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Public Choices and Social Learning: The New Multimedia Technologies in Europe

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The idea that we are moving toward an "information society" in which the rapid and pervasive adoption of increasingly cheap/powerful information and communication technologies (ICTs) will bring far-reaching economic and social change stands in sharp contrast to the very slow and uneven emergence of such applications. This special edition of *The Information Society* seeks to understand the dynamics of the development, implementation, and use of these technologies (captured under the rubric of multimedia). Articles addressing "the social shaping of multimedia" explore the detailed process of innovation in different settings. They highlight the deep uncertainties and difficulties and the choices surrounding both the development of technology and its application and use.

Perhaps the most profound uncertainties concern the responses of future consumers and users to the new types of multimedia-based products and services that are expected to emerge. How can suppliers seek to understand the requirements of such potential users? How may user needs change with the emergence of new technologies? Technology is emerging through a complex interaction between many diverse players (suppliers of competing and complementary products; intermediate and final users and their proxies), with their own, often differing, perceptions, commitments, and interests. In this "technological ferment" it is very difficult to achieve "closure" around particular options. The outcome cannot be imposed, even by the largest players, but emerges through a complex de facto "negotiation" process among these heterogeneous constellations of players.

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SOCIAL LEARNING

The concept of "social learning" was advanced by Rip et al. (1995) to explicate the detailed processes whereby advanced technologies are developed and taken up within society. It highlights the complex processes of negotiation and flows of knowledge between different social actors and groups about technologies and their uses. We have been interested in using this concept to explore the ways in which generic ICT technical capacities are "domesticated" (Brosveet & Sørensen, in this issue)—selectively taken up and adapted to particular contexts and appropriated by users to meet existing and emergent social needs.

The focus on social learning brings a particular concern with the supplier–user interface—in other words, with suppliers' attempts to build representations of current and future users into their offerings, and the responses of various actual users to these offerings. However, social learning is not restricted to this learning economy of supplier–user interaction around the design and appropriation of artifacts, but also encompasses the activity of public policymakers, as well as promoters and other players in civil society in setting the "rules of the game." This "learning by regulating" (Sørensen, 1996) includes the attempts by policymakers to find mechanisms of influence and control that are appropriate to this evolving sociotechnical terrain.

In addition to this revealed, and not necessarily conscious, societal appropriation of technology, the idea of social learning highlights reflexive processes, regarding both the ways in which the players themselves are changing their strategies in the light of particular experiences (which are articulated into new models and programs of multimedia innovation) and the possibility that social science research can help us understand how better to organize this learning.

These considerations point to the diverse kinds of social learning processes that may arise. This article briefly reviews some of the different types of social learning, and

these are analyzed in greater detail in the articles that make up this special edition.[1]

THE GAMBLE OF TECHNOLOGY

Information technology has from its earliest days been stuck somewhere between the revolutionary visions articulated by its proponents and the mundanity of many of its current applications. This tension between expectations and what can be achieved in the short term has, in certain periods and fields, called into question the credibility of promises held out by technology (Winston, 1998). Indeed, the way that successive generations of information and communications technologies have been "sold" to the world as new "technological revolutions" in some ways represents an acceptance that earlier generations somehow did not live up to expectations, acknowledging a sense of past failure within the promise that the new generation will somehow overcome these problems. However, the success of a new technology program depends on its ability to mobilize the resources by convincing others to buy in to the vision and make the investments and commitments needed for further development. These expectations and visions can be fueled by demonstrator projects, as well as by imagined extrapolations from emerging technology potential, which may provide convincing evidence of technological futures.

The "gamble of technology" (Hamelink, 1988)—the difficulties in anticipating its outcomes and prospects—in many ways seems to become greater as the technologies become more sophisticated and more pervasive and engaging in their application, and as the costs of developing and launching new large-scale technological systems escalate. This places a premium on ways of reducing (or at least structuring) the risks and uncertainties, and of bringing the benefits into the foreground.

Currently, expectations are being built around intertwined ideas about the coming of the Information Superhighway—bringing information processing capability to every area of human life—and the Multimedia Revolution—and in many ways exemplify these tensions. Put simply, increasing computing and communication power, and the development of techniques to manipulate, store, and convey video and sound channels as well as text in a mutually compatible digital form potentially herald a new era. As our way of engaging with information technology shifts from the rather forbidding point of access of a screen full of text and figures toward a more accessible interface with graphics and video pictures, the vision has been conjured up of ICT becoming an intimate part of our lives. ICT will be directly linked to the home and all the spaces of everyday life. It will embrace the worlds of art, popular culture, and entertainment, of enchantment and pleasure, as well as the more functionally-oriented worlds of work, "defense," and science, which were the previous main abodes of computing.

These compelling images of technology and the benefits it will bring have been taken up and articulated across the globe. In this process, we can highlight the activities of many international companies in fields such as media and information services as well as information technology and telecommunications suppliers. Another powerful player has been government. There has been a remarkable proliferation of policies and initiatives by governments across the developed and even developing world (see, e.g., Kahin & Wilson, 1997; Kubicek et al., 1997). In their attempts to keep ahead of the field—or at least not be left out of these new technologies, and the social and commercial benefits expected to flow from them—we can see governments (and supragovernmental bodies such as the European Union and the G7 group of countries) trying to match or outdo each other in setting up different kinds of experiments. In this we find processes of convergence—for example, through mimicry of policies developed in other countries and through alignment of views. Despite this, as we see later, differences in emphasis and style remain (e.g., around differences in national contexts and long-standing policy styles and traditions).

