielberg (1998) compares the introduction of e-mail in current medical consultations to the introduction of the telephone in medical practice just over a century ago. Although Spielberg shows how the telephone was accepted and used comparably much faster and on a much wider scale than e-mail has been to date, she uses the analogy to enrich understanding of the changing expectations, standards and potential liabilities that accompany the use of e-mail for communication between doctors and patients. Rigby *et al.* (2001) compare use of healthcare related software, telemedicine and Web sites to the employment of experimental pharmaceuticals in health care just 40 years ago. The authors analogize current concerns about the dangers of unregulated information to concerns voiced in 1963 about the marketing of products that were neither properly tested, nor independently controlled for safety and efficacy, as well as about the lack of protection for the public in this regard.

3. It is important to be reflexive about our use of particular sources. Johns introduces his work by demonstrating how the "reliability" of his own printed book, for example, is indeed now by and large unquestioned. That is, there is no reason to doubt his identification, the quality of the content, and so on, because these are essentially a "given". Why can we accept Johns's standpoint or the theories of Latour and Akrich? How would we feel about utilizing these works if they were pulled from the Internet? What is the inscription contained in the book as

a technologically produced object, whereby we trust it without question and base our reasoning upon the information it contains?

4. We acknowledge that what one author typifies in one place is not necessarily applicable to other regions at that same point in history. Especially within Europe, the differences within and between locations during this period of history were great. As Eisenstein (1983, p. 9) asserts, "Quattrocento Florence, in any case, is scarcely typical of other Italian centers (such as Bologna), let alone of regions beyond the Alps. But then no region is typical. There is no 'typical' book dealer, scribe or even manuscript. Even if we set aside problems presented by secular book producers and markets as hopelessly complex and consider only the needs of churchmen on the eve of printing, we are still faced by a remarkable diversity of procedures".

5. See also Biagioli (1990) for information about Galileo's patronage at the courts.

6. Although the concept of separation of church and state was prevalent in early Medieval Europe, historical accounts reflect that the two institutions are not easily separable into two isolated entities. Especially with the rise of monarchies and the creation of the "modern government", the intricate relationship between the two and their intertwined power becomes increasingly evident. Many authors handle the two in a linear manner, with the church preceding the state in influence, but this representation is not always accurate – as the respective roles differed throughout the European countries and a specific point of time of change of influence could not be identified. When not referring to the work of a specific author, this piece attempts to handle the two in conjunction with one another.

7. The first version was published in 1611.

8. The transcript of the session referred to in this article is available at: www.hon.ch/Conf/Info/sessions2.html

9. For historical information about the Internet, see Hafner and Lyon (1996), Randall (1997), Berners-Lee (1999) and the W3C homepage (www.w3.org/History.html).

10. This was later exemplified in the case of drkoop.com. In 2001, the former US Surgeon General's then four-year-old site was the second-most visited health site on the Internet (Mabin, 2000). However, criticisms of the site increased because the sources for information provided on the site were not clearly disclosed. Funding from larger companies was necessary to the existence of the site, but it was alleged that advertisements were presented as educational, rather than promotional, information (Cho, 2000). Widely publicized criticisms caused other institutions, such as the National Library of Medicine to withdraw their support of Dr Koop's site. In 2002, banner ads on the site were clearly labeled as sponsored information. However, the home page also stated that the site was no longer affiliated with the former Surgeon General (www.drkoop.com).

11. C. Baur, personal communication.

12. In the course of the next five years, other groups also attempted to establish guidelines for practice, even collaborating with one another to ensure that different codes corresponded with each other in their fundamental principles. The Internet Healthcare Coalition (IHC), a group of individuals in the medical community, held a summit in Washington, DC in February, 2000 that resulted in a code of ethics for Web sites that later became known as the Washington Code of eHealth Ethics and is used to facilitate the efforts of several of the organizations that are discussed in this section (IHC, n.d.). Other examples include the Health Summit Working Group (HSWG) from Miritek systems, which published seven major criteria for assessing information quality (HSWG, 1998), and Hiethics, a collaboration of organizations and companies providing medical services via the Internet that met and developed ethical guidelines (based on the URAC accreditation codes) for health services that also included information guidelines (Fried *et al.*, 2000). The American Medical Association also published a set of guidelines in 2000.

13. For extensive explanation of the HON Code and hyperlink set-up, see: www.hon.ch/HONcode/audience.html.

14. MedCERTAIN was in a three-year experimental phase that lasted until February 2002, when it entered a second phase and became known as MedCIRCLE (see: www.medcertain.org or www.medcircle.org).

15. Guidelines for evaluating as were listed on the MedCERTAIN site are taken from the Washington Code of eHealth Ethics. See footnote 12.

16. www.accesible.org/wmc/wmc-1.htm

17. Concerns about illegitimate medical claims were not new. In the USA, organizations such as the LeHigh Valley Committee Against Health Fraud, which at this point had been active for 25 years, began to include Web-based claims in their focus on fraud. This group established a Web site under the name Quackwatch (www.quackwatch.org), seeking to improve the quality of health information on the Internet and to attack misleading advertising on Web sites. Among target sites were chiropractic, nutritional, dental and homeopathy sites.

18. See Pinch and Bijker (1987).

19. For a discussion of such "reliability" work see, for example, Timmermans and Berg (1997) and Bowker and Starr (1999).

20. See Adams and de Bont (2003) for a discussion about different constructions of reliability in three of the initiatives discussed in this paper.

21. For more on this, see other works in STS. For example, Steve Shapin (1995, p. 257), in discussing the analogous idea of credibility in relation to scientific claims asserts, "All propositions have to win credibility and credibility is the outcome of contingent social and cultural practices". See also Latour (1987), Shapin and Schaffer (1985) and Berg *et al.* (2000).

22. C. Boyer, personal communication.

23. See Payer (1989) for a rich discussion on the manifold cultural differences that inhabit biomedicine between countries. See also Berg and Mol (1998).

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Redefining the network: enrollment strategies in the PDA industry

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Abstract *Theories of sociotechnical change seek to understand technology as both material and social artifacts. Actor-network theory (ANT) offers an approach to sociotechnical change that has been criticized for emphasizing a micro-level analysis of political strategies at the expense of larger social and cultural processes. This paper presents an approach to sociotechnical change that links the enrollment process of ANT with broader social practices, through the concept of inclusion in multiple technological frames. Inclusion in different technological frames is used to explain the sources of enrollment strategies in the early personal digital assistant (PDA) industry. Two case studies of PDA evolution (Psion, led by David Potter, and Palm, led by Jeff Hawkins) are used to illustrate the link between enrollment strategies and inclusion.*

Introduction

Theories of sociotechnical change seek to understand technology as both material and social artifacts. A long tradition of technological change research has identified the importance of theoretical concepts that do not distinguish *a priori* between the technological/scientific and the social/cultural/economic/political aspects of technological change (Bijker, 1995). In the world of information technology (IT) research, this tradition has influenced the use of "ensemble" theories of IT change, which have been used to understand the dynamic interactions of people and technology during IT development and use (Orlikowski and Iacono, 2001).

One of the most popular and influential approaches to sociotechnical change in IT research has been actor-network theory (ANT), as developed by Latour, Callon, and colleagues (McLoughlin, 1999; Law, 1999). An early review of ANT in IT research cites examples of its application to IT development, IT-enabled organizational change, computer-mediated communication, and infrastructure standards (Walsham, 1997).

A major focus of Actor-Network Theory is to explain how stable networks of sociotechnical relations are created and maintained by the strategies of both human and non-human "actants" (e.g. Akrich, 1992; Latour, 1992). A major attraction of ANT for IT research, and one of its most controversial elements, is its symmetric treatment of people and technologies as members of actor-networks. The concept of a non-human "actant" (i.e. an information technology), influencing a network on the basis of the interests and assumptions inscribed within it, is one that has an undeniable appeal for understanding the IT world of today, where pre-packaged systems and global standards are routinely transplanted between very different use contexts.

This paper uses a key concept from ANT, enrollment in an actor-network, to account for the origins of the most commercially successful forms of personal digital assistant (PDA) technology. The enrollment process is linked to broader social

practices, however, by adding the concept of inclusion in different technological frames (Bijker, 1995). Inclusion in different technological frames is used to explain the sources of the relatively successful, yet at the time counterintuitive, enrollment strategies at two PDA manufacturers: Psion, led by David Potter, and Palm, led by Jeff Hawkins.

The enrollment process of ANT

An ANT-inspired analysis of sociotechnical change does not assume that technological outcomes are determined by pre-existing technological capabilities, or trajectories (e.g. Bijker and Law, 1992). An ANT analysis seeks to explain how sets of actants (human and technological) with diverse interests come together to create relatively stable technological arrangements. "How is it that things get performed (and perform themselves) into relations that are relatively stable and stay in place?" (Law, 1999, p. 4). A key process for creating and maintaining these actor-networks is through enrollment (sometimes spelled enrolment), a continuing process of persuasion and control in which the behavior of diverse actants is kept in accordance with a specific set of technological arrangements. "Successful networks of aligned interests are created through the enrollment of a sufficient body of allies, and the translation of their interests so that they are willing to participate in particular ways of thinking and acting which maintain the network" (Walsham, 1997). The concept of enrollment highlights the idea that otherwise divergent interests must be kept in line. "Actor-networks are the consequence of an alignment of otherwise diverse interests. Alignment is dependent upon the enrolment of different actors into the network" (McLoughlin, 1999, p. 94).

ANT's focus on the details of enrollment activity is the source of much of its analytic value, particularly in IT research studies reluctant to engage with technological details (Orlikowski and Iacono, 2001). Its strength, however, is also the source of one of ANT's main critiques: that ANT is too focused on the local and contingent aspects of sociotechnical change, at the expense of broader social and cultural processes. The main concern of an ANT analysis "is on entrepreneurial political activity in enrolling human and non-human actors into actor-networks" (McLoughlin, 1999, p. 101). The almost exclusive focus in ANT studies of the micro-politics of alliance-building has been described as Machiavellian, paying little attention to the influence of institutional or cultural routines (Layne, 1998). ANT researchers are well aware of its "well rehearsed machiavellian or managerialist difficulties" (Law, 1999, p. 5), agreeing that "ANT has often been criticized for presenting actors guided by the quest for power" (Callon, 1999, p. 193).

Despite these criticisms of ANT, it is still controversial to claim that an ANT-style analysis needs to be linked to a larger, macro-level analysis. The enrollment concept was originally intended to provide a middle ground between a structural approach that assumes actors have fixed or background interests on one hand, and an ethnomethological focus on the contingencies of discourse on the other (Callon and Law, 1982). Theorists such as Latour (1999) claim that ANT is a technique that bypasses and transcends the traditional divide between micro- and macro-level analyses. Nevertheless, the criticism remains that, in practice, "the actor network is an excellent explanatory device at the micro level, but it fails to explain the events that transcend the immediate microworlds of the actors" (Parayil, 1999, p. 167).

ANT analyses of sociotechnical change share with other schools of sociotechnical research the assumption that "certain agencies have locally stable interests or practices

... though most of the authors are at pains to argue that such interests are subject to change, they tend to work on the assumption that actors have a (relatively stable) concern to preserve the structure of their existing practice" (Law and Bijker, 1992, p. 300). Though actor strategies are central to understanding sociotechnical change, some observers argue that it cannot be fully reduced to these strategies. "If the strategies for delegating and controlling are successfully deployed, an institution results, an arrangement is stabilized, a structure emerges. Institutionalization cannot, therefore, be detached from the strategies of actors, but neither can it be reduced to these because the delegates that an actor seeks to array and hold in place are drawn from a structured environment" (Law and Bijker, 1992, p. 299).

It is difficult for even an ANT-style analysis to avoid making brief, relatively unproblematic references to the larger social and cultural context (see, for example, the example of technology transfer offered by Law (1997) as a prototypical example of an ANT-style analysis). The question then is how to conceptually bridge the divide between micro- and macro-level analyses, while still preserving the unique strengths of an ANT-style analysis.

In his review of ANT in IT research, Walsham (1997) agrees with the critics of ANT, and suggests combining ANT with theories of social structure such as structuration theory. Law and Bijker (1992) offer three suggestions for concepts that can help ANT-style analyses bridge the gap between actors and structural elements. The use of one of these concepts, the technological frame, is explored in this paper as one promising way of addressing this problem.

Enrollment in context: inclusion in technological frames

Recent work by Bijker (1992, 1995) provides a means for linking the enrollment process of ANT with broader social and cultural processes. Three of Bijker's concepts are important for making this link: technological frames, inclusion, and configurations.

For Bijker, a technological frame structures interactions among the actors of a social group. A technological frame consists of "all the elements that influence interaction ... and lead to the attribution of meanings to technical artifacts" (Bijker, 1995). Following Kuhn's (1970) concept of a disciplinary matrix in the natural sciences, Bijker's technological frame provides for a social group:

- goals for a technology;
- key problems to be solved by a technology;
- problem solving strategies;
- requirements to be met by solutions; and
- an exemplary artifact – a physical role model for what the technology should be.

These elements of a technological frame both enable and constrain certain kinds of action, following Giddens' (1984) concept of structuration in social interaction. A technological frame "guides future practice, though without logical determination" (Bijker, 1995) – it offers a powerful way of both seeing the world with respect to a technology, and a set of strategies and examples for how to successfully develop and use a technology, but it does not dictate how interaction around a technology should take place.

Technological frames are maintained by social interaction. They are also, of course, changed by social interaction, and an important source of dynamism in Bijker's theory comes from the concept of inclusion in a technological frame. Inclusion is "to what extent the actor's interactions are structured by that technological frame" (Bijker, 1995). Earlier versions of the social construction of technology (SCOT) approach, for which Bijker is probably most famous, described social groups as fairly monolithic, with basically fixed ideas about the appropriate problems and solution with regards to a technology. The concept of inclusion opens up new possibilities. Actors may have a high degree of inclusion in a technological frame, in which they are both heavily influenced and greatly skilled, or they may have a lower degree of inclusion, which perhaps makes them less skilled but more open to the influence of other technological frames. Actors can be participants in multiple technological frames, translating both problems and solutions across social boundaries.

A classic example of technological frames and inclusion comes from Bijker's study of Leo Baekeland, the inventor credited with developing the first synthetic plastic. According to Bijker, Baekeland participated in two different technological frames: the frame of Celluloid chemists, who were trying to develop a substitute for natural plastics to be used for fancy articles such as buttons and billiard balls; and the frame of photo chemists, who were trying to create better materials and processes for photography. For Celluloid chemists, the key problem solving strategy was to find new and better combinations of solvents that would produce an artificial plastic that was less flammable and cheaper. Progress, measured relative to the goals of the Celluloid chemists' frame, was slow. Baekeland shared the overall goal of the Celluloid chemists' technological frame, but also actively participated in the photo chemists' frame, where the main problem solving strategies included the careful variation and study of process parameters, such as the amount of heat and pressure applied to a reaction. This was not a common way of conceptualizing the problem in the Celluloid chemist frame. By drawing from his interactions within both technological frames, Baekeland was able to create a practical process for making Bakelite, the first widely used synthetic plastic.

Bijker's third concept divides sociotechnical change into three distinct types, or configurations, depending on whether no clearly dominant technological frames shapes interactions, one technological frame is dominant, or two or more technological frames are important. According to Bijker (1995), each configuration is associated with a different sociotechnical change process. When no technological frame is dominant, innovations should be plentiful and radically different. The most important change process when no frame dominates is the enrollment process described by ANT, which tries to create a new constituency that can stabilize a sociotechnical innovation. In other configurations, different change processes become more important. When two or more technological frames dominate, Bijker's theory claims that rhetoric and compromise (his "amalgamation of vested interests") are the most important change processes, while the search for improvements within the parameters of a given frame (his "functional failure" and "presumptive anomalies") are most critical when one technological frame dominates interaction.

Taken together, the three concepts of technological frame, inclusion, and configurations link together detailed enrollment activities and larger social and cultural processes. Enrollment is one important change process, but its importance depends on the configuration of technological frames guiding social interaction. Even

within a single technological frame, varying degrees of inclusion open up the possibility of multiple technological frames, each with their own definitions of reasonable problems and solutions, having an influence on the enrollment process. The four main concepts used in this study (enrollment, technological frame, inclusion, and configuration) are summarized below:

(1) *Enrollment*. Process of persuasion and control which creates, and maintains, actor-networks.

(2) *Technological frame*. Resources for structuring interactions, including technological goals, problems, problem solving strategies, requirements, and an exemplary artifact.

(3) *Inclusion*. Extent to which an actor's interactions are shaped by a particular technological frame.

(4) *Configuration*. Number of technological frames shaping interaction (zero, one, or many).

Case study design
The two case studies discussed in this paper are part of a larger research project to understand the evolution of emerging information technologies (IT) as examples of sociotechnical change. The overall research objective is to understand the processes through which newly emerging ITs stabilize into a commonly accepted form. In the early years of the PDA industry, many radically different technological forms were proposed, varying in size, shape, applications, input and output methods, and target audiences. A few proposed forms, such as "pen-based computers", attracted a substantial following, but have yet to establish themselves in the longer term.

Despite direct competition from the established giants of the personal computer industry, two smaller companies were the first to establish a relatively stable new form of PDA technology, and sell more than one million units by the year 1997: Palm Computing Inc., and Psion PLC. Using the concept of enrollment in an actor-network, the specific research question in these two cases is: how did enrollment take place around the new PDA forms offered by Palm and Psion, and how did their enrollment strategies differ from other PDA producers?

The data used in the cases came from three sources: a database of the 71 consumer-oriented handheld computers released by North American and European companies between 1987 and 1997; a collection of 425 trade press articles over the same period, taken from the ABI/Inform Global database; and 25 in-depth interviews producer company employees, user representatives, and industry analysts. Within the broad parameters specified by the theoretical perspective, standard qualitative data analysis techniques such constant comparison, theoretical saturation, and the search for negative cases were used (Strauss, 1987).

Enrollment, technological frames, and inclusion were used as sensitizing concepts in the qualitative analysis. By focusing the case analyses on these concepts, what was in fact an extremely messy and complicated process of technology evolution over many years is presented in a simplified way. The hope is that, with the use of a few concepts, a reasonable account can be made of the surprising forms that PDA technology eventually stabilized into.

PDA industry background

To understand the enrollment strategies of both Palm and Psion, and how different they were from the rest of the PDA industry, it is helpful to review the early evolution of PDA technology. This study considers the period from 1987 to 1997, roughly the decade from the release of the first handheld computer (the Psion Organiser) until the surprising commercial success of the Palm Pilot. 71 products were released during this period by 34 different companies, including the major personal computer (PC) manufacturers of the day (including Apple, IBM, Compaq, HP, and Tandy), telecommunications companies (including AT&T, Motorola, Nokia), and consumer electronics companies (including Sony, Sharp, and Casio).

The decade can be divided into three time periods, depending on the technological frame that was most prevalent during that time. Until 1992, the technological frame of "palmtops" dominated interactions in the PDA industry. The "palmtop" frame defined the goal of PDA technology as providing a smaller version of a PC that could be carried in a pocket or purse. The requirements for successful PDAs were taken directly from the world of PCs: more memory, faster processors, and familiar PC operating systems such as DOS. The Poqet PC or the Atari Portfolio can be considered as exemplary artifacts of this technological frame, when the physical form of PDAs was assumed to a smaller version of a laptop. The products from this era were launched mostly by medium-sized PC companies, and had varying degrees of modest, if unspectacular, commercial success.

