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A Critical Review of the Literature on the Management of Corporate Information Infrastructure

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The purpose of this chapter is to look at the basic ideas, models, and recipes that the current management literature recommends for the building, implementation, and management of information infrastructures within corporations. The literature stretches from the emerging area of 'global information systems'—the analysis and design of IT systems that support a global enterprise (Ives and Jarvenpaa 1991; Roche 1996; Peppard 1999)—up to the technical and consulting manuals dedicated to the management of corporate computer platforms. Despite such a large spectrum, the fields of global information systems and IT infrastructures are still in their infancy, and therefore offer a rather limited body of models, prescriptions, and case material that may be used as a reference to identify key concepts and approaches. On the whole, as we shall try to show, the literature lacks originality. It mostly consists of attempts to extend the current approaches and models in the information-systems (IS) field to the new idea of global information infrastructure. This review, then, offers an opportunity to present and criticize some of the principles, models, and recommendations that are already in good currency within the more established IS literature.

We divide the presentation and discussion into two main parts. First, we present a selection of key concepts and approaches. Secondly, we criticize the existing literature mainly from a methodological point of view. We believe that, for such an emerging discipline, it would be of little value to the reader and for the advancement of the discipline itself to engage in lengthy discussions about the fine detail of definitions. In any case, given the turbulence and innovativeness of the field, definitions and frameworks are going to change. Rather, this review offers an opportunity to criticize and deconstruct some general approaches to the study of the role of IT in organizations.

Key Concepts

What is an infrastructure? What are the main types of infrastructure? How is an infrastructure (or how should it be) linked to (global) business? And, more generally, how

should its deployment and use be managed? These questions point to some of the fundamental concepts in the management literature.

Definition of infrastructure

What is a global information infrastructure? As we enter the new century this is a question that is receiving multiple and evolving answers. But we do not consider that this is a severe problem, since the field is relatively young.

Corporate infrastructure as a concept emerged in the 1980s in relation to the planning of large corporate information systems. It emphasized the standardization of systems and data throughout the corporation as a way to reconcile the centralized IS department and resources, on the one hand, and the distribution of systems and applications, on the other. More recent developments in networking focus on the aspects of infrastructure that deal with communication (of data, documents, and so on). Given the association of infrastructure deployment with Business Process Re-Engineering (BPR) projects, some authors also include in a broad definition of infrastructure those chains or sequences of processes that are directly supported or enabled by the IT infrastructure. More generally, in relation to BPR, there can be an overlap between the 'systems and applications' infrastructure and the lighter 'process' or BPR infrastructure. Fig. 2.1 shows that there are cases that fall in the overlapping area (where the 'hard' infrastructure is present with the 'process' one), cases where infrastructure is not accompanied by any special redefinition of processes, and cases where the new processes are the existing infrastructure, while the tools to support the processes are still being developed. In the area of overlap, some authors introduce the concept of 'inscription': the execution of a certain business process gets 'inscribed', frozen into, the infrastructure (see Chapter 5).

Typical representations of infrastructures may be pyramidal, as the one provided by Weill and Broadbent (1998),[1] or multilayered, as suggested by Hanseth (see Chapter 4). Weill and Broadbent point out the following main layers:

- IT components;
- human IT infrastructure (people, skills, etc.);
- shared IT services;
- shared applications.

The diagrams provided by Hanseth have a different emphasis. They are derived from the 'layering' of different technologies, as discussed in the software field (think, for example, of the ISO model of communications standards): no pyramid is envisaged here. But the differences are not just in the ways of representation.

[1] We will draw many ideas and definitions from this recent book. We do this for two main reasons. First, we follow Thomas Davenport's advice, according to which, 'This book contains most of what the world needs to know about this critical topic.' Secondly, the models, principles, and normative prescriptions contained in the book are based on an extensive set of empirical material, both qualitative and quantitative, and a long list of scientific publications, including award-winning ones.

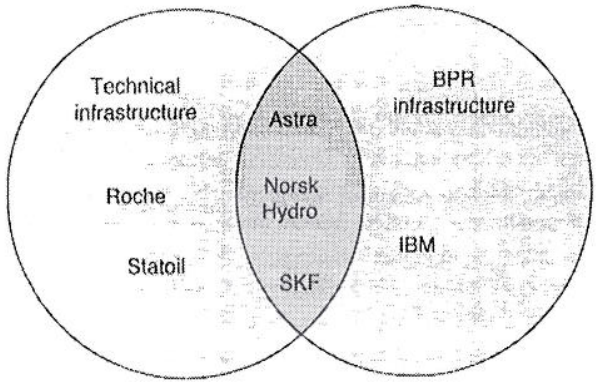

FIG. 2.1. Technical and process infrastructures: how the cases qualify

They are more profound. There is another perspective, which is very much at the core of this book.

The managerial definition echoes in form and substance the traditional definition of Management Information Systems (MIS) (see Davis and Olson 1985). The pyramidal view suggests that the contours of infrastructures are fairly well delineated (it is possible to argue about *where* to draw the boundaries, but not to question the fact that they *can* be drawn). Infrastructure components may be difficult to evaluate, but their services are not: so it is possible to price them—for example, by looking at how much the market values them. Finally, the infrastructure can become a firm's capability if management is able to deploy it in a way that is unique and strategic for the firm.

In the second part of this chapter, by contrast, we examine an alternative definition, which puts an emphasis on the openness, multilayering, and inertia of infrastructures.

Relationships with the business

The boundaries and organization of an infrastructure, and specifically the services it can provide, are set by defining the value of variables such as *reach* and *scope*. Reach is the number of activities or processes actually touched by the infrastructure, while scope refers to the type and variety of applications running on it (that is, the range of processes being partially or totally automated through the infrastructure) (Keen 1991). Depending upon these two variables, and especially the strategic intent of the firm, infrastructure can play different roles: *utility*, *dependence*, and *enabling* (Weill *et al.* 1996). In the first role, infrastructure is a utility aimed at reducing the costs of processing and communicating information throughout the organization. Here, the emphasis is on achieving economies of scale. A utility architecture maximizes efficiency in processing and transmission but does not

necessarily interfere much with the nature of applications or business processes. In the second case, the performance of key business processes depends upon the infrastructure, like the use of an ERP package in a specific area of the business. Here, the link between business strategy and infrastructure investment is apparent and conscious. Enabling infrastructures provide architectures and platforms for new applications and new businesses (think of the Internet as a platform for electronic commerce). 'The flexibility of the infrastructure permits a number of as-yet-unspecified business strategies to be implemented more rapidly than in firms with a dependent or utility view of infrastructure' (Weill and Broadbent 1998: 101).

These three types of infrastructure point to a more general issue: how to link the information infrastructure to the global business strategy—that is, the issue of strategic alignment. Here the literature is vast and has various origins and ramifications (see e.g. Henderson and Venkatraman 1993; Earl 1996; Peppard 1999).

