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The Past and Future of Information Systems

Kim Viborg Andersen
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The past and future of information systems

A tribute to Niels Bjørn-Andersen

BUTTERWORTH-HEINEMANN INFORMATION SYSTEMS SERIES

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Edited by

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and

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SAN DIEGO SAN FRANCISCO SINGAPORE SYDNEY TOKYO

Elsevier Butterworth-Heinemann
Linacre House, Jordan Hill, Oxford OX2 8DP
200 Wheeler Road, Burlington MA 01803

First published 2004

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British Library Cataloguing in Publication Data
A catalogue record for this book is available from the British Library

ISBN 0 7506 61410

For information on all Butterworth-Heinemann publications
visit our website at www.bh.com

Typeset at Neuadd Bwll, Llanwrtyd Wells

Printed and bound in Great Britain by MPG books, Bodmin, Cornwall

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Preface

Gordon B. Davis

The academic discipline of information systems is the newest field within the broad field of management or economic sciences. This field developed almost from its very beginnings as an international community of scholars. Niels Bjørn-Andersen has played vital roles in nurturing the international discipline of information systems. I count him on the short list of the 25 most important founders of the field. It is appropriate to honour his contributions on this occasion.

I have been fortunate to have been a part of many of the developments that helped the formation of an international community of information systems scholars. Niels participated in most of these developments. I will focus on some important events where I observed Niels personally or was aware of his activities. A list of some important events will position Niel's work within the context of events in information systems in organizations.

1954 First business use of computers (in the UK and the United States)

1958 Important speculation of importance to business of computers in *Harvard Business Review*

1960 Founding of International Federation for Information Processing (IFIP)

1965 Börje Langefors appointed in Sweden as professor in Information Processing, with special emphasis on Administrative Data Processing.

1968 First formal MIS academic degree programs in the United States (M.S. and Ph.D.) at University of Minnesota.

1968 Establishment of organization for information system executives (CIOs); first called Society for Management Information Systems and now Society for Information Management (SIM)

1976 Establishment of IFIP technical committee on information systems (TC8)

1980 First International Conference on Information Systems (ICIS)

1994 Formation of Association for Information Systems (AIS) as an international academic organization with an international governance structure. Merger in 2001 with ICIS as world conference for AIS. Alliances with regional conferences in Europe, Asia, and America (ECIS, PACIS, and AMCIS).

Computer science emerged during the formative years of electronic computing in the late 1940s and early 1950s. Information systems came a bit later. There was an 11-year delay before the first professorship in administrative data processing and a 14-year delay before the first formal academic program in management information systems in the United States. Many academics were working on problems related to information systems in organizations; the delay was in recognizing information systems as a separate academic field. This is shown in the fact that IFIP was formed in 1968 but its Technical Committee 8 on information systems was not formed until 1976.

There was a time delay between the introduction of computers into organizations for data processing and the recognition by industry that there needed to be a new organization function to manage the design, development, implementation, and operation of the systems. That industry recognition happened about the same time as the recognition by academics that there were interesting, important research issues in information systems. Many of the early academic leaders in the field of information systems had diverse backgrounds, leading to a rich academic field with a variety of underlying disciplines and research methods. Niels' career starts as a systems analyst (1967–1969) during the period when Langefors was starting his professorship, Minnesota was formalizing information systems degree programs, and CIOs were organizing themselves. Finishing he doctorate in 1973, he rose to the challenge of developing the field. Four especially important contributions were with development of international organizations for the field: IFIP, ICIS, ECIS, and AIS.

When IFIP established the technical committee (TC8) in 1976, Niels was appointed the Danish representative to TC8 and served for 17 years. He has been very active in TC8 working groups, especially WG8.2 on organizations and information systems. He sponsored and helped organize conferences for TC8 and for WG8.2. He was program chair for a conference on information systems assessment in The Netherlands in 1986 and a conference in India on information systems in developing countries in 1988. These working groups brought together scholars from around the world. One conference that was very significant in building a community of scholars was the IFIP WG8.2 1984 Manchester Conference on information systems research methods (E. Mumford, R. Hirschheim, G. Fitzgerald, and T. Wood-Harper, eds, *Research Methods in Information Systems,* North Holland, Amsterdam, 1985). This conference was a landmark, and Niels was an important contributor. The reason I count this conference as very important is its role in opening up the discussion of different research paradigms. Most of the researchers in North America at that time tended to emphasize a positivist approach to research with experiments, surveys, hypothesis testing, and so forth. Many of the Europeans were doing post-positivist, interpretive research. The conference opened the minds of many of the conferees and helped open the field of information systems to a variety of research paradigms. There will be a second Manchester conference in 2004 to mark 20 years of research in the field.

The second important development in the organization of an international field was the formation of the International Conference on Information Systems (ICIS). Early researchers in information systems had disciplines to which they belonged. There was no general, well-accepted, high quality information systems conference. The first conference was held in 1980, and it rapidly developed in scope and quality. Niels brought ICIS to Europe in Copenhagen in 1990 and established ICIS as a world conference. It has been held four times outside North America in the past eight years. A major feature is a high quality, invitational doctoral consortium with a mix of doctoral students from different countries. Niels was honoured by being appointed to doctoral consortium faculty for the 1986 ICIS and chairman of the consortium faculty in 1992.

Niels assisted in building a third organization, the European Conference on Information Systems (ECIS). Niels had sponsored activities to bring together academic researchers in Europe, such as his preparation of a directory for information systems faculty in Europe. Although ICIS was clearly a success as an international conference, Niels and others saw the need for regional conferences of similar scope. The result was the formation of ECIS. Niels was the general conference chair for ECIS in 1998.

The fourth event in the organization of the field was the formation of the Association for Information Systems (AIS). From the time of the first ICIS in 1980, there had been discussion of a new international organization devoted exclusively to the academic field of information systems. The Association for Information Systems was established in 1995 with Bill King as its first president. The governance structure was designed to create a truly international organization. The position of president rotates among three regions, and all presidents have been leaders in the field. Niels was the second president (1996). AIS has grown to include close to 50 percent of faculty members worldwide. It has helped the field to concentrate and rationalize many of its resources. AIS honoured Niels as an AIS Fellow.

Although I have focused on Niels' contributions to the organization of the academic discipline, he has been very active in research, in the journal system as member of editorial boards of major journals and as Associate Editor for the *MIS Quarterly*, in doctoral advising and examinations, research boards, and advisory editorships. He has published much in a broad range of journals. He is an international scholar and moves freely among nations. His visiting appointments have included England, France, Sweden, Finland, USA, and Australia.

