

Narrative Networks: Patterns of Technology and Organization

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This paper introduces the *narrative network* as a device for representing patterns of “technology in use.” The narrative network offers a novel conceptual vocabulary for the description of information and communication technologies (ICTs) and their relationship to organizational forms. We argue that as ICTs have become increasingly modular and recombinable, so have organizational processes and forms. The narrative network draws on concepts from structuration theory, actor network theory (ANT), and the theory of organizational routines. A narrative network expresses the set of stories (performances) that have been, or could be, generated by combining and recombining fragments of technology in use. This paper discusses how thinking of technology and organizations as narrative networks influences our understanding of design.

Key words: information technology; organizational form; narrative; organizational routines

Introduction

To see how technology and organization are intertwined, we need to study people going about their work: *people* using *tools* to do *tasks*. The interconnected nature of people, tools, tasks, and organizational form is a well-known phenomenon, demonstrated by decades of research on sociotechnical systems (Trist and Bamforth 1951, Woodward 1958, Emery 1959, Perrow 1967, Thompson 1967, Pasmore et al. 1982, Grint and Woolgar 1997). With modern information and communication technologies (ICTs), people, tools, and tasks are more vividly interconnected than ever. People and organizations are recombining modular chunks of network-based functionality to accomplish all kinds of things. We use cell phones to exchange photos; we use global positioning systems (GPS) to get directions; and it seems like we use websites for everything. These novel combinations are transforming traditional organizational processes such as logistics, sales, and customer service (Andal-Ancion et al. 2003). As many commentators have pointed out, the economic importance of these technologies and the services they enable has been steadily increasing relative to agriculture and manufacturing (e.g., Chesbrough and Spohrer 2006). What we need now is a conceptual vocabulary that facilitates describing and theorizing these phenomena and their implications for organizational processes.

In this paper, we introduce the *narrative network* as a way to fill this need. We use the term “narrative” to emphasize a set of actions or events that embodies coherence or unity of purpose (Abbott 1992, Abell 2004). We

use the term “network” to emphasize that these actions can be interconnected in many different ways. There is not just one narrative that describes organizational forms such as “hierarchy,” or functions such as “e-commerce” or “vendor-managed inventory.” Rather, the social world can be seen as a “network of stories” (Abbott 1992, p. 438) drawn from a sea of phenomena that constitute the potential for making stories. We suggest that the use of ICTs to accomplish organizational tasks and enact organizational forms can be conceptualized and empirically summarized as patterns of narrative fragments connected into networks. In Orlikowski and Iacono’s (2001, p. 126) terms, a narrative network is an “ensemble view” where technology is “enmeshed within the conditions of its use.”

The combination of terms—narrative network—is disruptive of the traditional ways in which many readers understand the terms separately. We use the term network to draw attention to both potential and realized interconnections between actants and actions and the fluidity of these interconnections. Different interconnections make different stories, transforming the context and, therefore, the nature of the things that are connected. The networks we talk about, thus, are not stable entities but are a means of making movement visible.

Narrative is also a term with many meanings, not all of which we incorporate in our analysis. In particular, narrative is often used to convey rich contextual information in relation to a series of events. While we recognize the importance of such contextual information, for the

purposes of this paper we have focused more narrowly on the series of events that makes up the core story. This emphasis on the series of events brings action and agency into focus and positions these important phenomena for further analysis.

By representing organizational forms as emergent patterns of activity, the narrative network builds on the sociological tradition that treats patterns of interaction as “organizational forms” (Barley 1986, p. 100). Barley (1989, p. 42) traces this perspective through Robert Park (of the Chicago School of Sociology) to Georg Simmel, who conceived of social forms as “patterns of interaction whose repetition accounts for the coherence and reproduction of bounded social worlds.” The emphasis on patterns of interaction is consistent with the trend in the organizational literature away from “organization” toward “organizing” (Weick 1979) and the resulting focus on the *enactment* of organizational forms. The basic properties of ICTs provide occasions for structuring organizational forms that go far beyond older technologies where the features and functions are relatively fixed. Designers may envision certain patterns of use but people using tools to do tasks can selectively (re)produce these patterns and invent entirely new ones. By combining and recombining various fragments, we (re)create our world.

The paper begins with an example of the phenomena we hope to encompass: purchasing an airline ticket. Airline ticketing includes sales and service in a way that has transformed the structure of the industry and the organizations in it. Customers research their own flights, finalize the reservation and payment, and assign their own seats. On some airlines, they can even check themselves in. While it seems commonplace now, this way of doing business via ICTs was not possible until the mid-1990s.¹ Through this example, we identify the distinctive features of ICTs that facilitate novel organizational forms.

The narrative network is an analytical device for describing, visualizing, and comparing these patterns. Rather than offering a new theory of technology and organization, the narrative network offers a methodology that builds on insights from existing perspectives, such as structuration (Orlikowski 2000), actor-network theory (ANT) (Law 1992, Latour 2005), and the theory of organizational routines (Feldman and Pentland 2003). We use the airline ticketing example to describe the methodology of constructing a narrative network. We conclude the paper by discussing the opportunities created by this approach to visualizing technology and organization.

“I Used My Computer to Buy an Airline Ticket”

When organizational scholars describe technology in terms of abstract categories or properties, the details and

features of specific technologies are often lost. These omissions are worrisome because research and practical experience have shown that when it comes to ICTs, the details matter. For this reason, we start from a narrative perspective: What does a person *do* when s/he uses tools to accomplish a specific task?

To make our discussion as concrete as possible, we have selected an example with which our readers may be familiar: purchasing an airline ticket. For convenience, the example is written in the first-person present tense. We will return to this example throughout the paper.

One Story

I need to fly to Denmark, so I have to buy a ticket. Before I pick the specific dates and buy my ticket, I need to figure out if I can afford to make a side trip to the original Legoland in Billilund with my family. If it looks workable, I will get tickets for my spouse and child who are big Lego fans. This requires checking maps, train schedules, hotels, and so on.

My laptop allows me to bring together a set of tools (including the laptop itself) that are perfect for all this research. When I turn it on, the built-in WIFI interface negotiates a connection with the nearest access point it can find (when I’m sitting outside, it usually connects to my neighbor’s house). Once the computer is finished booting up and connecting to the network, I launch my Web browser. I visit several websites to gather information.

Once the plans are settled, I can shop for a flight and purchase the tickets. I am not sure what airline will offer the best deal or the best itinerary. So I start by visiting sites like Expedia, Orbitz, and Travelocity to see what the market is like. The best itineraries seem to connect through Amsterdam, since there are no nonstop flights to Denmark from my home town. Luckily, it looks like my usual airline has a good flight at a reasonable price.

I go to my airline’s website and login by entering my name, frequent flier number, and personal identification number (PIN). After entering my itinerary and choosing my flights, the website asks me if I want to select seats. It presents me with a map of available seats and I pick the ones I want. To complete my purchase, I enter my credit card number, including the three digit security code on the back. The website checks with VISA to authenticate my credit card. It gives me a confirmation number and suggests that I print the confirmation page. I print the confirmation page so I have a record of the transaction. The website also sends me an email confirming the transaction.

Many Stories

We have told this story as it appears from one particular point of view: a person sitting at home, using a computer. Each person booking a flight makes choices in researching, reserving, paying, and selecting seats, and

each choice entails some use of ICTs. Of course, this is only one story of many that could be told about this event. As Abbott (1992, p. 438) notes, the social world has “multiple plot structures”:

Every event lies in many narratives at once. Every event has multiple narrative antecedents as well as multiple narrative consequences That is, the full social process, when viewed in narrative terms, makes up a network of stories flowing into the present and future.

In this view, organizational forms (including e-commerce, as exemplified by airline ticket sales) can be understood as a network of interconnected, overlapping stories. What kinds of stories are constitutive of “airline ticketing”?

- There are other participants in this specific story, each of whom sees the story from a unique perspective. For example, we could tell the story from the perspective of one of the Web servers.

- There are simultaneous, parallel stories. For example, there are other people purchasing tickets for the same flight, each of whom has their own story and their own specific way of using ICTs to accomplish the transaction. And, of course, there are other people purchasing tickets for other flights, all of whom are engaged in “airline ticketing.”

- There are alternative ways in which each of these stories can unfold. For example, I might have purchased the ticket on Orbitz or Travelocity instead of purchasing directly from the airline. And I might have telephoned for seat assignments, instead of using the Internet.