Peppard provides a summary scheme of the major interdependencies between infrastructure and strategy when addressing specifically the issue of globalization. The scheme highlights in a new 'diamond diagram' four interconnected bubbles: global business strategy, global business model, global business drivers, and global information strategy. Despite the variations among different authors, the basic idea of strategic alignment still dominates the theme of the relationship with the business. 'It is sensible and desirable for management to focus on aligning the information technology portfolio with the business strategy' (Weill and Broadbent 1998: 40). Strategic alignment was originally defined as concerning the inherently *dynamic fit* between external and internal domains of the firm—such as product/market, strategy, administrative structures, and business processes—with IT (Henderson and Venkatraman 1993). Economic performance, it is argued, can be enhanced by finding the *right fit* between external positioning and internal arrangements.[2]

IT infrastructure as an investment portfolio

Information technology includes a firm's total investment in computing and communication technology. Within this encompassing investment different components can be distinguished according to the hierarchical view of information systems, applications, and technologies. The IT portfolio of a firm represents such an investment in people, machines, and services, in whatever way they are

[2] Among the results of the MIT research programme 'Management in the 1990s', a framework was set out, whereby information technology (IT) was regarded as a variable linked with others such as strategy, organization, and culture in a so-called diamond diagram (Scott Morton 1991). Strategic alignment inherits that representation. In 1993 a special issue of the *IBM Systems Journal* featured a series of articles on the concept of 'strategic alignment', including the leading article by Henderson and Venkatraman (1993). Another paper, by Broadbent and Weill (1993), reported on an empirical study on strategic alignment in the Australian banking industry. The aim of that study was to identify organizational practices that contribute to alignment. The authors present a model of strategic alignment based on fifteen propositions, concluding that enhancing business and information strategy alignment will remain a key challenge in the future.

employed or outsourced. Weill and Broadbent (1998) suggest the following major classifications of the IT portfolio:

- infrastructure: the largest component of systems and applications, which are reliable, shared, and usually centrally managed;
- transactional systems dedicated to the processing of the routine transactions of the firm;
- informational technologies to support or automate the main management and control functions;
- strategic applications aimed at gaining competitive advantage.

Each class of technology contributes in varying degrees to generate value and has a cost component (the infrastructure being the major cost item). The authors recommend that, in order to use IT adequately, an IT investment portfolio should be managed in the same way as a portfolio of financial investments. 'Individuals make different decisions about personal investments based on their commitments, aspirations, experiences, values and attitudes to risk. Managers make decisions about information technology investments based on a cluster of factors, including capabilities required now and in the future, the role of technology in the industry, the level of investment, etc.' (Weill and Broadbent 1998: 24). The largest component of the IT portfolio is the infrastructure, which involves investments that are large, shared, and have a long planning horizon. In general, the composition of the portfolio must be driven by the objective of increasing shareholder value and by demands of business strategy. The latter requires a constant alignment of the portfolio with the business strategy. The IT portfolio needs to be managed in the same way as financial portfolios, balancing risk and return for each selected strategic objective. Analytic tools like the Balance Scorecard (Kaplan and Norton 1993) can help to identify indicators for high-risk, longer-term returns (customer satisfaction; new-products generation) with safer, shorter-term, or lagging indicators (return on investment; cost-cutting applications): 'A balanced scorecard approach encourages a firm to change the balance in good times and bad, just like bull and bear markets for financial investment . . . as with personal investment portfolios . . . a little needs to be invested with a longer-term perspective' (Weill and Broadbent 1998: 33).

How to deploy and manage an infrastructure

Managing an infrastructure to deliver effective IT capability means dealing with problems such as: aligning strategy with IT architecture and key business processes information requirements (Luftman 1996); universal use and access of IT resources; standardization; interoperability of systems and applications through protocols and gateways; flexibility, resilience, and security. Ideally, the infrastructure reconciles local variety and proliferation of applications and uses of IT with centralized planning and control over IT resources and business processes.

A typical management (and consulting) agenda concerning the creation and governance of a corporate infrastructure would entail the following activities:

- analysis of the firm's strategic context so as to elicit the key business drivers;
- a joint consideration for the need to improve or transform existing business processes and infrastructures (various combinations are possible in the sequence and significance of the change in both areas);
- formulation and implementation of a relevant BPR and technical change plans;
- envisioning the related changes in roles, responsibilities, incentives, skills, and organizational structures required by BPR and infrastructure reforms.

Again, by way of example, and not being able to survey all the normative suggestions and prescriptions that the management literature provides, we report here only on a typical approach to implement strategic alignment and, more generally, develop an infrastructure: the 'management-by-maxim approach', presented by Weill and Broadbent (1998). Quoting the authority of Aristotle, the authors see in maxims (a 'practical course of conduct to be chosen') a means to express strategy in a way that is actionable and that can be coordinated centrally. In a given company, management has to focus on both firm-wide maxims and IT maxims in order to capture the essence of both in an interdependent way.

Examples of the former are statements such as 'relentless cost reduction' and 'continuous innovation'; examples of the latter are 'data must be accessible through common systems', 'to develop a firm-wide infrastructure', and so on. The point of translating strategies, or IT portfolio choices, into maxims is to articulate complex propositions in phrases that can be easily 'understood and communicated'. Senior management are recommended to pay ongoing attention to the fact that IT maxims are in line with business maxims, and that at all times the business maxims reflect the strategic positioning of the firm, or what changes are required.

There exists, however, another way to build corporate infrastructures: the 'management-by-deals' approach (Weill and Broadbent 1998). The deal-making stems from a variety of factors and business circumstances, such as the will to satisfy short-term needs, or being servant to the more powerful groups in the organization: 'the deal-making process is the free market of information technology infrastructure formation', the same authors suggest (ibid. 159). This means, at best, an uneven establishment of the infrastructure. The management-by-deals approach seems to be frequent: it is present in about 50 per cent of cases. According to the authors, however, by 'dealing' one can hope to achieve only certain types of infrastructure, ranging from 'none' to 'dependent'. An 'enabling' infrastructure can hardly be the outcome of fragmented deals.

Shifting from a management by deals to management by maxims depends ultimately upon senior management's consideration of the way business and technology strategies should be integrated. Leadership, supported by a due attention to governance, is the essential ingredient to achieve the results of the management-by-maxims approach—that is, to gain the most out of the IT investment portfolio and develop an infrastructure according to the current strategic intent and vision. In this respect, Weill and Broadbent (1998: 250) claim that, by adhering to their Ten Leadership Principles, it is possible to gain up to 40 per cent premium for the same

level of investment. These principles capture in a nutshell what the management literature prescribes for the optimal governance of an IT infrastructure, for example:

- to manage the IT infrastructure in the same way that a financial portfolio is handled, continuously changing the mix between risky and less risky investments, trying to maximize returns; this principle obviously requires a centralization of the supervision of the overall IT investment in the firm;
- to achieve strategic alignment by the strategic maxims approach;
- to agree on business value indicators and responsibilities;
- to learn from the mistakes made during implementation and to keep the process of evaluation transparent, so that the memory is not lost of what has been achieved and what has not and of which are the successful best practices;
- to pay attention to the dynamics of information politics: 'Appreciating the dynamics of information politics is essential when planning the development of IT infrastructure capabilities, as destructive behaviours can make the investment not worth the effort' (Weill and Broadbent 1998: 252).

Let us now turn to a more critical analysis of the principles and recommendations contained in the management literature. This will provide an opportunity to deepen and extend our review, but also to begin to show some of its limitations and contradictions. This exercise should enable the reader to appreciate better the scope and content of the case studies presented in Part Two of this volume, and indicate the validity of a more interpretative (that is, less immediately concerned with modelling and prescriptions) approach to studying the dynamics of global corporate infrastructures.

Problematic Issues

Empirical studies, and insightful thinking related to the actual management of infrastructures, point out some problematic aspects of the management agenda just presented. For example, empirical findings suggest that, the more firms undergo change, the higher the need for investment in infrastructure. One may ask, however, are there decreasing returns to infrastructure (Cordella and Simon 1997)? Does more investment mean more sophisticated infrastructure or does it just mean facing maintenance and adaptation costs of an existing, rigid infrastructure? Relatedly, is it better to have a highly flexible infrastructure that enables the firm to seize a wide range of future, unplanned business redesign options, or a highly consistent (that is, aligned) infrastructure with the current strategic intent? Thus, should one aim for alignment, as repeatedly suggested by the literature, or for flexibility? Extensive review of top managers' opinions does not seem to lead to any clear-cut conclusions (Duncan 1995; Peppard 1999).