In these developments, we see a close association among ICT corporations (acting in combination to promote their industry even at the same time as competing to maximize their share of these new markets) and with key sections of government, in their support for particular visions of the scale and social significance of innovation in ICTs. This tie between government and industry elites is geared toward a consensus about the need for greater ICT investments in order to achieve competitiveness and social advance (see, e.g., West, 1996). These public and private initiatives are in turn associated with particular rhetorics about what ICTs will deliver. They typically deploy arguments about an economic imperative—stressing the competitive threats to firms and nations who fail to pursue advanced technologies and the huge profits that will accrue to those who prevail, coupled with extremely utopian views of the social benefits that will be obtained. Similarly, many of these accounts stress the transformatory potential of these new technologies. Barriers of space will be dissolved; barriers within and between organizations will disappear; markets will be freer and more open; now the citizen can be in direct contact with government; computer-based education will bring the classroom to the home, bypassing the teacher and the school.

What is surely most striking, however, is the way that this remarkable consensus that has been achieved on many points, at least among certain key industry, technical, and governmental elites, seems to be in sharp contrast with the deep uncertainties surrounding the immediate prospects of this technology. What is the market for such products and

services? How big is it? Which technology applications will prove successful? Various different technical configurations are possible for the infrastructure that will carry these services. Some of the key choices here concern the platform and delivery system that will bring multimedia into the home—particularly about the nature of the terminal and its communications linkages (where different views are articulated by the various industries potentially involved), as exemplified in the case of interactive TV (Curry, this issue). Confidence about continuing advances in the power per unit price of information-processing and transmission technologies sits alongside a marked lack of understanding of these new application domains and how technology may deployed to meet current and emerging needs. Indeed, there is remarkably little evidence to date that the consumer is willing to pay enough for the new imputed services and in sufficient numbers to give a payback on the potentially enormous costs of installing new delivery systems (especially for mass-produced services directed toward the home).

If corporate strategies and public policies remain tied within technological utopian rhetoric and hype, the result could be disastrous—as evinced by the failure of some very costly, large-scale ICT projects. We cannot simply extrapolate from imputed technical potential to widespread commercial uptake. Nor can we simply extrapolate from the past. Existing models of human social activities and established needs and the role of technology in meeting them do not provide a reliable guide to future ICT-based products and services. Indeed, one of the key lessons of the history of ICT is that the conceptions of the future utility and use of new ICTs held by many of the key players have at the outset been extremely wide of the mark. This calls into question the "just-so story" approach, based on retrospective accounts of the development of successful innovations as a self-evident unfolding of a simple trajectory (whether based on human need or technical potential).

The emergence of a number of detailed historical studies of development and use of ICTs has begun to challenge such (social or technological) deterministic accounts. These include cases where the prospects of a technology were grossly overestimated (e.g., videotext, the videophone [Dutton, 1995], "Video-On-Demand") or underestimated (e.g., the telephone,[2] phonography, mainframe computers—where Thomas Watson, chairman of IBM, commented in 1943, "I think there is a world market for may be five computers").[3]

Unanticipated outcomes seem to be the order of the day, in relation to both the development and the use of these new technologies. Some of the biggest difficulties surround the nature and extent of consumer demand—especially in relation to mass-market goods and services. Indeed, meeting the needs of the "the user," amorphously conceived as a kind of generic individual, has become one of the obligatory points of departure of technology promotion programs in the 1990s.[4] The problem is that users are many and diverse. And although in previous generations of information technology adoption, users were typically members of organizations, scrutinized by and subject to various formal managerial mechanisms such as job descriptions and time and motion studies, many of the settings of use today are in the privacy of the domestic sphere or the dispersed arenas of civil society. Knowledge of these users and their settings remains pretty rudimentary. Moreover, many users of future technologies simply do not yet exist. In this sense, developers may be faced with a problem of how (and how far, as we see in Jaeger et al., in this volume) to prefigure the user in advance.

NETWORK TECHNOLOGIES: UNCERTAINTY AND ENTRENCHMENT IN TECHNOLOGY DEVELOPMENT

Perhaps most significantly, many of these technologies are what have been described as "network technologies." Their functioning and utility depend not on the individual artifact but on how the artifact is integrated into a wider network of interoperating elements. This is particularly relevant in relation to new delivery systems and platforms. Two aspects of this lend particular uncertainties to processes of technology development, relating to the (closely related) difficulties of creating and of changing large-scale systems based on network technologies. First is the problem of *entrenchment*. This arises, for example, where the commercial viability of a new technology relies on achieving a critical mass—or rather, on convincing a critical mass of players to invest in the technology (Schneider, 1991, 1997). These issues may be particularly acute where technologies exhibit economies of scale and network externalities (In other words, where the arrival of new users increases the value of the product or service to an existing user—as is the case, for example, with telephony or Electronic Data Interchange; Graham et al., 1996). Uncertainties thus arise about whether enough people would be convinced to adopt a technology to recoup development costs—to bring down the price of a product and to make it useful to consumers (e.g., by establishing a market of content providers and/or service users). The second problem, of *path dependencies*, is closely related but derives from the difficulties of changing large-scale technological systems once they are entrenched. Sunk investments into particular options and paths create path dependencies, built around particular standards and approaches (well-known examples are the QWERTY keyboard and railway track gauges), which tend to be reinforced by the increasing returns on such investment given the cumulative nature of technological advances. A new set of uncertainties arises, that