- There are also other intersecting stories. For instance, there are stories that produce the airline’s pricing structure, including the price’s for the specific flight in our featured story. There is also a story of the construction and maintenance of the World Wide Web that is so important to our ability to enact the buying and airline ticket story.

The point is that “airline ticketing” is not just one story. There is more than one way to buy an airline ticket and there is more than one set of tools for doing so. Feldman and Pentland (2003) make a similar point in their analysis of “hiring.” Anyone familiar with hiring can produce an abstract summary that is fairly stable (advertise, collect resumes, screen applicants, . . .), but the actual performances are different every time and from different perspectives. Similarly, anyone familiar with airline ticketing knows the basic story (research, reserve, pay, . . .), but each and every instance is different. Thus, the organizational forms that we recognize as “hiring” and “ticketing” are constituted of multiple stories. This multiplicity motivates everything that follows here; we regard it as central to understanding ICTs and organizational forms.

The Role of Technology

Throughout the ticket purchase story, ICTs played several key roles. Nearly every action in the story required

some technology, although it is often hidden or taken for granted. For example, each time the user clicks on a link or a button in the Web browser, the storyline jumps to some distant data center. Even if we skip the long and circuitous trip along the information superhighway, with miles of fiber optics and possible trips to satellites in space, there is plenty to tell. The Web server will examine the details of each request (origination, destination, dates, number of passengers, and so on) and send back an appropriate HTML page. To do this, the Web server must make requests to an application server. The application server’s job is to create itineraries that meet user preferences (e.g., nonstop flights only). To do this job, the application server must query the flight database server to see what flight segments are available.² Some of these connections are initiated by the user (e.g., connecting to the website in the first place), some are pre-configured by the engineers who designed the system, and some are configured dynamically by the technology itself (e.g., the network routing).

The potential significance of new ICTs arises not just from their individual function, but from their potential for recombination (O’Reilly 2005, McAfee 2006). As one commentator noted in *The New York Times*:

The Internet is entering its Lego era. Indeed, blocks of interchangeable software components are proliferating on the Web and developers are joining them together to create a potentially infinite array of useful new programs. (Markoff 2006, p. E1)

Through these recombinations, familiar activities such as shopping, watching television, or talking on the telephone can be transformed. For example, we can download TV shows to our iPods or stream them over the Internet from our digital video recorders to our laptops. In this way, we can “watch TV” without using any device that could be recognized as a television. Similarly, we can use voice over IP (VoIP) to “make a phone call” without a telephone. Equally important, we can make a telephone call without a telephone company.

While single-user Internet-based software technologies exemplify the phenomena most clearly, a similar trend is apparent in the world of large-scale enterprise systems. Enterprise resource planning (ERP) and customer relationship management (CRM) systems are composed of modules. They can be extended and recombined with additional “bolt-on” applications and “middleware” that serve all kinds of specialized functions (Coyle 2002). The emergence of Web services and “service-oriented architecture” (SOA) provides even finer grained, readily combinable chunks of functionality (Chen et al. 2003, Cherbakov et al. 2005). This technology allows organizations to use pieces of ERP functionality without having to acquire the whole ERP system. Firms who wanted enterprise functionality used to have to purchase large

software “packages” and it was common for many functions to go unused. Now, they can just pay for the services they use.

Thus, across the entire spectrum of ICTs, from the smallest scale to the largest, it seems that the Lego era is upon us. ICTs seem to have occasioned a huge array of organizational innovations (McAfee 2006). In financial services, we have online banking and investing and mortgage application, approval, and origination. In education, we have distance learning and adaptive testing. In daily life, we have shopping, entertainment, getting directions, and finding a mate. Even in Woodward’s (1958) original domain of manufacturing technology, we have mass customization, flexible specialization, and third party logistics. Most of these innovations have occurred in the last 10–15 years. While organizational scholars have long recognized the linkages between ICTs and organizational form (Fulk and DeSanctis 1995, Baskerville and Smithson 1995), our conceptual frameworks for understanding these linkages are still rooted in the world of relatively fixed, monolithic technologies of the 1960s.

ICTs Expand the Set of Possible Stories

If we view social and organizational forms as collections of stories, then anything that influences the “plot structure” is organizationally significant. Thus, ICTs are significant for organization theory because they influence the set of possible stories. ICTs provide new and different ways for people to use tools to do tasks: across space, across time, with different participants, and so on. Until 1996, computers could not be used to buy airline tickets, but now this story has transformed the travel industry.

The transformative potential of ICTs arises from some well-known properties of the technology itself. These have been identified elsewhere (e.g., Orlikowski and Iacono 2001, Coyle 2002, Markoff 2006); we summarize them here to underscore the ways in which the technological landscape has changed since the 1960s. We consider these properties “basic” in the sense that they are an essential aspect of any technology that we currently recognize as an ICT. Anything lacking one or more of these properties is probably not an ICT.

Modular. ICTs consist of small pieces or modules that tend to be useless in isolation (Orlikowski and Iacono 2001). For example, HTML was an integral part of our story about the airline ticket, but it would have been useless without HTTP (hypertext transport protocol) plus a myriad of servers, routers, and network protocols that together form what we take for granted as the Web.

This is a familiar aspect of many kinds of technology. For example, anything that runs on electricity requires a power source (maybe just a battery, but typically a vast network of power plants, transformers, and distribution

lines known as the power grid). With ICTs, as with Legos, the modular nature of the artifacts is particularly evident. Modularity, layering, and standardization have been used as conscious strategies to increase the potential for interoperability and reusability of the pieces (Coyle 2002). So an ICT is almost never just one thing; it is an ensemble.³

Recombinable. People can recombine ICTs in many different ways to serve many different purposes (O’Reilly 2005). The same laptop one uses to purchase an airline ticket can be used to view a TV show or place a phone call. ICTs are not just interchangeable, like mass-produced parts where there is an equivalency between standardized parts for a given purpose. Rather, by creating different connections between them and possibly reprogramming them, they can serve different purposes. One can add new components to a computer network that transform the network into a medium for television or telephone. And one can often substitute ICTs quite easily. If one has trouble purchasing an airline ticket over the Internet, one can pick up the telephone and talk to a travel agent, thereby substituting one ICT for another. Substitutions and recombinations multiply the possible storylines for accomplishing tasks.

Distributed. It has been widely observed that ICTs bridge time and space (Cairncross 1997). People use tools to do tasks, but ICTs allow people, tools, and tasks to be separated by both time and space. We can choose a seat on an airplane that will not take off for weeks. Where we used to visit the ticket counter to get a printed, paper ticket (produced through the physical transformation of a material object), that is no longer necessary. We can use a computer to buy a ticket from nearly anywhere in the world. In this way, the spatial and temporal distribution of the parts of a technical system opens up the space of possible stories associated with this organizational form.

Communicative. ICTs facilitate communication between people. They also communicate with one another. We deliberately use the phrase “information and communication technologies” and not just “information technologies,” or “advanced information technologies” (DeSanctis and Poole 1994). The ability to communicate relies on even more basic properties, such as the inscription of symbols, encoding of rules, and so on. It is their communicative nature *per se* that makes ICTs particularly significant to organizational scholars. Communication is central to, and constitutive of, social organization. For this reason, ICTs would be important even if they only mediated communication between people. Their ability to communicate with each other (e.g., via TCP/IP) and mediate communication between one another reinforces this importance.

Memory. All but the simplest ICTs have the ability to store and retrieve information. In other words, they support “inscription” (Latour 1987, Orlikowski 2000, Foray and Steinmueller 2003). While memory is often a modular, recombinable element of larger ensembles, it stands out as a basic property of ICTs for two main reasons. First, memory allows ICTs to store instructions (programs) that define their functionality. Software can transform the functionality of computers, PDAs, cell phones, and other programmable devices.⁴ Second, memory allows ICTs to store and retrieve data as in the database of flights, seat assignments, and tickets sold. Memory is what enables the most striking part of the airline ticketing story: We can buy a ticket and eventually get on the airplane without ever having an actual ticket.

The properties of ICTs influence possible storylines in many ways. At the simplest level, ICTs can provide additional ways to do a given step. For example, I can send a message via voicemail, email, or fax. I can launch a Web browser on my computer or on my cell phone. Over time, ICTs may create the possibility of larger changes in the possible plot structure as well. For example, the communicative quality of ICTs lets innovative organizations change the physical location of various parts of an overall process. This creates the possibility of call centers in Ireland and India. We can also change who is allowed to do certain steps. Consumers no longer need to present their credit card in person for the clerk to verify the signature on the back. Rather, we can enter digits on a website which the Web server will verify with a request to a credit card clearinghouse. Rather than issuing actual paper tickets, the airline can use ICTs to remember who bought which seat. Social and economic factors influence which alternatives become institutionalized but, almost by definition, innovation expands the space of technically feasible alternatives. With ICTs, the expansion of alternatives appears to be a combinatorial explosion (O’Reilly 2005).