Niels has been a vital part of a very interesting saga of development of an international academic discipline of information systems. If one starts counting the emergence of the field from the appointment of Langefors in 1965, then the new field is only 39 years old. Niels has been part of its development for 35 of those years (counting from his research scholarship in 1969). His has been an outstanding career of scholarship and service. He has done all this with a pleasant personality, good humour, and collegiality. I am pleased to be able to extend my best wishes on Niels' 60th birthday and to express my appreciation for his contributions.

Gordon B. Davis
University of Minnesota

1 Introduction: adventuring into the past and the future

Kim Viborg Andersen and Morten Thanning Vendelø

Trees and fields tell me nothing: men are my teachers – Plato: Phædrus

If the Smithsonian Museums included halls of information technology displaying the devices, gadgets, mainframes, processors, and so on, we would, in line with Plato, argue that they missed out an important element if the people that created, industrialized, implemented, and used the information technology were not included. The researchers who analysed the processes and the factors that helped foster and raise the information systems research field should be given equal attention.

In this book, colleagues of Professor Niels Bjørn-Andersen explore evolutions of the IS research field. We could have chosen other experts in the many-layered IS net. A number of IS scholars, such as Gordon B. Davis, the late Rob Kling, Michael Myers, Rudy Hirschheim, Kenneth L. Kraemer, John L. King, Robert Zmud and many more have experienced how the field has evolved from the early 1970s, and their research has helped develop the IS research field into its current status. Also, we could have focused on a particular research approach or methodology as the 'spider' of the IS net (Myers and Avison, 2002). Yet, we do not think that a different approach would change the fact that the four themes – IS systems development, implementation of IS in business settings, the human factor, and policy challenges – stand out as critical and important segments in current and future IS research.

The chapters in the book are written by 14 IS researchers that have excelled within their subject and been exponents for ways to conduct research, stimulate diffusion of research, and initiate innovation in the IS research field. The researchers have in one way or another been involved in IS systems development and implementation, which are considered as the creation of the trees and fields of IS and as contributors to this book they raise a number of stimulating issues as reflections of the past and the future of IS research.

The IS research field has matured over the past 30 years, bringing it from a situation where scholars of IS worked in computer science as well as business school departments, such as accounting, organization, management and operational analysis, to a situation where almost every business school has an IS research department, acknowledging the importance and viability of this new field of research.

In the early 1970s, at the Copenhagen Business School's Department of Organization & Industrial Sociology, Niels Bjørn-Andersen started his career by studying management information systems (MIS) and decision support systems (DSS) (Bjørn-Andersen, 1974). The realization that the implementation of such systems provoked important organizational changes, for example, in the form of changing power relations and organizational structures, led him to study social and organizational consequences of computerization (Bjørn-Andersen et al., 1979, 1982, 1986). This focus of the negative externalities of computerization subsequently created the momentum for focusing on development of IS systems development methodologies with a human face (Bjørn-Andersen and Davis, 1988; Schäfer et al., 1988). Niels Bjørn-Andersen influenced this research in two ways. First, he rejected the search for a 'one-best' methodology for all applications; instead, he argued for a contingency theory to help choose an appropriate approach for developing systems in practice. Second, he searched for a more ethical view of IS development, suggesting that broader effectiveness considerations were more important than narrow efficiency considerations. Throughout this first phase a major influence was the care for creating better work settings for the people working with and being influenced by the new technology (Markus and Bjørn-Andersen, 1987). In a societal perspective this research agenda very well reflected a general trend focusing on democratic work environments, quality of working life, and participation by and empowerment of the employees.

The late 1980s and early 1990s represented a new era in the IS research field, as the dominating perspective changed to one of the corporation and its management. New themes such as interorganizational IS, in the form of electronic data interchange (EDI) (Krcmar et al., 1995), and new ways of organizing with IS, such as business process reengineering (BPR) (Hammer and Champy, 1993) and IT outsourcing (Lacity and Hirschheim, 1993), came into focus. Hence, in this period we witnessed the coming of an intense, rational choice-based interest for achieving organizational effectiveness and efficiency in managing IS. From a theoretical perspective this can be viewed as a return to the early 1970s IS research focus with its belief in information technology application as the driving force for preparing organizations for survival in a still more competitive environment.

In the late 1990s and the start of the millennium, the emergence of web-based technologies, such as the Internet, intranet, virtual technologies, and later mobile technologies, moved the IS research to a third era focusing on new ways of working, new forms of organization in public and private life, and new conceptions of the corporation and the public sector. During this third phase, the application of technologies at the activity level (Yap and Bjørn-Andersen, 1998, 2002) and in the extended organisational room (Chatfield and Bjørn-Andersen, 1997) came in focus. Also, the information society became an important policy issue, whereas in the previous phase information technology was primarily an aspect of work life. Drivers for how to benefit from information technology became central also for developing countries (Andersen et al., 2003). Finally, in the era before the bubble burst in January 2000, referred to as the new economy, the IS research field moved to several new conceptions such as electronic commerce, which later became electronic business, digital administration, and knowledge management.

The themes in this book

The book is organized into four main themes, each reflecting the history of IS as well as presenting core themes in the IS research field: IS systems development, implementation of IS in business settings, the human factors, and IS policy challenges.

Theme 1: IS systems development

In Chapter 2, Michael Earl highlights that scholars of IS in Europe, and especially in Scandinavia, have always studied the IS systems development process and sought to *improve practice*. Thus, a central theme has been that of prototyping and *pilots*. This is completed in Chapter 3 on Piloting Socio-Technical Innovations, where Tilo Böhmann and Helmut Krcmar argue that an important part of practice is how IT could be fitted into the *working lives of the people* that are going to use it and how individuals concerned best relate to the computer system.

In Chapter 4, David Avison, Richard Vidgen and Trevor Wood-Harper stress aspects of Multiview that are most relevant to the concerns of Niels Bjørn-Andersen, namely, the belief that IS development should embody *multi-disciplinary and ethical perspectives* suggesting genuine human progress in organizations, not simply naïve technical and efficiency viewpoints that had hitherto been its main concerns, and also that approaches should be adapted to the particular requirements of the organization and its culture.

In the final chapter within this theme (Chapter 5), the team of designers and developers of IS is in focus. Suggesting a knowledge quality assessment model, Salvatore Belardo, Donald P. Ballou and Harold L. Pazer argue that if using such a model to evaluate and track the knowledge possessed by design teams and individual members of design teams, managers will make better decisions about resource development and resource allocation. Hence, the authors address the issue of knowledge management in IS systems development.