these standards and approaches may be bypassed or come to be seen as outmoded and limiting. This creates risks for both users and suppliers of "inappropriate" investment in technologies that later become obsolete. Some of these issues are particularly acute in relation to the information infrastructure, and particularly the delivery systems and end-user technology platforms in the workplace and especially the home; these are widely dispersed but together involve enormous sunk investments. The existence of multiple competing systems imposes additional costs and uncertainties on suppliers and users, culminating in standards wars (as demonstrated, e.g., by various well-known cases, such as that between Betamax and VHS systems for video recording). These experiences in turn have mobilized a further dynamic to agree a single standard (de Laat, 1999). Following from this, suppliers of new delivery systems and platforms may seek to collaborate closely with their intermediate users—suppliers of complementary products (e.g., Sony's tie with content providers in developing their interactive CD product; Collinson, 1993; Collinson & Molina, 1998). This kind of collaboration in developing standards and building markets becomes crucial to the likelihood of success of a technology.

These two interlocking processes in the creation and entrenchment of new technologies (aligning coproducers and enrolling future users in both developing artifacts and building markets) set into train further strategies that in turn compound the uncertainty and indeterminacy of technological development. Though in theory a firm might seek to develop and launch new technologies on its own, escalating development costs, globalization and pressures for standardization of many ICT systems mean that technology development has an increasingly collective character—taking the form of a networking activity, involving interorganizational linkages and modes of engagement between suppliers and "users" or their proxies. Various forms of collaboration emerge as an attempt to share costs and risks—and reduce uncertainties by foreclosing options in advance—rather than incur the costs of fighting out standards wars in the marketplace.[5] However, these efforts, paradoxically, impart a higher degree of indeterminacy and apparent fluidity to development processes. Indeed, some of the key decisions affecting the future prospects of a technology may be taken in the "virtual space" of standards-setting committees and of industry fora, where key players seek to align expectations around their particular offerings. Stewart (1999) has coined the term *poles of attraction* to describe the way in which particular conceptions of future ICTs may be proposed—to moot possible support—to seek to orient and win commitments from potential suppliers of complementary products, to inform customer expectations, to ward off competitors, and more generally to test out and shape ideas about technological futures. Recent examples include the espousal of the network computer as a solution to platform harmonization problems in distributed business computing, and a challenge to an established pole in the shape of the IBM clone personal computer and the Microsoft Windows environment. The concept draws attention to the way in which options may gain support and momentum—by aligning expectations and winning commitments and investments in particular technological routes.[6] Conversely, proffered poles of attraction may, of course, fail to win commitments; even where some momentum has been established, this may be reversed and the option may lose support and fall back into the fermenting brew of emerging technologies.

SOCIAL LEARNING AND THE EXPERIMENTAL CHARACTER OF MULTIMEDIA DEVELOPMENT

These observations point to the way in which the development of multimedia-based products and services is profoundly experimental (Jaeger et al., this issue). Given these manifold uncertainties about the behavior of other players—of collaborators such as suppliers of complementary products and in particular of the elusive "user"—one of the key ways in which a technology may be carried forward is through the launch of pilot studies and commercial trials. Firms in this sector are trying to develop more effective methods of understanding the responses of potential users. There is growing awareness of the limitations of conventional market research techniques in a context where existing concepts of product and service and of user and uses may be called into question in the face of radical changes in technologies and in the boundaries and relationships between product markets and industries. Market research techniques typically depend upon suppliers prejudging who are the likely users (e.g., in choosing an appropriate sample of consumers for polling) as well upon those selected having some understanding of the product and its utility. Firms may, for example, seek to create panels of users, who can be introduced to their offerings and requested to assess these. However, questions remain about such panels—for example, about how adequately these users represent the larger cohort of future potential users. The development of "baroque technologies" such as the microwave oven or videocassette players with programmable functions that most consumers cannot utilize provide one testament to the dangers of extrapolating consumer responses from early adopters and more technologically adept users. In this situation, trials and pilots may have a particular value (Nicoll, this issue). Here developers can learn about the acceptability, attractiveness and use of their offerings by potential users in more or less natural settings (Nicoll, this issue; Jaeger et al., this issue).[7]

Trials and Experiments Are About Process as Much as Outcome

Trials are a way to learn *how to* develop new Multimedia products and learn about uses/users as much as they are about *what* these products and services will look like. When we come to examine the "social learning processes" involved in particular initiatives, trials, and experiments, the most striking point is that players are involved in a multilevel game—and that there are many different kinds of social learning under way. This is amply demonstrated by the two case studies of interactive television services in this volume: Videoway (Curry, this issue) and the Cambridge trial (Nicoll, this issue). For example, a supplier may be concerned with addressing technical and operational problems in getting an infrastructure to work as much as in trying out particular applications. Players may also be wanting to learn about the strategies and capabilities of collaborators—and how to build a sociotechnical constituency with the resources needed to carry the technology forwards. There may be other, perhaps covert and informal, objectives—for example, firms may wish to signal their competence and establish a reputation as a future player in this and other markets (Slack, in press). Indeed we can see the more high-profile and widely publicized initiatives as part of a more "Machiavellian" strategy by firms of promoting poles of attraction within the technology ferment—seeking to attract customers and collaborators, to forestall and frighten off competitors, and generally to align expectations and in this way to build and shape emerging markets.