Theorizing the Lego Era

What insights does social or organizational theory have for this phenomenon? What implications does this phenomenon have for social and organizational theory? Latour (1991) posed the problem as follows:

The main difficulty of integrating technology into social theory is the lack of a narrative resource. We know how to describe human relations, we know how to describe mechanisms, we often try to alternate between context and content to talk about the influence of technology on society or vice versa, but we are not yet expert at weaving the two resources together into an integrated whole. (p. 111)

While progress has been made, scholars have pointed out that we still have a tendency to swing between social

and material determinism (Berg 1998, Orlikowski and Barley 2001). In this section, we draw on some key ideas from structuration theory, ANT, and a theory of organizational routines to help us weave the kind of sociotechnical tapestry that Latour (1991) seems to have been envisioning.

Structuration Theory

Even though the original formulation made little mention of technology, Giddens’s (1984) theory of structuration has been highly influential in the literature on organizations and information systems (Orlikowski 1992, DeSanctis and Poole 1994, Jones and Karsten 2003). The recursive nature of agency and structure is one of the key ideas of structuration theory. Rather than seeing either agency or structure as primary, a structuration perspective theorizes them as mutually constitutive. Agency produces and reproduces structure; structure constrains and enables agency. Conceptualizing agency and structure as mutually constitutive focuses attention on the interaction between them and raises questions about where to place technology in this relationship.

While some early applications of structuration theory suggested that technology served as a vehicle for embedding social structure, Orlikowski (2000, p. 406) argues that such interpretations differ significantly from Giddens’s (1989) original concept. In particular, social structure can not be embedded in technology or any other material entity that is apart from society. Giddens (1989) makes this point very clearly:

... a position I want to avoid, in terms of which structure appears as something “outside” or “external” to human action. In my usage, structure is what gives *form* and *shape* to social life, but is not *itself* that form and shape—nor should “give” be understood in an active sense here, because structure only exists in and through the activities of human agents. (p. 256)

Structure exists through action, as it is enacted by participants. Technology is a resource for enacting structure, not a vehicle for embedding structure. Orlikowski (2000) articulates this idea as follows:

Rather than starting with the technology and examining how actors appropriate its embodied structures, this view starts with human action and examines how it enacts emergent structures through recurrent interaction with the technology at hand. (p. 407)

Orlikowski (2000) refers to these enacted structures as “technology in practice.” She argues that recurrent interaction with technology over time tends to create behavioral and interpretive templates whereby the technology in practice can be “stabilized for now”:

... even as technologies-in-practice may become institutionalized over time, this is only a stabilization for now. Every engagement with technology is temporally and contextually provisional, and thus there is, in every

use, always the possibility of a different structure being enacted. (Orlikowski 2000, p. 412)

Our example of buying an airplane ticket illustrates the construction of a network of actants and actions as a means of making purchases. The structure of online purchasing exists as a result of many diverse actions that created the technologies and the ability to connect them *and* the repeated practice of consumers who connect these technologies to make purchases. Without the participation of consumers, the structure would only be a possibility.

Actor Network Theory

ANT complements and extends the idea of “technology in practice” and its contingent “stabilized for now” quality (Law 1992). ANT has become an increasingly popular way to analyze information systems (see also Walsham 1997, Doolin and Lowe 2002, Mutch 2002, Hanseth et al. 2004, Faraj et al. 2004). There are many variants of ANT (Law and Hassard 1999, Latour 2005), yet there are some core ideas we will enroll and translate here, as follows.

First, ANT offers the principle of translation—indeed, ANT is sometimes referred to as the “sociology of translation” (Law and Hassard 1999). Translation is a way of understanding how the use of ideas and objects change as they move from one context to another. Translation is perhaps best understood in contrast to diffusion. Where diffusion implies that the idea or object remains the same as it moves from one context to another, translation implies that the idea or object changes (Latour 1986, 1996). For this reason, “the meaning of ‘translation’ in this context far surpasses the linguistic interpretation” (Czarniawska and Joerges 1996, p. 24).

Latour (1991, pp. 105–106) identifies translation as the “first principle” in studying technology: In spite of what its designers may intend, the fate of an artifact is “in the hands of others.” In some cases, the extent of translation may be so minor it goes unnoticed (e.g., when Web browsers are used for browsing the Web). In other examples, the translation is more striking (e.g., when cell phones are used as bomb detonators). Translation is roughly analogous to the concept of appropriation (the act of changing a thing by using it) in adaptive structuration theory (DeSanctis and Poole 1994), except that the distinction between faithful and unfaithful makes no sense from the perspective of ANT. Translation is fundamental to our ability to recombine artifacts in different ways.

Second, ANT defines actants as a category that includes human and nonhuman members (Latour 1991, Law 1992). Regardless of one’s stance on the more radical versions of ANT, which propose complete symmetry between humans and nonhumans, any analysis of technology and organization needs to include both people and machines. Treating humans and nonhumans as

functionally similar reflects the empirical reality that in many situations, machines can substitute for people and vice versa. For example, when shopping for an airline ticket, one can visit the website of each different airline looking for the best deal. Alternatively, one can visit a website like Orbitz that does the comparison shopping for you. Similarly, one can plan an itinerary, select seats, and purchase the ticket with the help of a human or with the help of a website. From simple answering machines to the most sophisticated voice response systems (“What is your destination...?”), ICTs act as our agents. The substitutability is not perfect or complete, but it is a commonplace aspect of ICTs that should be reflected in our conceptual vocabulary.

Finally, ANT gives us the idea that organizational forms can be conceptualized as stabilized, heterogeneous networks (Law 1992). Law argues that “the social is *nothing other than patterned networks of heterogeneous materials*” (1992, p. 381, emphasis in the original). As Latour (2005) argues, the “social” lies in *associations* between the actants. The heterogeneity refers to the inclusion of both human and nonhuman actants, as discussed above. Stabilized networks occur when patterns of actants appear together repeatedly (Latour et al. 1992). If the pattern is sufficiently stable, it may become a “black box” (Latour 1987). Black boxes are often political phenomena in that they constitute a dominant program that serves the interests of some group. By black boxing a pattern of actants, the pattern is seen as an integral entity and the processes of enrolling and translating actants are hidden (Law 1992). The extent to which patterns remain stable (and therefore hidden) is an empirical question because, in principle, they are always contingent. The contingent quality of buying airplane tickets online is relatively visible because the ability to do it is recent enough that we are very much aware of other means of completing this task.

Theory of Organizational Routines

Where ANT focuses on patterns of actants, organizational routines are defined as patterns of action: “repetitive, recognizable patterns of interdependent actions, carried out by multiple actors” (Feldman and Pentland 2003, p. 95). Organizational routines are central to our perspective here because when people in organizations use tools to do tasks, they most often do so as part of an organizational routine.

Feldman and Pentland (2003) argue that any social system that satisfies the definition of organizational routines must consist of two complementary aspects: the ostensive and the performative. Thus, the stabilized pattern we recognize as buying an airplane ticket must also embody ostensive and performative aspects. The performative aspect consists of the concrete, specific performances of the routine. Each performance is a story. In terms of our example, the performative is the

purchase of a particular ticket to Denmark by a specific person. In practice, performances are often filled with improvisations—adjustments and variations that make it possible to get things done in diverse situations.

In contrast, the ostensive aspects consist of the abstract, generalized understandings of the participants. In terms of our example, it is the general idea of buying an airplane ticket and the generalized steps involved in accomplishing this task. The ostensive is a generative resource—participants draw on their understandings of a routine to reproduce it, to plan, guide, and account for their actions with respect to the routine (Feldman and Pentland 2003). Like Geertz's (1973) concept of "models of" and "models for," the ostensive provides a model that allows participants to recognize and describe a particular activity (a "model of"). At the same time, it provides a road map for carrying out the activity (a "model for"). The ostensive aspects provide coherence between parts of a task that may be widely distributed in time and space. Like Weick's (1995) concept of sensemaking, they allow participants to recognize and organize diverse parts of a performance (a story) as a coherent whole.