Theme 2: Implementation of IS in business settings

The book moves on to another classic theme in the IS research field, namely the study of organizational consequences of the implementation of IS systems. Perhaps more than any other IS research theme, this theme has the feature of cross-fertilizing other fields of research. Three chapters address the theme in three different ways, though united in their call for a careful re-examination of the *focus* of IS research. Lynne Markus and Daniel Robey take us in Chapter 6 into the world of *unintended consequences* of information technology *use*, and provide us with elaborate insights into the various theoretical explanations (design and affordances, human agency and appropriation, context of use, and sociological dimensions) with which to analyse and understand this phenomenon.

Thereafter Niels Dechow and Jan Mouritsen (Chapter 7) provide one of the most recent updates on research into the association between IS and accounting. They submit that this association has grown stronger with the introduction of more advanced and complex management control systems commonly described as enterprise resource planning systems (ERP-systems). For the analysis of these systems, they use manuscripts about an ERP system, and they suggest that this analytical approach may enable the development of a new space for analysis of the consequences of management control systems, which requires a simultaneous understanding of accounting and information systems.

Finally, in Chapter 8, Jon A. Turner reviews the models that underpin the technology and organization change literature, arguing that the two seem quite far apart and that practice could be brought more into the research models. He calls for more action research, field experiments, and case studies of actual implementations by researchers with a practical system implementation experience and the *use of the cases to build models of the dynamics of implementation*, enabling us to understand and aid unsuccessful implementations.

Theme 3: The human factor in IS research

The third theme – the human factor – derives from the challenge in the 1980s of the human–computer interaction community to become humanistic minded. In Chapter 9, Ken D. Eason traces the history of the research and design practice of this community since 1984 to establish whether it has become more humanistic. Though trends in this direction are detected, both research and practice are still mostly oriented towards technical system development rather than integrated socio-technical systems design. Major progress has been made on participation in design work, whereas little progress has been achieved in design of socio-technical systems, and as a result IS is more likely to exploit than empower users of IT.

In Chapter 10, Liam Bannon argues for giving the knowledge quality more awareness and room in design processes in order to improve resource allocation. The background for the model is the ongoing IS tension between, on the one hand, spending resources and time to build up explicit knowledge of the projects and, on the other hand, employing someone with a considerable level of tacit knowledge.

Theme 4: Policy challenges and the field of IS

The theme on policy challenges has three chapters. The use of information technology to facilitate economic growth and enhance social welfare has been on the IS research agenda for many years. During the 1970s a perspective taking on the interest of the workers was prevalent in the IS literature. Here, this agenda is reflected in the chapters by Chrisanthi Avgerou and Ramon O'Callaghan, respectively. Both chapters reflect how the agenda has evolved over the years. Information technology, its implementation and so on, are no longer viewed as imposing threats on the workers, by being implemented in order to take away jobs from workers. Instead, the focus is on how information technology can be used to create more jobs, economic development and enhance quality of life for people in various regions of the world. The third chapter of this theme (Lars Mathiassen) addresses a strategy for collaboration between the research and the business community, focusing on the policy options for IS research departments.

In Chapter 11, Chrisanthi Avgerou reviews the work of a research group on IT and development, the IFIP WG9.4, on the *social implications of computers in developing countries*, pointing to the socio-cultural and economic dilemmas that underlie obstacles to mobilizing IT for development purposes. Whereas IS research in developing countries has been rich in questions about the meaning and consequently the feasibility of IT development, *the support of IT implementation and the sustainability are less commonly addressed*.

In Chapter 12, Ramon O'Callaghan considers the G-NIKE growth node concept and argues that governments and other policy bodies clearly have a role to play in facilitating and supporting the development of competitive industrial clusters. The G-NIKE approach to growth nodes does not indicate that governments can create clusters or growth nodes through a set of specific policies or actions. Rather, they should contribute by providing the business, innovative and institutional environments that are vital for the success of growth nodes.

Lars Mathiassen concludes the book in Chapter 13. *The knowledge-as-relation* ideal undoubtedly leads to greater coherence and mutual influence between research and practice. Arguing that while not throwing out classical credibility measurement of good research when *seeking increased relevance*, the policy and research challenge for the IS community is to shift the balance between the rigour and relevance by taking a more *relevant active role in the development of the knowledge society*.

An outlook for the IS research community

Using the historical account and the contributions to this book as our point of departure, we propose that the IS research field faces three central challenges across the themes, in order to deliver more effective IS and for the consolidation of the IS research community.

First, IS research must maintain its awareness and inclusion of *activity-centric computing*. The drift of IS from exclusively being large-scale installations used by experts to being daily activity 'implants' calls for still more disciplines to be brought to the IS research arsenal. Thereby it challenges the often management-centric and rational choice approach employed in much IS research.

Second, *the scope and reach of IS will continue to grow*. As a result the social–economic issues and global initiation of IS loom high on the agenda. The developing world indeed looked very different 30 years ago, but has proved to be a melting pot for production of hardware and outsourcing of yet more IT services and programming. This change implies that still more applications are developed and launched in what the IS community is still not studying intensively.

Third, more dynamic accumulation and transfer of knowledge *from older to younger generations of IS researchers* is still more critical. There is an urgent need for addressing the concern raised in this book, namely whether there has been sufficient means and people that have taken accumulation of knowledge as part of their research agenda. Already, this call is out and taken seriously at many levels: in international academic IS journals, and at national, institutional level, and individual level. We propose that this will need to be taken even more seriously by writing more on this, but also by talking about and challenging this dimension in our research community.

2 Prototypes are not pilots (and vice versa): reflecting on a 25 year old idea

Michael J. Earl

Introduction

I first met Niels Bjørn-Andersen, quite briefly, at Manchester Business School in 1975. Niels was visiting for a period and I was a newly arrived junior member of faculty. We were both being influenced and encouraged by Enid Mumford, who was making an impact in the worlds of academe and practice through her work on participative systems design (Mumford, 1981). Today, Niels and I may be perceived as working in different zones of the information systems domain – not hugely so – but I thought it would be appropriate in this chapter to return to that important question of the 1970s, namely how to design computer-based information systems, for it is a question which is no less relevant or important today.

Looking back, I believe Niels and quite a few information systems researchers in Europe were concerned at that time with three related questions:

1 How to develop systems that *worked* – in the sense of achieving their organizational or business objectives.

2 How to develop systems that enhanced or at least did not degrade users' *job satisfaction and work practices*.

3 How to develop systems by *involving users* not only as a means of improving practice and performance in the above two objectives, but also as a worthy goal in itself.