It is therefore important to address the complexity of the commitments, goals, and interests of the various players, which may underpin their involvement in a particular trial or experiment. *Trials may be a multilevel game*. In this sense, "the mistakes are as important as the successes" (Curry, this issue). It may not be necessary for a project to proceed to roll-out/widespread use and commercial viability of a new service for an experiment to be deemed worthwhile. Trials may offer various opportunities for learning by different participants at a number of different levels. For example, a technical trial of a new infrastructure is likely also to require trials of particular applications and thus of user contexts (Jaeger et al., this issue). Although the technology underpinning the Videotron interactive television trial has been largely superseded, Curry (this issue) notes that much of the knowledge thus obtained—about user responses, about linking with collaborators and building markets—could be applied in a different technological context. From this perspective, a key social learning ability is the capacity to unbundle different elements; to build upon relationships established; to retain and transfer relevant knowledges and creatively apply them in different settings.

Multimedia development is experimental even where it is not intended to be so. Even product launches not intended as experiments will inevitably involve a process of negotiation and exploration of the potentialities of new multimedia technology between suppliers and potential users. However, this does not imply that social learning is effective in all these cases. In such de facto experiments, it seems that the lessons may not always be systematically sought or communicated (Brosveet & Sørensen, this issue). As a result, it seems, some lessons seem to have to be learned time and time again. This raises important questions about the kinds of linkage that may exist, for example, between supply and demand side players. These considerations have important policy dimensions—about how best to promote such linkages and exchanges, and, for example, how to communicate more widely the experiences of multimedia trials.

We have already noted that those involved in experiments are learning how to manage this process internally, as well as finding out about artifacts, usage and the responses of users and other players in the market. Following Molina (1992), Nicoll (this issue) describes this as a process of building an internal sociotechnical constituency, able to mobilize the necessary resources. This can be a delicate process, particularly at the outset. Retrospective accounts of a new successful technology often miss out the earliest historical stages of an innovation process when a coherent view of the technological future was lacking, giving the impression that the organizations taking a leading role were committed to that technology from the outset. However, this is often not the case, particularly where the prospects of a technology remain fluid and unproven. Clearly the project will need an individual or collective champion (Curry, this issue). But how then can this local actor build up the internal commitments of the resources needed to bring this "tender seedling" to fruition—particularly where it may require inputs from very different specialist groups within the organization? Collinson (1993) has explored the way in which organizations in the domestic electronics sector have sought to encourage this kind of "intrapreneurship." Nicoll (this issue) draws attention to the way in which representations of the user, and thus of the potential market, can become key resources in winning internal commitments.

The process of justification of an investment are complicated enough when the main decisions are being made within a firm. But where decisions surrounding development are being shared across a number of organizations, the difficulties can become much more significant. As the case of the Cambridge trial shows, such collaboration may fail because of the difficulties of managing the relationship between players (Nicoll, this issue). This is important, given the already established point that multimedia developments are very often the product of collaborative effort

among heterogeneous "constellations" of players with diverging interests and commitments.

In a review of social experiments being conducted across Europe (Jaeger et al., this issue), we ask, "Was it not ever thus?" And indeed, demonstrators and pilots have been a feature of technologies, and especially information and communications technologies, from the outset. However, these learning processes and channels have been brought to a new level today. Two factors appear to be critical to this. The first factor is the increasing rate and dynamism of technological change, and the fact that, through the growing resort to interoperability standards, many of these innovation processes are taking place in parallel (partly mediated through the use of ICT) (Fransman, 1996; Williams, 1992); second is the fact that industrial actors and other players in this arena seem to be becoming increasingly reflexive. This is exemplified by the account, in this issue, of the lessons of Videoway by Curry, the manager most directly concerned. Managers, engineers, and policymakers increasingly seem to be seeking to theorize what they are doing. Particular industrial experiences rapidly become disseminated and discussed across the field and thus come to form part of the strategic repertoire for further technological and commercial strategies. Today every practitioner can tell you why Apple failed, despite having a markedly better product, and the IBM "clone" became the industry standard personal computer. And while attempts to "reinvent" the microprocessor (notably the Tron project under the Japanese Fifth Generation Computer Systems program and to a lesser extent the United Kingdom's Transputer) failed ultimately because its founders did not recognize the need to open it up to the existing market—the huge installed base of earlier microprocessor architectures and languages—this lesson was not lost on those who, shortly afterward, sought to promote the RISC (Reduced Instruction Set) processor in its battle with the entrenched CISC technologies (Molina, 1992).

Though it may be possible to generalize about some challenges confronting the development of new technologies and the range of strategies to meet them, much of what is learned may be highly contingent upon particular local circumstances, and much of the knowledge acquired may be tacit and hard to formalize. This is why experiments and trials are likely to be a continuing phenomenon. Some kinds of learning can be achieved only by doing (Curry, this issue).

DESIGN AND DEVELOPMENT OPTIONS

Moreover, the dynamics and rules of the game may be changing. The history of videotext provides an exemplary illustration. Uptake in the United Kingdom (where the technology was originally conceived) and Germany fell far behind expectations, while the case of Minitel in France was widely hailed as a success (Schneider et al., 1991; Berne, 1997). The much greater uptake of Teletel/Minitel in France (with over 6 million subscribers by 1990) was attributed to her centrally coordinated strategy to promote the development and use of the network—and in particular "to create demand through specific strategies in technical design and coordinated market penetration" (Schneider et al., 1991, p. 189). However, the longer term outcomes of this initiative may be more mixed. Although over the last decade the electronic information market has become established in France, with a widespread and vigorous sector of information providers, today the widespread adoption of Minitel, based on dedicated technologies and standards, in some ways constitutes a barrier to the adoption of the new, global paradigm for information exchange: the Internet and World Wide Web! Paradoxically, in Germany, an unanticipated consequence of the fact that, since the 1990s, industry standard personal computers were selected for the videotext terminal made it possible to upgrade the German teletext system to the new Internet environment (Schneider, this issue). This highlights the uncertainties surrounding technological innovation. As the context changes, successful recipes may be called into question.