Certainly, the cases in this volume add more empirical evidence to the fact that the issue of how to design and especially implement an infrastructure is much less clear-cut than the management literature wants us to believe. Our cases show that, for one reason or another, management by deals is a far more common approach

than other authors suggest, and that at least in one case (Roche) the opposite is true—that is, the abandonment of a top-down, strategic alignment approach has been the precondition for the take-off of a corporate infrastructure. It is not intended here to compare contrasting empirical results—a comparison that to date would be bound to be inconclusive—but to enquire whether certain basic definitions, assumptions, and research approaches typical of the current management literature might bias the data collected and the ensuing models and normative prescriptions. To wit, enquiring how infrastructure has been studied may offer an opportunity to reflect upon the basic tenets of undertaking (managerial) research on IT use issues (Dahlbom 1996).

Contrasting definitions

We have seen above that the definition of infrastructure given in the management literature is non-problematic. There might be doubts related to where one draws the boundaries (at the applications level or at the business processes level?), or arising from the confusing technical terminology that sometimes refers to platforms, architectures, or simply systems and networks (Peppard 1999). But the relative 'straightforwardness' of the definition can be welcomed only if one confines oneself to a purely managerial perspective. As soon as one looks towards other disciplines interested in the study of infrastructure, the definitions change, and so do their implications for research and normative prescriptions. Consider, for instance, an alternative definition that comes from the domain of science studies (Star and Ruhleder 1996). The authors characterize the information infrastructure by maintaining that it is 'fundamentally and always a relation', and that infrastructures in general tend typically to emerge with the following dimensions (see also Chapter 4).

- *Embeddedness*. Infrastructure is sunk into, or is inside, other structures, social arrangements, and technologies.
- *Transparency*. Infrastructure is transparent in use, in the sense that it does not have to be reinvented each time or assembled for each task, but invisibly support those tasks.
- *Reach or scope*. This may be either spatial or temporal: infrastructure has reach beyond a single event or one-site practice.
- *Learned as part of membership*. That artefacts and organizational arrangements are taken for granted is a *sine qua non* of membership in a community of practice. Strangers and outsiders encounter infrastructure as a target object to be learned about. New participants acquire a naturalized familiarity with its objects as they become members.
- *Links with conventions of practice*. Infrastructure both shapes and is shaped by the conventions of a community of practice—as, for example, the way that cycles of day–night work are affected by and affect electrical power rates and needs.
- *Embodiment of standards*. Modified by scope and often by conflicting conventions, infrastructure takes on transparency by plugging into other infrastructures and tools in a standardized fashion.

- *Built on an installed base*. Infrastructure does not grow *de novo*; it wrestles with the 'inertia of the installed base' and inherits strengths and limitations from that base.
- *Visible upon breakdown*. The normally invisible quality of working infrastructure becomes visible when it breaks.

The bundle of these dimensions forms 'an infrastructure, which is without absolute boundary on a priori definition' (Star and Ruhleder 1996: 113).

In contrast with the one seen previously, the definition stresses the heterogeneous character of infrastructures as expressed by the notions of embeddedness as well as its socio-technical nature by being linked to conventions of practice. These aspects also mean that, although information infrastructures are enabling and generic, they are not completely independent of their use. Certainly, the notion of service put forward by the management literature also captures the dimension of use, but in a different light. When service is well defined, it becomes a commodity on a market for services and has a price. Instead, Star and Ruhleder (1996) look at infrastructures as 'institutions', norms, and conventions that provide the 'often implicit' context, for the performance of practices.

In Chapter 4 Hanseth points out that information infrastructures are larger and more complex systems, involving significant numbers of independent actors as developers as well as users. Further, information infrastructures grow and develop over a long period of time, new parts are added to what is already available, and extant parts are replaced by improved ones. An information infrastructure is built through extensions and improvements of what exists—never from scratch. It is open in the sense that any development project, independently of how big it is, will just cover part of an infrastructure. The rest is there already and will be developed by others who are out of reach of the project and its control. What is developed by a defined, specialized activity will have to be hooked into an existing infrastructure. Eventually, what exists has significant influence on the design of the new. Certainly, the focus on infrastructures as open systems raises some questions. Are the boundaries between open and closed systems absolute and predetermined in some sense? Is the crucial role played by the installed base a unique feature of infrastructure and systemic technologies or is it a more general one? Focusing on information infrastructures as an open installed base (see again Chapter 4) means that such infrastructures are never developed from scratch: they *always already exist*. If so, when and how can an information infrastructure be built, acquired, or dropped at all?

As mentioned at the beginning, there is no point in ranking these two alternative definitions. However, maybe a deeper lesson can be learned by pointing out the difference in the perspectives, beyond their provenance from the managerial and the science studies literatures. Our empirical evidence casts a vote in favour of the latter. We submit that, despite being more open-ended and less structured, it addresses some issues and puzzles that the other leaves unexplained. And, perhaps more importantly, the definitions point to alternative perspectives in approaching

empirical research, handling qualitative evidence, and coming up with normative indications. We now turn to these issues, which also explain the philosophy underlying our empirical research.

The case-studies approach: two styles of rhetoric and interpretation

It may be not by chance that Weill and Broadbent (1998) refer twice to Aristotle's *Treatise on Rhetoric*. In fact, the way they use short case studies to argue for selected ideas, principles, and prescriptions on what are their main views on infrastructure—how management should lead the effort to build a corporate infrastructure aligned with the business strategy, and so on—owes much to the art of rhetoric. Their qualitative cases are snapshots to persuade the reader about the realism of the statement, model, or advice contained in the text. Certainly, there is no point in requiring a quantitative survey to settle the matter. It would be too pristine at this point for the scarce knowledge we have of the phenomenon. We want neither to engage in the debate about the rivalry between qualitative and quantitative research methods, nor to feel guilty about the superiority of quantitative hypothesis testing, representativeness, and statistical generalizability. These are all positivist concerns relevant in the IS field, especially in the USA, which sometimes unduly distract European researchers. Still, the gathering and use of qualitative data can lend themselves to different styles of presentation. Without getting into the nitty-gritty of how to carry out case-study research in organizations (Yin 1994), it is useful in this context to contrast the two styles of qualitative research in the area of infrastructure. Of course it would make little sense to compare the eighty (qualitative) cases mentioned in Weill and Broadbent's book with the bare six contained in this volume. Looking at the sheer size of the sample would indicate to the reader which study should be trusted. But such a conclusion would be misplaced for a number of reasons. First, we are not given enough 'evidence' to evaluate the nature, depth, and scope of Weill and Broadbent's company cases. We are provided only with short synopses, which tell a striking story or convey a telling message on how a certain infrastructure issue was dealt with in a corporate context. Still, there are oddities in the way some of these stories are reported or not told at all. We were struck in particular by two stories that refer to companies that also figure in our very limited sample: IBM and Hoffmann la Roche (see Chapters 7 and 11). In Weill and Broadbent's book (1998: 197), Roche is mentioned briefly in relation to a knowledge-management application in R & D, presented as an undisputed, inspiring success. However, the sources mentioned are second-hand, coming from the business press and from a manager who had since left the firm. It turns out that the story is somewhat more complicated and the outcome of those KM and CSCW projects is much more open, as already reported elsewhere (Ciborra 1996*a*). Moreover, Roche is such a complex and varied company, and the infrastructure initiatives are so many and disparate, as to warrant a thorough, attentive analysis. The Roche case study in this volume, for example, offers to the reader a first glimpse on the evolution of the infrastructure deployment in just one tiny section

of the corporation: Strategic Marketing. The lessons to be learned are exciting, but a full coverage of the Roche infrastructure dynamics would require one or more books in itself. Instead, one snapshot of a project—discontinued at the time of writing (and in any case one that was never based on IT, but rather on paper support)—is presented to the reader to demonstrate (or, better, to argue in a rhetorical fashion) that such a knowledge-management programme is 'still thriving and delivering benefits', indicating a successful way for harnessing the information infrastructure to enable knowledge management. It may be persuasive, but it is not accurate.