From 1992 until 1996, a wave of unprecedented enthusiasm, publicity, and finally very high-profile public disappointment swept the PDA industry. Two newly proposed technological frames took attention away from the "palmtop" concept. The first, "pen-based computing", originated mostly in the largest PC firms such as Apple, Microsoft, and IBM. According to the "pen-based computing" frame, the goal of a successful PDA was redefined as the creation of a pen-input tablet computer to be used by customers that were intimidated by existing computers and keyboards. Instead of shrinking existing computers, the "pen-based computing" frame proposed that features like free-form handwriting recognition and intelligent assistance were the critical problems to be solved. The infamous Apple Newton is the exemplary artifact of this technological frame. The PC companies pursued a strategy of large investments in unproven, cutting edge technologies, combined with high-profile attempts to enlist many different corporate partners of all kinds.

In parallel with the "pen-based computing" frame came the concept of PDA as a "personal communicator". Led by telecommunications companies, the "personal communicator" frame defined the goal of PDA technology as providing a platform for wireless communications. An exemplary artifact for the "personal communicator" frame would be the EO 440, a four-pound tablet that used cellular phone networks to send email and faxes. As in the "pen-based computing" frame, enrollment strategies in the "personal communicator" frame featured much publicity, investment in leading-edge technology, and high-profile partnerships and alliances.

By 1995, both the "pen-based computing" frame and the "personal communicator" frame were widely perceived to be commercial failures, and neither had formed a stable network of producers, investors, and consumers. The PDA industry as a whole was condemned as "over-hyped". The year 1996 began a third phase of the industry, with the arrival of the original PalmPilot. The first Palm PDA was very different from its

predecessors. It was a small, relatively simple "connected organizer" with long battery life, a focus on personal information management (PIM) applications such as calendar and address book, pen-based character recognition, and easy synchronization with a personal computer (PC). The goals and problems that had been considered essential in previous areas, such as handwriting recognition and wireless communications, were no longer defined as important features. Within a year, Palm developed a large commercial following and established itself as the market leader. During this period, slowly and without the fanfare of other high-flying PDA companies, Psion managed to establish its PDA technology through the Series 3 machines. How is it that smaller, less well-connected companies like Palm and Psion were able to establish new technological forms in the face of such serious competition? How did they enroll others in their networks? What did they do differently?

Psion: the "organiser palmtop"

David Potter, a professor of mathematical physics at UCLA and Imperial College, founded Psion PLC as a PC software company in 1980. Concerned about the increasing level of competition, and the growing capital requirements of PC software, Psion changed in the early 1980s from a software company to a handheld computer company, releasing their first handheld computer (the "Organiser") in 1984. Psion introduced a modestly successful industrial handheld (the "HC"), and a commercially disastrous notebook-sized computer with solid-state storage and long battery life (the "MC"), before releasing the first Series 3 handheld in 1991.

The Series 3 adopted the same "clamshell" form factor as the existing palmtop computers of the day (for example, the Atari Portfolio and Fujitsu Poqet PC), using a small keyboard as the only input device. It differed from existing palmtops in two important ways. First, it was designed from the ground up to be a low power device, using solid-state storage to achieve long battery life. This meant designing a new operating system from scratch (the 16-bit "SIBO" platform), rather than assuming that using a PC compatible operating system such as DOS was a prerequisite for successfully establishing a new technological form. Second, the Series 3 was designed to have very easy to use personal information management (PIM) applications, such as scheduling and contacts information, available at the touch of a button.

With these redefinitions of the handheld computer concept came shifts in the enrollment strategy of Psion, in contrast with other handheld producers. The consumers were redefined as executives and professionals, rather than existing PC users who wanted mobility, resulting in design, marketing, and distribution decisions focused on busy executives rather than technophiles. Instead of the traditional PC industry emphasis on enrolling strategic partners and independent software vendors, Psion focused much more attention on enrolling suppliers and subcontractors to control the entire "user experience" of the Palmtop Organiser. Using these enrollment strategies, Psion was able to establish the Series 3 as the exemplary artifact in a sustainable new technological community.

The source of Psion's different (and relatively successful) enrollment strategies can be seen in terms of technological frames and inclusion. Though Potter and his initial management team were mathematical physicists, they were all heavily involved in computer technology, and saw the industry largely in terms of computing. Successful PDAs for them would basically be computers, with a computer CPU and hardware

architecture, an operating system, and separate applications software. As late as 1996, Psion was still announcing their new products with the slogan "A Computer For Every Pocket". Like other PDA producers, an important source of enrollment strategies for Psion was the successful PC industry.

In contrast to other palmtop computer companies, however, Psion's management team participated in two other very different social worlds. One was the unique world of the British PC industry, which in the early 1980s had a 24 percent share of global PC sales, almost entirely on the strength of Sinclair products (Langlois, 1992). The early Sinclair computers, such as the ZX81, were influential for Psion in showing that very small, relatively low power devices could be successful – moving from a ZX81 to a PDA was a small conceptual leap in the UK. In the US, the IBM PC was the exemplary artifact, and the ZX81 was a "side show". Second, Psion was unique in the early PDA industry because it designed computers for both mass-market consumers and niche vertical industry applications. Psion entered the world of industrial applications by accident, after some early industrial successes with the original Organiser product, but became heavily involved after the introduction of the HC range. Psion was able to draw upon industrial experience with more expensive, cutting edge technologies, such as new screens and wireless communications, before they ever became practical for a mass-market audience.

Psion, with its Series 3, was not only able to establish a new technological form that differed from its palmtop predecessors, it was also able to successfully resist many of the trendy, seemingly obvious ideas about the future of PDAs in the industry's early chaotic phases. Psion's enrollment strategies differed from the conventional wisdom. The first case of successful resistance already mentioned above was to depart from the existing "palmtop" technological frame, which defined successful PDAs as smaller versions of existing PCs.

Psion was also able to depart from the "pen-based computing" frame by drawing upon its inclusion in other technological frames outside of the traditional PC industry. Every major PC company of the day (including Apple, IBM, Microsoft, Tandy, and Compaq) pursued the dream of a small tablet device with intelligent freeform handwriting recognition, a product intended to serve a mass market of "technophobes" who were intimidated by keyboards and other PC complexities. While PC companies busily enrolled venture capital and software partners for a mass-market assault, Psion drew upon its experience with mobile professionals to argue that reliable data input through a keyboard was crucial for enrolling their defined set of customers. Though Psion's management team thought the "death of the keyboard" idea was evidence that "the industry went mad", Psion management organized a US study tour in late 1993. The director of Psion Computing assessed their findings as follows:

> We visited the USA to see the pen platform, Microsoft, everyone. We asked them why they did this? Why leave out the keyboard? It was a management axiom that they should start with a pen ... they had bought Sculley's concept [of a pen-based PDA like the Apple Newton] and we'd better do that just in case he's right. It was a given.
>
> For us, it was an example of West Coast groupthink. If we'd been in California, would we have been sucked into that? But we weren't immersed in it. We asked ourselves: did we know more about the market, or were we on a different planet? (Interview, December 1997).

Following the commercial failure of the Apple Newton in 1994, the pen-based computer concept fell out of fashion. The "personal communicator" technological frame became a

significant source of new product ideas. During this time, many of the major telecommunications companies (including AT&T and Motorola) proposed PDAs based on the assumption that wireless communications was the key to success in the PDA world. Producers tried to enroll large telecommunications companies as resource and infrastructure providers, and "content providers" to create the content that would drive network traffic. Psion drew upon its interactions within the industrial applications frame to reason that wireless communications was still too difficult and expensive for mass-market use. By drawing upon its inclusion within the industrial applications frame, with its different problems and solutions already at play, Psion was once again able to successfully resist an emerging technological frame that, in retrospect, was an unsustainable technological fad.

Palm: the "connected organizer"

Palm Computing was founded in 1992 by Jeff Hawkins as an application software company for handheld computers. Palm supplied the PIM applications, handwriting recognition, and the PC connectivity software for the Casio/Tandy Zoomer handheld, introduced soon after the Apple Newton in 1993. Palm supplied handwriting recognition and PC connectivity software for other PDAs, until a frustration with existing products led them to develop their own handheld computer. Their first handheld, the PalmPilot, was released in 1996, and quickly became one of the fastest selling consumer products of all time.

Given the state of the handheld computer industry in the mid-1990s, when widespread disillusionment had set in after the disappointing performance of "pen-based computing" and "personal communicators", the original PalmPilot was a radical departure from the conventional wisdom. The PalmPilot was small enough to fit in a shirt pocket, used a pen rather than a keyboard, and had relatively little computing power and memory. Two redefinitions were particularly important. First, the PalmPilot used pen input at a time when pen-based computing was blamed for the high-profile failure of the Apple Newton and similar PDAs. Instead of recognizing freeform handwriting, however, the PalmPilot used a technology called Graffiti invented by Hawkins. Graffiti forced the end user to write one character at a time, requiring users to learn a simplified new alphabet. The second major redefinition is reflected in the name that Palm gave to their new products: Connected Organizers. The PalmPilot was designed around the assumption that the handheld computer user would also have a PC. The design of the PalmPilot made it extremely easy to connect to a PC and synchronize PIM data.

As in the Psion case, these redefinitions called for different enrollment strategies from what was then the industry norm. Using a simplified handwriting recognition technology, developed in-house, radically decreased the hardware and software requirements of the PalmPilot. This redefinition allowed Palm to develop the PalmPilot using their existing resources, rather than having to sell outside investors and potential partners on a new and unproven technology concept. For end consumers, the enrollment message shifted from accurate handwriting recognition to the simplicity and ease-of-use of the PalmPilot's PIM applications. Redefining the handheld as a PC companion also shifted Palm's enrollment tactics away from technophobes with no previous computing experience – the message of pen-based computing – and towards technophile early adopters who were already comfortable with PCs. By connecting

through PCs to outside networks, rather than relying on wireless communications, Palm removed the need to enroll wireless infrastructure providers, a major stumbling block even today because of the expense and unreliable performance of wireless networks.

The source of Palm's unique problem redefinitions, and therefore its different enrollment strategies, can be seen as the inclusion of Palm's founders in different technological frames. As in the Psion case, the successful handheld for Palm would basically be a computer, with a typical computer hardware architecture, an operating system platform for developing new applications, and separate application software. Palm's founders all had years of experience in the California PC industry, at companies such as Intel and Apple. Palm also absorbed existing features of Psion's "organiser palmtop" concept, such as low power requirements and easy access to PIM applications. Probably the most surprising redefinition was the use of Graffiti handwriting recognition. Though difficult to appreciate in retrospect, this was a technology so counterintuitive that no independent analyst, and even few within Palm itself, could see it as a viable PDA technology. Making end users "learn a new way of writing" went completely against the founding assumptions of the PDA industry. Jeff Hawkins, however, did graduate work in biophysics at Berkeley, and was peripherally involved in the pattern recognition and neural network research community. From this unique experience base, Hawkins was able to see the potential of Graffiti. Through their experience with the Casio/Tandy Zoomer product, Palm was exposed to the very different world of consumer electronics, where "out of the box" experience and low price points take on much more importance than in the PC world. Even though it was a commercial failure, it was primarily through their surveys of Zoomer users that the key performance criteria of PC connectivity became a major focus (Butter and Pogue, 2002).

By drawing upon their inclusion in other technological frames, Palm was able to resist many of the industry's commonly held assumptions. Following the lead of Psion and others, it was relatively easy to grasp that the "palmtop" notion of PDA as shrunken PC was not a sustainable new form. Much more difficult to resist was the idea that, because of the failure of products like the Apple Newton and the Casio/Tandy Zoomer, that "the pen was dead". Jeff Hawkins was able to draw upon his experience in the world of pattern recognition research to see that a new and different kind of pen input could ultimately be a stable new technological form for a substantial audience of end consumers. With their redefinition of PDAs as a "connected organizer", drawn from their experience in the consumer electronics world, the key problem of the proposed "personal communicator" form became much less significant. Rather than having to wait for cheap, ubiquitous wireless communications to become a reality, Palm was able to draw upon the strengths of the PC while still creating a relatively easy to use consumer device.

Discussion
Enrollment
Both case studies investigated the enrollment strategies used by PDA producers to create new and relatively stable actor-networks around a particular form of PDA technology. The enrollment process involved both human and non-human elements.

As specific technological elements were included or excluded, such as pen input or wireless communications, so too were specific human agents. A costly, leading-edge solution required the inclusion of outside investors and strategic partners in the proposed actor-network, while the use of less complicated technologies could result in these players, and their interests, being left out of the network. Decisions to include different sets of end users (for example, technophobes vs. PC users) were also linked to the inclusion or exclusion of different non-human technological elements. The concept of enrollment is useful for focusing attention on this boundary drawing activity in a prospective actor-network.

The case studies also show some of the limitations of the enrollment concept, as it is sometimes deployed in an ANT-style analysis. ANT in general, and the idea of enrollment in particular, has been criticized for providing too Machiavellian view of technological change. Given ANT's usual focus on micro-politics and negotiation tactics, the example of PDA evolution is useful for reminding us that enrollment is not only a matter of negotiation and power plays. Enrollment is also a matter of redefining the technology, including and excluding different network elements.

Taken too literally, this view of enrollment as negotiation tactics can lead any ANT-style analysis to conclude that the secret of establishing a new technological form is to "create [a] network of aligned interests" and that technologists should "enroll stakeholder groups to align their interests with the technology" (e.g. Walsham and Sahay, 1999). This would not have been a suitable conclusion in the PDA industry. Many producers in the early PDA industry made what, in retrospect, appears to be the mistake of spending too much time and energy enrolling the "wrong" social groups and the "wrong" technologies, forming "grand alliances" with other producers and investors and placing all their bets on leading-edge technologies. The challenge of establishing a new technological form is to include or exclude a non-obvious set of social groups and technological elements in a new technology definition, as well as to bring these human and non-human elements on-board.

Technological frame
The concept of a technological frame is meant to capture both the social and technical resources that are drawn upon to create stable interactions. Technological frames were used in the case studies to describe the evolution of the PDA industry, from "palmtops", to "pen-based computing" and "personal communicators", through to the "connected organizer" frame established most clearly by Palm. Technological frames include both technological detail (such as solution requirements, and physical forms) as well as social conceptions of the goals and key problems of a new technology. As a concept that tries to include social and technological elements, the technological frame is suited for structuring or complementing an ANT-style analysis of sociotechnical change.

As the case studies indicate, the technological frames proposed by early PDA producers were not the only influential sources of enrollment strategies. Ideas were drawn from other, more established technological communities, such as the PC or telecommunications industries. The technological frame concept provides a means for connecting PDA evolution to these other communities.

Inclusion

The concept of inclusion in a technological frame was used to explain the sources of the unique, counterintuitive enrollment strategies employed by Psion and Palm. As the Psion and Palm cases illustrate, this concept allow an analyst to trace the influence of a larger institutional background – to group practices around a technology which are relatively stable – while still creating a detailed account of how enrollment took place. In our case studies, our understanding of the details of the enrollment process was aided by an account of existing community practices involving a technology (the technological frames), and the participation of key actors in those communities (inclusion).

In both the Psion and Palm cases, the sources of their unique problem definitions and enrollment strategies have their roots in larger social group practices. Their view of the PDA world, and their ability to skillfully act in the PDA world, was most shaped by their participation in the technological frame of the PC industry, from which they adopted many of their established problem definitions and solution strategies. Their successful establishment of new technological forms, however, requires reference to places outside of normal PC industry practice. How was it that these companies, and not others with many more resources, were able to establish new forms, and do it in such a unique way? The intended contribution of the cases was to identify exactly how each of these companies redefined the problem of the PDA, and the sources of these redefinitions in community practices outside the PC industry.

The use of inclusion in a technological frame is one way of addressing the critique of ANT as too focused on the micro-politics of enrollment, at the expense of broader social and cultural processes. No one approach can ever resolve the tension between the actor-oriented and structure-oriented aspects of sociotechnical change, but inclusion in a technological frame provides a bridging mechanism between the details of enrollment, and larger institutional practices. The concept of inclusion in multiple technological frames also adds some dynamism to the relatively static view of actors having fixed interests and strategies.

Configuration

In Bijker's (1995) theory, each configuration of technological frames (either zero, one, or many) is associated with a particular sociotechnical change mechanism. Bijker predicts that in a configuration of no dominant technological frame, such as in the early PDA industry, enrollment will be the dominant change mechanism, rather than political negotiation or the search for solutions within a shared problem space. The evolution of the PDA industry supports his claim. Interestingly, many of the actors chose to pursue strategies that focused on rhetoric and alliance building (which Bijker claims is the primary change mechanism for the two or more dominant frames configuration), or that focused on improvements within what they assumed to be a problem space that was obvious to everyone (which Bijker claims is the primary change mechanism for the one dominant frame configuration).

The concept of configurations assigns a crucial role to the enrollment process, but also contextualizes it by claiming that it dominates in some configurations more than others. The configuration of technological frames might provide a useful means of deciding how, and to what extent, the enrollment process of ANT is an appropriate starting point for an analysis of sociotechnical change. Conversely, the detailed

examination of enrollment in the PDA industry shows that dominant frames from other communities can influence a situation of no dominant frame in the new technology, suggesting that the notion of zero dominant frames may have to be revisited.

Conclusion

Theories of sociotechnical change seek to understand technology as both material and social artifacts. ANT offers an approach to sociotechnical change that has been criticized for emphasizing a micro-level analysis of political strategies at the expense of larger social and cultural processes. This paper has presented an approach to sociotechnical change that links the enrollment process of ANT with broader social practices, through the concept of inclusion in multiple technological frames. Inclusion in different technological frames is used to explain the sources of enrollment strategies in the early PDA industry.

Two case studies of PDA evolution (Psion, led by David Potter, and Palm, led by Jeff Hawkins) were used to illustrate the link between enrollment strategies and inclusion in technological frames. In each case, the company was able to establish a stable new technological form, enrolling the sustained interest of a set of producers, investors, and consumers in an actor-network. For each form, an exemplary artifact served as part of an organizing definition in an emerging technological frame – the Series 3 for Psion, the PalmPilot for Palm.

Both companies redefined the PDA in an attempt to enroll groups that had not yet been successfully drawn into the PDA industry, and to exclude others that were inaccessible or uncooperative. The inclusion of the management teams at Psion and Palm in different technological frames was used to account for the source of their counterintuitive problem definitions that resulted in successful enrollment. Their inclusion in technological frames was also used to account for how they were able to avoid redefinitions such as "pen-based computing" and "personal communicators" that led to many unsuccessful enrollment attempts in the early PDA industry.

Using the concepts of technological frames, configurations, and inclusion, it is possible to create a link between the details of enrollment activities, and larger social and cultural processes. This approach addresses one of the central problems of sociotechnical theory identified by Bijker (1995): maintaining the balance between actor-oriented and structure-oriented explanations of technological change. Clearly, many of the important details of the enrollment process have been left out of these case studies. The specific events that led to changes in enrollment strategies over many years could be plotted in much more detail. Similarly, many of the larger institutional elements of the stories, such as new venture financing, national legal environments, or opinion leadership in the IT industry, have also been omitted, or only briefly referred to. The objective of our analyses should be to provide carefully conceptualized pathways between different micro- and macro-level phenomena. The analyst must ease the way for other analysts to find pathways into the account, making it easier to supplement, challenge, and change our stories of sociotechnical change.

The approach used in this paper allows us to extend and deepen our understanding of enrollment. Enrollment through mechanisms such as problem redefinition can be just as, if not more, important than obvious political tactics such as negotiation and rhetoric. Enrollment is an attempt to "impose order on a part of the social world . . . [to]

build a version of social structure" (Callon and Law, 1982, p. 622). The sources of enrollment strategies can be found in the inclusion of organizational members in different social groups, such as the pattern recognition social world in the Palm case, and the peculiarities of the British personal computer industry in the Psion case.