In particular, as Schneider points out, there is a dilemma between the desire to cooperate—in agreeing on standards for the development of network technologies, in promoting demand and aligning it with supply to obtain the critical mass needed for commercial viability—and the risks of such interventions being made around options that turn out to be the "wrong" choices (Schneider, this issue). But this case points to the difficulties of identifying the right choice in advance. Building powerful alliances around particular options may help minimize the risk of selecting the wrong route. But this is a slow and cumbersome process, and always runs the risk of being bypassed by subsequent developments. These problems are potentially made more acute by the increasingly global scale of technology development and its decentered nature (i.e., the way it is carried forward by a range of more or less tightly coupled players, which impart a chaotic element into the development process). One possible solution may be to find ways of building flexibility into the development process (Collingridge, 1992). Rather than await the emergence of global standards, it may be possible to build migration paths and upgrade strategies into contemporary systems (Spacek, 1997). The risks of ending up with unsupported nonstandard solutions (the "angry orphan" syndrome; Swann, 1990) suggest the advantages of choosing global standard components, in the hope that future technological offerings will be designed to offer some degree of longitudinal compatibility.[8]

A related dilemma concerns how far to dedicate an application to a particular context and class of use. For

example, a highly customized application might be more attractive, by being better designed for certain uses and user settings and thus offering a higher value for particular types of user. On the other hand, such dedicated solutions will tend to be more expensive than standard offerings. Their customization is likely to involve some loss of flexibility and adaptability. Overall, the tendency would seem to favor industry standard solutions. This is particularly marked in relation to delivery systems, which may increasingly take the form of media, designed to be largely independent of the content they transmit.[9] One implication is that multimedia applications may increasingly take the form of configurational solutions—particular configurations of standard and customized components—rather than dedicated systems (Williams, 1997). A corollary is that one of the important lessons to be learned concerns which technology "black boxes" need to be opened and mastered and which can be left shut—which can perhaps be bought in and used as tools and building blocks in other systems.[10] This reminds us that technological innovation and broader forms of social learning are expensive of time and effort; they can be frustrating, and need to be economized on unless they offer particular benefits! We may need to learn not to learn about certain domains and players in the sociotechnical system. An important aspect of the current developments around the World Wide Web and the Internet is the way it is constructed as a series of technical tools, designed for interoperability around standard interfaces. This makes it easier, even for nonspecialists, to configure these generic tools and adapt them for specific applications and local requirements.

THE KEY ROLE OF INTERMEDIARIES

Although stand-alone ICT applications may arise from the efforts of individual organizations, networked multimedia applications typically involve more or less formalized coalitions of players. This is partly because the development of networked technologies may call for collaboration with suppliers of complementary products. Moreover, multimedia products often require diverse resources and diverse kinds of knowledge: about the technology infrastructure, about graphics and the presentation of information, and about the user context. Multimedia developments are thus typically mediated between a range of actors. In certain circumstances this interaction may be mediated primarily through the artifact (through its rejection or uptake by the user—e.g., where a new computer game or CD product is launched upon the market). However, there will often be an active intermediation process, with certain players acting to bridge the divers domains of development and use. This raises questions about how these intermediations are organized: who is and is not involved, and the relationships between them. We can think of this in terms of different kinds of constellations of players—a metaphor that seeks to convey the idea that there may be gulfs between players, with some players remaining rather peripheral or loosely connected to each other.[11]

Not all possible constellations exist, however. Some are more frequent than others. In particular, we point to the role of two particular kinds of intermediary in sustaining constellations around the development of multimedia applications and around the appropriation of multimedia by users.[12] The latter "appropriation intermediaries" (e.g., cybercafé managers and providers of community information systems) seem to play a critical role in configuring ICT component technologies and systems toward particular potential user constituencies.[13]

SOCIAL LEARNING AND PUBLIC POLICY

These dilemmas surrounding the development of multimedia pose particular challenges for public policymaking. Though the state continues to be an important player in technological change—as a promoter of change, as a regulator, and as a direct participant in development—its roles and methods of intervention are changing. This points to an important process of social learning that is taking place in the formation and implementation of public policy.

Much debate has centered around the respective roles of state and market in providing the information infrastructures and the products and services that will run upon them (Kubicek et al., 1997). Despite the universalistic claims of much technological discourse (and the convergence arguments that often underpin ideas about the transition to an information society), we can see some very clear differences in the public policy frameworks emerging from different national contexts—which can in turn be related to differences in the local context, institutional structures, and policy styles and tradition. There have also been some important common elements (Schneider, 1997). Emphasis on the contribution of the private sector and the commercial provision of multimedia products and services has been set alongside recognition of areas of market failure and the consequent need for public intervention. So although differing reliance has been placed on market versus public provision, government policies—from laissez-faire U.S. to Northern European social democracies—have looked to a combination of public and private provision.