The theory of organizational routines emphasizes the participation of multiple actants, since this is what distinguishes a routine as organizational rather than individual. The involvement of multiple actants (human and nonhuman) reinforces and extends the ensemble view of Orlikowski and Iacono (2001). Multiple actants insures that there will be multiple points of view, multiple understandings, and potentially multiple goals. As a result of this multiplicity, different actions may be taken and different ICTs may be used at various points in accomplishing the same routine. Moreover, though we have traditionally thought of organizational routines as the ensemble of actions taken by people in a particular organization, when we observe how tasks are accomplished through ICTs, we notice actants that are not inside the organizational boundary (e.g., the protagonist in our airline ticketing story and many of the nonhuman actants, such as HTTP). We do not mean to suggest that boundaries do not exist. Rather, there are multiple, different boundaries that depend on the point of view of the observer (Pentland 2003, Pentland and Feldman 2005).

Summary

We are starting from the perspective articulated by Abbott (1992), that social and organizational forms can be viewed from a narrative perspective as collections of stories. How can these stories be represented? How can we respond to Latour's (1991) call for a "narrative resource" that combines the technical and the social? Drawing on the key ideas from structuration theory, ANT, and the theory of organizational routines, we suggest three basic principles that should be reflected in any attempt to describe or theorize about these phenomena.

First, action has to go in the foreground. Technology enters the social world through action. This principle is consistent with Orlikowski's (2000) concept of technology in practice. Whether we conceptualize this as practice or translation, it is the task that defines the tool, at least for the time it is in use. Technology is not infinitely malleable (Kallinkos 2002), but whatever form it does take in a particular situation is the result of action.

Second, patterns are important. Across all of these theoretical perspectives, patterns define the phenomenon. Structures are enacted patterns of interaction and technology in practice (Orlikowski 2000). Actor networks are patterns of actants. Organizational routines are patterns of interdependent actions. Patterns help to guide and coordinate actions, but they can also be misleading when they become black boxes and the underlying processes are hidden.

Third, the patterns are contingent. All of these theoretical perspectives emphasize that the patterns they describe are not fixed; they are replete with possible alternatives. At any point in any story, an agent could choose to act differently, an actant could enroll and translate differently, and people could take different actions to accomplish the same task. Organizational forms are filled with improvisation and whatever representation we use should reflect this fact.

The Narrative Network

The narrative network is a method for representing and visualizing patterns of technology in use. Consistent with theory, it puts action in the foreground and expresses patterns of action in a way that retains possibilities and alternatives. Table 1 summarizes the hierarchy of concepts and their definitions from concrete to abstract.

Actants and Actions

Actants are the human and nonhuman actors. In airline ticketing, the human actants include the people researching and booking the flights as well as various personnel at the airlines and travel agencies. The nonhuman actants include the hardware and software, the satellites, the protocols, and so on. Actions connect the actants to one another (e.g., "I launch my Web browser"). With ICTs, the action is frequently something like using, communicating, authenticating, or connecting. Some actants and actions are potential or latent from the perspective of any particular narrative. When we do not use the telephone to buy an airline ticket but we know that it is available for potential use. The telephone is a potential actant.

Narrative Fragments

Narrative fragments are the basic nodes within a narrative network. Narrative fragments build directly on Hendricks's (1972) concept of a "functional event" in

Table 1 From Actants and Actions to Narrative Networks

Concept	Description	Example
Actants and actions	<ul style="list-style-type: none"> • Like atoms or elements 	<p>“the user” “the Web browser”</p>
Narrative fragments = combination of actants and actions	<ul style="list-style-type: none"> • Like molecules • Can fit into many different narratives 	“the user launched the Web browser”
Narrative = Particular sequence of functional events that cohere	<ul style="list-style-type: none"> • Like polymers or proteins • Beginning, middle, end depends on point of view of narrator • Coherence from unity of purpose 	“I launched the browser and typed in the URL of the airline website. I logged in in order to the site...” to buy an airplane ticket.
Narrative Network = Actants and actions coupled into fragments or potential fragments and connected into narratives and potential narratives	<ul style="list-style-type: none"> • Narrative fragments and the connections between them • Summary of the sequential connections between fragments that are part of a narrative, or could be used to create a narrative 	
<ul style="list-style-type: none"> • Nodes = fragments • Ties = sequence 		

Note. Example narrative network depicts the sequential relationship between twelve categories of events in technical support process (adapted from Pentland 1999).

a narrative (Bal 1985). Narrative fragments consist of at least two actants and some kind of action that occurs with them or between them, for example, “I log onto my computer.” More famous examples do not necessarily include technology: “The Princess kisses the frog” and “Cinderella dances with the Prince.” Basically, narrative fragments advance the plot. Each fragment answers the question What happens next? Yet the fragment contains more than just the action or event. Events do not happen in isolation; they occur with or between actants. It may be helpful to think of narrative fragments as little chunks of technology in use.

Hendricks’s (1972) use of the adjective “functional” does not imply that every event is well-adapted in some rational or normative sense. Functional events simply advance the plot, which can be dysfunctional for the characters (e.g., “Snow White bites the apple”). We prefer the term narrative fragment in part because it does not carry the connotation of being functional in a normative sense. Typical ICT narrative fragments involve human and nonhuman actants: “The user visits the website,” “The Web server authenticates the user,” and “The firewall blocks the protocol.” As these examples illustrate, we envision fragments of relatively short duration.

Narratives

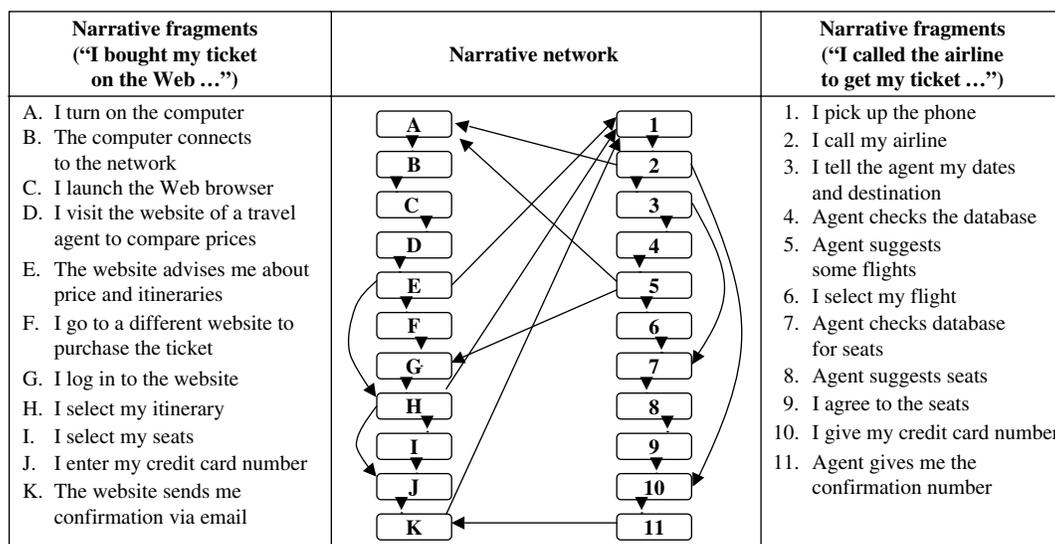
While there are many forms of narrative, here we are using the term to indicate a coherent progression or sequence of events with a purpose or goal (Rimmon-Kenan 1983; Czarniawska 1997, 1998). Hendricks

(1972, 1973) argued that a narrative can be modeled as a sequence of “functional events” of the kind we have just described. The sequence will generally have a distinct beginning, middle, and end, although these boundaries will depend on the point of view of the narrator (Bal 1985). For example, does the story end with the purchase of the ticket, or does it include the flight and the trip to Legoland?

To qualify as a narrative (rather than a chronicle or just a set of disconnected events), the fragments need coherence (White 1981, Abbott 1992, Abell 2004). Although White (1981) emphasized the importance of moral context or purpose, coherence can come from a variety of sources. In his *Poetics*, Aristotle identified unity of time, place, and purpose as three key elements in a narrative (Walker 2004). Thus, the classic Greek drama had to occur in one day, in one place, with a single dramatic point. As the airline ticket example illustrates, narratives involving ICTs are often widely distributed in time and space, which limits the utility of these classical guidelines for coherence.