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Contested artifact: technology sensemaking, actor networks, and the shaping of the Web browser

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Abstract *Much of IT research focuses on issues of adoption and adaptation of established technology artifacts by users and organizations and has neglected issues of how new technologies come into existence and evolve. To fill this gap, this paper depicts a complex picture of technology evolution to illustrate the development of Web browser technology. Building on actor-network theory as a basis for studying complex technology evolution processes, it explores the emergence of the browser using content analysis techniques on archival data from 1993-1998. Identifies three processes of inscribing, translating, and framing that clarify how actors acted and reacted to each other and to the emergent technological definition of the browser. This spiral development pattern incorporates complex interplay between base beliefs about what a browser is, artifacts that are the instantiation of those beliefs, evaluation routines that compare the evolving artifact to collective expectations, and strategic moves that attempt to skew the development process to someone's advantage. This approach clarifies the complex interdependence of disparate elements that over time produced the Web browser as it is known today.*

Introduction

Over a short period beginning in 1993, the graphical Web browser developed into an essential tool for accessing the Internet. Today, in less than a decade, "browsing" has become a routine activity for over 580 million Internet users (NUA Internet Surveys, 2002). The browser has arguably become the most widely used software application in the world, and thus a de facto technological standard. For the vast majority of personal computer users, the browser appears as one of the many functions provided by Microsoft Windows. However, the fact that the browser functionality became so deeply embedded in the Windows operating system was not a preordained outcome; radically different conceptions of the role and functionality of the browser were in play during its crucial early period. Yet apart from some first person recollections by key players (e.g. Berners-Lee, 1999) and analyses of inter-firm rivalry (e.g. Cusumano and Yoffie, 1998), little research has explored the evolution of the browser and the factors that have shaped its development. This paper focuses on how the browser came into being and evolved over time.

Most research on new information technology (IT) has focused on individual and organizational factors that affect the pace of adoption of new technologies (e.g. Davis, 1989; Moore and Benbasat, 1991; Fichman and Kemerer, 1997). Similarly, the managerial literature on IT development emphasizes the development of new software products as a linear or spiral process of gradual refinement (Grady, 1997; Boehm, 1987). As a result of this emphasis on technology production, adoption, and implementation within organizations, little is known about broader processes of IT development that encompass efforts across organizations and communities (for an exception, see Yates and Van Maanen, 1996). By studying how a core Internet technology came into being and evolved over time, we share Orlikowski and Iacono's (2001, p. 121) critique of IT research as "conceptualizations of IT artifacts as relatively stable, discrete, independent, and fixed", and respond to their call to theorize the IT artifact.

This paper presents results from a theoretically grounded qualitative investigation of the early years of the Web browser, focusing on 1993-1998 as the years most critical to its development. We use actor-network theory (ANT) as a theoretical basis for investigating the complex evolution of the browser, and to better understand how and why it took on a form that subsequently became so widely adopted. The paper is organized as follows: The theory section explores various approaches to understanding technology evolution and identifies ANT theories for technology evolution as uniquely suited to the exploration of complex IT artifacts. The next section describes our grounded theory approach to studying browser evolution. Our results lead us to a model of technology evolution, which is presented next. Finally, we discuss the implications of our findings for the study of IT artifacts and assess the utility of this theoretical approach for understanding the rise of dominant technologies.

Theoretical background
Perspectives on technology evolution
Relevant theories of technology innovation research fall under two major headings: a macro-level perspective that focuses on the industry and the firm as innovation-bearing milieux, and a micro-level perspective that looks at individual innovation and identifies team-level factors that lead to successful development. The macro perspective investigates such phenomena as the characteristics of innovative firms (Dosi, 1988), how industry-dominant designs emerge (Anderson and Tushman, 1990), the impact of a firm's absorptive capacity (Cohen and Levinthal, 1990), and the importance of routines that cannot easily be duplicated (Nelson and Winter, 1982). This approach accepts the innovation process as inherently uncertain, dynamic and stochastic (Jelinek and Schoonhoven, 1990; Van de Ven *et al.*, 1999). By identifying company attributes that encourage innovation, this approach advances our understanding of technology development in the marketplace (Cheng and Van de Ven, 1996).

By contrast, the micro perspective investigates development team characteristics and processes. This intra-organizational research examines factors that can maximize the likelihood of producing successful innovations, such as a team's internal and external communication, composition, and work organizing strategy (e.g. Ancona and Caldwell, 1992; Clark and Fujimoto, 1991; Dougherty, 1992; Eisenhardt and Tabrizi, 1995).

These two streams of traditional research suffer from a number of limitations when applied to the study of radical innovations such as the Web browser. First, both streams take a prescriptive and predictive stance, assuming that an optimal innovation process exists, that successful technologies are those that best match the current needs of the marketplace, and that managers can dictate these specifications to their scientists and engineers. In spite of several examples of widespread adoption of inefficient innovations (David, 1985; Nelson and Winter, 1982), the focus in both approaches remains on the identification of rational design processes. A second limitation is analysis bifurcation. The macro (industry level) research stream does not incorporate findings from the micro (team level) literature, and vice versa. In spite of recent recognition of the fact that understanding complex technology requires studying networks of individual developers, institutions, standard setting bodies, product releases, and intransient properties of the technologies themselves (Van de Ven *et al.*, 1999), little recognition has been given as to the importance of cross-level understanding of broader technology development processes. A third limitation is the assumption of a linear temporal sequencing within a relatively orderly organizational context. Most innovation research assumes that technology evolution consists of a linear sequence of steps that include idea formulation, applied research, technology development, product development, production, and diffusion (Marquis, 1988; Bijker *et al.*, 1987). Much less is known about how a completely new technology emerges outside the context of the firm.

Responding to these criticisms, constructivist theoretical approaches have generally emphasized a dynamic and social view of how technology evolves. They focus on technology in development, the continuous social construction of meaning, and the reciprocal web of relationships between the technology and its context (Bijker, 1995; Fulk, 1993). Some researchers have adopted Giddens's (1979) structuration theory to explain the reciprocal processes of sensemaking, negotiation and adaptation that necessarily accompany the adoption of complex technologies in organizations (Barley, 1986; Griffith, 1999; Orlikowski, 1992, 2000). The structurational approach is most effective at explaining the process of adaptation that inevitably accompanies the introduction of a new technology into the social order of an organization. Yet this body of research has not provided sufficient insights for the specifics of technical artifacts in development (Monteiro and Hanseth, 1995).

ANT approach

The traditional views of technology discussed above emphasize the two conceptual elements of developer beliefs and the technology artifact. Technology is approached through the lens of one-way temporal sequencing, as either artifact "determines" belief, or belief "shapes" artifact. Technological determinism is consonant with the macro perspective, which emphasizes the physical aspect of technology. Conversely, social constructivism emphasizes the importance of interpretative human actors and favors the micro perspective. Structuration theories stress duality and emphasize the interplay between the two conceptual elements. Actors may have the flexibility to interpret, yet at the same time be bounded and restricted by objective properties surrounding them (Orlikowski, 1992).

In comparison, ANT rejects the foci of these the two conceptual elements and bypasses the distinction between them. For instance, actors' subjectivities – their

motives, intentions, interests and prejudices – are imposed on the technological artifacts they develop. Thus, users of the technology respond to designers' original intentions as they are manifest in the artifact (Akrich, 1992). From this perspective, artifacts are not merely physical; they include and embody the active projection of actors, hence the label "actant". In this way, the difference between the subjective intention and physical artifact becomes less consequential. The advantage of minimizing differences between human and non-human actors is that we can now focus our theoretical lens on the nature of the network that ties together all actors in a web of discovery, action, scientific fact, and artifact.

By de-emphasizing traditional subject-object controversies, the ANT approach allows the development of a rich language for describing how technology, actors, and social arrangements are constantly shaped and how they interact over time. This makes ANT especially appropriate for investigating the interlocking elements of individual inventors, broader institutions, and the larger social, economic, and sometimes political aspects that surround technology development (Latour, 1987; Latour and Woolgar, 1979; Law and Callon, 1992; Akrich, 1992). By looking at the relationships between actors, institutions, the environment and artifacts, it identifies "actor networks" (interested groups and institutional forces) as the fundamental building blocks of technology. In this way, it allows the investigation of such questions as how technologies come into being and how users and other actors conform, ignore, modify, or usurp the original designers' interests.

In this paper, we discuss the core processes related to the development of the Web browser, focusing on three aspects – inscribing, translating, and framing. As shown in Figure 1, these processes show recurring spiral moves in which networks of actors continuously react and interact, creating a spiral of technology development. Rich descriptions of these processes provide insight into how beliefs about a technology emerge and are then communicated to many interested actors, negotiated as evaluation routines, and embodied as artifact forms. The core processes are described in Figure 1.

Inscription
Inscription refers to the fact that an artifact never begins as a blank slate; instead it embodies the innovators' beliefs, social and economic relations, previous patterns of use, legal limits, and assumptions as to what the artifact is about (Akrich, 1992). The term inscription is used when designers formulate and shape technology in such a way as to lead and control users. Inscription can also refer to the way technical artifacts embody patterns of use, including user programs of action. The term also encompasses the roles users and the system play (Monteiro, 2000; Berg, 1999). Since inscription can guide users to join or behave in a way that forces a definition of the form and function of the technology, many actors actively seek to inscribe their vision and interests into the artifact. For example, early on Netscape inscribed additional HTML functionality in its browser in order to set it apart from other browsers that simply followed the HTML standard. By studying inscription over time, we can assess how actors directly affected the technological artifact's functionality and thus affected the overall technological trajectory.
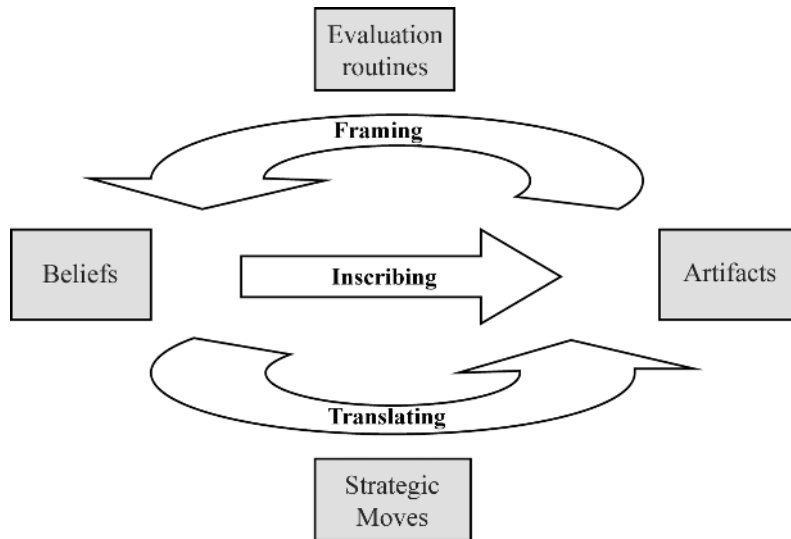
Translation

The notion of translation describes a variety of ways in which actors actively seek to interest others in supporting the construction of a claim, enrolling them directly or indirectly in a coalition dedicated to building a fact or a machine (Latour, 1987). As the evolution of a new technology usually involves various actors with diverse sets of interest, backgrounds, motivations and prejudices, those seeking to build such coalitions must build on their own strengths in order to align others' interpretations and interests with their own (Monteiro, 2000). Translation may take a variety of forms for various actors. In this process, each actor develops or is offered an interpretation to channel his or her energy in a new direction that will advance the coalition's goals. Once an innovator's beliefs and interests are embodied in forms of inscription and technical arrangements, networks of actors with their own chains of translations can react to them. These actors can form an alliance of interests and compete for standards. The actors race first to choose the technology that seems most beneficial for them and then enroll this technology in their own actor-network (Hanseth and Monteiro, 1997). For example, in the context of the browser evolution, corporate actors such as Netscape and Microsoft tried to rapidly build alliances and enroll supporters in order to gain market share and delineate the relationship between the browser and the operating system.

Framing

Inscribed patterns of use do not succeed when users do not conform to their assigned program of action. In many new technologies, lead users modify and adapt the artifact into new forms of use (Von Hippel, 1994). Based on actual practice, unexpected uses are developed and new functionality is envisioned, leading to a new perspective on what the tool does and is expected to do. Thus, when studying the user of technical artifacts, one necessarily shifts back and forth "between the designer's projected user and the real user" in order to describe this dynamic process of negotiating design (Akrich,

1992). It is necessary to measure which of these superimposed inscriptions actually succeeds in shaping the pattern of use in order to measure the strength of an inscription (Monteiro, 2000).

We define framing as the emergent outcome of the process of an artifact instantiation-meeting practice. One micro aspect of framing is the momentum given to a set of features and functionality. In our case, this means crystallizing conceptions of what the browser is: Netscape 2.0 subsumed the FTP and NNTP protocols and included cookies, but did not directly include an HTML editor. Once a set of accepted functions is recognized as core to the technology, the process is hard to reverse: these functions are embedded in the expectations of users, evaluation routines (standards), and the beliefs of developers themselves. New versions of the technology must then incorporate or improve on this functionality. On a macro level, framing is defined by how key actors engage in actions in support of a certain vision or pattern of usage. As with the micro level, this results in irreversibility (Hughes, 1994; Hanseth and Monteiro, 1997). The examination of how users and actors together frame criteria for selecting and stabilizing features is essential for understanding the irreversible and path dependent aspects of technology evolution.

Research methodology

This study is based on analytical counts of archival longitudinal data. We utilize a process theory approach to develop rich interpretations of longitudinal data (Miles and Huberman, 1994). Template coding schemes are designed drawing upon the recommendations of qualitative research and ground theory (Boyatzis, 1998; Eisenhardt, 1989; King, 1998; Miles and Huberman, 1994; Strauss and Corbin, 1990). We also used visualization techniques in order to render recurrent patterns in our data (Langley, 1999). The resultant figures depict the complex process of browser evolution in terms of reciprocal interdependence among the networks of actors, incorporating relevant competitive moves. Such longitudinal methods are appropriate for the study of complex technology development processes (Van de Ven and Huber, 1990).

Congruent with ANT assumptions, we do not theoretically differentiate the elements of technological beliefs and artifacts; rather we view these as a thematic focus of our coding and a choice of theory application. In order to specify these themes, we build upon the conceptual elements beliefs, artifacts and evaluation routines, initially proposed by Garud and Rappa (1994), and develop the element of strategic moves, which we define as an actor's attempt to interest and line up other actors as allies. We illustrate how these elements are related to the central notions of ANT theories.

Technology can be defined in terms of both its subjectivity and objectivity, two aspects which coexist. Technology as physical artifact is an intuitively clear construct, consisting of the formal and functional characteristics of the focal technology. Technology as beliefs is based on its representation as knowledge and the activity of knowing, and comprises the cognitive elements that emerge as the technology is put into play, enacted, and interpreted (Weick, 1990). This element assumes that the phenomenon can include not only what exists, but also what individuals believe possible. A belief can also be viewed as a mapping of cause-and-effect relationships that define "what the technology does" and how it relates to other technologies. Other terms used by researchers to refer to this causal map are paradigm, cognitive framework, and mental model.

The third dimension of the model consists of technology evaluation routines. Evaluation practices consist of testing routines and normative values that serve to validate and sustain certain aspects of the technology over others as it evolves. The emergence of such accepted standards makes it possible to comparatively evaluate product features and provides a framework for assessing market compatibility (Garud *et al.*, forthcoming). And since evaluation of technology is not independent from the purposeful human actors producing and evaluating it (Latour, 1987), evaluation routines interact with beliefs by serving as second-order frames. By giving actors a basis for claiming validity, evaluation routines tend to bracket perceptions and create path dependence. Designers and developers externalize their technological beliefs by creating evaluation routines that are then employed to assess the technology and filter data by relevance. Thus, attempts to negotiate technological standards among technology developers and interested commercial actors are often described as attempts to define what the technology is in terms of functionality and interoperability with other technological standards. This is a complex and multi-faceted process (Berners-Lee, 1999).

We introduce a fourth element, the competitive move, in order to explain the perverse influence of commercial interests on the development of the browser. While most actors initially involved in the development of a technology consist of individuals or small groups, some technological innovations necessarily involve large and powerful organizations throughout their development. These organizations can mobilize vast resources and significantly shape the evolutionary process. Clearly, strategic actions such as cooperation and competition among multiple organizations and infusions of funding from the public sector have played a crucial role in shaping the evolution of the Web browser. However, within a few months of the invention of the browser, its evolution was uniquely shaped by the early and inordinate influence of commercial actors. In particular, two large and powerful organizational actors, Microsoft and Netscape, identified the importance of the browser early on and initiated strategic moves to influence and attempt to control the development process (for a history of the competition, see Cusumano and Yoffie, 1998).

Data collection
We collected archival data in the form of practitioners' journals, published books, and company data such as annual reports. We used IT practitioners' journal articles[1] for data analysis. We employed books and internal company resource data as additional support materials and to verify the results of the analysis. In this way, qualitative data were validated by triangulation across multiple data sources. Using the ABI/Informs research database, we reviewed all articles (more than 1,500) that included references to terms such as "Web browser" and "Internet browser". From that set, we identified 344 articles that contained enough substantive material related to our theoretical categories to be coded.

Data analysis
In order to analyze large amounts of qualitative data, we developed a coding scheme and applied it to two distinct phases.

The first phase was template coding. In contrast to traditional grounded theory approaches that require starting with a blank theoretical slate, template coding starts

with an acknowledged theoretical framework and modifies this framework as the data generates new meaning (Maznevski and Chudoba, 2000; King, 1998). Following the initial conceptual coding and an interactive process of interpretation, we developed more refined coding schemes (see Appendix 1). During the process of coding, categories could be added, deleted and shifted, resulting in an empirically derived coding scheme. The final scheme includes the four main conceptual elements: artifacts, evaluation routines, beliefs, and strategic moves.

Two coders conducted the template coding. One of the coders was an author and the other was a graduate research assistant with IS experience. The reliability of the coding was determined by the extent to which the two coders agreed on the presence or absence of each conceptual element in each document. The percentage agreement and Cohen's Kappa were used for this purpose. Percentage agreement is recommended when the interpretive thematic codes require a presence/absence judgment (Boyatzis, 1998). Cohen's Kappa is used to complement the percentage agreement, since Kappa statistics deal with both the symmetric issue and the reliability in the data. All four categories in both tests exceed the 70 percent rule of thumb (Boyatzis, 1998). Brief definitions, descriptive statistics and reliabilities of these elements are shown in Table I.

The second phase was a categorical analysis. Here we analyzed relationships among the main conceptual elements, subcategories, specific technological artifacts and illustrative actions. For instance, the conceptual element of belief was broken into subcategories, e.g. functionality, security and standardization. Next, relationships between the conceptual elements and their subcategories were examined for general patterns (Langley, 1999).

We developed and used specific schemes and definitions for these subcategories of belief and evaluation routine[2]. Examples of these subcategories and the context in which these emerge and disappear at given times in the technological trajectory will be discussed in the next section. We didn't have to develop subcategories for the conceptual elements of artifact and strategic move. Instead, we simply used various versions of browser products (and their technological features) as subcategories of artifacts. These are summarized in Appendix 2. We also coded public announcements

| Categories | Brief definitions[a] | Descriptive stat.[b] | | Reliability[c] | |
		No. of articles	Percentage of total	Percentage agreement	Cohen's kappa
Artifacts	Product/technology descriptions	220	68.5	92.5	83.5
Evaluation routines	Technology assessment, use of instrument	76	23.7	93.5	80.9
Beliefs	Assumptions, effects, future conjecture	117	36.4	91.6	82.2
Strategic moves	Strategic actions and decision makings	203	63.2	87.9	74.5

Notes: [a] For detailed definitions and coding schemes, see Appendix 1. [b] These descriptive statistics are based on all 344 articles. The percentage of total = number of articles presenting each categorical element/the total number of articles analyzed (344). [c] This interrater reliability is based on the sample of 107 articles, which were randomly selected from all 344 articles

Table I.
Template coding – definition, distribution, and reliability of the category

of relevant corporate activities and alliances as strategic moves. Specific actors and their strategic moves are chronologically illustrated in Appendix 3.