For me, recently coming from an Information Systems Management post in industry, I was drawn to the particular question of methodology. Learning inductively from three events in practice, I proposed prototyping as a promising way forward (Earl, 1978). Prototype systems had been suggested as a useful idea in 1971 (Kriebel and Van Horne, 1971) but very little further work appeared in the literature until 1978.

In my 1978 article, I advanced eight reasons why prototyping could improve the systems development process, but the thrust of the argument was that design methods should incorporate a phase of experimentation and learn from observing an experimental – or prototype – system in use. Prototype systems are cheap, flexible and simplified systems used for exploration and experimentation in an operational environment, before the 'production' system is developed (Earl, 1978). Before long, prototyping as a systems methodology was being classified by academics variously as an evolutionary approach, a mechanism for participative design or as a stage in the conventional systems development life cycle.

The reason for my resurrecting prototyping here is that in practice I sense that the idea has often been corrupted or diluted. It often is neither experimental nor focuses on operational use. Instead, it frequently is a relatively minor exercise where a system, usually the inputs and outputs, are 'mocked up' by the systems designers for users to comment on. It is an exercise of providing sample designs for selection. I would like to call these 'not-prototypes', but for contrast – because this is a term often adopted – I label them pilots. And such pilots are not prototypes.

The original argument

The eight reasons advanced for prototyping, perhaps representative of that time, were:

Systems are expensive: acquiring or developing information systems is an expensive activity, expensive in time and cost, especially if life cycle costs are taken into account or if the system fails to meet its objectives. So a mechanism for trialling a system and discovering probable costs and benefits makes sense, not least in reducing risks.

Participation is painful: one can advocate user involvement or participation in systems development, but making it work is not easy. Construction of a prototype can help by providing an actual, live system which can prompt designer–user dialogue and debate.

Models are abstract: in the 1960s and 1970s modelling was sometimes advocated as a mechanism for joint user–design dialogue in the systems development process. However, at that time most models were abstract and some scholars working in the modelling field had discovered that typically managers and users preferred to consider a physical representation. Prototypes could fulfil this function.

Organizations are complex: here the argument was that organizations comprise individuals of diverse psychological types and personalities, subtle interfaces between humans and work organization and between sub-units of organizations, and diverse values and cultures. So the introduction of a computer-based information system is likely to set off a series of reactions we cannot always foresee – especially if systems designers tend to make invalid assumptions about human and organizational behaviour. Therefore experimentation by prototyping – by being experimentation in use – might help explore and understand the interaction of a system and the organization and thus lead to the design ultimately of a more effective system.

Information is a process: studies of human information processing and managerial decision making suggest that users react to, interpret and manipulate information in different ways, not only because we vary in our psychological make-up, but also because decision contexts vary and information processing skills differ. Thus prototyping was advocated as a means both of discovering likely different uses of information and of educating users in alternative strategies of information use.

Users are 'perverse': likewise we know that managers and users can use information in dysfunctional ways and be just as inventive in subverting the aims of systems designers or of the systems themselves. Prototypes can be subjected to counter-implementation strategies as much as eventual operational systems, but perhaps prototyping allows some learning about why such behaviours happen, and thus can suggest more appropriate designs or implementation strategies.

Modelling has a message: research in the 1970s suggested that construction of what were then called corporate or financial models, later more commonly classified as decision support systems, benefited from an initial experimentation phase with a simple and flexible version of the model. Users learnt what was possible, what was inappropriate and what they could cope with. The same argument applies to prototyping.

Systems must learn: here the argument was that information systems tend to lock the organization into the assumptions and contingencies of the time they are built. Thus they can be a source of an organization's tendency not to adapt. Prototyping, it was claimed, might cultivate a climate of curiosity, flexibility and adaptation.

These were my arguments of the late 1970s. I would claim that they remain just as valid today. Indeed, both researchers and practitioners could argue that they are uncontroversial because prototyping has become common practice. My response or concern is that the practice is

Table 2.1: Do we want a title?

	Pilots	Prototypes
Emphasis	Design	Use
Goal	Technical options	Organizational impact
Location	IS department	Operational environment
Philosophy	Design through 'mock up'	Design through implementation
User protocol	Selection of alternatives	Discovery of alternatives

commonly a weak version of the prototyping ideal I called for 25 years ago. In Table 2.1 I contrast prototypes, or what one might call true prototypes, with pilots, or what one might call weak or false prototypes.The essence of the true prototype is live trialling of a system to examine and learn about use as well as design. Prototyping is thus experimental and evolutionary and embraces implementation as design.

When to prototype?

Back in 1978 I did not ask the question when was prototyping most required. I implied it could always make sense. Unusually for someone recently arrived from practice, I did not suggest any sort of contingency theory. I did recognize that managements might be too impatient for proper implementation of a system and be reluctant to invest in an experimental stage. Also, I ventured that systems analysts commonly were in a rush to get to the production stages of the systems development life cycle and thus tended to minimize time spent on feasibility studies and real systems analysis. Given these characteristics, I might have suggested that prototyping was best suited to large-scale, that is high cost, systems projects or to contexts perceived as risky.

In fact, soon scholars argued that prototyping and evolutionary methods were ideally suited to contexts of uncertainty (Davis, 1982). And uncertainty might apply to the domains of the analysts, the users, the system type or the utilizing context (Davis and Olson, 1984). This was useful and robust guidance.

Recently, however, I have argued in another essay that information technology is an *ambiguous* technology, that is to say ambiguous in scope, in making the technology work, and in implementation (Earl, 2003). I also called these enabling uncertainty, commissioning uncertainty and impact uncertainty. At least in the presence of the first and third of these ambiguities, there is a case for prototyping and I would argue that ambiguity is present more often than we admit.

Indeed, in the early days of e-commerce, start-up companies and IT departments working on e-commerce applications rediscovered the merits of prototyping (Earl and Kahn, 2001). In many cases this involved going live with a prototype version of an application – or what was sometimes called 'live testing' – to try out a new business idea, or to see how users, often customers, actually used an online facility. In other words, this was online strategy by doing, by experimentation or by learning. We might even have called it 'business prototyping'.

There also was evidence of recognition of the merits of prototyping when business process re-engineering became fashionable. Consultants would recommend 'organizational prototyping', by which they meant an experimental phase to assess how a radically new process might actually work. Such interventions would satisfy the uncertainty criterion and at least the third type of ambiguity. However, perhaps here the context could be described as one of high change.