Secondly, part of the infrastructure study carried out by Weill and Broadbent over a number of years has been funded by the IBM Consulting Group (see p. xi in their book). We are not told whether IBM is included among their sample of eighty companies: it does not seem so from reading the anonymous company vignettes dispersed in the book. In comparison to what happened to our research group, this looks strange: we also enjoyed the generous funding of IBM (this time through the Italian IBM Foundation), in our case aimed at studying IBM's current gigantic efforts to provide itself with an infrastructure geared to its key business processes. In this volume the case of one of these major processes is reported, the Customer Relationship Management (CRM) (see Chapter 7). The reader will have the opportunity to appreciate the maze of initiatives, projects, moves, advances, and setbacks that the implementation of CRM has created, and the finale is not yet written after more than five years of progress. Why, then, does IBM, with its achievements and problems in building a new worldwide infrastructure to support a new global enterprise model, seem to have eluded the authors of the 'best book on the subject'? Certainly, access should not have been a problem.

These remarks are put forward not to trigger a polemic, but to underline the divergence from tradition in the case studies the reader is going to find in Part Two. It is impossible to escape some kind of rhetoric when writing such a text, but we trust this is a different one. Our cases seldom point to solutions: rhetoric is aimed at talking the reader into a relentless effort of interpretation, appreciation, and questioning. Our cases are *interpretative*, in the sense that they are 'aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by its context' (Walsham 1993: 4–5). Thus, despite our cases being close to 'quick and dirty ethnographies' (Hughes *et al.* 1993), we still want to provide enough context to put any infrastructure initiative into perspective, and thus create a 'clearing' for readers to make their own judgement next to ours. We agree with Walsham when he puts forward the idea that the best prescriptions for an implementation strategy follow from a thorough diagnosis of the organizational setting in which the infrastructure is going to be used. The context and the longitudinal analysis contained in the case studies of this volume move in such a direction. The methodological approach, as in Walsham's book, focuses on the exploration of the 'multilevel context' of interesting, complex infrastructures, and the processes of technical, organizational, and economic change within which the infrastructure is a key element.

The role of empirical evidence in the case of strategic alignment

There is another methodological issue separating our research on and interpretations of infrastructure from those contained in the literature. Our research is not just a matter of contrasting gathered empirical material supporting different styles of rhetoric to attract the (limited level of) attention of the management audience. It deals, more fundamentally, with the status of the abstractions—that is, the models, the principles in both their descriptive and their normative functions—one so frequently finds in the management literature in general, and in the infrastructure literature in particular, and how they are related to what happens on the terrain. There is no better way to show this difference at work than by looking at the genesis and use of the notion of strategic alignment (Bloomfield *et al.* 1997; Sauer and Burn 1997).

We have seen above that in the 1990s the various research programmes on strategic alignment claimed to be able to draw a much-needed connecting line between strategy and IT planning and solutions.

Despite the attractiveness of the idea of strategic alignment, the managerial literature warns us today that it 'will be always difficult to achieve'. Indeed, the models of strategic alignment, the agendas that spell out what to do in order to extract the maximum IT capability from corporate infrastructure and the empirical studies of how corporate infrastructures are developed and used in practice, all seem to include some caveats. Typically, researchers and management authors make the following suggestions:

- Aligning business and technology strategies is an ongoing executive responsibility: 'strategic alignment is a journey, not an event'.
- Managers must be ready to learn and adapt, no matter what the alignment pattern selected at one point in time.
- There are expression barriers that prevent the clear articulation of the strategic intent of the firm, and thus hamper the effort for an explicit strategic alignment.
- Other barriers are due to political, cultural, or economic factors impeding the smooth implementation of any strategic plan concerning infrastructure (Luftman 1996).

Certainly, at the end of the 1990s the 'classic' scholars of strategic alignment suggest that the two-way link between business and IT strategies is 'an old question', since the term alignment describes a static equilibrium. They agree that what is needed is an innovative approach to design effective new business platforms (Venkatraman and Henderson 1999). Before adopting their newer, 'multi-vector' model, it may be worthwhile taking some time to reflect on why the concept of strategic alignment was, after all, static and limited. Without such a reflection, the risk is to jump on yet another bandwagon, only to realize the limits of the new fad when it is too late.

Thus, in a more reflective and interpretative spirit, let us consider a couple of issues that have been accompanying the frenzy of research and consulting activity

on strategic alignment, and that researchers are eminently responsible for having carefully avoided in the recent past:

- IT strategic plans have been around for years, and their link with the business strategy should have brought, however indirectly, some form of alignment. Often they have not, so there must have been a problem all along related to the difficulty or impossibility of alignment.
- Many cases of successful Strategic Information Systems seem to show that tinkering, not conscious alignment, was behind successfully aligned IT applications (Ciborra 1994).

Think for a moment. Alignment, as a conceptual bridge, urges us to reflect on the true nature of the foundations on which it lies: management strategy and technology. The researchers of the original theory took these concepts for granted. Perhaps that research programme is judged 'old' after ten years, because those very concepts should not have been taken for granted, but rather as problematic (see Ciborra 1997). For example, ethnographic research about groupware technology in large multinationals hints at the facts

- that leadership is often missing, and
- that technology is often drifting, as if out of control (Ciborra 1996*a*).

How come researchers privilege the geometry of the ideal lines connecting abstract concepts in a model, but remain blind to the blurred reality of connections that any, even 'light' ethnographic study would present them?

Here we encounter the general problem of management research regarding the relationship between management models (and their geometric representations, with lines and boxes) and everyday phenomena, which concern people at work.

What happens when we link the boxes of strategy, organization, and IT on the famous 'diamond diagram'? It changes our view of the interdependencies between some key business variables. We obtain a new 'geometrical' representation that materializes the idea of 'alignment' in front of our eyes. Thanks to such a representation, management scholars can raise the awareness of practitioners simply by showing them the diagram, as a reminder of what should be the new map with which to venture into the world of business and IT.

But how do these (newly traced) geometrical lines translate into a new management performance? Awareness and espoused theories may not be enough to learn new behaviour (Argyris and Schön 1996) (see below). Indeed, despite the research discoveries and their translation into new management models, the news from the field has constantly been that alignment is not easy to implement, awareness does not suffice, and the two main poles of alignment, strategy and technology, are actually drifting apart for one reason or another. The aim of our interpretative approach is precisely to get closer to the 'of course', the obvious dismissal of the intricacies of 'real life' that 'naturally' cannot be captured by a model, to that 'business savvy' to which the caveats implicitly make reference. It is this long journey towards the sources of obviousness that gradually makes our perspective on infrastructure very different from the one contained in the management literature.

For us, a representation like the one of strategic alignment that does not work provokes a breakdown. From an interpretative perspective, this breakdown offers an opportunity to encounter the world, possibly with different eyes (Dreyfus 1994). Indeed, the grey world of organizations, always there with its pasted-up sets of arrangements, people, machines, which are not aligned according to the models, reminds us of the following: when focusing on the geometrical representations of business variables and interdependencies we tend to grant them essence and existence. It is an ideal, perfect world to which the 'real' world has to conform. According to the conventional wisdom, thanks to a careful and rigorous method researchers can discover the 'objective' world, and then extract the relevant models. Once they have learnt them in the literature and executive courses, managers are supposed to steer the world towards the models.