For organizational narrative, unity of action or purpose provides coherence (Czarniawska 1997, 1998). Within the physical and technological limits of the situation, the connections between events (“what happens next”) are enacted in each case by the contingent actions of the participants. This is why we rely on the concepts and terminology from narrative, rather than notions of necessity and sufficiency (Mohr 1982), which locate causality outside the agency of the actants. Abell (2004, p. 300)

Figure 1 Narrative Network for Purchasing an Airline Ticket



refers to this form of coherence as “instrumentally (motivationally) linked actions.” Unity of purpose defines the function that one might ascribe to the narrative. In the theory of organizational routines, this unity of purpose makes the pattern of actions recognizable and coherent (e.g., purchasing airline tickets).

The purpose, of course, will vary depending on one’s point of view. For example, the difference between sharing music and violating copyright depends, in part, on whose point of view we adopt. The same set of fragments can create different narratives when they are assembled for different purposes and understood from different points of view.

Narrative Network

A narrative network is a tool for representing the actual and potential narratives that can be created within some sphere of activity. We use the term network to evoke the image of many interconnected elements, a maze of potential pathways from which particular performances can be identified and constructed. Actants are connected through actions into narrative fragments. Narrative fragments are connected with one another in the construction of narratives.

Nodes Are Narrative Fragments. The nodes in a narrative network are fragments of stories rather than actants. In this respect, the narrative network is similar to what Czarniawska (2004) and Pentland (1999) have called “action nets.” The nodes represent parts of stories—things that have happened or could happen. The shift in terminology from action net to narrative is more than just a difference in labels. It conveys the theoretical position that the combination of fragments form meaningful structures of technology in use and organizational form. We also use this term to allow for analysis of not

only fragments that have been enacted but also those that could be.

Kinds of Ties. The use of fragments as nodes forces attention to the connections between fragments or the kinds of ties in a narrative. Because fragments are arranged sequentially to form a narrative (Hendricks 1972, Czarniawska 1997), sequence is the most basic relation between fragments in a narrative network. This relation answers the question: What happens next? This relation implies not only chronology but also coherence (e.g., unity of purpose). In other words, just knowing that fragment A occurred before fragment B does not establish a relation between them. They must occur sequentially as part a coherent story, as discussed above.

Figure 1 contains an example of a narrative network for our story of the airline ticket. The left-hand side of the figure includes a set of narrative fragments from the story as it was told. Note that each fragment is a functional event (Hendricks 1972, 1973), which consists of two or more actants and some action. In that narrative, the fragments flow sequentially in a straight line from beginning to end. The right-hand side contains fragments from another potential narrative about purchasing an airline ticket using a different ICT: the telephone. In these fragments, the telephone and the reservation agent are actants that take the place of many of the actants in the narrative on the left-hand side. They can also form a straight line sequence but there are many points along the way where one could jump between these stories. The ability to choose between narratives generates variety. Figure 1 includes some typical examples but readers are probably familiar with still others.

- You can research and reserve a flight online, then telephone the airline to pay (H → 1).
- You can purchase tickets online, then telephone to get seat assignments (K → 1).

- You can get flight information via telephone, then go online to purchase ($5 \rightarrow A$ or $5 \rightarrow G$).

As we add actants, the possibilities multiply. For example, what if the traveler is *invited* to Denmark, so that *someone else* books and pays for the ticket? The traveler might still research the flight and select an itinerary, then send that itinerary to the person who actually books the flight. When the arrangements are complete, the confirmation information is sent back. In that scenario, the tasks and technologies are similar but there would be additional characters and different fragments, arranged in a different sequence.

We could add fragments from narratives where we need to change a flight, or use frequent flier miles, or the credit card could be rejected, and so on. The more fragments we add, the more connections become possible. Participants can arrange the fragments in a multitude of ways. We clearly see that buying an airplane ticket is not a simple, straight-line story. It is a complex network of possibilities.

At this point, some readers may be tempted to interpret narrative networks as an ontological construct, so that ICTs and organizational forms literally *are* narrative networks. The narrative network would be cast in the role of deep structure that would generate surface level performances. While this kind of “generative structuralism” (Abbott 1992, Fararo and Butts 1999) has some appeal, this is not our claim or intention. Treating a narrative network as an independent, causal structure would violate the principle of putting action first. We prefer to think of the narrative network as a methodological device—a way of representing and visualizing patterns of action that preserves the multiplicity of possibilities inherent in any organizational form.

Contrast with Other Graphical Techniques for Narrative

There is a long tradition of using graphical techniques for representing narrative, dating back at least to Vladimir Propp’s (1927) method for charting the structure of Russian folk tales. More recently, sociologists interested in narrative have applied a variety of graphical techniques. For example, event structure analysis (Heise 1989, Corsaro and Heise 1990) provides a method of identifying routinized patterns of interaction. Event structure models are based on the examination of “*actual performances*” (Corsaro and Heise 1990, p. 34, emphasis in original). The model represents a recurrent pattern of behavior as a graph (network) where each node is an action. The arcs show events that are necessary for other events to occur. In this way, an event structure graph illustrates the classic process model (Mohr 1982). Abell (1987, 2004) offers an alternative graphical technique where the nodes are states of the world and the arcs are actions that transform one state into the next. The model we propose is similar to event structure

analysis, except that we adopt a less rigid stance on the relations between events.

Ultimately, there are many different schemes for representing processes, each with their strengths and weaknesses for different purposes (Curtis et al. 1992, Suchman 1995). For example, a typical flow chart represents the sequence of events in a decision-making process with explicit attention to the decisions (usually shown as diamonds). A narrative network also depicts sequences of events, but instead of showing one version of a process (with some decision points that introduce branches and loops), it can display a broader range of possibilities. Unlike a traditional flow chart, a narrative network represents a broader range of variations and possibilities.

How to Construct a Narrative Network

There is a great deal of latitude in the degree of formality with which narrative networks can be constructed. Our airline ticketing example is quite informal. Although it is based on thousands of hours of experience, we have presented it more like a thought experiment than actual fieldwork. Through systematic data collection and coding, however, it could be made quite formal. In the following sections, we present the basic steps required to construct a narrative network.

Choose a Focal Phenomenon and Define Its Boundary

A narrative network is defined by a generic storyline that defines some sphere of activity, like buying airplane tickets or hiring. You can set the boundaries in many ways—by time or location, for example. Burke (1969) identified five elements that help define the boundary of the narrative: scene, act, agent, agency, and purpose. Any combination of these could be used, but for most organizational research, it seems likely that purpose will be an important part of the boundary.

Choose a Point of View

Having established a boundary on the phenomenon to be studied, one needs to confront the issue of point of view. While we strive for omniscience, the appearance of a complete story usually just means that aspects have been omitted, often because they have not been considered. Actual data (collected through fieldwork) will be descriptions of events told from someone’s point of view. As a result, fieldworkers never know the whole story—at best, we get partial stories (Boje 1991). In the airline ticket example, we never see what goes on at the data center and the people at the data center can not see us. The distributed nature of ICTs guarantees that observations of any given technology will be partial and will depend on one’s point of view (Pentland 2003).

A narrative network can be constructed from many different points of view. A researcher may want to pick

a single point of view or aggregate several different ones. Alternatively, one could use narrative networks to compare the same routine from different points of view. While choices about point of view are inevitable, being aware of making a choice and leaving some perspectives out is an important part of the process.

Narrative introduces additional degrees of freedom that need to be considered. For example, narratives can be actual, typical, hypothetical, or fictional (Reissman 1993). They can be first person, second person (imperative), or third person. They can be past, present, or future tense. Each of these ways of narrating the pattern of fragments has a very different empirical and theoretical status. Designers often narrate in the second person (imperative) in an effort to dictate or control what users should do. Their narratives are future tense and basically fictional: They describe associations between actants that may never exist. On the other hand, we can make detailed observations and record those observations as actual events in the past tense. This would be typical of ethnographic field notes, for example. In the grey area between fact and fiction, we find a large array of documents and descriptions such as standard operating procedures and process maps. These documents contain narratives, some of which are actual or typical and some of which are not. These possibilities are not necessarily problematic; indeed, they could be the focus of inquiry.

Collect Narratives and Code the Fragments

Once a point of view is established, we can collect data. For example, we might collect a sample of narratives of people purchasing airline tickets. One could use any method that seems appropriate. The most difficult part of the data gathering is likely to be that people are unaware of the connections that they are making and, therefore, are unaware of certain actants and actions. In our story about buying an airline ticket, for instance, many people would tell the story skipping directly from A to D (see Figure 1)—I turned on the computer and went to the website—skipping the browser entirely even though they do have to launch a browser to get to the website. Familiarity with the particulars of the interconnections allows us to include this connection. The analytical discipline of creating fragments will help ensure that researchers uncover many of the connections that their informants are making as they engage in the task they are performing. Indeed, one of the interesting uses of this analysis would be to explore which connections are transparent and which are opaque.