The purpose of this categorical analysis is not only to describe the sequence of events and tell the stories of the categorical elements, but also to crucially identify patterns in the process. To this end, we use a visual technique to capture the evolutionary pattern of technology through over time. Visual techniques allow the presentation of large quantities of information in relatively little space, and can be useful tools for the development and verification of theoretical ideas (Miles and Huberman, 1994). They are particularly attractive for the analysis of process data because they allow the simultaneous representation of a large number of dimensions and can easily be used to show precedence, parallel processes and the passage of time (Langley, 1999). In the next section, we use this visual technique to aid the explanation of our findings and their theoretical interpretation.

Findings: emerging technology beliefs

Beliefs can arise either from the technology histories of particular actors or from interdependent relationships among multiple actors. The beliefs of dominant actors are embodied in the form of the technological artifact and fundamentally shape its form and evolutionary trajectory. Fundamental beliefs about what the technology is and is not drive the evolving development spiral. For this reason, we begin by identifying six primary beliefs and trace the interdependent relationships among the model elements within the context of each of these six beliefs. Defined in detail below, the six most important beliefs suggested by the data are: integration of protocols, add-on applications, platform-independent architecture, integration with platform resources, enterprise Intranet, and provision of content.

In keeping with the call for careful demarcation of and theorizing about the artifact (Orlikowski and Iacono, 2001), the six beliefs we identify here are browser-specific rather than general IT beliefs. At the same time, and consistent with the ANT perspective, these browser-specific beliefs stretch beyond the artifact to encompass the processes and issues related to browser development. Thus, the six beliefs described below are not only about narrow intrinsic technical properties but also include broader aspects of what is possible within the existing institutional environment. They reflect core beliefs that built the evolutionary process that shaped technology development[3].

Figure 2 shows how actor networks initially shape the technological artifact, negotiate with each other, frame issues, and stabilize designs over time. The thematic components reveal how various actors and users actually interact with technology actants and the evolution of the technology over time. The next section elaborates on this evolution by using the mechanisms of inscribing, translating and framing as they occurred during the five-year period studied.

Belief 1: integration of protocols (hypertext paradigm)
Inscribing of belief 1. Early browser designers embraced the idea of using the hypertext paradigm to enable seamless protocol integration. This idea originated in Europe among scientists using hypertext for research. It became popular in the early 1990s as it came into contact with Internet commercialization and government subsidization in the USA[4]. As Berners-Lee (1999, p. 30) says, "I took one quick step that would demonstrate the concept of the Web as a universal, all-encompassing space. I
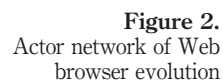
Figure 2.
Actor network of Web
browser evolution

programmed the browser so it could follow links not only to files on HTTP servers but also to Internet news articles and newsgroups". Widespread acceptance of the hypertext paradigm rapidly ensued when the National Center for Supercomputing Applications (NCSA) at the University of Illinois built the functionality in XMosaic and initiated its free distribution in November 1993. This belief was then quickly strengthened when additional Internet protocols such as Gopher, Telnet, WAIS, and FTP were integrated into the graphical hypertext format.

Translating of belief 1. In the spring of 1994, the US government profoundly impacted the state of browser technology by awarding a $6 million grant to CommerceNet, a nonprofit consortium of companies, to enhance the commercial use of the Internet in the USA. This move prompted increased commercial interest in the browser and increased development efforts related to protocol integration through a hypertext interface. The NCSA at the University of Illinois, a central software development site for the browser, was unclear about the commercial potential of licensing the XMosaic browser to commercial interests, a move that singularly affected the artifact's developmental path. Spyglass Inc., a private company formed by ex-NCSA developers, was the first to sign a master license agreement for commercial use of this technology in August 1994. The company was now in a position to freely develop the technology for profit and to license it to others.

Both Spyglass and Netscape (which had also licensed the technology) realized the potential of technological alliances for altering the trajectory of the technology in ways that would favor them over the competition. In December 1994, Spyglass initiated a program of partnerships called Mosaic Partners Program aimed at licensees of Mosaic-compatible technology. Netscape and Sun also rapidly announced a technology alliance to extend the Navigator client and server protocols. The need to ensure compatibility with the hypertext protocol and competitive moves by the licensing consortia played an important role in the adoption of the integrated hypertext belief.

Framing of belief 1. As usage became more prevalent, Mosaic products became subject to public evaluation. Evaluation routines related to this early technological belief included assessments of the extent to which the technology supported access to multiple file protocols and the degree to which it made possible multiple newly developed features. Although hypertext integration of protocols continued to be a fundamental property of Web browser technology, our content analysis shows that this belief fell into disuse by the end of 1996. Data sources no longer mentioned it after this time. We believe that by that time, a paradigm-like expectation prevailed that the browser application needed to support multiple protocols. It became an acknowledged standard for browser applications, and thus was no longer a criterion for browser selection.

Belief 2: add-on applications

This belief started to appear in December 1994, reflecting a growing interest in having the browser extend beyond the display of formatted pages to include active processing.

Inscribing of belief 2. Netscape believed its Navigator to be a full suite of Internet applications, so it tapped application developers to build interactive capabilities even before its plug-in technology was ready. Successful recruiting of independent developers resulted in a high quality of artifacts under this concept. An important part of this concept was the display of known applications such as multimedia players and

spreadsheets, using the concept of program plug-ins. This belief was first incorporated in the browser artifact in October 1995, when the Beta release of Netscape Navigator 2.0 included support for Java applets. The firm promoted a free suite of Java-based business applications developed by a collection of third-party vendors. Many of the third-party vendors in this cooperative program used this integration as an opportunity to show off their applications (*Network World*, 1996).

Translating of belief 2. In March 1995, Netscape agreed to integrate an Acrobat PDF reader into Navigator and encouraged other companies to build add-on capabilities such as a spreadsheets, workflow functionality, real-time audio and video. Netscape also published detailed specifications that enabled any developer to write Netscape-compliant plug-ins.

Microsoft engaged in similar moves in support of its beliefs, although it did this later than Netscape. For example, in March 1996 Microsoft announced plans to deal with Sun in order to license the Java programming language and release ActiveX OLE controls. Again, we see that the competitive moves of these players helped to form the dominant belief of the importance of add-on applications, which in turn shaped the artifact and the industry.

Framing of belief 2. Reviewers began evaluating browsers in terms of such criteria as compatibility with add-on applications (e.g. the extent to which a browser is compatible with plug-in and interactive applications) and the quality of multimedia capability. Mention of these evaluation criteria disappeared at the end of 1996, at which point add-on capabilities such as spreadsheets, workflow functionality, real-time audio and video became widely available. The new browser versions that emerged at this time, Beta versions of both Netscape Navigator 4.0 and Internet Explorer 4.0, were compatible with these various add-on applications. Thus, as with hypertext design, add-on application compatibility lost its evaluative potency since it became the de facto standard. In our data, evidence of this belief paradigm and corresponding evaluation routines dies out just before the introduction of Beta versions of 4.0 of Netscape Navigator and Internet Explorer.

Belief 3: platform independent architecture
Inscribing of belief 3. One long-term implication of the Sun-Netscape technological alliance, formed in September 1994, was the possibility of achieving the holy grail of network computing – the "write once-run everywhere" goal, using the Java-browser combination. Under such a scenario, applications are stored on Internet servers and are downloaded to the PC as needed. By using the browser layer as a "sand box" to run various applications, application functionality is separated from the underlying operating systems and it becomes possible to write applications that run easily on different platforms. As a result, the operating system becomes a collection of device drivers and base interface functionality separate from applications. Netscape began the inscription process by including Java technology in its Navigator 2.0 in October 1995, and both Netscape and Sun actively worked to ensure the compatibility of Java applets across computing platforms.

Unmistakably, the development of such a capability represented a huge strategic threat to the dominance of Microsoft's Windows operating system as well as to the company's suite of Office applications. It became one of the key reasons why Microsoft responded so vigorously to Netscape by making Internet Explorer available for free. It

also generated a counter-belief promoted by Microsoft that the browser should be more fully integrated with the operating system rather than less. Starting with version 2, Internet Explorer started including functional linkages specific to the Windows OS such as OLE and Active-X.

Translating of belief 3. Based on their belief in the advantages of cross-functionality and their successful cooperation with OS vendors, Netscape invested significant effort in developing versions of the browser artifact for multiple platforms such as Macintosh, OS/2, Unix, and mainframes; and vendors such as Sun, DEC, HP, Oracle, and IBM. Microsoft did not support this belief due to its detrimental impact on the Windows-Intel platform. Yet Microsoft could not restrict its browser to Windows alone. It was difficult for Microsoft to use ActiveX to provide cross-platform capability since the technology was specific to the Windows platform, although the company did cooperate with third parties for multiple-platform offerings compatible with Unix, Macintosh, and Sun's Solaris. These examples make it clear that platform compatibility beliefs interacted with competitive moves within the industry to affect the extent of artifact interoperability.

Framing of belief 3. Starting with Mosaic, all browsers were evaluated in terms of their ability to support multiple platforms, such as Windows, Macintosh and Unix. Significantly, the belief in the importance of platform-independent architecture seems to have become increasingly important for the Netscape and Sun Java alliance following the emergence of Microsoft as a major browser provider. The trajectory of this belief illustrates how a simple evaluation routine can become a critical technological paradigm. Before the introduction of Internet Explorer, as various Mosaic products were being evaluated, the ability to support multiple platforms was just one of many important browser evaluation criteria. However, once Microsoft became involved in the Web browser market, this seemingly simple criterion took on greater significance. As Internet Explorer became increasingly integrated with the Windows OS, the belief in the importance of platform independent architecture became Netscape Navigator's most distinctive technology paradigm, making it attractive to those opposed to domination of the marketplace by a single player. After the release of Beta versions of Netscape Navigator 3.0 (in April 1996) and Internet Explorer 3.0 (in May 1996), the evaluation of the browser's cross-platform support became highly salient.

Belief 4: integration with platform resources
Inscribing of belief 4. This belief proclaims the value of integrating the browser with the platform, and so stands opposed to belief 3. It originated prior to the introduction of Internet Explorer, since some early Mosaic makers were touting the importance of integration with the operating system. However, the importance of this belief increased dramatically once Microsoft became involved, to the point where it became the main technological paradigm across artifacts. At the Microsoft Professional Developers' Conference in March 1996, Microsoft described its "embrace and extend" view of the Internet by adopting the Internet browser metaphor for viewing all files and documents, whether stored locally or on the public Internet (*InfoWorld*, 1996). This announcement represented Microsoft's positioning of Windows at the center of its Internet strategy.

Central to this vision were ActiveX controls and the notion of the Active desktop, in which the Web elements are tightly integrated with the Windows OS. This belief later became manifest in the ActiveX standard of Internet Explorer, representing a network extension of the existing OLE (Object Linking and Embedding) Microsoft standard[5].

Translating of belief 4. Integration with the platform gave Internet Explorer a marginal speed advantage. However, the embrace and extend strategy based on the Integration belief carried with it the potential for violating antitrust laws and causing technical difficulties for Original Equipment Manufacturers (OEMs) should they need to remove the Internet Explorer browser from the Windows OS. The lawsuit that Netscape filed in December 1997 accusing Microsoft of violating US antitrust law gave OEMs the choice of whether or not to install Internet Explorer on the desktop. Beliefs concerning the extent to which the browser should be integrated with the OS are manifest in various competitive moves and are clearly expressed in the long-running legal battle between Microsoft and the US government.

Framing of belief 4. The need to protect the Windows operating system was the core reason why Microsoft embraced integration with the platform. It became a source of competitive advantage for the company as Microsoft expanded its de facto operating system standard to include Web-browsing functionality, a move that the rival Netscape alliance could not match effectively. This belief in OS integration received public attention in the form of evaluation measures such as extent of integration with platform resources and the consequent speed enhancement. After Beta 1 of the Netscape Navigator and Internet Explorer 3.0 in May 1995, the frequency with which these evaluation routines were mentioned in the practitioner press dramatically increased.

Belief 5: enterprise Internet
Inscribing of belief 5. Database and groupware makers saw the potential for the browser to serve as the user interface for network-wide applications and internal data resources. While this concept was embodied in the Beta versions of Netscape Navigator and Internet Explorer 3.0, it took a while to crystallize and only became clear when "Netscape management began to notice that most of its revenue was from corporate customers who wanted to use Internet technologies to build internal networks, not from corporations seeking a place on the Web" (Cusumano and Yoffie, 1998, p. 29).

In February 1996, Lawson Software became the first enterprise vendor to use the browser as a unified interface for the ERP application across computing platforms. Prior to Lawson, no ERP vendor had provided a browser-based interface, and users had been forced to develop their own interfaces and Web applications (*Computerworld*, 1996). Virtually every ERP vendor, including SAP, Baan, and PeopleSoft, followed suit and built Web front-ends on their enterprise applications.

Translating of belief 5. Netscape and Microsoft released parallel Intranet strategies in June 1996, and both worked hard to court the active cooperation of Client/Sever and Groupware vendors whose support was necessary to enact this concept. However, IBM Lotus Notes and other Groupware vendors embraced Internet Explorer at first, because Netscape was actively promoting its Communicator suite, which included groupware functionality in addition to the basic browser. Netscape later unbundled its Navigator from Communicator (Netscape Navigator 4.0) in order to allow these Groupware vendors the flexibility to offer Navigator as their front-end. This is a good example of

the way that competitive moves of other companies influenced a dominant technological belief and so caused the major players to change their artifacts. Cooperation with dominant database and groupware makers was valued under this paradigm.

Framing of belief 5. As soon as ERP and Groupware vendors reframed the browser as a universal interface, both Netscape and Microsoft entered into partnerships and alliances with various vendors to provide customized browser-based interfaces for such applications. Interestingly, the impetus for the adaptation of the browser to solve an interface problem common to all sorts of collaborative applications came from outside the Netscape and Microsoft development groups. Both groups basically reacted to this user innovation and invested significant resources in meeting the needs of this emergent market for Intranet, and later, Extranet services. Examples of artifact features embodying this belief are capabilities for managing groupware, e-mail, chatting and videoconferencing. Examples of evaluation routines that emerged for assessing the artifact in terms of this belief were the capability for collaborative communication and administrative flexibility of the browser server.

Belief 6: provision of content

Inscribing of belief 6. This belief embodies the notion that wide availability of proprietary content might enhance the value of the browser to the user. "Push" technology allowed users to create pages containing selected content of interest, which was regularly updated and automatically transmitted by content providers. The shift from displaying static HTML pages to the display of dynamic content rapidly turned into inscription in the artifact of information channels that downloaded content from the Internet or from the corporate Intranet. This belief was embodied in "push" functionality in the artifact starting with Beta 4.0 versions of Netscape Navigator and Internet Explorer. Microsoft called this technology Webcasting using Channel Definition Format (CDF). Meanwhile, Netscape called its offering Netcasting and used the Castanet Turner technology.

Translating of belief 6. From 1996 on, both Microsoft and Netscape realized the importance of recruiting qualified content providers and actively forming alliances with them. Even before the inscribing of push technology in 1997, Microsoft announced agreements in the summer of 1996 that gave Internet Explorer users free access to valuable Web sites such as the Wall Street Journal, InvestorsEdge, and ESPN. During that same period, Netscape entered into similar deals with content providers for its E-mail technology, Inbox Direct.

Once the importance of push technology dominated belief systems, both Microsoft and Netscape continued to enter into strategic alliances with successful content providers. Content providers were interested in developing new ways beyond Web site visits to distribute their material on the Internet. The guiding metaphor was "the Information Superhighway", where hundreds of information channels would be available for download and subscription. In line with that vision, Microsoft partnered with Pointcast in March 1997 for its highly prized Premium Channel Services and offered a broad range of content such as Forbes, Fortune, Lexis/Nexis, DesktopData's News Edge, DowJones, and MSNBC. A month later, Netscape announced that it was featuring Marimba Inc.'s channel partners in its Netcaster push functionality, along with deals with a number of content and push channel providers, such as ABC News,

CNN, CBS Sportsline, Yahoo, and Infoseek. These competitive moves reinforced the emerging belief that the browser should include content provision and push technology.

Framing of belief 6. As push technology was slowly being validated in the marketplace, the framing of the browser as an interactive information channel became dominant. The technology was framed as a novel and effective way to provide hundreds channels of content into the home while avoiding the lock on content that cable companies had perfected. Similarly, in the corporate arena, the same push technology was positioned as providing an efficient and paperless way for the firm to share information with its employees. This led to a subtle shift in thinking about basic browsing functionality, which by 1997 had become stable and well accepted, to a broader vision of push client capability and wider content provision and availability.

Discussion
We have described the emergence of the Internet browser over the key period 1993-1998. In focusing on the browser, we found that commercial organizational actors played a key role in shaping the development of the technology. Our findings contribute to the literature on ANT by prioritizing the role of commercial actors. Our setting differs from those of previous actor-network historical studies of technology development because of the speed with which innovation took place and the immediate recognition of the commercial value of Web technologies.

Our results confirm findings from the emerging research on organizational sponsorship of common technological standards by showing that standard-setting during the development of rapidly changing and equivocal innovations is enabling yet also constraining because it makes it difficult for actors to reach an agreement (Garud *et al.*, forthcoming). In the case of the budding browser industry, competition was based on multiple and changing technological beliefs that heightened ambiguity and motivated ongoing attempts at competitive moves. Confronted with an ambiguous and rapidly changing environment, actors struggled between the need to be part of the emerging standard and the necessity to develop superior and differentiated products.

Our findings confirm the ANT viewpoint that technology development is a broad phenomenon that cannot be understood by studying innovation within a firm or even an industry. Much insight and explanatory power is gained from accepting the viewpoint that technology development is an occasion for "redistribution of cards" among established actors who pursue their interests and translate them into technical or social arrangements. A novel kind of technology, such as the browser, can create new actors, such as Netscape, or stimulate established actors, such as Microsoft or Sun. These actors will enact dual processes of translation and inscribing to affect or even hijack the technological development process, sometimes in ways that significantly depart from the original artifact design. In the case of the Web browser, the US government's initial step of allowing commercial traffic on NSFNET and privatizing the Internet led within a couple of years to the emergence of the dominant Netscape browser. How Microsoft reacted to this threat to its operating system, how Sun translated the browser into a Java-based computing platform, how application developers gravitated to the browser as a way to easily distribute their applications as plug-ins, and how content providers supported the technology as a way to provide

information channels, are all important factors in this story. Narrower interpretations of the interacting set of actors cannot do justice to the complexity of the development process.

Our analysis contributes theoretically by identifying the four actants of beliefs, artifact, evaluation routine, and strategic move. We also identify three mechanisms through which the spiral process of development takes place over time: inscribing, translating, and framing. This model is offered as an aid to understanding the complexity of the technology development process rather than as a set of precise constructs and specific relationships. Some of the factors that we describe as if they were separate often overlap and are highly intertwined. For example, the processes of translating (e.g. by forming alliances) and inscribing the artifact are difficult to separate. When the process involves multi-actor joint development, forming an alliance is a precondition for inscription. Yet if the possibility of inscription is not there, the alliance is not possible. For example, Netscape and Microsoft were both extremely active in contracting and allying with literally hundreds of technological partners and interest groups such as multi-media and application makers, collaborative technology providers, and content owners. The result of these activities is constant turmoil about what the browser is and how to develop an evaluation standard during a highly dynamic and erratic development process.