We argue, instead, that operating in this way may be a source of deadlock and ineffectiveness, and even crisis in the IS field (Ciborra 1998). Look more closely at what happens when we follow the line of argument and reasoning in the management literature: the messy world that we encounter daily, already there, largely outside our control and that we know by pre-scientific evidence and intuition, provides us with the raw materials for our abstract representations. We intentionally take such raw materials, we sanitize them, elicit (through some measurement method) a limited number of connections, and build models by fitting empirical data. However sophisticated, the models remain a de-worlded image of the organization. They are granted essence and existence in the domain of abstractions. Outside that domain they are not 'indexed' by the same degree of reality as the 'world-out-there'. Thus, for example, we can understand the very notion of alignment only thanks to our (tacit) knowledge of the messy corporate world. But the reverse relationship does not hold: from the notion of alignment we cannot reconstruct, let alone intervene in, the everyday world of business.

The world-out-there is the precondition for our understanding of the models and methods, and thus the latter presuppose it, while the former is far from being presupposed by them (Husserl 1970). It is our pre-scientific understanding of and participation in organizations that give to the notion of alignment its existence as an abstraction in our discourses and representations about the world. This is precisely the scope of the alternative definition of infrastructure given above.

We should regard the geometrical models as a superstructure world, as outcomes of an idealization process. But in order to manipulate the raw materials of what has been idealized, we need to go back to the foundations of the superstructure: the lifeworld and the immediate evidence of our lived experience. (A similar urge to value the 'non-logical processes' of the mind engaged in everyday affairs was also expressed in the management literature by C. I. Barnard as early as 1936.)

If we pay attention to the evidence provided by recent cases of automation and work organization, we conclude that in the world-out-there alignment does not obtain because *strategy* is not such a clear concept or practice, because, owing to turbulent and unpredictable circumstances, managers are busy in muddling through, betting, and tinkering (Mintzberg 1980). Furthermore, the use of the *technology* itself is characterized by improvisations of various sorts (Ciborra 1996*a*; Orlikowski 1996*b*) and by many unexpected outcomes (see Chapter 10).

We are now in the position to explain the trajectory of the formerly promising research programme on strategic alignment. Those researchers made multiple abstractions out of the muddling-through and drifting. They idealized tinkering and called it strategy; idealized technology as a controllable set of means and called it IT; granted to these concepts existence and essence, transformed them into boxes and traced a line between them. Then, they started the difficult journey back to the real world, and found difficulties in measuring 'the strength of the line' or formulating prescriptions that would be followed by practitioners when walking along the line on the field of practice. They provided more and more sophisticated representations of alignment, as more analytical and detailed maps for the actors to 'measure' the real world (see, for example, the Appendix on 'checking your level of alignment' contained in Weill and Broadbent 1998: 257–9). To no avail: the higher conceptual detail remained confined to the world of idealized abstractions. But, we submit, it has only a limited impact on the lifeworlds of business and organizations.

Consider now the alternative path. We stick to basic evidence, and encounter the world as it presents itself in our everyday experience. We rely on evidence, intuition, and empathy. We listen to practitioners and participate in their dealings with puzzles and riddles, and we do not confer any particular relevance to words such as 'strategy', 'processes', or 'data'. In this way, by suspending our belief in the models of management science, we approach the everyday life of the manager, made up of frustrations, accomplishments, confusion, joy, and desperation. We can be discouraged: all this is too close to the world we live in! Can we come up with any sense of this blurred reality and address some of the issues raised so far?

Certainly, if we listen to the everyday conversations of practitioners, we hear the familiar terms of strategy, product/markets, and even alignment of systems and administrative structures. These practitioners can be interviewed on such topics, and some of their statements even lead to empirical measurements on a Lickert scale. But, beyond their espoused views, we can observe phenomena such as: plans that keep being diverted, surprises that arise constantly, opportunistic adjustments that must be carried out on the spur of the moment. Planning may be espoused, but circumstances may compel managers to improvise (Ciborra 1999*a*). This is the organizational, 'primordial soup of anonymous practices and events' (De Certeau 1984), in which every well-running infrastructure will float, as the second definition of infrastructure here provided tries to suggest.

Infrastructure implementation is punctuated by unexpected outcomes and side effects, turns that require frequent adaptations if not reinventions of the initial solution (Rice and Rogers 1980; Bikson 1996; see also Chapter 3). We have called this phenomenon 'technology drifting' (Ciborra 1996*a*).

At this point, we can do what management science suggests—that is 'to realize' these 'surprises in implementation' as exceptions, build an ideal world of 'how things should be', and try to operate so that the messy reality in which practitioners act moves towards this idealized model (where surprises are absent or under

control). Alternatively, we can *suspend belief* on what we think we know about strategy, structure, markets, feedback mechanisms, and so on, and reflect upon what we observe. If we stick to this second approach, we encounter the structure of business phenomena that may enrich our geometric notion of alignment and infrastructure deployment, such as care, hospitality, and cultivation.

Care

Henderson and Venkatraman (1993) note that seeking the fit between strategy and the other main business variables is a dynamic exercise. Our research shows that the driving force behind alignment in action, as opposed to the one on paper, is a great amount of caring performed by the various actors involved in the design, implementation, and use of IT infrastructures. What is striking is that there is nothing special in this caring: it is just familiarity, intimacy, and continuous commitment, from the initial needs analysis through the construction of the infrastructure, training the users, introducing the systems and applications into practice, modifying them as new practice emerges, and so on. Care itself has a 'structure' linked to how we are-in-the-world, articulated in perception, circumspection, and understanding processes (see Ciborra 1996*a*).

Hospitality

What calls us to align technology? First, the general need to cope with and understand the world. Secondly, alignment presupposes acceptance and hosting. To wit, previous empirical research has shown that technology can be both fragile and ambiguous (Grudin 1988; Ciborra 1999*b*). Fragility derives from the ubiquitous presence of substitutes at the automated workplace, usually tools that are better 'understood'. Often, new applications—compared to those that already exist—appear to be incongruous, an obstacle in the workflow. They require circumspection and to be worked at (or 'work-arounds') in order to be embedded in the workflow and to deliver their potential. They require an extra, subtle effort of acceptance. Secondly, because today's infrastructures enable multiple uses, and since shifting in the practices of coping, use, and reinvention occurs continuously, they often lead to surprising outcomes. Thus, a groupware system designed to enhance transparency and knowledge sharing can instead raise fears among users of being a 'Panopticon' for centralized control (Zuboff 1987). Technology is in a state of flux in organizations, and it is highly ambiguous. Acceptance has to face ambiguity: coping, thus, becomes hospitality. In its turn, hospitality is an unstable way of coping with the stranger: it can suddenly turn into hostility. Behind the technocratic idea of planning and alignment, the phenomena from the field make us encounter one of the oldest arts of mankind: hosting a stranger.

Certainly, if the technology were totally 'disambiguated', univocal in producing its effects and impacts, hosting would consist of straightforward adaptation and alignment. The latter is precisely the picture of the world of implementation as portrayed by both the structured methodologies and the management literature: systems are objects, infrastructure is a well delimited pyramid, knowledge is data, work is business process, and people are emotionless decision-makers who have to align their preferences and adjust to the changes rationally planned for them. It is the world of business re-engineering models, where designers, consultants, and managers juggle around boxes and arrows to come up with solutions that optimize pre-selected performance criteria. The intricacies and uncertainties of ambiguity, hospitality, and hostility are ruled out from such a world of abstract organizations, but equally ruled out is the 'organizingness' of everyday business life (that is, the essence of the experience of operating in an organization), or, better, what Walsham (1993) calls the multilayered context in which infrastructures are embedded. It is precisely such 'organizingness' and rich context that help infrastructures become integrated in the workflow, 'aligned', and 'understood'. Unfortunately 'organizingness' cannot be represented geometrically: it is made by real-world participants from their experiences of coping and caring, of being there amidst ambiguity and intimacy, and of sporting hospitality as well as tamed hostility towards what the new and the unknown disclose.