The relationship between formal policy pronouncements and the de facto regimes of public rule-making and intervention in particular countries is, of course, rather complex. For example, the National Information Infrastructure; Agenda for Action (IITF, 1993), although emerging from avowedly laissez-faire United States, places great emphasis on the role of state intervention. In contrast, the Bangemann Report, which laid the base for European Union (EU) policies (High Level Group on the Information

Society, 1994), placed at center stage the liberalization of telecommunications (which has to be seen in terms of the uneven progress across Europe toward the privatization of public telegraph and telephone administrations [PTTs] and the introduction of competition into telecommunications services[14]).

When we move from policy formation to implementation, and address the actual patterns of multimedia developments and experiments underway today, we find that government (at various levels: local, central, and international) is probably the paramount player, through its funding of many initiatives in public administration and information systems, in education, and in culture, as well as projects geared toward local economic development (Jaeger et al., this issue). Here we find the state acting in its own right as a powerful intermediary in development, or more usually as providing resources for other intermediaries, in relation to both the development and appropriation of multimedia. On the other hand, many projects are hybrid, involving some combination of public, private, and quasi-public bodies (the latter including, e.g., nonprofit organizations in the voluntary sector and quasi-autonomous nongovernmental organizations). An intriguing aspect of many multimedia projects is the way they involve new relationships between public and private bodies and a rearrangement of the boundaries between them (Brosveet & Sørensen, this issue).

We have to view these developments in a world in which neo-liberal approaches have gained increasing influence and in which the process of technological innovation is becoming more dynamic and operating at a global level. In this context we see changes in the models of state intervention—from more *dirigiste* models in which the state directs (or even conducts) innovation, toward more indirect, catalytic models of the role of the state as a facilitator of innovation. However, the language of "deregulation" should not lead us to confuse this shift with the departure of the state from the field, nor a withering away in the role of the state. Instead, the state's role is changing, away from its traditional modes of involvement in directing and supporting particular technology development paths (or even as a provider of technologies/services) to become an organizer of collaboration and knowledge flows across among networks of players: providing and disseminating information, bringing groups together, and supporting demonstrator and awareness programs. Central and local government and international bodies thus provide the resources for the creation of intermediaries in both multimedia development and appropriation—and may even become intermediaries directly in the case of public services. Within the European Union, the European Commission has become a major sponsor of trials and projects. Its role is particularly significant in countries such as Ireland with a modest internal development base.[15] The state may be important actor in establishing the terrain and setting the "rules of the game" for multimedia developments.[16] Drawing on the experiences of a small and technologically advanced economy like Norway, Brosveet and Sørensen (this issue) have pointed to a shift in the mode of state activity from planful development and growth of technological capabilities toward a more opportunistic model drawing on global developments as being "fishing not farming." Although "farming" characterized 1980s strategies of nations to grow technological capacities in core technological fields, "fishing" implies a selective strategy, drawing on offerings found in that global market.

This points to an important shift in emphasis of policy from the development of the core technology components of ICT delivery systems (in which staying ahead of the global field may only be a feasible objective for some of the larger European economies, the United States, and Japan) toward the local opportunities for developing multimedia applications and cultural content (Brosveet & Sørensen, this issue). Although information technology policies to date have often focused unduly on the technological base rather than content and applications (and have tended to bundle up the economic and social benefits of technology as a consequence of provision of technology infrastructure), it is around the application of technology that national and local government initiatives can arguably have most influence—and will ultimately have the greatest economic and social significance.

TOOLS FOR ANALYZING THESE DEVELOPMENTS?

Our attention thus is drawn to the interactions between organizations as well as between individual and groups within an organization/institution (in other words, to the meso as well as micro level of analysis). Let us consider the intellectual tools that may be needed to analyze these complex developments. This collection is broadly informed by a common concern to understand "the social shaping of technology" (MacKenzie & Wajcman, 1985), conceived in an inclusive sense to include social constructivist and "actor–network" accounts of technological change (Williams & Edge, 1996). This perspective seeks to understand the social implications of new technologies by studying technological change as a social process (or more precisely, all change as a sociotechnical process). In criticizing "deterministic" concepts of technological trajectories or imperatives,[17] it emphasizes the choices that exist at every stage in innovation, and the way these choices are patterned by the social setting and the strategies of actors involved. Although early accounts often emphasized the way that particular values and purposes might be built into technology design, social shaping research has drawn attention to the *negotiability* of technology: Artifacts can be adapted and reinvented after they leave

the laboratory, as they are implemented and consumed; even nonspecialists may be able to deploy such "interpretive flexibility" (Pinch & Bijker, 1984) about how a technology is used and in its meanings and social implications. In relation to large-scale network technologies, such as multimedia, social shaping and related "actor-centered" approaches (e.g., actor–network [Latour, 1988], sociotechnical systems [Hughes, 1983] and constituencies [Molina, 1992]) draw attention to the efforts of actors to pursue their own interests and strategies, in collaboration with others. However, questions arise about whether we can produce entirely satisfactory explanations of these developments in terms of purposive individual action. In particular, some of the most important features shaping technology may not be sought or even perceived by the actors involved, but may arise instead from shared presumptions—what is taken for granted in the broader technological frame of actors and groups (Bijker, 1992). Many of the outcomes may be unintended, and not necessarily recognized, but arise from interactions between large numbers of players.