Another interesting finding of this research is the emergent aspect of evaluation routines as feedback cycles and technological negotiation. Evaluation routines embody social consensus around the importance of a particular aspect of the technology artifact during a period of time, yet are thought to reflect intrinsic technological performance at the time. Our findings demonstrate how apparently objective evaluative measures can rapidly change over time and go in contradictory directions. Our findings confirm Hanseth and Monteiro's (1997) contention that the process is not neutral and involves an evolving set of alignments. There is a need for new research to systematically investigate how and why evaluation and standard-setting processes change over time.

The work reported in this paper is exploratory in nature and our findings must be interpreted with caution. A first limitation of our study is the use of archival data. In order to understand the developmental trajectory of a technology, one should ideally be immersed in it at the time of its development or at least be in close contact with its developers. Findings here are based on the exhaustive analysis and coding of longitudinal data. First-hand accounts by developers could provide a complementary perspective. In addition, while we are confident that our analysis supports the model of technology evolution, other studies focusing on different Internet technologies would be of great value in confirming our findings. Future research is needed to ascertain the extent to which our findings are applicable to other fields.

This study contributes to IS research by applying an ANT theoretical lens as a means of understanding the messy interdependent complexity of the evolution of browser technology – a critical technology in modern organizations. We view this study as meeting the call for research that focuses on how IT artifacts are "designed, constructed, and used by people, they are shaped by the interests, values, and assumptions of a wide variety of communities of developers, investors, users, etc." (Orlikowski and Iacono, 2001, p. 131). Through the lens of changing networks of actors, our ANT-based theoretical lens illustrates the various interdependences between actors and how processes of inscription, enrollment, and framing dynamically enabled

and constrained browser development. Similar investigation of other network-based technologies may start answering the question of what is unique about technology development "on Internet time".

Notes

1. Such as *InfoWorld*, *Online*, *Link-up*, *Computerworld*, and *Network World*.
2. Detailed coding schemes are available upon request to authors.
3. This list of beliefs is not all-inclusive – clearly other beliefs about browser technology developed. However, based on our data analysis, these six beliefs dominated the evolution of Web browser technology.
4. For detailed histories of early Web development, see Berners-Lee (1999), Cusumano and Yoffie (1998) and the Web site: www.isoc.org/internet/history/index.shtml
5. Microsoft established the ActiveX standard to ensure object-oriented integration between Internet Explorer and Windows.

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Appendix 1

Context	Definition	Practical guide for codable moments
1. Artifacts Objectively, what is the technology?	Product/technology descriptions	Identify whether it refers to M-N-E-O-B[a] Identify: form (features and characteristics of the browser and its components, and the design of either); function (aspects of implementation and use)
2. Evaluation routines How we come to believe in our "truths"	Technology assessment Organization of experience Use of instruments Testing routines + normative values = traditions of testability, i.e. robustness of conclusions	Identify whether it refers to M-N-E-O-B[a] Identify the practices of those determining validity. Identify the "testing process" or normative value, including description of the community claiming validity
3. Beliefs What we come to believe is true determines why we select a particular artifact	Assumptions, Effects the tool might have Based on evaluation routines (what about prior results? Learning) Things that might happen in the future (conjecture)	Identify what the belief pertains to, M-N-E-O-B[a] Describe the belief – things we "know" to be true. Identify rules, heuristics, cause-effect relationships
4. Competitive moves How to change marketplace, the industry, regulations	Decision making at the strategic, business level Competitive moves of actors Market situation	Identify what the issue pertains to, M-N-E-O-B[a] Identify the issue, such as: competitive moves, i.e. giving it away for free, source code licensing; regulatory changes; proprietary moves; partnerships and alliances; pricing

Table AI.
Content analysis scheme

Note: [a] M-N-E-O-B: Mosaic, Netscape, Explorer, another specific browser or browser in general

Appendix 2

Mosaic	Netscape	Explorer
1.0 (November 1993, first official release) URL, HTTP, HTML Support most standard internet protocols (Gopher, FTP, and Telnet, etc.) Graphical user interface	*1.0 (October 1994, first Beta release)* Forms and Functions in Mosaic 1.0 Stop button, download text first *1.1 (Mar. 1995, first Beta release)* Application Programming Interface Advanced layout capabilities, Dynamic document updating *1.2 (Jun. 1995, first Beta release)* Enhanced interface for bookmarks, full e-mail capabilities	*1.0 (August 1995, base release)* Basic functionality of Mosaic
2.0 (March 1995, first Beta release) Text based chat sessions Autosurf Standard HTML 2.0 tags HTML 3 tables, character styles	*2.0 (October 1995, first Beta release)* Incorporate Java technology In-line media plug-ins HTML 3.0	*2.0 (October 1995, first Beta release)* Visual Basic, Object linking and Embedding languages Support secure sockets layer HTML 3.0, VRML
	3.0 (April 1996, first Beta release) Multimedia enhancement VRML Live 3D Collaboration features Audio conferencing	*3.0 (May 1996, first Beta release)* ActiveX, OLE controls Support Java applications Netmeeting with audio and text HTML 3.2 Cascading style sheets (CSS)
	4.0 (December 1996, first Beta release) Support groupware products Collaborative messaging support Style sheets Netcasting push technology	*4.0 (April 1997, first Beta release)* Active Desktop (using Web as desktop interface) Video conferencing Support interface with Internet resources Webcasting push technology

Table AII.
Illustration of artifacts

Appendix 3

Time		Actors	Competitive moves
1994	Spring	Government, CommerceNet	US Government awards $6 million to enhance the commercial use of Internet
1994	August	U. Illinois, Spyglass	Spyglass signs a master license agreement for Mosaic
1994	December	Netscape	Navigator 1.0 ship
1994	December	Spyglass	Spyglass initiates partnership programs; Microsoft purchases licensing rights to browser code
1994	December	U. Illinois, Netscape	Agreement gives Netscape the freedom to market without interference
1995	February	Netscape	Navigator 1.1 ships, includes a prototype plug-in interface
1995	March	Netscape, add-on makers	Netscape agrees to integrate Adobe's Acrobat reader into Navigator
1995		Netscape, ISPs	Netscape announces partnership agreement with ISPs
1995	August	Groupware	Lotus Notes announces intention to integrate Web browsing capability into Notes 4.0
1995	August	Explorer, Mosaic	Microsoft Win95 includes Enhanced Mosaic (NCSA)
1995	October	Netscape, Sun	Netscape ships Navigator 2.0 and integrates plug-ins and Java technology
1995	December	Microsoft	Microsoft unveils its "embrace and extend" Internet strategy
1995	December	Groupware	Action Technological Inc.'s Action WorkFlow Metro offers Workflow function to Web browsers
1995	December	Add-on makers	Visual Components Inc.'s Formula One Net offers spreadsheet functionality as a plug-in for Netscape Navigator 2.0B
1996	March	Microsoft	Microsoft announces that the browser will be used for viewing all files and documents, whether stored locally on an intranet or on the public Internet
1996	March	C/S vendor	Lawson Software becomes the first c/s vendor to provide access to standard Web browsers
1996	August	Explorer, content providers	Microsoft announces free content agreements with several providers including the Wall Street Journal, InvestorsEdge, and ESPN
1996	August	Netscape, Microsoft	Versions 3.0 of Navigator and Explorer ship within a week of each other
1996	August	Netscape	Netscape initiates a lawsuit against Microsoft
1996	September	Netscape	Netscape purchases Collabra Software Inc., a producer of integrated groupware products
1996	December	Microsoft	At IW96 (Internet World 96), Microsoft reveals plans for ActiveX controls
1997	March	Microsoft	Microsoft announces a partnership with PointCast for the provision of Premium Channel Services
1997	April	Netscape, content providers	Netscape announces agreements with content providers including ABC News, CNN, CBS Sportsline

Table AIII.
Selected competitive moves by actors

(*continued*)

Time		Actors	Competitive moves
1997	April	Netscape	Netscape announces that it is featuring Marimba Inc.'s channel partners
1997	June	Netscape	Communicator 4.0 ships
1997	August	Netscape	Netscape unbundles Navigator from its Communicator product
1997	September	Microsoft	Explorer 4.0 ships
1997	December	Government	US legal ruling temporarily requires Microsoft to give OEMs the choice to install Windows without Internet Explorer
1998	January	Netscape	Navigator and Communicator are available for free download

Table AIII.

Trojan actor-networks and swift translation

Bringing actor-network theory to IT project escalation studies

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Abstract *This study investigates the potential of actor-network theory (ANT) for theory development on information technology project escalation, a pervasive problem in contemporary organizations. In so doing, the study aims to contribute to the current dialogue on the potential of ANT in the information systems field. While escalation theory has been used to study "runaway" IT projects, two distinct limitations suggest a potential of using ANT: First, there is a need for research that builds process theory on escalation of IT projects. Second, the role of technology as an important factor (or actor) in the shaping of escalation has not been examined. This paper examines a well-known case study of an IT project disaster, the computerized baggage handling system at Denver International Airport, using both escalation theory and ANT. A theory-comparative analysis then shows how each analysis contributes differently to our knowledge about dysfunctional IT projects and how the differences between the analyses mirror characteristics of the two theories. ANT is found to offer a fruitful theoretical addition to escalation research and several conceptual extensions of ANT in the context of IT project escalation are proposed: embedded actor-networks, host actor-networks, swift translation and Trojan actor-networks.*

Introduction

Escalation is a phenomenon in which an organization or other acting entity persists in pouring resources into a failing course of action (Staw, 1976). In the field of information systems, the problem of project escalation is an important issue given that escalation in software projects is quite common (Keil *et al.*, 2000), that it is often a precursor of

failure (Ewusi-Mensah and Przasnyski, 1991; Lyytinen and Hirschheim, 1987) and that the frequency and costs of IS development failures are considerable (KPMG, 1995; Johnson, 1995). The problem of IT project escalation remains highly relevant, while the remedies are far from well known (Keil and Robey, 1999, 2001).

Notwithstanding their important insights in understanding runaway IT projects, existing escalation studies present two distinct limitations that suggest an opportunity to apply ANT. First, there is a need for research that builds process theory on the escalation of IT projects (Montealegre and Keil, 2000), a shortcoming shared with escalation theory (Ross and Staw, 1993). Second, previous escalation studies have not investigated whether the shaping and role of technology is an important factor, let alone actor, in how escalation occurs (cf. Keil, 1995a; Newman and Sabherwal, 1996; Staw and Ross, 1987).

Actor-network theory (ANT) in general (Callon, 1986; Callon and Latour, 1981; Latour, 1999), as well as in its applications within the information systems field (Holmström and Stalder, 2001; Walsham, 1997; Walsham and Sahay, 1999), addresses the role of technology in social settings and the processes by which technology influences and is influenced by social elements in a setting over time. Given this focus, ANT offers a promising theoretical approach to the understanding of IT project escalation.

In particular, the ANT view of how ideas, values and intentions of social actors become inscribed in technology (Akrich, 1992; Akrich and Latour, 1992) and how this inscription renders intentions immutable over time (Latour, 1991) suggests a possible complementary (or alternative) view of how escalation occurs. This view would specifically address the role and constitution of technology that is not expressly addressed by escalation research. It is expected that viewing technology as an actor in escalation will pose a different understanding for reversing escalation trajectories than previously suggested in escalation and de-escalation studies.

Thus, this paper investigates the potential of ANT for theory development on the subject of IT project escalation. It also contributes to the conceptual tools of ANT in this context.

To the best of our knowledge, this is the first effort to apply ANT to IT project escalation and to contrast it with escalation theory. It should be noted, however, that what this paper offers is a comparative analysis of two different theory-informed readings of the same case. We do not claim or attempt to assess and compare the complete bodies of research on escalation and ANT.

Moreover, the aim of this research is not to make unitary claims in favor, or against, either of the two theories. Instead, the aim is to identify distinctive qualities of each theory and thereby explore how the use of ANT can impact research in a specific research area within the field of information systems. This, in turn, is a way of contributing to the current dialogue within the information systems field on the use of ANT.

The methodological approach builds on a well-known and well-publicized case of IT project escalation, the computerized baggage handling system at the Denver International Airport (DIA) (Applegate, 1999; Montealegre and Keil, 2000; Montealegre et al., 1996a, b). The use of an existing case study that has been analyzed from the viewpoint of escalation theory (albeit with an emphasis toward understanding de-escalation) indeed raises the bar for finding the benefits of ANT, but also

strengthens the case for the contributions that ANT brings. However, before reviewing and considering the case from two theoretical perspectives, the current state of affairs with regard to escalation theory and ANT, particularly as applied within the information systems field, is considered.

Escalation theory: factors and processual aspects

The escalation literature examines why (and how) organizations pursue failing courses of action, even over long time periods and in the face of repeated negative feedback concerning the viability of an undertaking (e.g. Brockner, 1992; Staw and Ross, 1978, 1987; Whyte, 1986).

In general, the escalation literature assumes a close interrelationship between escalation of a course of action and escalation of individual and organizational commitment to this course of action (e.g. Brockner, 1992; Staw, 1997). Escalation is seen as occurring through a series of decisions favoring persistence (Brockner, 1992; Staw and Ross, 1987) and thus, it is frequently seen as resulting from flawed decision making at the individual or group level. Additional characteristics of escalation situations include an opportunity to persist or withdraw and uncertainty about the outcomes of decisions (Staw, 1997).

Although multiple theories have been invoked to explain escalation of commitment, no single theory fully explains the phenomenon[1]. It is well-established that a wide variety of factors can promote escalation, and Staw and Ross (1987) provide a listing of these factors organized in a useful framework that distinguishes between project, psychological, social, and structural factors (as shown in Table I). Several studies that apply escalation theory to the study of information systems development and IT projects use this framework (Keil, 1995a; Newman and Sabherwal, 1996; Keil *et al.*, 2000). The Staw and Ross (1987) framework was originally proposed as a quasi-process model. The Expo86 case (Ross and Staw, 1986) provided some evidence for temporal sequencing of these different types of escalation factors, suggesting that escalation begins because of project-related factors and then is reinforced by psychological, then social, and finally structural (or organizational) factors (Ross and Staw, 1986; Staw and Ross, 1987).

However, subsequent studies (e.g. Ross and Staw, 1993; Newman and Sabherwal, 1996) have suggested that the sequencing of factors may be more complex and case-specific than previously believed. These results indicate that the framework may be weaker as a dynamic model than as a static typology. In addition, the framework has been used as a factor model (Keil, 1995a). In the escalation literature, the aim to develop knowledge on factors that promote escalation is often accompanied by an underlying purpose of halting or reversing escalation (e.g. Keil, 1995a).

Within the information systems field, Keil (1995a) applied the Staw and Ross (1987) framework to the study of IT project escalation, finding support for a majority of the factors mentioned above, as well as identifying additional factors, namely emotional attachment to the project (psychological), empire building (organizational), and slack resources and loose controls (organizational). Newman and Sabherwal (1996) also applied the Staw and Ross framework, placing emphasis on the evolution and management of commitment to an IT development project over time. Consistent with Staw and Ross (1987), they found that factors are interrelated, but contrary to the Staw and Ross framework, they found that different types of factors may occur at several

Factor types	Description	Relevant examples
Project factors	Concern the objective features of the project and how decision makers perceive these features (Ross and Staw, 1993)	Projects are more prone to escalation when they involve a large potential payoff, require a long-term investment to be profitable, and are costly to abandon and when setbacks are perceived as temporary problems that can be overcome (Staw and Ross, 1987)
Psychological factors	Cause managers to convince themselves that "things do not look so bad" (Brockner, 1992)	High personal responsibility for the project outcome, visible personal attachment to the project, prior history of success, and information-processing errors (cf. prospect theory) are psychological factors that promote escalation (Brockner, 1992; Staw and Ross, 1987)
Social factors	Stem from the social environment that can hold the decision maker(s) to a course of action even after their personal beliefs no longer justify it (Brockner, 1992; Brockner and Rubin, 1985)	A group's competitive rivalry with other groups, a group's modeling of behavior after another group, the need for external justification (resulting from leading external stakeholders' belief in project success) and behavioral norms that favor "staying the course" are all factors that increase the likelihood of escalation (Brockner, 1992; Ross and Staw, 1993; Staw and Ross, 1987)
Structural factors	Concern the political and organizational context of the project	These include political support for the project, and administrative inertia and tie-in with organizational objectives and values (Goodman *et al.*, 1980; Pfeffer, 1981; Staw and Ross, 1987; Ross and Staw, 1993). They also include external political support and external pressure to persist (Ross and Staw, 1993)

Table I.
Types of factors that can
promote escalation

stages of a project and that factors may disappear and reappear during the course of a project.

In this paper, the choice of the Staw and Ross framework to analyze escalation of the selected case means that the analysis tool consists of a framework that summarizes a substantial part of escalation research and that has been used in several studies on IT project escalation. We adopt a similar strategy in our use of ANT.

ANT: underlying ideas and central concepts

Pioneered by Michel Callon and Bruno Latour (Callon and Latour, 1981; Callon, 1986), and later extended and further developed by the original authors and other researchers (Latour, 1999; Law, 1991; Law, 1994; Law and Hassard, 1999), ANT provides a rich approach for understanding the creation of networks of aligned interests. The theory outlines how actors form alliances and enroll other actors, and use non-human actors (artifacts) to strengthen such alliances and to secure their interests, thus creating

actor-networks made up of humans as well as of artifacts (Callon, 1986; Callon and Latour, 1981; Latour, 1996). In the field of information systems, ANT has been recognized as having a potential for understanding the complex social interactions associated with IT (Walsham, 1997), and has specifically been used to interpret the political processes of IT implementation (e.g. Holmström and Stalder, 2001; Monteiro and Hepsø, 2000; Walsham and Sahay, 1999).

According to Callon (1986), the creation of an actor-network, also referred to as translation, consists of four major stages: problematization, interessement, enrollment, and mobilization. Before discussing the details of each stage it should be noted that all translation processes do not pass through all these stages and that translation processes may fail and halt at any stage. The choice of the word "translation" derives from Callon (1985), who defines it as "the methods by which an actor enrolls others" (Callon, 1985, p. xvii).

During the problematization stage, an actor initiating the process defines identities and interests of other actors that are consistent with the interests of the initiating actor. In this initial stage in building an actor-network certain actors position themselves as indispensable resources in the solution of the problems they have defined. They define the problems and solutions and also establish roles and identities for other actors in the network. As a consequence, initiators establish themselves as an "obligatory passage point" (Callon, 1986) for problem solution.

The second translation stage is interessement, which involves convincing other actors that the interests defined by the initiator(s) are in fact well in line with their own interests. This also involves, if necessary, creating incentives for actors such that they are willing to overcome obstacles in the way of becoming a part of the actor-network. As Callon puts it, successful interessement "confirms (more or less completely) the validity of the problematization and the alliances it implies" (Callon, 1986, pp. 209-10). Interessement thus includes locking new allies into place and cornering entities not yet co-opted.

If interessement is successful, enrollment occurs. Enrollment involves a definition of roles of each of the actors in the newly created actor-network. It also involves a set of strategies through which initiators seek to convince other actors to embrace the underlying ideas of the growing actor-network, and to be an active part of the whole project. In other words, it is "the group of multilateral negotiations, trials of strength and tricks that accompany the interessements and enable them to succeed" (Callon, 1986, p. 211).

The fourth and final stage of translation, mobilization, includes initiators' use of a set of methods to ensure that allied spokespersons act according to the agreement and do not betray the initiators' interests. Building on a set of enrolled actors, initiators seek to secure continued support to the underlying ideas from the enrolled actors. With allies mobilized, an actor network achieves stability. This stability would mean that the actor-network and its underlying ideas have become institutionalized and are no longer seen as controversial.