Cultivation

The intricacies of the relationship between strategy and technology, hidden by the deceptively clear management-science concepts, can also be captured by the notion of 'cultivation'. Itami and Numagami (1992) see cultivation as the dynamic interaction between current strategy and *future* technology—a process by which technology is accumulated (often in unplanned ways) with a much greater future potential than is necessary to meet current needs. For example, Toyota's lean product system was the outcome of technology investments made out of necessity to cope with short-term problems, such as small production runs for small market volumes. But, in retrospect, those investments helped Toyota's later strategy to become an internationally competitive manufacturer.

To wit, cultivation is based on frequent misalignment and misfit: the technology being accumulated is greater, or different in its potential, from current internal and external needs. The ensuing paradoxical prescription for the firm is to overextend: cultivation is about destabilizing current strategy and 'creating imbalances' with the current level of technology. One example is a strategy of coexistence of multiple projects in different stages of technological evolution as opportunities to create new knowledge (Clark and Fujimoto 1991): the resulting tension, misfit, and coping will stimulate learning and possibly the building-up of new solutions.

For Dahlbom and Janlert (1996), cultivation is a way of shaping technology that is fundamentally different from rational planning and constructing a technical system. While constructing and aligning are about selecting and putting together objects (systems) to form a coherent system, cultivation is about interference with and support for a material that is in itself dynamic and possesses its own logic of growth, like helping a wound to heal.

Besides evoking misfits, breakdowns, and resistance, as the stuff which 'alignment-in-action is made of', the concept of cultivation invites us to reconsider the role played by the object of alignment—technology.

Technology tends to drift when put to use. Thus, the idea emerges of technology with a certain degree of autonomy and inner dynamics; of technology both as a drifting system and as an organism to be cultivated (see Chapter 5).

The traditional conception of technology, which originated with Aristotle (Hood 1983), is that technology is a human development or arrangement of tools, machines, materials, and methods to serve the attainment of human purposes. In other words, technology is a 'passive' and neutral set of means to achieve some ends. This perspective lies implicitly at the core of most management and economic literature in good currency.

As a logical system (a set of beliefs about cause–effect relationships (Thompson 1967)), technology possesses its own tendency towards perfection and systematization. On the other hand, recall the definition of infrastructure given by the science studies scholars (Star and Ruhleder 1996):

- it operates through standardization and extension of linkages;
- it is sunk into other social arrangements, institutions, or technologies;
- it is invisible and transparent in supporting the execution of tasks;
- it is embedded in a set of conventions of practice;
- it is an installed base: infrastructure does not grow *de novo*; it wrestles with the inertia of the installed base and inherits strengths and limitations from that base.

A closer look at the *internal* dynamics of IT infrastructure would show that:

- many actors are involved in its establishment or development, so that it cannot be controlled by only one actor;
- the issue of standards becomes paramount; battles of standards involve the setting-up and management of complex coalitions of actors and technologies (David 1987);
- history, path dependency, unique events punctuate the development of infrastructure and have an irreversible influence on its configuration at any given moment.

Such phenomena can be observed, for example, when looking at the dynamics of the 'installed base' (see Chapter 4). As a consequence, a totally new idea about what alignment is can emerge: it is an alliance between humans and non-humans, where non-humans (the architectures, the operating systems, the standards) seem to have a say as important as the humans (Latour 1999). Specifically, alignment would correspond to the successful translation of the interests of one actor into the behaviour of another actor, within a complex network of actors and intermediaries (Callon 1991; see also Chapters 5 and 9).

The idea of the information-technology portfolio

We have seen above the close parallel instituted by the recent management literature between an ordinary financial portfolio, even an individual one, and the corporate IT portfolio. The new definition of infrastructure, in particular its installed-base dimension (see Chapter 4), suggests a different scenario. The portfolio analogy invites the idea that the assets involved are easy to acquire or to dispose of, according to the evolving strategic goals, and the necessity of constant fine-tuning of IT strategic alignment. The governance of IT would, then, resemble a 'holding organization' (Williamson 1975), exiting and entering businesses according to their respective returns. The current corporate landscape offers, however, a more complex picture than the one of a frictionless investment environment. There are signs of this 'holding-organization' approach in managing an infrastructure portfolio—for example, in the process of outsourcing IT services. But the very 'politics' of outsourcing (Willcocks and Lacity 1997) also shows that some outsourcing decisions are much more complicated than expected, have to be reversed, and in some cases lead to failure. In one word, externalizing IT does not prove to be as smooth as promised: after all, assets are *not* easily transferable. There are transaction costs. The analogy with a personal portfolio, composed of stocks, obligations, cash, and so on, assumes a context with very low—at the limit zero—switching costs. Consider again the IT portfolio, and in particular its main infrastructural component. Look at infrastructure-in-use as a set of *shared* resources, where *synergy* is paramount, and consider its aspect of sunk and sticky investment (the installed base). These assets have all the characteristics of idiosyncratic, transaction-specific investments that generate switching costs. Hence, the holding organization model cannot be applied in this case where transaction costs are high. The litigations that often punctuate outsourcing decisions and the other phenomena of slow-moving infrastructures, or even infrastructures impeding business redesign exercises because of their stickiness and lock-in effects (see the IBM case, Chapter 7), seem to confirm the latter perspective. The portfolio idea gives management the illusion of being able to plan and decide how to pick or drop the more revenue-generating applications or systems. But this freedom is simply not there. There are constraints, instead, or actions performed by the technology itself (see Chapter 5), that limit severely such easiness to revise investment initiatives on an ongoing basis. Switching costs may dictate that management accepts compromises and lives with a suboptimal infrastructure, being allowed to modify its components only incrementally and slowly. Existing infrastructures are far from being liquid assets. This does not rule out different possibilities for the future (see Chapter 12). Indeed, an infrastructure could be treated in the same way as a personal investment portfolio, if its components, standards, and applications could be easily (with low transaction costs) dropped, as one can get rid of falling stock to increase the value of a portfolio. But such a scenario would hardly justify the need for books or case studies on infrastructure management. It would be Legoland: components of an infrastructure could be rejected or added on swiftly as building blocks equipped with standardized interfaces. The invisible hand of the

market would be the main governance mechanism needed for the 'management' of such a modular infrastructure. And, above all, there would be no need to represent an infrastructure in a hierarchical way.

But at the time of writing companies are struggling with a very different problem: complexities in outsourcing, and the panic and huge investments to avoid the problem of the year 2000, testify that the corporate world is far from operating in such a Legoland infrastructure environment. They are living in a world where infrastructure tends to be a *non-separable* technology: replacing, modifying, or splitting it involves high switching costs and sticky assets. Effective governance must deal with these issues (Shapiro and Varian 1999). The cases in this volume bring further evidence of how attempts at governance are made in action: they all seem to be distant from the portfolio approach. In the only case where a whole infrastructure was dropped (actually its upper, more volatile applications layers), it took eight years to make this decision, given the symbolic as well as the material investments that had been made in it by managers and systems developers (see the Roche case, Chapter 11).

Last, but not least, the IT investment portfolio idea does not seem to capture one key aspect of infrastructure: its being above all a 'relation' (recall our second definition). A fundamental economic dimension of 'infrastructure as relation' is to be able to enjoy the positive feedback effects of the economics of networks, as opposed to the economies of scale (Shapiro and Varian 1999). A successful infrastructure is able to 'tip' the user community (and the market) in its favour, by exploiting the fact that the value of connecting to and using the infrastructure depends on the number of the extant user base. As a consequence, the value of the IT portfolio depends upon demand-side economies of scale—in other words, on the size and dynamics of the virtual network of users. The value of the IT portfolio depends, then, upon a factor that lies outside the 'pyramid' of high- or low-risk items that compose the information infrastructure: the networking of users and the positive externalities it may bring.