Some extremely interesting accounts of technological change emerging from evolutionary economics have drawn attention to these kinds of processes patterning technological development. An early contribution was Dosi's (1982) espousal of ideas of technoeconomic paradigms and of trajectories of technological development. However, Dosi's account of the endurance of technoeconomic paradigms implies that technological innovation takes place in relatively stable and uniform selection environments. Schneider's account (this issue) draws our attention, instead, to discontinuities and turbulence in the selection environment, where he draws a parallel between biological and technological evolution about the role of *preadaptive advances*, which gain value only after significant changes in the environment. This contribution reminds us of potential weaknesses in actor-centered accounts, and their lack of tools for analyzing structural and institutional influences (and by the same token for analyzing changes in those structural conditions). On the other hand, there may also be pitfalls in the resort to evolutionary metaphors and structuralist accounts. In particular, we have already argued that selection environments are themselves being transformed as a result of the reflexive actions of the players involved, changing their strategies and collaborative structures in the light of feedback from earlier social learning about innovation. The analytical challenge seems to be one of developing concepts that enable us to link action-centered and institutional accounts. This suggests a two-way process of building concepts up from action perspectives to try to characterize innovation and alignment processes at a collective level (such as "poles of attraction"), and introducing action elements into structural accounts (e.g., through concepts such as "technology regimes" [Rip, 1995], which address the rules of the game in a technological domain, and how these may be changing, inter alia as a result of learning by and changes strategy of the players involved).

CONCLUSIONS

This collection addresses a field of rapid technological and social change, as well as an arena in which new understandings and ways of looking at the world are emerging.

It provides ample evidence of the dangers and difficulties of making meaningful predictions about the development, application, and social implications of information and communications technologies (and the information society they are supposed to bring in), which remain, as we have seen, subject to deep uncertainties. This collection seeks to throw light upon these pressing questions by increasing our understanding of the processes of technological innovation—and in particular the processes of social learning as emerging new generic technical capabilities are matched to evolving social needs and contexts.

We have pointed to important lessons that may be drawn from history (particularly in challenging accounts of technological innovation as the straightforward emergence of artifacts of which the utility can be taken as self-evident). However, these discussions also point to the difficulties of generalizing from particular technologies and contexts, as well as the pitfalls of attempting to extrapolate from earlier experiences—not least because of the reflexivity of actors, modifying their strategies and thus transforming the world in the light of experience. The future is thus underdetermined, and indeterminate in many important respects.[18]

New understandings of the social character and implications of multimedia are emerging as experience and familiarity grow—through the processes of social learning described in this collection. Of crucial importance here are the collective learning processes involving communication and collaboration across a range of different players, including public policymakers and regulators, managers and technical specialists in industry, and final users and their proxies. What are perhaps most intriguing are the growing levels of engagement among industry and policy players technical specialists and social scientists in a relatively open exploration of the dilemmas that surround multimedia futures and use. Here we point to the possible contribution of approaches within technology studies,[19] which by engaging with the detailed processes of technological change can hope to play a constructive role in promoting social learning, by providing analytical tools for practitioners (e.g., to improve the effectiveness of the multimedia "learning economy") as well as for broader publics. Indeed, by integrating concerns with the promotion of innovation and with assessing its social impacts, they may open up opportunities to give voice to societal and policy interests within the learning processes and thus

enhance the coevolution of technology and society (Rip 1995).

NOTES

1. The papers were originally presented at an International Research Workshop on the Social Shaping of Multimedia, jointly sponsored by the European Commission, Targeted Socio-Economic Research Project on Social Learning in Multimedia; and the COST A4 Action on the Social Shaping of Technology (University of Edinburgh, Edinburgh, June 1997).

2. For example, in 1876 a Western Union internal memo stated, "This 'telephone' has too many shortcomings to be seriously considered as a means of communication. The device is inherently of no value to us." Across the Atlantic, Preece, Chief Engineer of the General Post Office, argued that the telephone would not take over from telegraphy in Britain "as we have an ample supply of messenger boys." Even Bell, the architect of the telephone, saw it as primarily a business communication device, rather than for personal communication—and perhaps even more surprisingly saw the early phonograph in the same light—as a dictation device!

3. Indeed, there is a fashion in contemporary consumer advertising of ICT products to cite the misleading predictions of the potential of a technology—though these, for some reason, seem to focus exclusively on those (exceptional) cases where demand was underestimated!

4. The European Commission's Fourth and Fifth Framework Programmes for Research and Technological Development (RTD) provide a case in point. ESPRIT (the European Strategic Programme of RTD in Information Technology) under the Fourth Framework Programme "integrates R&D and take-up actions into a single programme—thereby facilitating the user-supplier collaborations that stimulate innovation" (http://www.cordis.lu/esprit/src/intro.htm). In its successor under the Fifth Framework Programme launched in 1999—the Information Society Technologies Programme, subtitled the User Friendly Information Society—user needs and technical advance appear as equally important strategic objectives "to realise the benefits of the information society for Europe both by accelerating its emergence and by ensuring that the needs of individuals and enterprises are met" (http://www.cordis.lu/ist/).

5. Pressures toward harmonization should not be seen as a simple victory of cooperation over competition. In fact, we see an extremely complex politics around contradictory tendencies around on the one hand pressures to align supply-side players around overall creation of markets and on the other competitive desires to dominate (and at times fragment market or lock customers in to proprietary standards). The case of electronic funds transfer at point of sale in the United Kingdom provides an effective illustration (Howells & Hine, 1993).