The translation stages are often found to be more fluid and interrelated than Callon's analytical translation model might suggest. Recent ANT research paints a picture of a fluid translation process where the order of things is created and maintained through actors' strategic efforts to negotiate and maneuver one another into networks of aligned allies (Latour, 1999; Law and Hassard, 1999; Scott and

Wagner, 2003). Bearing this in mind, the four translation stages still provide a suitable vehicle for analysis and for communication of results.

In addition to the four stages of translation, the process of inscription is critical to building networks, as most artifacts within a social system embody inscriptions of some interests. As ideas are inscribed in technology and as these technologies diffuse in contexts where they are assigned relevance, they help achieve socio-technical stability (Latour, 1987). While technologies are, in part, open for interpretation, there are some features that are in practice "beyond" (re)interpretation and that increase stability in the networks in which technologies are encompassed (Latour, 1991). Inscription takes place in the formation of a technology and in the placement of this technology in an actor-network. This means that the technology does not have to be "implemented" for it to exist. It has to be conceived, but once it is conceived it is a force to be reckoned with: it is an actor (Latour, 1996, 1999). Inscriptions prescribe a program of action for other actors, which the latter may or may not follow, depending on the strength of the inscription (e.g. Latour, 1992). In relation to translation, inscription to a large extent takes place simultaneously and interrelatedly; it starts as soon as a technology enters the picture and is beginning to be formed by its "creators" (Akrich, 1992; Latour, 1992).

Another important phenomenon and concept of ANT is irreversibility. Irreversibility refers to the degree to which in a certain situation it is impossible to go back to a point where alternative possibilities exist (Callon, 1991). Irreversibility is often the result of the inscription of interests into technological artifacts, whereby those interests become increasingly difficult to change (Hanseth and Monteiro, 1998).

Hanseth and Monteiro (1998) also point out that there is often more than one relevant network in relation to complex IT-related change efforts. In the context of changing irreversible networks, they proposed three actor-network configurations involving more than one network: disconnected networks (networks that are unrelated and unaligned), gateways (links between two actor-networks that are unable to establish direct interaction), and polyvalent networks (distinct but partly overlapping actor-networks joined through certain multi-attaching, or "polyvalent", nodes)[2]. The decomposition of an actor-network into smaller units (creating disconnected networks, or networks connected through gateways or polyvalent nodes) might enable change of a previously irreversible network (Hanseth and Monteiro, 1998).

Method

While the overall interest underlying this article concerns the potential of ANT in the field of IS, we pursue this interest by focusing on the particular area of IT project escalation. In order to assess the potential of ANT to this research area, a vehicle for carrying out a theory-comparative analysis was needed. For this, a single case study was used.

This research approach is well supported by methodology on the use of case studies for theory-building and theory-testing (Eisenhardt, 1989; Lee, 1989), as well as by two influential articles by Markus (1983) and by Lee (1994). There is also an example of this research design within IT project escalation studies (Keil, 1995b).

Markus' (1983) research, which used a case study to compare three theories, incorporated an original case study. Lee (1994) instead used secondary data from a study on electronic mail (by Markus, 1991) to perform an analysis that differed from

the original author's in several ways. In particular, it varies in its epistemological and ontological stance and in the theoretical approach employed, thus illustrating how positivist and interpretive approaches to organizational research can be integrated or combined (Lee, 1991).

Compared to Markus (1983) and Lee (1994), this study employs a combined strategy in which a case based on secondary data is analyzed from two different theoretical perspectives with differing basic assumptions: Escalation studies frequently employ a positivist stance (e.g. Brockner, 1992; Keil *et al.*, 1995; Whyte, 1986), whereas actor-network studies are predominantly interpretive or critical (e.g. Hansen and Mouritsen, 1999; Walsham and Sahay, 1999). We thus employ two different epistemologies within one article with the purpose of comparing and contrasting two theory-based analyses, but not with the aim of combining these theories. This aim is well within the boundaries for how positivist and interpretive research can be combined and opens the door for further cross-fertilization between research traditions over time (Lee, 1991).

The strengths in applying multiple theoretical perspectives on a single case have to do not only with being able to understand more facets of the case, but also with being able to better understand the distinctive strengths of the perspectives involved. This aim might essentially be seen as interpretive (uncovering multiple meanings) rather than positivist (explaining causes and effects of events in the case) (cf. Alvesson and Sköldberg, 2000). However, the purpose of the analyses is primarily to contrast and compare theories and to let each analysis reflect the theory used. Thus, our goal is primarily to contribute to an emerging discourse, rather than to find either the objective truth about the case (cf. Rorty, 1979, p. 377) or even the most meaningful interpretation of it.

An essential aspect of the research design is that case studies are well suited to both interpretive and positivist positions (cf. Lee, 1989; Lee, 1991; Walsham, 1993; Yin, 1994). Furthermore, case studies have been repeatedly used in both IT escalation studies (Keil, 1995a; Montealegre and Keil, 2000; Newman and Sabherwal, 1996) and IT ANT studies (Holmström and Stalder, 2001; Walsham and Sahay, 1999).

The use of an existing case study also had the advantage of providing a data set that was manageable and fixed in its content. Furthermore, the original case study (Montealegre *et al.*, 1996a, b) was not originally geared towards either of the two theories, although it has later been used to investigate de-escalation (Montealegre and Keil, 2000).

While the chosen case has been used in research that employed basic assumptions and methodological positions common in escalation research, only the de-escalation side of the case was addressed (Montealegre and Keil, 2000; Keil and Montealegre, 2000). The escalation process of the case has not been previously analyzed. Choosing a case study that has been used in escalation research certainly raises the bar for finding the benefits of ANT, but also strengthens the argument for identified contributions of ANT.

As can be concluded from the above, several efforts have been made to design and carry out a theory-comparison that is fair towards both escalation theory and ANT. The division of responsibilities within the author team was also used to further this aim. Of the four authors, one author is highly knowledgeable about escalation theory,

one author has expertise in ANT, and two authors are familiar with both theories, albeit with more substantial research experience within escalation theory.

The division of responsibilities was designed so that each author with expertise in a specific theory performed the first analysis using that theory independently from the other analysis. Each "expert", however, did this in collaboration with the first author, who was responsible for balancing or "arbitration" of the analyses. This author was responsible for triangulating the emerging analyses against each other and the case and for securing the integration of the separate analyses into the discourse of the paper. The fourth author, who had extensive knowledge of the events at DIA and direct access to data of the case, corroborated the case description as well as the two case analyses. This provided further tests of the quality of the analyses. Subsequent developments of the separate analyses and the theory-comparative analysis were carried out in iterations involving all authors. Through the sequence of steps in this process, a dialectical process (cf. Klein and Myers, 1999) was built into the writing of the article.

IT project escalation: a case and two theoretical lenses

In this section the case of the computerized baggage handling system (CBHS) escalation at DIA is presented. Two distinctively different analyses of the case using escalation theory and ANT as analytical lenses are then presented and subsequently discussed.

The computerized baggage handling system at the Denver International Airport

In 1987, the City of Denver, including the mayor, the mayor's office and members of the city council, completed a master plan (with input from the airport users, airlines, pilots and Federal Aviation Administration (FAA)) that called for building the world's most efficient and the nation's largest airport[3]. Construction was to begin in late 1989 and completion was to occur by October 1993. The need for a new airport had been discussed and investigated since the mid-1970s, involving the above actors as well as the media, the general public and the regional business community (often represented by the local Chamber of Commerce). It had even been a key issue in the 1983 mayoral election and was often described as a technologically advanced project that would attract federal capital, create jobs and attract new business to the region.

The 1987 master plan for the new airport presumed that airline tenants would install their own baggage handling systems, thus excluding construction of baggage handling systems from the overall DIA project. This was customary in earlier airport construction projects.

In December 1991, as a result of its relatively early commitment to DIA as a major hub, United was the first to start work on a baggage handling system, commissioning BAE Automated Systems Inc. to build a CBHS at the new airport. BAE was a leading manufacturer of material handling systems with a solid track record for installing airport baggage handling systems. Since United planned to use DIA as a major hub, the airline placed high demands on the prospective system, aiming for an advanced solution. The main reason was the customer convenience and service level an advanced CBHS could bring, particularly in reducing transfer times for passengers (less than 30 minutes was the goal).

Phase 1: conceptualization of the airport-wide CBHS. At the end of 1991, two years into the construction of the new airport and with BAE already working on United's baggage system, the DIA project's top managers began to recognize the potential benefits of an airport-wide CBHS. At that time, United and Continental were the only carriers that had committed as leaseholders of the new airport. Moreover, as one DIA senior manager explained, "airlines other than United simply were not coming forward with plans to develop their own baggage systems". As a result, airport planners and consultants began to develop specifications for an airport-wide CBHS and the City sent out a request for bids. While sixteen companies (both domestic and foreign) were contacted, only three responded; and a consulting firm recommended against all three submitted designs on the grounds that the configurations would not meet the airport's needs. A member of the DIA management team commented, "All had the same response: 'there was not enough time to build such a system'".

While BAE was one of the companies contacted, it elected not to bid on the airport-wide system. A United project manager explained: "BAE told them from the beginning that they were going to need at least one more year to get the system up and running, but no one wanted to hear that". The City of Denver was getting the same story from the technical advisers to the Franz Josef Strauss Airport in Munich. The Munich Airport had a CBHS far less complex than the one proposed for DIA, yet its technical advisors had been testing the system for two years before the airport opened.

Phase 2: emergence of a solution and a supplier. The fact that BAE had already begun constructing United's CBHS, together with their international reputation, convinced the DIA project management team to approach the company about designing an airport-wide system. BAE was asked by the City of Denver to study how the United concept could be expanded into an integrated airport system that could serve the other carriers in the various concourses. The City of Denver had two major concerns, recalled Di Fonso, president of BAE:

> First, they had no acceptable proposal. Second, United was probably going to go ahead and build what it needed and the rest of the airport would have been equipped with something else.

BAE presented a proposal to develop the "most complex baggage-handling system ever built", explained Di Fonso. The proposed CBHS was to route bags (including suitcases of all sizes, skis, and golf clubs) from the main terminal through a tunnel into a remote concourse and directly to the gate. It was to include 3,100 independent "telecars" to route and deliver luggage among the counters, gates, and claim areas of 20 different airlines. Although this system would be more expensive initially than simple tugs and baggage carts, it was expected to reduce the labor required to distribute bags to the correct locations (Bouton, 1993). Bags unloaded from aircraft arriving at a particular concourse would barely be touched by human hands. To prove the capability of the system's mechanical aspects, and demonstrate the proposed system to the airlines and politicians, BAE built a prototype CBHS in a 50,000 square foot warehouse near its manufacturing plant in Carrollton, Texas. The prototype system convinced Chief Airport Engineer Walter Slinger that the computerized system would work.

In April 1992, BAE was awarded the $175.6 million contract to build the entire airport system. According to Di Fonso, company executives and City officials

hammered out a deal in three intense working sessions. "We placed a number of conditions on accepting the job", he observed. "The design was not to be changed beyond a given date and there would be a number of freeze dates for mechanical design, software design, permanent power requirements and the like".

The design of the United baggage system was frozen on May 15, 1992, when the DIA management team took over managerial responsibility for the integrated CHBS. Because of the tight deadlines, Denver officials committed to unrestricted access for BAE. In addition, substantial changes had to be made to the overall design of the terminal, and some construction already completed had to be taken out and reinstalled.

Phase 3: turmoil in the governance of the project. In October 1992, six months after BAE had been awarded the contract to build the CBHS, the chief airport engineer, Walter Slinger, died. Slinger, who had been a strong proponent of the baggage system and closely involved in the negotiations with BAE, exerted a significant impact on the project. His management style was autocratic, and he was detail-oriented. Gail Edmond, who was selected as Slinger's replacement because she had worked closely with him, had a managerial style quite different from Slinger's. Her style was more consensus-oriented and she preferred to follow a hands-off approach, allowing different parties to work out differences among themselves. A Public Works manager recalled his first reaction to the change: "[The airport] is not going to be open on time". A United Airlines project manager explained the significance of replacing Slinger with Edmond:

> Slinger … was controversial because of his attitude, but he was never afraid to address problems. He had a lot of autonomy and could get things done. Gail … had a good understanding of how the project was organized and who the key players were, but the City council didn't give her anywhere near the autonomy and the authority that Slinger had.

To further complicate matters, the airlines began requesting changes to the system's design, although the mechanical and software designs were supposedly frozen. "Six months prior to opening the airport", a senior vice-president of BAE recalled, "we were still moving equipment around, changing controls, changing software design". Di Fonso also recalled his frustration at that time: "we kept asking the City to take prompt action to assure BAE the ability to continue its work in an uninterrupted manner. Without the City's help, the delays to BAE's work quickly became unrecoverable".

Phase 4: mounting problems and repeated delays. Initially, construction problems kept the new airport from opening on the originally scheduled date in October 1993. In February 1993 Mayor Wellington Webb delayed the scheduled October 1993 airport opening to December 19, 1993. Later, this December date was changed to March 9, 1994. Then, in September 1993, problems with the CBHS forced a further postponement – this time until May 15, 1994.

In late April 1994, as BAE was preparing the first test of the system, the City of Denver invited reporters to observe the test. So many problems were discovered that testing had to be halted. Reporters saw piles of discarded clothes and other personal items lying beneath the Telecar's tracks. After the test, Mayor Webb delayed the airport's opening once again – for an indefinite period of time. "Clearly, the automated baggage system now underway at DIA is not yet at a level that meets the requirements of the City, the airlines, or the traveling public", the mayor stated. "There is only one thing worse than not opening DIA … [and] that is opening the airport and then having to shut it down because the [CBHS] doesn't work".

Two days after the failed tests, city leaders met with United and Continental Airlines executives to discuss the pending delay and financing plans. United Airlines agreed to front $8.8 million per month over the next three months to pay for the delay. The other airlines were to be assessed their share of delay costs once DIA was open (Svaldi, 1994).

Epilogue: abandonment of the CBHS project. Shortly after Webb's decision to delay the opening of the airport until the CBHS was fully operational, external pressure mounted as DIA came under the investigation of a federal grand jury as well as multiple federal agencies (including the Securities and Exchange Commission (SEC) and the FAA). Mayor Webb eventually succumbed to the pressure and withdrew his commitment to the CBHS project. Dealing with the costs of further delays had become untenable, and an effort was made to find the most expedient way of getting the airport operational. To accomplish this, a manual baggage handling system based on propane-powered tugs and carts was implemented. Webb positioned this as a "back-up" system that would enhance the value of the airport, but for all practical purposes, it became a substitute system.

When the airport finally opened in late February 1995 (16 months behind schedule and close to $2 billion over budget), the CBHS project had essentially been abandoned, leaving two concourses served by a manual baggage system and one concourse served by a scaled-down semi-automated system, serving only United Airlines outbound passengers.

The CBHS project from an escalation theory perspective

This section presents an analysis of the CBHS project based on the Staw and Ross (1987) framework[4]. In the escalation literature, escalation is viewed as resulting from a sequence of distinct decisions occurring over time (Brockner, 1992; Staw and Ross, 1987). In order to facilitate an analysis of processual aspects of escalation, key decisions that contributed to escalation were identified and factors were identified in relation to each key decision (cf. Staw and Ross, 1987).

Table II provides an overview of the escalation process according to the escalation theory analysis, showing the timeframe in which each key decision occurred, the situation that gave rise to the decision, what the key decision concerned and the consequences of each decision.

Table III then shows what factors were identified in each phase, thus providing an overview of how different factors and types of factors were present at different points in the escalation process. This analysis suggests that both project and psychological factors were quite salient in the initial phases and remained strong throughout most of the project. The presence of 5-6 project-related factors and 2-3 psychological factors was noted in all phases of the escalation process.

Structural (or organizational) factors were also present throughout the process, while social factors were not detectable in the first and third phases. Factors of the latter two types increased in number in late phases (two to four factors present for each type). The analysis supports Newman and Sabherwal's (1996) finding that different types of factors may occur at several stages of a project and that factors may disappear and reappear during the course of a project.

In the following, each identified factor will be discussed in more detail. This discussion is structured in accordance with the Staw and Ross (1987) framework.

Timeframe (phase)	Situation that gives rise to decision	Escalation decision	Decision consequences
December 1991 (phase 1)	Growing recognition of potential benefits of airport-wide CBHS Airlines other than United had not come forward with plans to develop their own baggage handling systems	Build airport-wide computerized baggage handling system	Specifications are developed for airport-wide CBHS request for proposal process is initiated (16 companies contacted) Proposals are received from three companies – all judged to be inadequate
April 1992 (phase 2)	BAE had a history of success in building airport-wide CBHSs BAE was already working under contract with United to create such a system BAE was willing to enlarge the project from handling United's needs to creating a system that would handle the needs of the entire airport, on certain conditions	Award contract to BAE	BAE's contract with United is frozen BAE is promised that it will have priority over other contractors in terms of site access and that the design will not be changed beyond a given date Though construction has already begun, substantial changes must be made on the terminal and concourses in order to accommodate the computerized system
October 1992 (phase 3)	Chief Airport Engineer Slinger had died Edmond was DIA's chief of construction and acting director of aviation, and had worked very closely with Slinger	Appoint Edmond new Chief Airport Engineer and continue with the project	Edmond becomes the new chief airport engineer, while keeping her previous responsibilities Project management style changes Project governance structure becomes ambiguous Mayor's office exercises tight control over Edmond, who also has considerably less credibility within the DIA project Problems with the computerized baggage handling project begin to emerge
April 1994 (phase 4)	Mayor Webb had reconfirmed his commitment to the airport-wide CBHS	Delay DIA opening until CBHS is operational	City of Denver approaches tenant airlines for financial support Tenant airlines agree to participate in covering costs of delay Pressures from external parties increase

Factor types	Factors	Phase 1	Phase 2	Phase 3	Phase 4
Project factors	Investment character of the project	✔	✔	✔	✔
	Efficacious resources	✔	✔		
	Large size of payoff	✔	✔	✔	✔
	Long-term payoff	✔	✔	✔	✔
	Infeasibility of alternatives	✔	✔	✔	✔
	Temporary cause of setback		✔	✔	✔
Psychological factors	Personal responsibility for failure	✔	✔	✔	✔
	Ego importance of failure	✔	✔		
	Prior success/reinforcement		✔	✔	
	Prior expenditures irrevocable		✔	✔	✔
Social factors	Responsibility for failure		✔		✔
	Norms for consistency and hero effect				✔
	Public identification with course of action				✔
	Job insecurity				✔
Structural factors	Political support	✔	✔	✔	✔
	Institutionalization			✔	✔

Table III.
Factors identified as contributing to escalation in different phases of the CHBS project at DIA

Table IV summarizes all the factors identified in the CBHS case, categorized according to the framework and listed in the order discussed below.

Project factors. Project factors included:

- *Investment character of the project*. The CBHS was perceived as an investment rather than an expense. Staw and Ross (1987) suggest that cognitively treating a project as an investment is likely to set up expectations of future gain, which can engender escalation behavior. Investing in an airport-wide CBHS was seen as something that would pay off in the future because it would make the airport more attractive to both carriers and the traveling public. In addition to saving carriers the time and expense of creating their own baggage handling solutions, the CBHS would also reduce turnaround times on the ground, allowing more effective use of airplanes. Moreover, quick delivery of bags would also make the airport more attractive to travelers, especially those who needed to make tight connections.

- *Efficacious resources*. In retrospect, the decision to add an airport-wide CBHS two years into the construction of the airport was a risky undertaking, especially since it would require undoing portions of the airport that had just been constructed. On the other hand, a solution for baggage handling had to be found and Slinger's and other actors' actions indicate that resources were seen as available and efficacious. If decision makers believe that additional "investment is likely to be efficacious or turn the situation around" (Staw and Ross, 1987, p. 45), they may be prone to take on risky projects and to escalate their commitment to such courses of action even in the presence of negative feedback.