Relate Nodes by Sequence

Given the fragments, one needs to put them in order. Within each narrative, one can simply consider the sequence: What happens next? In some respects, this is the easiest part of the process. Because the network model

captures dyadic relationships, even short subsequences (partial stories) are useful. If an event seems like part of the story but its sequence can not be determined, it could be treated as an isolate—a node with no ties.

The degree of formality in a narrative network depends on the application. If one's research question requires it and a large enough sample is available, one can count the relative number of sequential relations between fragments. In this case, a narrative network can be treated as a valued, directed graph (Wasserman and Faust 1994, Abell 2004). If appropriately normalized so that the transition probabilities sum to one, a narrative network could be treated as a first-order Markov model (Abbott 1992, Pentland 1999). The result can be visualized as a directed graph with arcs of various thickness between nodes (thicker lines denote more frequent paths). If most people who provide data buy their tickets online, that narrative will stand out without losing the potential for other narratives to be seen.

Applications of Narrative Networks

A narrative network primarily helps us to visualize patterns of action without losing touch with the specific performances that make up these patterns. Explaining how we summarize specific performances into generalized patterns is an important problem for understanding organizations (Birnholtz et al. 2007; Feldman and Pentland 2003, 2005; Tsoukas and Chia 2002; Weick 1979, 1995; Weick and Sutcliffe 2006; Whitehead 1978). Much of social science has simply taken for granted the abstraction and missed the processes that create it (Latour 1986, 2005). As a result, Bourdieu (1990) claims that through recognizing, we misrecognize. For instance, by focusing on stability, we miss change (Tsoukas and Chia 2002). By focusing on routine, we miss the mindful processes that constitute the routine (Feldman 2000, 2003; Levinthal and Rerup 2006; Weick and Sutcliffe 2006). The narrative network allows us to represent the tension between fixity and fluidity that characterizes many organizational forms.

Given the ability to describe and visualize, a variety of empirical applications are possible. For example, narrative networks provide a way of comparing whether an organizational form has more or less structure. When the structure is relatively rigid, the network should be sparsely connected. Lower density implies fewer paths, which may afford less flexibility and less room for improvisation. On the other hand, where structure is flexible, the network is more densely connected. Higher density implies more possible associations, which may afford more flexibility and more room for improvisation.

The narrative network can also be used to analyze and illustrate ethnographic data. Because it allows us to see central tendencies without losing the paths less often taken, the narrative network should help raise questions

for which rich contextual data are needed. For example, it might lead us to investigate the conditions under which certain exceptional patterns arise.

Exploring Organizational Change

Narrative networks might help us investigate why some patterns become stabilized in particular forms. Why are some patterns flexible while others are rigid and resistant to change? What are the connections that stabilize a particular pattern and what would disrupt these connections? In the closely related areas of adoption and diffusion of technology, the narrative network provides an alternative vocabulary for the microdynamics of change. For example, one might investigate the conditions under which one fragment gets associated with (or substituted for) another fragment. Isolates provide another point of departure for analysis. One might investigate what it would take to engage a node that is otherwise isolated. Would the incorporation of the isolate, for instance, affect the enactment of other organizational practices?

The narrative network provides a straightforward way to describe organizational change because patterns can be changed by adding or removing fragments and adding or removing connections. At each node in the network, the question of what happens next is always potentially uncertain and subject to change. The extent to which uncertainty and change are manifest is an empirical question.

Theorizing Design

Even without the benefit of empirical studies, the narrative network raises some interesting theoretical questions. For example, the narrative network challenges the idea that design is separate from and prior to use. Orlikowski and Barley (2001) have noted that technology is shaped by designers *and* users. The narrative network suggests that there is potentially considerable fluidity between these roles. The construction of particular narratives out of the fragments that join agents, tools, and tasks *is* an act of designing, whether it is done by designers or users or some blend of these. From this perspective, using *is* designing and design is emergent.

The narrative network has some implications for the growing interest in the design of ICT artifacts (Hevner et al. 2004). Current research on the designed artifact generally builds on the intellectual tradition established by Herbert Simon in *The Sciences of the Artificial*. Designers are concerned “with how things *ought* to be—how they *ought* to be in order to *attain goals* and to *function*” (Simon 1969, pp. 5–6). Simon defined artifacts in terms of their boundaries:

An artifact can be thought of as a meeting point—an interface in today’s terms—between an “inner” environment, the substance and organization of the artifact itself, and an “outer” environment, the surroundings in which it operates. If the inner environment is appropriate to the

outer environment, or vice versa, the artifact will serve its intended purpose. (1969, p. 6)

In this view, artifacts are the quintessential black boxes, with clear boundaries. Designers work inside the boundary so that users can stay outside. This classic division of labor between design and use is reinforced in the ubiquitous warning “No user serviceable parts inside.” Design science is predicated on the existence of well-defined, well-bounded artifacts. In current research on organizational design, this traditional division of labor and the assumption of well-defined boundaries appears to be alive and well (Dunbar and Starbuck 2006, Jacobides and Billinger 2006, Westerman et al. 2006).

The narrative network undermines this perspective in several ways. First, the narrative network blurs the distinction between inner and outer. Each participant has his/her/its own point of view (the traveler, the travel agent, the website, etc.), and each point of view introduces a potentially different boundary. The distinction between inner and outer works well when applied to devices that have physical covers that conceal their inner workings, reinforced with warnings about voiding the warranty if the cover is opened. The distinction does not work so well when users are combining narrative fragments into the patterns needed to accomplish meaningful routines. In this case, everyone is potentially on the inside. Users *design* their own collection of fragments, and deploy them as they see fit. I choose my laptop, my browser, my airline, and so on, and I use this configuration of resources as I please.

Second, the idea of a singular goal or purpose is undermined. Multiple participants with points of view and potentially divergent goals are the root of the difficulty. Simon (1969) makes no distinction between clients and users and assumes that designers have some idealized, rational goal. Churchman (1971) introduced the notion of a “client” whose interests may be different from the designer or the user. For example, a manager (the client) might hire a programmer (the designer) to implement help-desk software for his staff (the users). In his analysis of a failed public transportation system, Latour (1996) opened the field even further, noting that every participant (including the technology itself) had potentially divergent interests and goals. In recognition of this potential diversity, the narrative network makes no assumption about shared understanding or shared goals. A particular sequence of events is connected by unity of purpose, but the purpose is localized to the individual adding the next fragment to that particular story.

The traditional assumptions about design imply a single narrator (the manager) with a single point of view who determines how events should and will unfold. The designer/manager may also determine what happens if there are exceptions or problems. This traditional design perspective fits well with an emphasis on standard operating procedures and other material artifacts. But while standard operating procedures are certainly important

to organizational routines, they are distinct from both the specific actions people take in performing a routine and the abstract patterns that emerge from these performances (Feldman and Pentland 2003, Pentland and Feldman 2005). These performative and ostensive aspects of organizational routines have not one but many narrators. The choice of what pieces belong together as a routine varies from different organizational perspectives, and as the performances unfold over time everybody gets a choice of what happens next.

Limitations

Narrative networks have several important limitations many of which stem from the transformation of many unique, situated narratives into a single, encompassing abstraction (the narrative network). This analytical move necessarily entails some trade-offs and sacrifice. In this section, we call attention to some of these sacrifices.

Loss of Meaning

Each enactment of a particular fragment (each chunk of technology in use) can entail a different translation (appropriation) of the underlying pieces. For example, “I launch my Web browser” can be part of airline ticketing or nearly anything else. In each of these instances, it may have a very different significance. In the airline ticketing story, for example, the possible trip to Legoland was *very* significant to certain members of the family, and it spilled over into every other travel plan for the summer. Abstracting removes these details and it also removes the layers of meaning and context that surround each fragment in the network. This is where advocates of traditional narrative methods are likely to find fault with the narrative network. Once the network has been constructed, you can recover sequences of events, but you can not recover the significance of those events for the participants. This is another reason why treating a narrative network as a deep structure is a flawed idea.