From knowledge to action

While the management agendas are very effective in guiding the *formulation* of an infrastructure plan, they do not give any special advice on the *implementation* and adaptation side. They provide only wise words of caution: the business world out there is complex, varied, and changing; any of the models on which the management agenda is based should be used with a grain of salt, and so on.

However, these obvious caveats and words of caution may make the management agenda largely irrelevant for action, since it does not deal with the key transition between having a nice vision and producing that vision (Argyris and Schön 1996). Management agendas are obvious, sound, and look pragmatic. In reality, they are deceivingly persuasive. They are not actionable, first, because they are highly simplified and based on sweeping generalizations and abstractions (such as 'strategy', 'utility', 'infrastructure') as discussed in the previous sections, and, secondly, because they do not take into account the counter-productive effects of self-defensive routines in organizations pointed out by the organizational learning literature. Let us look at the latter point in more detail.

Introducing a new infrastructure, or—as the advocates of strategic alignment proclaim—the design and implementation of new business platforms (Venkatraman and Henderson 1999), implies the management of broad and sweeping changes across the organization (see, for example, the IBM case study, Chapter 7). What course of action should management follow? As Fig. 2.2 suggests, it depends

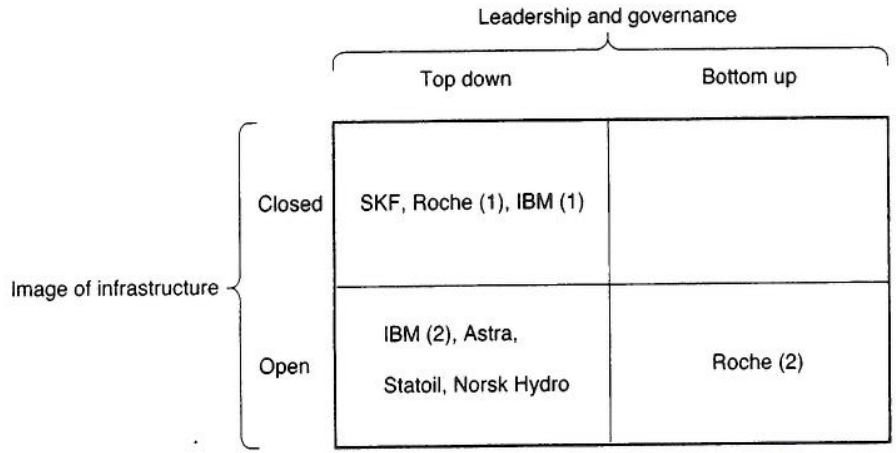

FIG. 2.2. Approaches to infrastructure governance

upon the match between the scope of the infrastructure *definition* (a closed, controllable system versus an open and embedded network) and the style of management *intervention* (top-down, control oriented versus tactics or deals or 'releasement' oriented). The strategic, top-down approach works when the infrastructure can be planned and controlled in all its main features. In the cases reported in this volume, only SKF conforms to this approach. The infrastructure of the Swedish multinational could be developed according to the control model given the particular circumstances of a firm that was enjoying stability, growth, and market dominance over time, while its products were not subject to radical innovations. The result is a uniform, but rather 'old' infrastructure that serves the business well (good alignment), but with a question mark: how long will it last? Will the extant infrastructure adapt to the dramatic changes that might affect the industry in the future, or will it prove to be too rigid?

All the other cases in the figure are characterized by ineffective or effective ways of dealing with large, amorphous infrastructures. In particular, the attempts made by Astra, IBM (in an earlier phase of CRM deployment), and Roche (in a first phase

with their corporate network, MedNet), are biased towards the idea that infrastructure can be designed and implemented top down in a controlled way. All such attempts backfired, led to more or less explicit failures, and were subsequently abandoned, in favour of various ad hoc tactics, if not the complete releasement of central control, as in the Roche case (second phase), in order to foster the development of the Internet and Intranet platforms (see Chapter 11).

Thus, the cases in this volume point to the fact that, while, at the start of their infrastructure projects, the firms studied would split in a fifty–fifty percentage, in a similar fashion to that reported by Weill and Broadbent (1998), over time management by deals emerged as the prevailing approach in all but one. And, as already pointed out, the conservative success of SKF may be due more to the special circumstances of the industry and the firm that has dominated it for decades, rather than to the validity of the top-down approach itself.

Now, the management literature portrays all this as a matter of will. If top management and IT management *favour* a joint, comprehensive view of infrastructure, then a top-down approach is the option of choice. Otherwise, management by deals appears to be the second-best, almost default, alternative: 'Good infrastructures rarely just emerge. They are the result of sound and proactive management processes aimed at maximizing business value' (Weill and Broadbent 1998: 173). Our longitudinal case studies suggest a more deterministic view of the matter. It is the very nature of the infrastructure, captured by the more complex definition provided by science studies (see above), that dictates the failure of the management-by-maxims approach, and favours a variety of ad hoc, partial moves. Conversely, almost any attempt to manage a complex infrastructure top down is voted to fail. Let us see a number of reasons why.

Separation between formulation and implementation. The management-by-maxims approach is just the latest form of strategy model that focuses on getting the 'right' strategic formula (here concerning infrastructure and its links to the business), by identifying the abstract characteristics of the context and the technology. As Mintzberg (1980) has suggested in general, and Ciborra (1994) in the case of Strategic Information Systems, it is dangerous to assume a divide between formulation and implementation, in the sense that what may appear valid and seductive on paper cannot be achieved during implementation. Strategy should not be looked at as an analytical document to be handed over to the organization in order to be executed. Strategy is what emerges from the actual implementation process, which may be characterized by deviations, surprises, and conflicts. No initial 'analytical formula' will be able to address beforehand all such events occurring during implementation. Only special circumstances—long planning horizon, continuous care, and relative immunity from market or technology pressures—can guarantee enough leeway for the detailed implementation of a plan into its concrete realization. Today, most firms operate in a much more volatile and unpredictable context to be able to ensure such an orderly implementation process. Furthermore, the very nature of the infrastructure itself, given its ramifications, internal dynamics,

and almost boundary-less character, is a relevant source of unpredictability, side effects, and surprises (see Chapter 3), as most of our cases show with due detail.

Espoused theory versus theory in use. Our cases also suggest something more fundamental that connotes all the management agendas provided so far in the area of IS and infrastructure management. Such approaches are formulated in forms of 'advice' to senior and IT management. They list all the governance aspects to be considered, from the strategic issues up to the information politics. They then point to implementation approaches, such as 'start with low profile, transactional applications', 'set up user committees', and so on. What our cases show is that senior and IT management are well aware of these 'leadership principles' in one form or another, but adhering to these principles does not imply success or the avoidance of having to 'muddle through'. One of the main reasons for such a deviation is that the advice given and followed concerns only the espoused, expressed theories and visions that actors claim will orient their actions, not those theories that actually lead action (theories-in-use) (Argyris and Schön 1996). So, in some of the cases it emerges that the vision might be one of user-led development, while the practice is of centralization. Or, the new organization might put a premium on teamwork, but the technology inscribes a centralization of the data flows. Or, processes and the tools that support them are launched to streamline the company, but their accompanying procedures are extremely bureaucratic (that is, new red tape). And so on. The result is that the management literature may indeed convey all that 'the world needs to know' about infrastructures and their deployment, but this knowledge is not directly *actionable*—that is, the advice does not prevent it shifting, or being biased by the extant circumstances, when it is put into practice. And the more infrastructure is 'embedded', the more the web of local and global circumstances will have an impact on the implementation of any advice, no matter how sound it may be.