In other words, we could conclude that, except in the most structured or predictable situations, inserting a prototyping phase in the feasibility or systems analysis stages of the conventional systems development life cycle makes sense.

Ensuring prototypes do not become pilots

Practitioners could assess their prototyping endeavors against Table 2.1, to ensure that they are not suboptimizing with pilots. Of course, what I label 'pilots' is something of a 'straw man' or an ideal type that may not quite exist in its pure form. Accordingly, I suggest some rules for ensuring that a prototype system deserves the label.

1 Explicate the prototyping endeavour; in particular be clear that the goal is experimentation in an operational environment, fund this adequately and do not proceed to development of a robust system without a full review.

2 Ensure that users as well as designers take part in the specification, use and review of the prototype.

3 Do not call a test or experimental system a prototype unless it has undergone live trialling and the review includes assessment of the system in use.

4 Look for signals not only about technical features of the system, but the impacts, the uses (both intended and unintended) and the abuses.

5 Be sure that resources and process consultancy skills are made available for modifying the system, assessing its operation and impact and facilitating user–designer interaction and dialogue.

Critical success factors in prototyping

The above rules, or factors which differentiate prototypes from pilots, can be regarded as critical success factors for prototyping. Three others are important.

First, it helps enormously if rapid application development software is employed, particularly languages or methods which enable changes to be made easily as learning occurs in the prototyping process. This is hardly a constraint today compared with the 1970s. The constraint is more likely to be the will of the system developers.

Second, whereas process consultancy can help mediate between designers and users (rule 5 above), deploying systems analysts or designers with consultancy skills and a use and user orientation can make a substantial difference.

Finally, it is important not to prototype for ever. There has to be a decision point where it is agreed the current version of the prototype is either the basis for the specification of a new production or 'industrial strength' system or the project is abandoned. One lesson relearned by teams developing e-commerce applications is that 'doing it twice' is a necessary strategy when the business is the system.

Conclusion

This short chapter is for me a return to, in some ways, what is the heartland of the information systems field, namely the development and implementation of systems. It is, in my view, appropriate for this volume because researchers in Europe, especially in Scandinavia, always have recognized and studied the systems development process and sought to improve practice. Niels Bjørn-Andersen has been important in these endeavours, as researcher, teacher, mentor and organizer of events. Of course, he has developed wider interests too, but concern with effective practice and from a stakeholder view have been hallmarks of his work.

It is easy to forget or overlook good ideas and robust principles derived from studies of the early days of information systems research. It can be amusing to see such ideas and principles rediscovered by later generations of practitioners and researchers. This rather personal view of systems prototyping, I hope, will serve as a reminder of a good idea – and a jolt to those who only embrace prototyping in its weak form. It might also stimulate further applied research in today's context.

3 Piloting socio-technical innovations

Helmut Krcmar and Tilo Böhmann

Introduction

Information and communication technologies (ICT) have been a major enabler of change in the world of business, public administration and society at large during the last decades. We work and live differently since ICT have permeated organizations and private life. Not surprisingly, the power of leveraging ICT for socio-technical innovation has been at the forefront of information systems research. In manifold ways such research has given evidence of this power for transformation, as it becomes apparent in the seminal case of OTICON's spaghetti organization that compellingly shows what ICT-based innovations can do if embedded in the very fabric of organizations (Bjørn-Andersen and Turner, 1994; Morsing, 1994; Witte, 1997).

A key thrust of IS research is the further understanding of the drivers for and effects of ICT-enabled change in practice. Much of this research is empirical in nature as it quantitatively or qualitatively studies ICT initiatives in organizations or society. Given the abundance of such initiatives in practice this proved to be a fruitful approach for IS research, generating theoretical explanations and management frameworks on ICT-enabled change. One example is the thorough examination of the use, diffusion and strategic impact of electronic data interchange (EDI) in Europe (Krcmar et al., 1995). Essentially, the role of a researcher is that of an observer of a given ICT-based innovation, from which he or she can distil theoretical or management-oriented insights.

The German tradition of IS research, however, has long emphasized a more design-oriented role for research. Many researchers developed and still are developing new (business) technology or reference models for business technology. While a substantial part of this research may be seen as technology-centric, other research initiatives focus more on actually realizing technology-based innovations in field settings. Thus, instead of studying a given ICT-based innovation they take an active role in actually designing and implementing such innovations. This type of research contributes by fostering innovation in businesses, public administration or elsewhere and by generating knowledge for IS as a design science (Simon, 1996). These two contributions are intertwined. ICT-based innovations are designed artefacts that can only be studied if brought about beforehand. So by definition this results in an innovative information system applied in a field setting. Extending the breadth and depth of applying ICT furthermore puts researchers in the position of contributing to knowledge on designing leading-edge information systems.

Pilot projects of ICT-based innovations are a particular type of this design-oriented research. They aim to understand the preconditions for implementing socio-technical systems in a field setting and the effects on their context of use. The key stance of pilot projects is to bring about socio-technical innovations that negate a purely technical focus. Instead, they treat them as a complex bundle of artefacts that are designed to foster acceptance of an innovation and to facilitate desirable changes in its environment. By doing so, the outcomes of pilot projects may be an innovation in use in a field setting, an understanding of the design required to attract users and knowledge about organizational change as a condition for and result of implementing the innovation.

Overall, we argue that pilot projects are a promising approach for information systems research. We discuss what contributions can be expected from such an endeavour and show that a key contribution of pilot projects is the design knowledge necessary for realizing socio-technical innovations. While traditionally this design knowledge has been mostly related to the technical design and to the changes in the social or organizational context of use, we show that pilot projects are particularly apt to provide knowledge about the design of services delivering the innovation in a usable manner.

In the next section we introduce the essential characteristics and outcomes of pilot projects as an approach to research. Then we provide two examples of pilot projects that illustrate their characteristics and their potential outcomes. In the last section we discuss the broad stream of domain-specific design knowledge as an outcome of pilot projects and show that they particularly help to understand the service design necessary to realize such socio-technical innovations.