Black Boxing the Fragments

A closely related problem is the likelihood of reifying the fragments. While a narrative network can help unbox the *patterns* of fragments, it tends to box the fragments themselves. The fragments can become taken-for-granted entities or black boxes. Because the fragments could be further decomposed, using them as nodes tends to give narrative networks a boxes-within-boxes feel. This reflects an important characteristic of the phenomenon: ICTs are built in layers as are the processes and organizations that use them. It is important to recognize that the fragments are constructed through the actions of human and nonhuman actants. The nodes in a narrative network can not be isolated and identified like individuals in a social network. The graphical and analytical procedures might lead us to forget that.

History and Duration

The techniques described here are applicable only to nonoverlapping events of relatively short duration. As Abbott (1992) points out, real events can have duration and they can overlap. Modeling events with duration and overlap introduces a great deal of complexity that we have chosen to avoid here. The temporal model embodied in the narrative network is built on the idea of sequence—representing event time, not clock time. More generally, it is essentially a “Markovian” approach (Abbott 1992), i.e., it represents sequence, but not history.

Conclusion

When one uses a hammer to drive a nail, everything is tangible and visible, colocated in time and space. When one uses a computer to buy an airplane ticket, the story is different. The modular, recombinable nature of ICTs guarantees that to accomplish meaningful functions, they must be organized into ensembles (Orlikoski and Iacono 2001). The distributed and communicative nature of ICTs allows these ensembles to span time and space. Unlike traditional technologies, the pieces do not function in isolation. They are not single purpose, and their function/purpose is not determined by their designers. All of this is rather different from the technology described by Woodward (1958) or Thompson (1967).

ICTs have a special relationship to organizational forms because the ensemble properties of these tools transform any given task into an ensemble of possibilities. As we have seen, new organizational forms can develop around these ensembles (Lee et al. 2006). As ICTs continue to be incorporated in the way we work, we expect that new organizational forms and processes will continue to emerge. Increasingly, we find that organizational routines consist of modular, recombinable fragments that organizational designers, participants, and observers combine to create patterns that cohere through sequence, interdependence, and purpose. The narrative network provides a new conceptual lens for analyzing and visualizing these emerging patterns of technology and organization.

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Endnotes

¹It is easy to forget how recent these technological and organizational changes have been. For example, the Acceptable Use Policy for the Internet was reinterpreted to allow commercial use in March 1993, <http://www.w3.org/History.html>. Netscape Navigator 1.0, the first widely used Web

browser, was not released until December 1994, http://en.wikipedia.org/wiki/Netscape_Navigator#Release_history. Travelocity.com, the first website that allowed consumers to access airline schedules and purchase tickets without the help of a travel agent, was launched in 1996, <http://en.wikipedia.org/wiki/Travelocity>. And until January 2001, we could not have looked up these historical facts on a free, publicly edited encyclopedia like Wikipedia.

²This arrangement of servers (a Web server, an application server, and a database server) is often called an “N-tier architecture.” By separating different functions into modules, this widely used configuration facilitates recombination. If I were to book tickets by telephone, reservation agents would be connected to the same flight database but they would use different application servers that allow them to construct itineraries and assign seats that may not be available through the Internet.

³Indeed, many ICTs are nonmaterial entities such as HTML or HTTP. Standards, protocols, and languages are not things in any normal sense of the word, yet they play a crucial role in any ensemble of ICTs.

⁴Although programmability adds to the possibility of recombination it is not essential. For example, an Ethernet cable is not programmable but it can still participate in many different combinations.

References

- Abbott, A. 1992. From causes to events: Notes on narrative positivism. *Sociol. Methods Res.* **20**(4) 428–455.
- Abell, P. 1987. *The Syntax of Social Life: The Theory and Method of Comparative Narratives*. Clarendon Press, New York.
- Abell, P. 2004. Narrative explanation: An alternative to variable-centered explanation? *Annual Rev. Sociol.* **30** 287–310.
- Andal-Ancion, A., P. A. Cartwright, G. S. Yip. 2003. The digital transformation of traditional businesses. *Sloan Management Rev.* **44**(4) 34–41.
- Bal, M. 1985. *Narratology: Introduction to the Theory of Narrative*. University of Toronto Press, Toronto, Canada.
- Barley, S. R. 1986. Technology as an occasion for structuring: Evidence from the observation of CT scanners and the social order of radiology departments. *Admin. Sci. Quart.* **31** 78–108.
- Barley, S. R. 1989. Careers, identities and institutions: The legacy of the Chicago School of Sociology. M. Arthur, T. Hall, B. Lawrence, eds. *The Handbook of Career Theory*. Press Syndicate of the University of Cambridge, New York, 41–65.
- Baskerville, R., S. Smithson. 1995. Information technology and new organizational forms: Choosing chaos over panaceas. *Eur. J. Inform. Systems* **4**(2) 66–73.
- Berg, M. 1998. The politics of technology: On bringing social theory into technological design. *Sci. Tech. Human Value* **23**(4) 456–490.
- Birnholtz, J., M. D. Cohen, S. Hoch. 2007. Organizational character: On the regeneration of Camp Poplar Grove. *Organ. Sci.* **18**(2) 315–332.
- Boje, D. M. 1991. The storytelling organization: A study of storytelling performance in an office supply firm. *Admin. Sci. Quart.* **36** 106–126.
- Bourdieu, P. 1990. *The Logic of Practice*. Stanford University Press, Stanford, CA.
- Burke, K. 1969. *A Grammar of Motives*. University of California Press, Berkeley, CA.
- Cairncross, F. 1997. *The Death of Distance: How the Communications Revolution Will Change Our Lives*. Harvard Business School Press, Boston, MA.
- Chen, M., A. N. K. Chen, B. B. M. Shao. 2003. The implications and impacts of web services to electronic commerce research and practices. *J. Electronic Commerce Res.* **4**(4) 128–139.
- Cherbakov, L., G. Galambos, R. Harishankar, S. Kalyana, G. Rackham. 2005. Impact of service orientation at the business level. *IBM Systems J.* **44**(4) 653–668.
- Chesbrough, H., J. Spohrer. 2006. A research manifesto for services science. *Comm. ACM* **49**(7) 35–40.
- Churchman, C. W. 1971. *Design of Inquiring Systems: Basic Concepts of Systems and Organization*. Basic Books, New York.
- Corsaro, W. A., D. R. Heise. 1990. Event structure models from ethnographic data. C. Clogg, ed. *Sociological Methodology: 1990*. Basil Blackwell, Oxford, UK, 1–57.
- Coyle, F. P. 2002. *XML, Web Services, and the Data Revolution*. Addison-Wesley, Reading, MA.
- Curtis, B., M. I. Kellner, J. Over. 1992. Process modeling. *Comm. ACM* **35**(9) 75–90.
- Czarniawska, B. 1997. *Narrating the Organization: Dramas of Institutional Identity*. University of Chicago Press, Chicago, IL.
- Czarniawska, B. 1998. *A Narrative Approach to Organization Studies*. Sage, Thousand Oaks, CA.
- Czarniawska, B. 2004. On time, space and action nets. *Organization* **11**(6) 777–795.
- Czarniawska, B., B. Joerges. 1996. Travels of ideas. B. Czarniawska, G. Sevón, eds. *Translating Organizational Change*. Walter de Gruyter, New York, 13–48.
- DeSanctis, G., M. S. Poole. 1994. Capturing the complexity in advanced technology use: Adaptive structuration theory. *Organ. Sci.* **5** 121–147.
- Doolin, B., A. Lowe. 2002. To reveal is to critique: Actor-network theory and critical information systems research. *J. Inform. Tech.* **17**(2) 269–278.
- Dunbar, R. L. M., W. H. Starbuck. 2006. Learning to design organizations and learning from designing them. *Organ. Sci.* **17** 171–178.
- Emery, F. 1959. *Characteristics of Socio-Technical Systems*. Tavistock, London, UK.
- Faraj, S., D. Kwon, S. Watts. 2004. Contested artifact: Technology sensemaking, actor networks, and the shaping of the Web browser. *Inform. Tech. People* **17**(2) 186–209.
- Fararo, T. J., C. Butts. 1999. Advances in generative structuralism: Structured agency and multilevel dynamics. *J. Math. Sociol.* **24**(1) 1–65.
- Feldman, M. S. 2000. Organizational routines as a source of continuous change. *Organ. Sci.* **11** 611–629.
- Feldman, M. S. 2003. A performative perspective on stability and change in organizational routines. *Indust. Corporate Change* **12**(4) 727–752.
- Feldman, M. S., B. T. Pentland. 2003. Reconceptualizing organizational routines as a source of flexibility and change. *Admin. Sci. Quart.* **48**(1) 94–118.
- Feldman, M. S., B. T. Pentland. 2005. Organizational routines and the macro-actor. B. Czarniawska, T. Hernes, eds. *Actor-Network Theory and Organizing*. Liber and CBS Press, Stockholm, Sweden, 91–111.
- Foray, D., W. E. Steinmueller. 2003. The economics of knowledge reproduction by inscription. *Indust. Corporate Change* **12**(2) 299–319.
- Fulk, J., G. DeSanctis. 1995. Electronic communication and changing organizational forms. *Organ. Sci.* **6**(4) 337–349.
- Geertz, C. 1973. *The Interpretation of Culture: Selected Essays*. Basic Books, New York.