- *Large size of payoff*. The CBHS represented a large potential payoff in two respects. First, a functioning airport-wide CBHS could help to entice other carriers to set up operations at DIA. Second, getting the CBHS up and running by January 1, 1994, would allow the airport to open before the city would need to

Factor types	Factors	How factors promote escalation
Project factors	Investment character of the project	Expectations of future gain can engender escalation behavior
	Efficacious resources	Assessments that additional investment is likely to be efficacious or turn the situation around promotes escalation
	Large size of payoff	Large projected payoff makes decision makers more inclined toward escalation behavior
	Long-term payoff	Expectations of long-term (rather than short-term) rewards promote escalation
	Infeasibility of alternatives	Perceived lack of feasible alternatives contributes to escalating commitment
	Temporary cause of setback	Viewing problems as temporary and manageable engenders escalation
Psychological factors	Personal responsibility for failure	High perceived personal responsibility for failure contributes to escalation of commitment
	Ego importance of failure	Concern with personal reputation and ego will increase the perceived costs of withdrawal
	Prior success/reinforcement	History of prior success reinforces belief in possibility of success, thus promoting escalation
	Prior expenditures irrevocable	Expenditures that cannot be recovered contribute to escalation
Social factors	Responsibility for failure	The social aspect of responsibility pertains to the need to save face, which contributes to escalation
	Norms for consistency and hero effect	Social norms that favor consistent behavior and norms that find the successful turnaround of failing projects heroic promote escalation behavior
	Public identification with course of action	Public identification contributes to the binding of decision makers to that course of action
	Job insecurity	If being associated with a failing course of action threatens a person's job security, there is incentive to persist in the hope of achieving a turnaround
Structural factors	Political support	When advocates for a project are also governing and overseeing this project, the risk for escalation increases
	Institutionalization	When the existence of a project and the necessity of its deliverables are taken for granted and become embedded in the organization, escalation is more likely

Source: Based on Staw and Ross (1987)

Table IV.
Factors contributing to escalation in the CHBS project at DIA

begin paying interest to the bondholders who had helped fund the construction of the airport. Thus, there was a large potential payoff if the CBHS could be completed successfully within a certain time frame and this appears to have contributed to the escalation of commitment.

- *Long-term payoff.* The baggage handling system was embedded in the context of the airport construction itself, which was viewed as a long-term public works project that would bring job growth and economic recovery to the region. As

suggested by Staw and Ross (1987), initiatives that are perceived to have a long-term payoff structure are more likely to engender escalation because there is no expectation of an immediate reward. There is also less of an impulse to reexamine such a course of action when things begin to go awry.

- *Infeasibility of alternatives.* The initial design for the airport did not incorporate an airport-wide CBHS, because it was assumed that individual airlines would develop their own baggage systems since this was the norm in most other American airports. By 1992, however, the project's top managers began to see the benefits of an airport-wide CBHS. The idea for such a system and its perceived benefits were largely the result of the original plan being perceived as infeasible in light of the fact that no airlines other than United had come forward with plans to develop their own baggage handling systems. As Staw and Ross (1987) suggest, the infeasibility of alternatives appears to have influenced the decision to commit resources to a risky endeavor.

- *Temporary cause of setback.* Escalation theory suggests that setbacks that are viewed as temporary are likely to promote escalation because they will be seen as minor obstacles that can easily be overcome. In the case of DIA, when airline carriers other than United were not planning their own baggage handling systems, it was relatively easy for Slinger and others to perceive this as a temporary setback that could be overcome with the application of additional resources. Indeed, viewing setbacks as temporary became a common response pattern as the airport encountered a series of construction delays followed by problems that surfaced with the baggage handling system.

With the exception of efficacious resources, all project factors remained present throughout all phases of the de-escalation process.

Psychological factors. Psychological factors included:

- *Personal responsibility for failure.* Individuals with a high degree of personal responsibility will have a tendency to escalate their commitment (Staw and Ross, 1987). In this case, Chief Airport Engineer Walter Slinger was a strong proponent of the airport-wide CBHS and later became closely involved in negotiations with BAE. The airport's initial sponsor, Mayor Peña, as well as his successor, Mayor Webb, also had high levels of personal responsibility for the outcome of the project, as the CBHS came to be seen as an integral part of the airport. Thus, the high degree of personal responsibility on the part of key decision makers encouraged them to escalate their commitment to the CBHS.

- *Ego importance of failure.* The "ego implications of failure will increase the perceived costs of withdrawal" (Staw and Ross, 1987, p. 51). Again, if the CBHS is viewed within the broader context of the entire airport construction project, it can be seen that the executives linked to DIA had staked not only their jobs but also their reputations on the success of the project. Webb's election and his re-election prospects were tied to DIA. Slinger had staked his reputation on the successful completion of DIA and undoubtedly spent considerable political capital in pushing for the construction of the CBHS. Thus, the ego implications of failure can be seen as being relatively high.

- *Prior success/reinforcement.* Escalation theory suggests that a prior history of success can reinforce behavior patterns that have previously been successful, thus promoting escalation. BAE had significant experience implementing this technology, albeit on a smaller scale (and with lower complexity) than would be required for DIA. BAE's reputation and success history, however, meant that city officials did not tend to question whether the job could be done successfully. The aviation director, for example, told a luncheon forum at the Denver Press Club, "No one [in the DIA management team] realized the complexity of the technology as it relates to this baggage system" (O'Driscoll, 1994). The impact of prior success history was reinforced when the project management team visited different airports and learned that there had never been an instance of an airport opening being delayed by a faulty baggage system. As one member of the DIA management team recalled, "what we heard was that BAE had a culture of always making it work on the last day". Thus, it is likely that BAE's prior history of success gave city officials a false sense of confidence in what could be accomplished.

- *Prior expenditures irrevocable.* Staw and Ross (1987) suggest that when prior expenditures are irrevocable, this can promote escalation. After the decision was made to build an airport-wide CBHS, funds were allocated and spent. Thus, it stands to reason that decision makers would view these prior expenditures as irrevocable.

Social factors. Social factors did not begin to emerge until it had become clear that that the airport construction was running behind schedule and that decision makers bound to the project would need to manage the expectations of various stakeholders:

- *Responsibility for failure.* The social aspect of escalation comes into play when decision makers are seen as being bound to a certain course of action and begin to engage in escalation behavior in order to save face. Since the entire DIA project was constantly under public scrutiny, the key decision makers could not help but be publicly identified with the project. This public identification carried over to the CBHS as well, which became an integral part of the overall project. Staw and Ross (1987) suggest that when prior expenditure commitments are irrevocable, public, and freely chosen, the tendency toward escalation increases. Once the CBHS contract was signed between the City and BAE, all these conditions existed and appeared to promote escalation behavior.

- *Norms for consistency and hero effect.* Staw and Ross (1987) suggest that social norms that favor consistent behavior can bind individuals to failing courses of action. Moreover, leaders who can successfully orchestrate turnarounds are often especially revered and regarded as heroes. These norms help explain why Mayor Webb "stayed the course" even in the face of the very unsuccessful public demonstration in April 1994 of the CBHS. Thus, while reporters saw mangled suitcases and piles of discarded clothes and other personal items lying on the floor, Mayor Webb pledged that he would not open the airport until the problems with the CBHS were resolved.

- *Public identification with course of action.* By vowing to delay the opening of the airport until the CBHS was up and running, Webb became publicly identified

with pursuing a course of action that escalated the city's commitment to the CBHS. Many individuals who saw the results of the failed baggage system test began to seriously question whether BAE would be able to get the system operating. But Mayor Webb reconfirmed his commitment to the system both publicly and in direct communication with the vendor, insisting that the airport would open when the CBHS operated successfully.

- *Job insecurity*. Another social factor that binds decision makers to failing courses of action is job insecurity. If being associated with a failing course of action threatens one's job security, there is an incentive to escalate commitment in the hopes of turning around the failing endeavor. In the case of the baggage handling system at DIA, one can argue that Mayor Webb as well as other public employees faced considerable exposure on this project. Indeed, in the case of Webb, realizing his future political aspirations depended on successfully navigating through the maelstrom that threatened to consume him.

Structural factors. Structural factors included:

- *Political support*. When advocates for a project are "represented on governing bodies and budget committees charged with the fate of a venture, one may expect substantial persistence in the course of action" (Staw and Ross, 1987, p. 61). In the case of DIA and the baggage handling system, one cannot easily imagine having more political support than the mayor's endorsement of the project.

- *Institutionalization*. Projects can become institutionalized in an organization when "actions are taken for granted" because they have become deeply embedded (Staw and Ross, 1987, p. 62). In the case of DIA, the baggage handling system had necessitated changes in the airport plans that were reflected in the actual concrete and steel that formed the structure of the new facility. This level of physical "embeddedness" probably made it difficult to visualize an airport without the airport-wide CBHS. Indeed, the evidence suggests that construction of the baggage system was already "taken for granted". Even after the system's primary champion died, there was no evidence of any serious discussion about whether or not to continue with the CBHS project. This suggests that some level of institutionalization had occurred by the time that Edmond took over as the new chief airport engineer.

The CBHS project from an ANT perspective
In analyzing the case from the point of view of ANT[5], the emphasis was placed on the efforts to create a sufficiently powerful consortium of actors to support and push forward the underlying ideas behind the project. Thus, understanding the escalation of the CBHS project from an ANT perspective is based to a large extent on the particular way in which a durable actor-network and its inscriptions were created.

It should be noted that there were two interrelated translation processes at DIA: one concerning the airport project *per se*, the other concerning the CBHS. It should also be noted that when the idea of an airport-wide CBHS was introduced, there was already an existing, stable, and far-reaching actor-network for the DIA airport. Among the actors in that network were the public, the regional business community, the City of Denver and its mayor, federal grant-providing agencies, prospective and present airline tenants, vendor tenants, bond investors, etc. Understanding the character of

these two actor-networks, and how they are interrelated, is central to the ANT reading of the case.

In the first stage of the translation process, problematization, problems, solutions and key roles are defined (Callon, 1986). At the time when the airport-wide CBHS idea came into the picture, the airport project was already well under way, with construction having been started two years earlier. At a certain point, the looming crisis brought about by the non-existence of baggage handling systems and the inaction of airlines (United exempted) prompted the DIA project team, particularly Slinger, to address the problem. When airlines were thought responsible, baggage-handling was practically a non-issue for the DIA project. When the situation was redefined as a problem for the DIA project, a solution had to be found. Slinger found a solution with very attractive characteristics: there was already a baggage handling system being built, which "only" had to be expanded to serve the whole airport. Conceptually, this was a short leap. Furthermore, this system happened (for reasons of passenger turn-around time) to exhibit characteristics that matched the grandeur of the new airport. It was a state-of-the-art baggage handling system for a state-of-the-art airport.

A key to establishing the CBHS actor-network was addressing how to define the roles of new actors and how to redefine the roles of actors within the DIA network to enable the airport-wide CBHS project. At this point, Slinger's problematization included redefinition of the role of United Airlines (buy-in to airport-wide system instead of commissioning construction of a proprietary system), definition of a new role (supplier of airport-wide system), and/or redefinition of BAE's role (no role or assuming the new role of airport-wide supplier). In addition, problematization built upon the inheritance of actors and roles from the DIA actor-network in which the emerging CBHS actor-network was embedded. The negotiation and casting of these and other roles was addressed in the interessement phase of the translation process.

In the interessement stage, actors commit to the problematization offered (Callon, 1986), accommodating to the proposed identity and future of the actor-network and approaching the roles to be played by actors in the network. Similar to the processes identified in the problematization stage, interessement was largely given by the actors and their roles and positions in the DIA actor-network. In some cases, these actors were not actively engaged in the CBHS project (vendor tenants, federal grant-providing agencies), whereas other existing actors were key in the interessement stage (Mayor Webb and the mayor's office, United Airlines, and in the latter stage BAE). Important, however, is that actors were inherited from the host actor-network and that even "silent" or passive actors in the host network would eventually become important in the abandonment of the CBHS project.

Slinger's main arguments for the proposed solution in the interessement stage was that the CBHS would provide a solution to the problem that the absence of baggage handling systems (present or under construction) posed for two out of three airport concourses. An airport-wide CHBS would also improve the overall service quality of DIA. Slinger also managed to frame the CBHS as a feature that would enhance the level of technological advancement of DIA and thus raise the stature of DIA even further above its competitors (i.e. other major airport hubs).

Through these maneuvers, Slinger reinforced and supplemented a coalition of interests involving significant actors and thus established a network of interest in the

deployment of the CBHS. Slinger worked at drawing these actors into a coherent coalition by establishing a common interest in the proposed solution – the adoption and re-development of the CBHS to the whole airport.

Early on, Slinger secured support for the new solution from the mayor. Next, United Airlines was persuaded that they would be served as well, or perhaps even better, by the overall CBHS as they would have been by their own system. Finally, a vendor for the airport-wide system had to be found and/or persuaded to come onboard. It is unclear whether Slinger had only BAE in mind from the beginning. However, as the incoming bids had been rejected, BAE was again approached and incentives were offered that were instrumental in persuading it to enter the emerging actor-network and assume its goals.

The successful interessement is demonstrated by the declaration from BAE that they would build "the most complex baggage handling system ever built". Not only had they agreed to take on the task, BAE had also assumed the challenge of building a CHBS that reflected the inscriptions being made into the emerging artifacts of the DIA.

Enrollment concerns the negotiation of roles between actors in the actor-network under formation (Callon, 1986). Closely interlinked with interessement, enrollment was partly expressed through the negotiations and agreements about terms and conditions of DIA's deal with BAE and similarly through mutual agreement about the redefined role of United Airlines with regard to the baggage handling system. The formalization of contracts was part of this process, and the resulting contracts were important as guarantees for what was agreed.

Translation processes are dynamic and emergent processes; a single actor does not hold a privileged position over – or control of – the development of events. Rather, different groups of actors compete in "trials of strength" (Latour, 1987) in order to establish their interests. As can be seen in the CBHS case, one actor will attempt to enlist the support of others and others may submit, but they may also refuse and attempt to forge alliances of their own to resist the plan (Holmström and Stalder, 2001, Latour, 1996). Here, Slinger's persuasion of United Airlines and BAE over their verbal (United's concerns about how their needs would be met) and non-verbal (e.g. BAE's decision not to bid) objections to the proposed solution bears evidence of Slinger's – and the mayor's – strength in these negotiations.

Enrollment took place in a small context, partly because many of the actors in the DIA actor-network saw the signing of the contract with BAE only as an extension of the existing actor-network. However, as the drama played out, it would become increasingly clear that the actions taking place within the CBHS actor-network, while embedded in the DIA actor-network, would not automatically benefit the intentions of members of its host actor-network.

Evidence of enrollment is found in actions such as the realignment of BAE's development work to the new project and its goals and United's acceptance of its new role in the expanded baggage handling system.

The basis for mobilization is the existence of enrolled actors. These actors may well retain their own specific agendas; they need only find it worthwhile to be part of the network on the basis of alliances concerning one or a few specific issues. Once the web of alliances is in place, it becomes possible for some actors to speak on behalf of a whole cause (i.e. to mobilize the action of an entire network) (Callon, 1986). Thus, mobilization

is largely about keeping actors aligned over some period of time, acting in agreement with the interests of the initiators.

After the initial actions that indicate successful enrollment, BAE's activities became increasingly frantic as they strived to deliver in accordance with a plan and an ambition level that from the very beginning – according to experience from various sources and several similar projects – was judged as having very slim chances of succeeding. How did BAE come to act so consistently in accordance with the inscribed interests of the initiators, even over mounting difficulties?

For a period, Slinger's management style and persuasion skills were probably enough to supplement the stability created through the earlier stages of the translation process, including the contracts created within that process. After the death of Slinger, the new airport manager, Edmond, did not fully assume this role, but rather acted on the order of Mayor Webb. The mayor and the City of Denver thus took over as guardians of the agreements that were embodied in the CBHS actor-network, and their roles grew to resemble that of initiators, particularly for the mayor.

In sum, key actors Slinger and Webb, together with the mayor's office and through successive co-optation of other actors, had succeeded with the translation process in spite of the initial objections from United Airlines and the initial refusal of BAE to take on the larger project. What had been created was an actor-network that pursued the dream of the most advanced CHBS ever built.

The roots of escalation existed from the very beginning of the CBHS project, and the successful translation process served to create a stable actor-network that would reinforce escalation behavior and monitor that actors did not deviate from the intentions and goals of the network. As a consequence of the successful translation and of the ongoing inscription, the emerging technological artifact embodied the intentions, goals, values, and dreams of the initiators.

The translation process during which the idea of the CBHS was established was quite rapid. It did not involve extensive negotiations with a multitude of actors. Moreover, it met limited resistance and opposition in the process of defining the problem and the proposed solution. The underlying condition for what we call swift translation was the embeddedness of the CBHS actor-network within the DIA actor-network. This condition meant that the embedded network inherited actors, roles, relationships and statements from its host network.

The notion of swift translation should not be construed as a weak translation: translation in the CBHS case was very strong until the point where central actors in the host network, the mayor and the airport itself, were threatened by the embedded network. However, since swift translation is enabled by and dependent on particular circumstances, in this case the embeddedness of the CBHS actor-network, the durability of the resulting actor-network may be fleeting if the enabling circumstances change.

From the beginning, a majority of actors in the DIA actor-network most likely viewed the emerging CBHS project as an integrated and subordinated part of the DIA project, aligned with the overall vision of DIA as a modern and efficient airport. In contrast, the CBHS project emerged into an actor-network in its own right, embedded but distinct, dependent but intentional – even willful. The problems mounting during 1993, with the CBHS seemingly out of control, became increasingly difficult to handle

for the DIA project management. At this time, the embedded network had developed into a Trojan actor-network – a threat potentially fatal for its host. Over time the host actor-network grew weaker, as a result of its inability to control developments in the embedded CBHS actor-network.

In spite of these developments, the inscriptions and network relations were still stable enough to hold actors in the determined roles and action patterns of the CBHS project well beyond the initial opening date of the airport and even through a publicly experienced and reported test disaster in April 1994. At this point, however, as previously passive actors in the host actor-network sprang into action (federal grant-providing agencies, FAA), fueled by other actors (the media) and outside entities entering the host network (the SEC), the CBHS actor-network began to unravel.

Just as the embeddedness of the CBHS actor-network influenced the form and the velocity of the translation process, this embeddedness also helps explain why CBHS was ultimately abandoned, namely to save the host network and central, individual actors in the host network.

The CBHS had up until this point been seen as a crucial part without which the host actor-network could not realize its full potential. Under pressure from new and newly vocal actors in the host actor-network, the intentions with regard to the CBHS changed from realization of DIA's full potential to putting an end to the delays in opening DIA and to the increasing scrutiny of the mayor, the City of Denver and DIA itself. This meant forsaking all but the basic ambitions concerning baggage handling services and settling for run-of-the-mill service levels in this area.

The redirection of what had been the CBHS project at DIA involved establishing two distinct but overlapping networks – polyvalent networks – in the form of separate, overlapping baggage handling systems[6]. One of the systems was based on familiar technology and procedures – on the "installed base" (Hanseth and Monteiro, 1998) – and the other system was the scaled-down version of the CBHS that served United Airlines' departures. The original CBHS was now treated as a dysfunctional part of the DIA actor-network, and the Trojan actor-network was separated from its host.

It should be noted that while the translation process that led to the acceptance of the CBHS was swift, the process of abandonment was not. It took some time to identify the CBHS project as a Trojan and abandon it. Furthermore, the swift translation process set the stage for making the Trojan possible, as so much of the actor-network (actors, goals, and intentions) was inherited from the DIA host actor-network.