Characteristics of pilot projects

Pilot research projects implement and evaluate socio-technical innovations in a field setting. In the context of information systems research they focus on novel applications of information and communication technology (ICT) in a specific setting (Schwabe, 2000). According to the general framework of pilot projects pioneered by Witte (1997), they aim to implement these innovations in a field setting and evaluate the antecedents for their acceptance and their effects. The field setting is selected because it enables researchers to conduct a comprehensive study of their feasibility in a natural environment. Traditional examples for German pilot projects are the field experiments on new media, such as cable television, online services, multimedia and tele-cooperation (Witte, 1997). Schwabe and Krcmar point out that pilot projects can deliver benefits to research as well as to businesses or society at large (Schwabe and Krcmar, 2000). They can serve as test-beds for innovations before they are implemented on a larger scale and they provide examples of best practice for others to imitate. In their first role as test-beds for socio-technical innovations, pilot projects first of all enable decision makers to assess what is needed for a successful implementation of the innovation. Compared to a laboratory environment, technical features such as availability, reliability and ease-of-use become more prominent. Equally important is the support the overall functions provide for the relevant tasks of pilot users. Furthermore, the technical features are only one aspect of the innovation. To gain user acceptance, pilot projects often need to envision and provide services that build on top of the features of the technical system or that safeguard its continuous performance. Yet to exploit the opportunities inherent in the innovation users and their organizational settings need to adapt, too. Using pilot projects as test-beds for socio-technical innovations therefore provides an extended understanding of their feasibility. In addition, they help to estimate the economic performance and societal impact of large-scale implementations of the innovation. These estimates enable a more informed debate about the desirability of the effort and outcomes associated with their implementation, in terms of their business potential as well as their political and societal merit.

Second, pilot projects can set examples for others to imitate. If imitation across individuals and organizations is desirable then pilot projects can absorb some of the risks associated with being a first mover. If successful they can direct attention to the benefits of the innovation. Since they are conducted in a real-world environment, these benefits can be expressed in terms of positive effects on the individuals and organizations using the innovation rather than in terms of technical merit. As a result, promoters of such innovations can make a much more credible case for implementing the innovation elsewhere. Especially in risk-averse environments such as public administration or other tightly regulated environments pilot projects thus define a feasible roadmap for others to follow.

To implement a socio-technical innovation, however, requires in most cases considerable resources (Schwabe, 2000). To achieve the desired results, researchers need to adapt the technology to foster acceptance in the field and bring about changes in the organizational and social setting into which the innovation is introduced. These parts of a pilot project require both adequate staffing as well as sufficient time for implementation as such changes cannot be forced upon the users and their organizations. A prominent cost driver of such projects is the set-up of a new technical infrastructure, e.g. if all users need to be connected to a common backbone or be equipped with special devices. As a consequence, pilot projects are contingent on adequate funding and an institutional environment that facilitates project-based collaboration among a larger group of researchers.

Pilot projects serve to answer two types of research questions (Witte, 1997). The first type of question addresses the contingent factors of a socio-technical innovation (cf. Figure 3.1). They may comprise as effecting variables the technology as such, the services provided with the technology, the legal environment and the economic context of the innovation. Pilot projects thus clarify which combination of these factors is necessary for realizing a particular socio-technical innovation.

The second type of research question investigates the effects of a socio-technical innovation on outcome variables such as usage, economic efficiency or societal impact (Figure 3.1). This strand of research assumes that the innovation is accepted and addresses its impact. Pilot projects pursuing this type of research question particularly support decision making on whether an extensive implementation of the innovation is economically feasible and socially desirable.

At the first glance, these types of research questions indicate an entirely empirical orientation. The nature of field experiments, however, does not allow these types of questions to be answered in a fully controlled environment. On the contrary, pilot projects often face issues of inadequate technology or conflicting interests that need to be addressed for the research project to proceed. Without realizing the intended innovation, there is no stimulus whose effecting or effected variables can be researched (Witte, 1997). As much as they answer research questions on contingent factors and effects of socio-technical innovations, pilot projects therefore also comprise a design component. Design in this context does not only relate to the technical components of the innovation but also to the social and organizational ones. The contingent factors indicate the breadth of design issues that may arise in pilot projects. They involve the design of both the technology and the services delivered as well as defining a suitable legal framework and viable business models. As a consequence, pilot projects produce a socio-technical innovation-in-use, not just publishable research papers.

Often, the design part of a pilot project is not just a by-product of implementation efforts but also explicitly one of the project's objectives. Schwabe and Krcmar distinguish between three degrees of freedom such a project can incorporate with regard to the design of the innovation (Schwabe and Krcmar, 2000). There is little scope for design in projects that are set up to test the acceptability of a certain technology. The

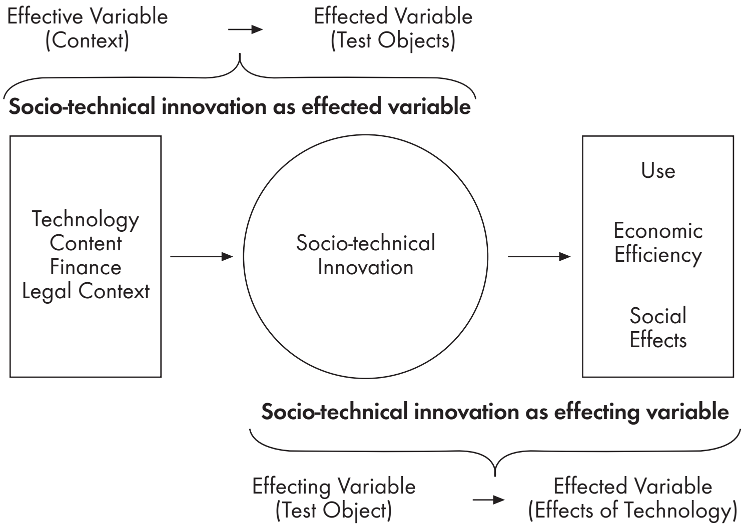


Figure 3.1: Witte's Framework for Pilot Project (adapted from Witte (1997) and Schwabe and Krcmar (2000))

results of such projects either confirm or reject the feasibility of a large-scale implementation but do not make improvements to the innovation so that its users are more likely to accept it. Thus the second degree of freedom in pilot projects includes this adaptation as an explicit goal of the project. These projects often start with a basic technical prototype of the innovation that is then continually improved during the pilot project. The third and largest degree of freedom is inherent to pilot projects that start with an organizational, social or business problem statement that a socio-technical innovation can potentially solve. In such projects the design of a satisfactory solution to the problem statement requires a substantial part of the project's resources. Yet by starting from a set of problems taken from a specific domain the design and its effects are directly related to these problems, which is important for gaining acceptance in the field.

Pilot projects thus involve the design of socio-technical systems in a field setting. We can thus situate them in the context of two traditions of IS research. In their technical aspect they generally follow a prototyping approach. When choosing a prototyping approach, designers develop preliminary versions of application systems to clarify requirements in close interaction with users or to solve development problems (Budde et al., 1992; Avison and Fitzgerald, 1995). While prototyping may include field-testing these systems it generally emphasizes issues related to the technical design. Pilot projects, however, often also comprise an organizational intervention to bring about IT-enabled organizational change. As such, they are a variant of action research (Frank et al., 1998; Baskerville, 1999) as they strive to effect change both to benefit the client organization as well as to advance scientific knowledge.