6. Poles of attraction, thus conceived, are complex entities—indeed, it is their multiple overlapping meanings that make them effective as a tool for orienting thinking across diverse constituencies. To succeed, a proposal must offer something for various different groups. Such poles may include not just proposed technology configurations and applications, but also ideas about how technologies will be used and who will use them—for example, the idea that everyone will be online.

7. An extremely interesting related development in the ICT sector concerns alpha and beta testing. Suppliers have succeeded in enlisting intermediate and final users, through more or less informal and voluntary networks, to take part in testing and providing feedback on their products. This form of collaboration has been a rather cost-effective way of both testing and signing up vanguard users to a technology. Within a technological subculture characterized by shared general commitments and expectations around ICT, barriers to and costs of communication are reduced, and many players find it in their self-interest to take part through, for example, early access to supplier offerings as well as a certain legitimacy in the case of high-profile suppliers. The cost of such coordination is thus modest. Problems of motivation and engagement are much greater, however, in relation to products that must move out of this "enthusiast" culture to a more general and nonspecialist audience.

8. These points have particular force in relation to the "delivery system" and its component telecommunications and computer hardware technologies. Here we note the emergence of "architectural technologies" whereby some elements of a product remain constant, providing some guarantee of compatibility consumers and producers of complementary products, through several different generations (Morris & Ferguson, 1992). These factors may become less relevant to nonmaterial products—software and multimedia content—to the extent that it is possible to write translators and converters to link together and exchange information between systems based on different standards.

9. Though we also note increasing standardization around the user interface, with the widespread adoption of the Macintosh and Microsoft Windows desktop environment and the explosive uptake of the World Wide Web interface for data display and navigation.

10. For example, many contemporary multimedia pilots and trials (and most of the multimedia projects encountered in the EC Social Learning in Multimedia project) use well-established standard technical elements—and above all the World Wide Web. They are thus able to concentrate on developing the information and service content, rather than embarking upon substantial technical development activities.

11. The term *constellations* provides a more effective metaphor for these often large and dispersed arrays of players than the language conventionally adopted by social constructivist or actor–network approaches of *system/constituency builders*, which conveys an image of a more orderly process involving a finite group around an identifiable center.

12. Coordination is of course expensive of time and effort—it involves delays and compromises in the strategies of individual actors. I have already suggested that social learning of this sort needs to be economized on (if not avoided) wherever possible. One of the surprising features emerging from our EC Social Learning in Multimedia research project is the rather marked absence of constellations directly bringing together users as well as supply-side players. Increasing the number and range of players involved increases coordination costs. Suppliers have had difficulties in engaging nontechnical users. Another factor, suggested by the study by Nicoll (this issue), is that commercial players treat their links with and knowledge of users as a proprietary resource and do not seek to share this information with potential competitors.

13. Significantly, many of these "appropriation intermediaries" are dealing with largely standardized technology components and systems (e.g., the World Wide Web). Their key role may be in acting as points of access for users to new supplier offerings, promoting and channeling the appropriation process. One important question concerns the extent to which these intermediaries provide feedback from users to future supply rather than just operating as a diffusion mechanism for new applications. Some appropriation intermediaries may of course verge on being suppliers—e.g., as intermediate users and suppliers of complementary

products (e.g, content) drawing on multimedia technologies to provide final services.

14. There have been very different responses across Europe to the global moves to privatize national PTTs and introduce competition within telephony. The speed of and enthusiasm about these changes has differed greatly, with Britain in the vanguard and Greece in the rear.

15. For example, in 1998 the EC ESPRIT program funded over 100 projects in its Multimedia Systems Domain (which had a budget of 164MECU), with similar programs run by the Advanced Communications (ACTS), and Telematics Applications programs (for more information refer to http://www.cordis.lu/esprit/src/intro.htm). In the 5th EC Framework Program these separate programs will be extended and integrated into a single program reflecting the convergence of information processing, communications, and the media. This information society technologies (IST) program will be the major source of research funding on information and communications technologies and applications, with a budget of approximately 4 billion ECU over 1999–2002 (for more information refer to http://www.cordis.lu/ist/). There will be some "pure" technological research, but most of IST emphasizes matching technical potential to social needs, by linking research and take-up activities. Activities will be focused around targeted clusters of projects around four strategic areas (or key actions)—systems and services for the citizen; new methods of work and electronic commerce; multimedia content and tools; essential technologies and infrastructure—and will be geared toward service providers and content owners (e.g., publishers) as well as software developers and IT specialists.

16. The extent of competition in telecommunications has important consequences for the way in which multimedia trials and pilots develop. Where national telecommunications monopolies continue, they, of necessity, constitute key actors across a range of developments. Equally, they may be more willing to invest in trials, as they will benefit directly from building the telecommunications markets.

17. For example, the technological determinism inherent in approaches that see technology and reflecting some inner "technical" logic or technoeconomic rationality (MacKenzie & Wajcman, 1985).

18. Though we can probably be confident about predicting the continuation of certain well-entrenched features and tendencies—for example, the continued improvements in performance per unit price of computing, data transmission, and storage—and the consequent likelihood of increasing penetration of ICTs and increasing levels of data exchange. Though technological change does not impose particular societal paths, it may change the terrain on which actors make choices. Here we may need to engage with arguments about structural influences and this kind of "soft" technological determinism.

19. Here we are pointing to a broad convergence of concerns and approaches rather than valorizing any particular analytic approached (Williams & Edge, 1996). In relation to understanding multimedia, extremely valuable contributions have also come from cultural studies and work on consumption processes.

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