Single-loop learning. The managerial literature urges senior management to learn from experience, too. One of Weill and Broadbent's (1998) leadership principles is to make a systematic evaluation of infrastructure projects in the spirit of organizational learning for future design and implementation efforts, taking care to avoid any witch hunt. However, we submit that there might be a mismatch between the learning requirements of an infrastructure project and those advocated by the literature. The latter are inspired by the governing values of single-loop learning: be in (unilateral and top-down) control, be rational, win (over resisting forces), and do not lose. The implementation advice also is consistent with such governing values: start with 'easing-in' approaches, plan to avoid information politics so as to preempt destructive behaviour during implementation, and so on. Our cases report instances where these approaches have proved to be lacking, leading to situations characterized by the very same features that they were supposed to eliminate. We submit that, to the extent that infrastructure projects may require a deep change in the way of running business, easing-in approaches may have a short lifespan; also that information politics might flourish in new, unexpected ways, and so on. It is

not so much a matter of finding new 'leadership principles' as of revising the very governing values that mould the articulation of those principles and ensuing practices. Roche, in its deployment of the Internet and Intranet, offers an example where such governing principles were deeply revised (in particular the principles of unilateral, central control). But this instance of double-loop learning (Argyris and Schön 1996) is still rare, and in any case difficult, and costly to achieve. The management literature is not helpful in this respect. On the contrary, it muddies the waters by reinforcing the illusion that extant management values and single-loop learning can govern the deployment of large, only partially predictable infrastructures.

Separation between management politics and the politics of non-human components. Another reason why the leadership principles and ensuing advice of the current literature may prove of only modest impact is the implicit, but fatal, assumption it makes about the nature of the infrastructure and technology in general. In its basically closed, pyramidal view of organizations and infrastructures, technology is a tool that has to be planned for and constructed. On the other (separate) side of the fence there is the managerial information and resources politics to be addressed. We submit instead that the take-off of an infrastructure is due to the 'alignment' of a complex, varying alliance between human and non-human components (see Chapter 5). At each point in time and for any organization one can identify competing complexes of people and technologies. Infrastructure as an installed base is a powerful actor in itself, driven by its own logic, seeking allies and fighting battles in order to survive (see the Norsk Hydro case, Chapter 8). The 'angry orphans' created by the new standards are most probably its first allies. Given the embeddedness of the infrastructure (highlighted by our second definition), separating a priori human actors and non-human tools creates difficulties in understanding and intervening in the implementation of infrastructure. Black-boxing an infrastructure into a pyramid hides the multiple, tortuous processes, interventions, and side effects that punctuate the process by which those diagrams can be painfully drawn. A well-run infrastructure is the outcome of a successful alliance between human and non-human actors. In most of the cases we have studied such an alliance is emerging, temporarily, and often steered, to the dismay of the strategic-alignment advocates, by non-human actors (for example, the expanding and inertial installed base).

A more 'symmetrical' approach to the whole issue (see Latour 1999) would lead us away from the naive assumptions and 'cowboy-like' managerial models based on the unilateral control strategies of humans over non-humans, plagued by uncontrollable surprises.

Conclusion: The Control Idea

Our critical review so far has pointed to the fact that the literature on infrastructure is moulded by the basic tenets of management literature in general, one of which

is the *centrality of control*. Although it is acknowledged that today's firms operate in fast-moving, global, and volatile business environments, when it comes to dealing with large IT assets that have a long life, investment must be managed 'judiciously'. Infrastructures that are 'undermanaged' can become a liability instead of an asset. 'The thousands of small information-technology investment decisions that are made every day in a large corporation are even harder to manage and co-ordinate. But if they aren't co-ordinated and managed, information technology can become a barrier, not an enabler' (Weill and Broadbent 1998: 10). Given its increasing size, information technology as corporate infrastructure runs the risk of being 'undermanaged'. Hence, the need seriously to rethink IT investments, and the way a firm manages and governs them. But along which lines should such a rethinking unfold? In the management-infrastructure literature the answer is quite clear: along a line of *increased control* (see Peppard 1999). For example, in the diagnostic questionnaire put forward by Weill and Broadbent (1998) to check the level of alignment between business strategy and infrastructure, and hence the level of urgency required for top-management intervention, seven out of the ten items are related to some form of control over IT resources, or the policies relevant to their deployment. Earl (1996) and Peppard (1999), on the other hand, suggest alternative ways of combining different strategies for the decentralization and centralization of control over IT resources. Their aim is to devise rules setting out the parameters and mechanisms for deciding how to divide activities, resources, and responsibilities between the centre and the peripheral units of the organization. In sum, what gets proposed as an effective means to manage these new degrees of complexity is a 'more elaborated control structure', such as 'an organizational body which will oversee changes and additions to the suprastructure [the set of infrastructure as well the policies and mechanisms for its governance] addressing any disputes which may emerge: a meta-decision making forum' (Peppard 1999: 89). Eventually, a single-loop learning approach will 'seal' the process of managing the infrastructure: learning about mistakes and deviations will be governed by principles that confirm and further sustain the idea of control.

We believe, instead, that our cases show that the control approach does not always work, and, surprisingly, works only if it is radically denied. Hence, the need to explore alternatives, challenging the very idea that the main risk for infrastructure, given its size and complexity, is undermanagement, and that the default alternative can only be ad hoc deals and a fragmented platform. What if size and complexity make the single-loop control approach impractical and ineffective, giving only the illusion of governance, for something that cannot be fully controlled? What if the infinite shifts and deviations of infrastructure are sources of innovations in use that may contain seeds for new, strategic ways of running the business (Ciborra 1994), and learning new things about a complex we do not know much about? What if our power to bring to life sophisticated and evolving infrastructures must be associated with the acceptance of the idea that we are bound to lose control? And that any attempt to regain top-down control will backfire, lead to further centrifugal drifts, and eventually impede our making sense and learning about how

to effectively take care of the infrastructure? Instead of worrying about under-management, and trying to regain control through approaches that prove from the outset to be too simplified, why not play with the idea of a different partition between the limited scope for our management of the infrastructure and the scope for the infrastructure itself to manage us?

3

Globalization and 'Risk Society'

Ole Hanseth and Kristin Braa

Globalization is widely acknowledged to be an important contemporary phenomenon. Globalization and technology are mutually reinforcing drivers of change. The role of IT as a key factor to bring about this change is often thought of as an opportunity to enhance control and coordination, while opening access to new global markets and businesses (Ives and Jarvenpaa 1991). Bartlett and Ghoshal (1998) claim that firms operating in these global markets will be at a serious strategic disadvantage if they are unable firmly to control their worldwide operations and manage them in a globally coordinated manner. According to their model, corporations are focusing on closer coordination of increasingly more complex and global processes. At the same time, we are aware that all globalization is creating an increasingly changeable, dynamic, and unpredictable world. These issues are in contradiction. Models for tight control and coordination presume stability. Such models require the different elements in the processes to be coordinated—the cogwheels in the machine—to be known and well specified. In a global system they need to be standardized. As the complexity of the 'machine' grows, the more time it takes to change it. And a global 'machine' made up of standardized components requires stability.

The companies studied in this volume are all struggling with this contradiction. They are all trying to implement more powerful control structures and improve global coordination while it seems as if their ability actually to control their business processes is decreasing.

In this chapter we look into this contradiction. We discuss models proposed for managing global organizations. These models are presented in the light of the more general management models proposed during the 1990s. We focus in particular on the issue of *control* in global organization: the issue of whether firms can control their worldwide operations, whether IT infrastructures can facilitate such control, and whether IT infrastructures themselves can be controlled. We look into these issues by following the thinking of Anthony Giddens and Ulrich Beck.