On closer investigation, pilot projects deliver contributions on different levels. First, they create a pilot system, i.e. the innovation proper. It serves as a proof-of-concept for the socio-technical design. At its core is a new technical system that is introduced into a field setting. The new socio-technical system may only prevail for the time of the pilot project, yet can also continue to be used and evolved beyond the project's lifetime. We provide an example for such a system later in this chapter. Second, pilot projects generate domain knowledge and design knowledge on socio-technical systems. To design socio-technical innovations for a field setting requires the designers to gather extensive knowledge of the system's domain. This domain analysis then serves as a reference point for the actual design of the socio-technical system. Taken together, domain knowledge and design knowledge may result in reference models or frameworks and methods for designing and implementing systems in this specific domain. Schwabe and Krcmar expect that knowledge on this medium level of abstraction is the main contribution of pilot projects (Schwabe and Krcmar, 2000). Third, pilot projects can also contribute to the development of general frameworks and theories, e.g. on IS-enabled organizational change or IS implementation.

As IS-related domain and design knowledge is likely to be the main result of pilot projects we take a more detailed look into the nature of this contribution. Inherent in the generic research questions is a focus on acceptance and impact of the socio-technical system. This requires a broad understanding of design. To begin with, this comprises technical design issues, like core functions and user interface design. These are linked to expectations about the impact of implementing such a system in an organizational or social setting. How does this setting need to change to enable the implementation of the new system and take advantage of it? Pilot projects also address this question when implementing a system in a field setting. This type of design knowledge may be labelled as organizational design and impact. Furthermore, both Witte and Schwabe and Krcmar imply as a third category of design knowledge the design of services that implement a new system and make it appealing to users. They do not explicitly address service design in their discussion of pilot projects and socio-technical innovations. The critical role of service elements, however, is in both papers clearly seen as an integral part of the antecedents of a successful realization of a new system. By taking this view, Witte as well as Schwabe and Krcmar imply that technical design, organizational design and services design are not loosely coupled elements but closely intertwined within a pilot project.

In sum, pilot projects can deliver results on several levels: a socio-technical innovation as such, domain and design knowledge, and generic framework and theories. One can particularly expect to gain comprehensive domain and design knowledge relating to technical design, organizational design and impact, and service design. In the following we investigate two cases of pilot projects to illustrate their contributions. For each case, we analyse what these projects have contributed on the different levels and particularly investigate the design knowledge gained from piloting innovative information systems.

Examples of pilot projects

Following this general discussion of the characteristics of pilot projects as a research strategy, this section introduces two examples that illustrate how pilot projects are set up in practice and what results they can deliver. Both examples are research projects from the Department of Information Systems at Hohenheim University[1] that were completed in 1999. The first example is the CASTLE project that designed and implemented a collaborative distance-learning course, developing Internet-based collaboration tools, the course structure and the course contents. The second example is CUPARLA, a collaboration platform for local city councils. The project designed the platform and introduced it to a large city having more than 50 city councillors of whom a clear majority were using the platform by the end of the project. Even after a council election, the newly elected council still uses the system today.

Telelearning

Within the CASTLE project, the project consortium developed an Internet-based learning environment that combines self-controlled, individual learning with distributed, synchronous learning sessions. CASTLE is designed to help specialists for environmental protection from public administration, research institutions and private-sector companies to acquire basic knowledge for their job about the use of data from earth observation satellites. The CASTLE learning environment offered access to course material for individual studies and to distributed, cooperative learning sessions.

While a key objective was to prototype a software system for collaborative telelearning, the design team recognized early on that implementation of collaborative telelearning in a field environment needed a broader scope of design. The overall framework thus added didactical and management design to the technological issues. Didactical design refers to a selection process by which teachers or

1. Both authors were previously affiliated with this department.

learners select from a number of learning aids the one which supports the specific learning process most successfully. Management design is understood as planning and organizing activities and resources for operating a learning environment. It is essentially referring to the service component of educational offers that ensure an efficient process of learning by registering participants' results, scheduling resources for joint events and providing learner support in an online learning environment.

Pilot system: The concept of the CASTLE learning environment was put into practice and evaluated at the end of the project in the form of an evaluation course. The aim of the course was to impart basic concepts of satellite-based remote sensing. Insights from a workshop held with students of distance-learning courses and providers of telelearning courses at the beginning of the project were specifically taken into account as a basis for the design of the evaluation course. In this workshop, time management and motivation had been identified as critical success factors for distance learning. The course 'Introduction to Remote Sensing' was based on five modules for individual studies and seven virtual seminars, which deepened the content of the modules. The virtual seminars had the purpose of motivating the students to participate regularly and to support them to structure the timing of their private studies.

From March to May 1999, a Europe-wide pilot course on the topic of 'Introduction to Remote Sensing' was held with a total of 15 participants from Great Britain and Germany. The course comprised web-based modules for individual learning and seven virtual, synchronous seminars plus an evaluation workshop. The participants taking the course worked in academic institutions, for the government, were self-employed or students. The tutors for individual seminars were selected experts from various universities and research institutes across Europe. As the evaluation course drew participants from a significant number of organizations and lasted only for three months, the participants accessed the virtual, synchronous seminars via workstations provided by the consortia's members, situated in the respective member's computer facilities. For more information about the CASTLE project see Böhmann (2000).

What results did the CASTLE project produce as a pilot project? The CASTLE project served primarily to elicit the necessary conditions for realizing collaborative telelearning as socio-technical innovation. In this respect, the evaluation focused on identifying critical design elements of the ICT system, of the didactics, and of the management of the overall course required to implement such an educational offer on a wider scale. Accordingly, the evaluation indicated parts of the design that proved helpful for the conduct of collaborative telelearning courses and parts that required redesign. These results pertain to the design of the technology (the CASTLE software systems) as well as to the design of the didactics and management of the CASTLE course and seminars.