Discussion

The understanding of escalation from an ANT perspective is directly related to the processes of translation and inscription: the creation of a durable actor-network with intentions, goals, and beliefs is a basis for whatever trajectory a development process has, whether resulting in an artifact that performs a role in a social setting or resulting in eventual abandonment of a project as the actor-network ultimately fails. It should be noted, however, that escalation occurs because translation is strong during a time period, although geared toward goals that are ultimately found to be unrealizable. Weak translation that fails at early stages would in terms of escalation theory be a "functional" or "correct" abandonment of a failing (or "dysfunctional") course of action at an early stage.

The ANT view of translation, however, is neutral with regard to what is formed; it deals primarily with the formation process and its characteristics. A faithful application of ANT is not concerned with assessing what is dysfunctional behavior and what is not. Rather, the concern is with understanding in some detail how and why translation processes evolve in certain ways. The concern is not with judging development trajectories or actions (decisions). In applying ANT to the study of IT project escalation, however, it follows that there is a focus on projects that display one or several prolonged periods of hardships. During these periods, the projects are in peril (i.e. questioned by actors, or experiencing problems related to resource consumption) and approach "failure" (however that term is defined in a particular social context). The difference is thus not in the phenomenon studied, but rather in how this phenomenon is viewed and assessed.

Seen from an ANT view, escalation also stems from the process of inscription of technological systems. Inscriptions have to do with ideas and assumptions about the role of the technology; what it is supposed to do, what relationships it is to have with other actors in the network. As these ideas and assumptions are formed at a relatively early stage of a project, they will be difficult to change as the project evolves. Thus, it becomes difficult to redirect the project.

There are several distinct differences between the two readings of the case. The ANT reading focuses on the creation of the project and how actors and goals were locked into a pattern of action. In so doing, it helps us understand escalation as something that is partly created by the very conditions and conjectures that are present even before a project is started. The escalation reading, on the other hand, focuses more on the successive build-up of escalation through a series of distinct decisions by decision makers who fail to identify, acknowledge and break a failing course of action. Escalation theory suggests that a set of factors helps explain why the failing course of action is not terminated. ANT, on the other hand, seems to view escalation as considerably more systemic. As a stable actor-network is being formed, actors increasingly hold each other in the "locked" positions assigned to and by them. As a result of these differences, ANT is arguably less informative about – and less concerned with – the personal and social psychology that holds even influential actors in fixed patterns of action, unable to break away from a failing course.

In spite of these differences in emphasis, the embodiment of ideas in artifacts somewhat surprisingly constitutes a point of contact between our analyses. Specifically, the escalation factor institutionalization implies that ideas and solutions are taken for granted and that physical structures or artifacts reinforce those ideas. This is remarkably similar to the ANT view of translation and inscription. The fundamental difference, however, is that the focus of the process-oriented ANT analysis is in the escalation analysis relegated to one factor within the Staw and Ross framework.

Another striking difference between our two readings of the case concerns the difference in language, which reflects the differences in language of the reference theories. Whereas escalation theory talks about "objective features" and "incorrect decisions" (Keil, 1995a; Ross and Staw, 1993), ANT talks about the "love of technology" (Latour, 1996) and about how artifacts inscribe behavior (Hanseth and Monteiro, 1997).

These differences are partly differences in views of rationality and objectivity, and partly attributable to epistemological and ontological assumptions of the two theories.

For the purposes of this research, it is also important to point out that ANT provides a coherent and integrated set of conceptual analysis tools that can be used for studying escalation processes. Given the earlier referred criticism of the Staw and Ross (1987) framework as quasi-process model, and given the herein demonstrated applicability of translation stages (cf. Callon, 1986), it seems highly likely that translation stages will provide considerably better guidance for the study of escalation as process, than does the Staw and Ross framework. The main differences between the ANT and the escalation theory analyses of this case are outlined in Table V.

Regarding the ANT analysis of the case, the embeddedness of the CBHS actor-network and how it turned into a Trojan actor-network in relation to its host actor-network was discussed earlier. Embeddedness was also found to enable swift translation, through the inheritance of actors, roles, goals, and intentions. It should be noted that a swift translation process does not necessarily imply that abandonment is swift. The ANT analysis suggests that the process of abandonment may still be complex and possibly lengthy. Indeed, our ANT analysis concurs with the escalation analysis in terms of how a trajectory is "locked", although the two analyses differ distinctly, but not completely, in their views of how this originally comes about and how escalation is brought to a halt.

The relation between Trojan actor-networks and their host therefore presents a problem situation different from the situations proposed by Hanseth and Monteiro (1998). The processes of abandonment may be similar (e.g. through the formation of several networks connected through gateways or polyvalent nodes – see section 3), but in the case of an embedded actor-network, an essential and probably very early aspect of the abandonment process is the disentangling of the Trojan from its host and thus the disruption of embeddedness.

While Hanseth and Monteiro (1998) identified three types of network relations (disconnected networks, gateways, and polyvalent networks), they did not identify the configuration that we found so important for the understanding of our case from an ANT perspective. We therefore propose embedded/host networks as a new network configuration in Hanseth's and Monteiro's typology. While their discussion on the change of "irreversible" networks (resembling de-escalation) is not the focus of this paper, our ANT analysis strongly suggests that the embeddedness of the CBHS actor-network influenced not only the escalation, but also the abandonment of the CBHS project.

Conclusions

In this paper, the case of the Denver International Airport CBHS was analyzed from two theoretical perspectives, escalation theory and ANT. Since the aim was to contribute to the current discourse on the application of ANT to the field of information systems, the concluding sections of the paper discuss not only the two different analyses, but also delves into specific aspects of how ANT can be applied and introduces several new ANT-related concepts.

When comparing and contrasting the ANT perspective to the escalation theory analysis, it can be seen how the two theories can help us make sense of a single case in two very different ways. Central differences between the employed theories were

Characteristics of the theories as illustrated by the case analyses	Escalation theory/IS escalation studies	ANT/ANT applied to IS escalation
Factor-oriented vs. process-oriented	Predominantly factor-oriented	Process-oriented
Focus on decision vs. action	Focus on decisions	Focus on socio-technical action
Focused actors	Decision makers	Multitude of human and non-human actors – and the relations, actions and mechanisms that hold them together
Focused levels	Individual, limited group	Network (i.e. systemic level beyond/above social group)
Epistemological and ontological stance	Predominantly positivist	Interpretive or interpretive/critical
Purposes of generated knowledge	Provide knowledge that help real-world decision makers make better decisions on runaway IT projects by accurately depicting organizational phenomena and identifying factors that promote escalation	Contribute to our understanding of how we create society through technology by providing meaningful stories and interpretations about socio-technical projects
Overall conceptualization of escalation as phenomenon	Escalation occurs through a series of decisions by organizational decision makers	Escalation takes place as a consequence of how the processes of translation and inscription occur in the evolution and stabilization of an actor-network.
Overall explanation of the CBHS escalation scenario	Factors promoting escalation were present and consequently escalation occurred. These factors included all categories, project, psychological, social and organizational. Escalation occurred as a result of influence of these factors over time and because counterforce were not present	The translation process led to the creating of a durable actor-network that embodied goals and intentions, which under the circumstances had little if any chance to succeed. However, the achieved stability of the actor-network held actors in position for an extended time period, thus causing escalation
Overall explanation of the abandonment of the CBHS project	Ultimately, there came a point where feedback on the viability of the CBHS project was devoid of any uncertainty and where external forces strongly pushed for abandonment. At this point, Mayor Webb extricated himself and the City of Denver through a sequence of steps that provided an alternative solution (based on Montealegre and Keil, 2000)	The CBHS actor-network was embedded within a host actor-network. Over time, the evolution of the embedded network led to a threat to its host. On the initiative of actors in (and entering) the host network, the embedded Trojan actor-network was ultimately sacrificed to save its host

Table V.
Escalation of CBHS: two
theoretical views

summarized in Table V. The main differences can be viewed both in terms of how each theory informs us about IT project escalation and in terms of a choice regarding research approach for the study of this phenomenon. In our theory-comparative analysis, the escalation theory analysis was found to be factor-oriented, partly as a

result of applying the Staw and Ross (1987) framework, whereas the ANT analysis, using Callon's translation phases, was geared toward processes. These differences are reflected in a broader set of studies within the two theory areas (see, for example, Brockner, 1992; Keil *et al.*, 1995; Monteiro and Hepsø, 2000; Walsham and Sahay, 1999).

The differences in terms of analytical focus, ontological and epistemological assumptions, and purpose of generated knowledge all point to two different ways of understanding IT project escalation. A researcher using escalation theory understands escalation as something that occurs through a series of distinct decisions by organizational decision makers, whereas an ANT perspective on IT project escalation frames escalation as something that takes place as a consequence of how the processes of translation and inscription occur in the evolution and stabilization of an actor-network.

This difference was evident in the two explanations of the CBHS escalation scenario: From an escalation theory perspective it can be seen how factors promoting escalation were present, including project, psychological, social, and organizational categories. Escalation occurred as a result of the combined effect of factors within these categories, manifested in consecutive decisions to persist. In contrast, the ANT reading of the case makes sense of the IT project escalation as a process of translation and inscription, where the translation process led to the creation of a durable actor-network that embodied goals and intentions, which under the circumstances had little, if any, chance to succeed. However, the achieved stability of the actor-network held actors in position for an extended time period, thus causing escalation.

Overarching differences between the theories (as reflected in our analyses) in views, values and goals concerning research (epistemology and ontology) were also found. These differences illustrate that the choice of theory to employ in analyzing a study is not merely a choice of a tool, but also a choice of philosophy, of perspective on greater things than a specific IT project. In line with Lee (1991), our current position is that IT project escalation studies would benefit from coexistence and cross-fertilization between studies of both theory traditions.

Since only one theory tradition currently populates this research area, it is particularly important to address the conceptual tools that ANT can bring to IT project escalation studies. Specifically, this study found embeddedness and swift translation to be central to the ANT reading of the case and thus to the understanding of how events unfolded. Our analysis also indicated that the specific character of an embedded actor-network emerging within a host actor-network potentially impacts the basis and character of the actor relationships, how the network is constituted, and how translation plays out. In particular, embeddedness facilitates inheritance of actors, goals, values, and intentions from a host actor-network to the embedded actor-network, thus enabling a rapid translation process, or swift translation.

This entanglement of two actor-networks – the embedded Trojan actor-network and the host actor-network – presents a complex situation that poses a special challenge both to real-world actors enmeshed in these networks and to researchers trying to make sense of them. In sum, ANT provides the foundation for a rich understanding of the complexities involved in escalation processes, particularly through its focus on complex socio-technical and political processes, and its view of technology. Through this, ANT offers a fruitful alternative, or complementary, approach to the study of IT project escalation.

Notes

1. Keil *et al.* (2000) summarize these theories and how they relate to escalation behavior.

2. Hanseth and Monteiro (1998) also use the term backwards-compatible network, but to denote a stable actor-network to which small additions are made over time (i.e. there is only one, slowly evolving, network).

3. This section builds on published accounts, primarily Montealegre *et al.* (1996a, b) and Montealegre and Keil (2000). If not otherwise stated, all quotes are from these sources. Newspaper articles and other official sources have been used to corroborate and supplement these accounts.

4. While this analysis was largely carried out "from scratch" as part of this study, it has benefited from insights gained during an earlier study using the same case (Montealegre and Keil, 2000).

5. To avoid repetition, this section recapitulates case facts more sparingly, with the assumption that the reader is by now familiar with the case.

6. Both of these networks were embedded in the DIA actor-network.

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The second chapter by Misa provides a glimpse into the way steel and steel technology shaped the skylines of US cities from the late nineteenth century. The historical account covers the construction of buildings with structural steel, from bridges to skyscrapers, and demonstrates how technical choices were intertwined with aesthetic considerations and the interests of architects, engineers and entrepreneurs. The third chapter by Rosen continues the discussion on buildings and the shaping of cities. It examines the influence of the electrification of cities on the form of the skyscrapers and the shaping of the cities skylines in the period from the 1920s to the 1930s. The author makes her case by analysing archival material on the controversies that surrounded the introduction of zoning laws that aimed to guarantee a minimum of light and air in the crowded business centres of large cities.

The three following chapters shift attention to cases outside the USA and deal with the theme of the relationship between technology and the state. Hecht examines aspects of technology and national identity in post-war France. In particular she studies the way the building of nuclear reactors, the so-called "nuclear programme", is interwoven with the shaping of French national identity and the French efforts to maintain their position in world politics. The following chapter by Allen addresses a theme that forms a "black box" in the history of technology, namely the technology of management and its relation to broader issues of power in society. His case is the technology and management of the labour camps for prisoners in Nazi Germany. The chapter by Lindqvist examines the relationship between technology and political power by focusing on the way technology gets implicated in the formation of a particular ideology and national identity. His narrative portrays the way technological systems, such as the railways, get bound up with the social and political order of the Italian society in the period of fascism.

The last three chapters deal more explicitly with the issue of technological change. Lassila studies the attempts to promote solar heating in Finland in the period from the 1970s to the 1990s. She traces the social and economic circumstances that are implicated in the successes and failures of the efforts to develop and commercialize the new technology. The chapter by Summerton examines the current transformations of infrastructure systems, such as electricity, water and telecommunications, as a result of privatization and deregulation. Her study suggests that our traditional understanding of such systems, and the concepts of their management, ownership and control, are challenged by the current changes. She argues for the need to develop new analytical concepts to improve our understanding of contemporary technological change. In the last chapter Kaijser revisits the question of the changing of technological systems in relation to social order and the organization of society. His narrative covers a broad historical period during which the Dutch managed to cope with the natural environment of water, canals and dikes. He traces the changes of what he calls the "hydraulic" order of society, with which the Dutch manage and control their relation to water, to the benefit of social prosperity and welfare.

Overall, the book succeeds in giving a good idea of the concerns, analytical approaches and contributions of historians of technology within the interdisciplinary field of SCOT. In this sense, the reviewed volume is a valuable companion to most cited sociological and anthropological studies of technology.

Eric Schatzberg, discusses the introduction of electrical street trolleys in American cities. His main concern is to sensitise urban historians that technology is neither just an external factor in the cultural history of cities, nor an uncontested choice of cultural preference. To that end, his case study demonstrates the simultaneous shaping of technology artefacts and cultural meaning through the mediation of politics by tracing the way the choice of electric street cars in the cultural setting of the late eighteenth century American cities was subject to the political struggles of who would bear the costs and reap the benefits of that particular technological change.

Amy Slaton and Janet Abbate's chapter discuss the development of standards at the work place of American organizations. They engage mainly with the concerns of historians of work and seek to show how the development of technology standards implicate tradeoffs of work efforts and responsibility among groups of workers, between industry sectors and between producers and consumers. They do this by studying the emergence of standards in two different areas – construction industry and Internet communication protocols – highlighting evidence that technological choices are not a techno-economic process of rationalization as they implicate political interest and authority.

The following chapters shift focus to empirical settings and issues of macro-level analysis, such as the ideology of modernity, professional authority, national identity, and regional geo-politics. Edmund Todd examines regional differences in the technological electrification infrastructures of Germany in the early nineteenth century. He shows that the choice of electrification technologies, far from following a technological imperative, was subject to the ideological biases of the engineers who developed them. Todd's case study aims at revealing the way three German engineers strove politically, but with a religion-like belief for a particular future of social structures, to make technology fundamental to decisions regarding the organization of systems of electrification.

Michael Thad Allen's case study addresses the historians' concern with the notion of modernity and he seeks to debunk the view that technology plays a rationalizing role in the emergence of modern democratic societies by showing the way technology was central in the National Socialist ideology of modernity of Nazi Germany in which it was mobilized to serve the most irrational undertaking of humanity: the Holocaust.

Erik Rau examines the emergence of the field of operational research in the context of British history in the post-World-War-II period in terms of politics for the establishment of professional authority. The chapters by Gabrielle Hecht and Hans Weinberger discuss the way technology was implicated in the national politics of France and Sweden in the Cold-War era. Specifically, Hecht associate the choice of nuclear reactor technology in France with that country's political struggle to maintain and strengthen its national identity in the context of the Cold-War super-power polarity. Weinberger discusses the way technology came to negate the Swedish principle of neutrality in the international relations of the Cold War.

In broad terms, the core message of this stream of history of technology studies is that technology does shape the history of society, but this shaping must always be understood in social as well as technological terms. Social choices shape the development of individual technology artefacts as well as the development and establishment of the technological systems that, endowed with physical, financial, and institutional durability, constitute the infrastructures of modern societies. The

materiality of the technology does matter. But, as material manifestations of human choices, technological systems embody, reinforce and enact social and political power. This conception of the technology/society relationship does not break new ground for IS scholars already familiar with the debates in SCOT, but it reinforces an understanding of a socio-technical relationship that avoids the pitfalls of technological and social determinisms.

A common thread through the chapters of this book is the question of how technology, power, and authority are mutually constituted. I find this concern of particular importance in the effort of IS theory to go beyond the debunking of technological determinism and to elaborate satisfactory analyses accounting for the way IT is implicated in the constitution of contemporary socio-economic orders. To that end, IS scholars can find useful analogies between the cases of IT innovation in contemporary social settings they study and the narratives on the mutual constitution of technologies and politics in the cases discussed in this book.

Nevertheless, the diverse cases and thematic attention do not amount to a clear conceptual basis for understanding the connections of technology, power and authority. Take for example the concept of ideology, which is used in the analysis of many of these empirical studies. In some chapters it refers to the ideas and motivations that fuel the actions of individuals, such as Hubbard in Carlson's case study, in others to the political aims pursued by national governments, such as the Swedish position of neutrality in the Cold War. There may be a link between these meanings of ideology but it is not explored in here. Also, in most cases the ideas and beliefs of the actors studied are associated with some form of nationalism, whether in the form of American progressivism, the French ambition to regain past glory, German Nazism, or the Swedish ambition not to succumb to the polarity of the two blocks of Cold War superpowers. Is this a coincidental common feature of the cases collected in this book, or an intrinsic aspect of the notion of ideology that is still relevant in today's assumed era of globalization? What other systems of belief and lines of distinction may be packed in the notion of ideology? Religion? Gender? Or is ideology unpredictably context contingent and should be traced without preconceptions in each case under study?

Also one can notice interesting omissions in the cases selected for study. All case discussed here show a mutual reinforcement of ideology and technology: they demonstrate how certain technology development avenues are pursued in relation to particular ideologies, which in turn appear to be consolidated or further unfold through the establishment of the technological systems they fostered. There is no case of technologies that did not find fertile ideological context. Particular technology/ideology instances may have been contested and defeated by others, but overall technology innovation has successfully occured. Nevertheless, endemic technology innovation failure appears to be a common problem in the area of my research, IT in developing countries and I am interested in understanding what might explain technology/ideology alignment or non-alignment? Are certain ideologies conducive to specific technologies, inimical to others, or none at all?

No answers to such questions can be found in this book. The authors neither elaborate a theoretical position on the nature of ideology nor make references to the literature debating the nature of ideology and power. But without delving into such theoretical fundamentals, the accounts of different cases appear fragmented and

isolated. Of course the book succeeds in convincing the reader that the technology/society relationship should be addressed as a process of mutual constitution, which was it main objective, but it then begs questions on the nature of the constituent parts, the conditions under which the virtuous circle of the mutual reinforcement relationship may occur, or the features of the emerging socio-technical entities.

In short, the chapters of this book are useful for maintaining the challenge to the still dominant techno-economic discourse, they can make rich cases for classroom discussion, and can be recommended as insightful reading to intellectually curious IS practitioners. For IS scholars already familiar with SCOT, the book is likely to provide the seeds for the crystallization of questions in the search for more satisfactory theoretical foundations of the technology/society relationship. This is not a small achievement for a collection-of-articles book.

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