- Giddens, A. 1984. *The Constitution of Society*. University of California Press, Berkeley, CA.
- Giddens, A. 1989. A reply to my critics. D. Held, J. B. Thompson, eds. *Social Theory of Modern Societies: Anthony Giddens and His Critics*. Press Syndicate of the University of Cambridge, New York, 248–301.
- Grint, K., S. Woolgar. 1997. *The Machine at Work: Technology, Work, and Organization*. Polity Press, Oxford, UK.
- Hanseth, O., M. Aanestad, M. Berg. 2004. Guest editors' introduction: Actor-network theory and information systems. What's so special? *Inform. Tech. People* 17(2) 116–123.
- Heise, D. 1989. Modeling event structures. *J. Math. Sociol.* 14 139–169.
- Hendricks, W. O. 1972. The structural study of narration: Sample analyses. *Poetics* 3 100–123. Reprinted in 1973, *Essays on Semiolinguistics and Verbal Art*. Mouton, The Hague, The Netherlands, 152–174.
- Hendricks, W. O. 1973. Methodology of narrative structural analysis. *Semiotica* 7 163–84.
- Hevner, A. R., S. T. March, J. Park, S. Ram. 2004. Design science in information systems research. *MIS Quart.* 28 75–105.
- Jacobides, M. G., S. Billinger. 2006. Designing the boundaries of the firm: From “Make, Buy, or Ally” to the dynamic benefits of vertical architecture. *Organ. Sci.* 17 249–261.
- Jones, M. R., H. Karsten. 2003. Review: Structuration theory and information systems research. Working Paper 2003/11, Judge Institute of Management, Cambridge University, Cambridge, UK.
- Kallinkos, J. 2002. Reopening the black box of technology artifacts and human agency. *23rd Internat. Conf. Inform. Systems*, Barcelona, Spain, 287–294.
- Latour, B. 1986. The powers of association. J. Law, ed. *Power, Action, and Belief*. Routledge, London, UK, 268–280.
- Latour, B. 1987. *Science in Action*. Harvard University Press, Cambridge, MA.
- Latour, B. 1991. Technology is society made durable. J. Law, ed. *A Sociology of Monsters: Essays on Power, Technology and Domination*. Routledge, London, UK, 103–131.
- Latour, B. 1996. *Aramis: The Love of Technology*. Harvard University Press, Cambridge, MA.
- Latour, B. 2005. *Reassembling the Social: An Introduction to Actor-Network Theory*. Oxford University Press, Oxford, UK.
- Latour, B., P. Mauguin, G. Teil. 1992. A note on socio-technical graphs. *Soc. Stud. Sci.* 22 33–57.
- Law, J. 1992. Notes on the theory of the actor-network: Ordering, strategy and heterogeneity. *Systems Practice* 5 379–393.
- Law, J., J. Hassard. 1999. *Actor Network Theory and After*. Blackwell, Oxford, UK.
- Lee, C., P. Dourish, G. Mark. 2006. The human infrastructure of cyberinfrastructure. *Proc. 20th Anniversary Conf. Comput. Supported Cooperative Work*, Banff, Alberta, Canada, 483–492.
- Levinthal, D., C. Rerup. 2006. Crossing an apparent chasm: Bridging mindful and less-mindful perspectives on organizational learning. *Organ. Sci.* 17(4) 502–513.
- Markoff, J. 2006. The software out there. *New York Times* (April 5) E1.
- McAfee, A. P. 2006. Enterprise 2.0: The dawn of emergent collaboration. *Sloan Management Rev.* 47(3) 21–28.
- Mohr, L. 1982. *Explaining Organizational Behavior*. Jossey-Bass, San Francisco, CA.
- Mutch, A. 2002. Actors and networks or agents and structures: Towards a realist view of information systems. *Organization* 9 513–532.
- O'Reilly, T. 2005. What is Web 2.0: Design patterns and business models for the next generation of software. <http://www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html>.
- Orlikowski, W. J. 1992. The duality of technology: Rethinking the concept of technology in organizations. *Organ. Sci.* 3(3) 398–427.
- Orlikowski, W. J. 2000. Using technology and constituting structures: A practice lens for studying technology in organizations. *Organ. Sci.* 11(4) 404–428.
- Orlikowski, W. J., S. R. Barley. 2001. Technology and institutions: What can research on information technology and research on organizations learn from each other? *MIS Quart.* 25(2) 145–165.
- Orlikowski, W. J., C. S. Iacono. 2001. Research commentary: Desperately seeking the IT in IT research—A call to theorizing the IT artifact. *Inform. Systems Res.* 12(2) 121–134.
- Pasmore, W. A., C. Francis, J. Haldeman, A. Shani. 1982. Sociotechnical systems: A North American reflection on empirical studies of the seventies. *Human Relations* 35(12) 1179–1204.
- Pentland, B. T. 1999. Organizations as networks of action. J. Baum, B. McKelvey, eds. *Variations in Organization Science: In Honor of Donald T. Campbell*. Sage, Thousand Oaks, CA, 237–253.
- Pentland, B. T. 2003. Conceptualizing and measuring variety in organizational work processes. *Management Sci.* 49(7) 857–870.
- Pentland, B. T., M. S. Feldman. 2005. Organizational routines as a unit of analysis. *Indust. Corporate Change* 14(5) 793–815.
- Perrow, C. 1967. A framework for the comparative analysis of organizations. *Amer. Sociol. Rev.* 32 194–208.
- Propp, V. 1927. *Morphology of the Folktale*. Translated by Laurence Scott, 2nd ed., 1968. University of Texas Press, Austin, TX.
- Reissman, C. K. 1993. *Narrative Analysis*. Sage, Newbury Park, CA.
- Rimmon-Kenan, S. 1983. *Narrative Fiction: Contemporary Poetics*. Routledge, London, UK.
- Simon, H. 1969. *The Sciences of the Artificial*. MIT Press, Cambridge, MA.
- Suchman, L. 1995. Making work visible. *Comm. ACM* 38(9) 56–64.
- Thompson, J. D. 1967. *Organizations in Action*. McGraw-Hill, New York.
- Trist, E. L., K. W. Bamforth. 1951. Some social and psychological consequences of the Longwall method of coal-getting: An examination of the psychological situation and defenses of a work group in relation to the social structure and technological content of the work system. *Human Relations* 4 3–38.
- Tsoukas, H., R. Chia. 2002. On organizational becoming: Rethinking organizational change. *Organ. Sci.* 13(5) 567–582.
- Walker, J. 2004. Distributed narrative: Telling stories across networks. *Assoc. Internet Researchers 5.0*, Brighton, UK.
- Walsham, G. 1997. Actor-network theory and IS research: Current status and future prospects. A. S. Lee, J. Liebenau, J. I. DeGross eds. *Information Systems and Qualitative Research*. Chapman and Hall, London, UK, 466–480.
- Wasserman, S., K. Faust. 1994. *Social Network Analysis: Methods and Applications*. Cambridge University Press, New York.
- Weick, K. E. 1979. *The Social Psychology of Organizing*, 2nd ed. Random House, New York.
- Weick, K. E. 1995. *Sensemaking in Organizations*. Sage, Thousand Oaks, CA.
- Weick, K. E., K. M. Sutcliffe. 2006. Mindfulness and the quality of organizational attention. *Organ. Sci.* 17(4) 514–524.
- Westerman, G., F. W. McFarlan, M. Iansiti. 2006. Organization design and effectiveness over the innovation life cycle. *Organ. Sci.* 17 230–238.
- White, H. 1981. The value of narrativity in the representation of reality. W. J. T. Mitchell, ed. *On Narrative*. University of Chicago Press, Chicago, IL, 1–24.
- Whitehead, A. N. 1978. *Process and Reality*. The Free Press, New York.
- Woodward, J. 1958. *Management and Technology*. HMSO, London, UK.