Technology design: The ratings and comments of the participants supported the three main design decisions of the CASTLE system. First, the participants rated the design of the user interface as suitable for learning processes. They regarded the process of familiarization with the CASTLE software as fairly easy. This enabled the tutors to explain the software environment on the fly, using the software itself in the first of the virtual seminars. Thus, assigning a high priority to simplicity of use certainly helped the participants to appropriate the system quickly without intensive training and supplementary materials. Second, the distinct separation of universally available communication support (e.g. chat) and task-related cooperation tools (e.g. outlining tool) appeared to be a promising approach for virtual learning sessions. Compared with the generic communication tools, the task-related tools helped to establish a shared context for interaction and focus the participants on the topic of the session. Third, the evaluation demonstrated the value of providing tutors with tools for structuring a session into individual activities and progressing through them within an actual session. To aid this progression the software system enables the tutor to start and stop activities on all students' screens. Starting means placing tools labelled with the name of the activity on all workspaces, stopping means removing these tools from all workspaces. This reconfiguration of the workspaces makes the progression through the phases of a seminar clearly visible for all participants. In a field setting, however, these features of the technology design cannot be evaluated in isolation from their application in the virtual seminars. The tools' effect on supporting and focusing learning interaction, for example, is tightly linked to the way the tutors have used them in their didactical designs. The same can be said of the features for supporting tutors. Likewise, the evaluation of the didactics and management design is closely linked to the technology being used.

Service design: Much more than addressing the technology in their comments, participants engaged in a debate about an effective design of the overall course and of the tutoring service provided in individual virtual seminars. They took a positive view of the overall approach to use virtual seminars to structure their individual learning processes and to provide an incentive for continuous and focused participation in the course. Equally, the participants considered the tutors' facilitation as very important for the success of the seminars. Facilitation in this context is, however, a socio-technical issue as it relates both to the special facilitation tools of the CASTLE software systems as well as to the tutors' structuring and guiding of a session in which they used the tools to implement their chosen design of a seminar. Moreover, the observation of the virtual seminars showed that tutors also had a number of roles to play. Most prominently, they were called to provide support in case of technical difficulties. This ongoing support was critical for the implementation of the course as such problems may quickly frustrate the efforts of participants and thus significantly lower their motivation to continue the course. In terms of the management of the overall course the participants primarily discussed the interval between virtual seminars. To maintain flexibility for their individual learning processes they considered a structure of biweekly seminars as most appropriate. Only the social presence of other participants was found wanting during the course, as interaction with others was mostly limited to the formal exchanges in the seminars.

Given the minimal dropout rate of the course (one of 15 participants) they thus asserted the initial proposition of the project that distance learning benefits from the structure and interaction of facilitated collaborative learning. The CASTLE project thus demonstrated that participants accepted mixed-mode telelearning courses and were ready to participate in a similar course again. The design of the CASTLE software and the course therefore provided a reference point for implementing such educational offerings in other contexts.

Organizational design and impact: The overall design framework for the CASTLE project would anticipate necessary organizational changes if the new approach to learning had been implemented in a specific organizational setting. For piloting the CASTLE systems, however, the project team decided to recruit participants across several organizations for the pilot phase only. As such, the project did not produce specific insights on organizational design and impact related to collaborative telelearning.

Framework or theory results: Pilot projects are, however, not limited to producing reference designs. Like more traditional research projects the project findings also contributed to theorizing about distributed meetings. The project provided researchers with ample opportunities to observe inhibiting factors of interaction in distributed meetings of learners and the task of the facilitator(s) in this context. Combined with the finding of a complementary research project this led to a taxonomy of distributed meetings with respect to their requirements for facilitation and differentiation of roles facilitators play in such meetings (Johannsen et al., 2001).

The example of the CASTLE project illustrates the inherently socio-technical nature of introducing ICT-based innovations in a field setting. The technological design is closely linked to the design of the process of use or the contents delivered via the technology. Only by combining these elements can the innovation address prevalent problems of a field setting and thus be perceived as problem solving. Since the CASTLE project primarily addressed the contingent factors for realizing an innovation its results provide guidance for designing collaborative telelearning. It did not have much to say to about the effects of this type of learning. While the main contribution may be design recommendations it also served as a base for theorizing about distributed meetings, thus delivering similar results than a more traditional research project that has no design and implementation component.

Public administration

The second example takes us to the work of local councils and thus to the realm of public administration. Local councils in a large city like Stuttgart work in a document-driven, distributed, multi-context, and often ill-structured environment. At the time of the CUPARLA project, information access and collaboration was dominated by massive paper-based documents and face-to-face or telephone interactions. Therefore, the project aimed at making council work more flexible and efficient, improving access to information, and reducing communication barriers between the council and the local administration by designing and implementing a socio-technical system for computer-supported collaborative work. While being based on ICT, the project deliberately started from the organizational problem of council work, conducted intensive requirements analyses, designed a socio-technical innovation, implemented this design within the local council and its various political subgroups and evaluated the intervention against the organizational problem. The overall project has produced numerous results so that we can only discuss selected issues here. Like the CASTLE project, CUPARLA led to a software system and effected changes in council work. Furthermore, the observations formed the basis for developing frameworks as well as for theorizing about implementation issues and CSCW support for councils and political institutions (see e.g. Schwabe and Krcmar, 1998, 2000). In the following we discuss the project results related to technology, implementation, effects and frameworks, but emphasize particularly the area of implementation management while treating the others only in a cursory manner.

Pilot system: The CUPARLA system provides councillors with easy access to information and allows them to leverage groupware function to collaborate more efficiently. The pilot system itself can be considered as a success, as the system is still in use today even after new council elections.

Technology design: The core of CUPARLA is a document management system designed to represent multiple contexts of council work. Functions and authorizations are attached to these contexts, such as a personal office, political faction offices, committees, and the council as such. Council members access the system on personal notebooks so that they can work with the system wherever they are. While the technical design as such realizes a number of important principles that the pilot project put to a test (in the example of CASTLE) we focus in this chapter on the role of implementation management as a key part of the pilot project. More information on the overall project and its key results can be found in Schwabe (2000) and Schwabe and Krcmar a, b2000).

Service design: To anchor CUPARLA in the work of the Stuttgart city council, the research team performed a number of implementation services. First, it analysed the particular context of council work in depth and based the design on this domain knowledge. Second, it took exhaustive measures to support the appropriation of the system. This design of the appropriation is called implementation management. It is separately part of the design and of the evaluation of the project. The implementation design consisted of measures for user support, training, and participatory design as well as incentives for using the system.

The user support includes a number of services available to council members and other users of the system to solve individual requests and technical problems related to using the system. Members of the project team regularly visited the offices of the different factions of the local council to offer clinics for the CUPARLA system, so council members could drop in, ask questions or request a solution to a technical problem. For more complex tasks, the support staff scheduled individual appointments at a location convenient for the individual council member. This flexibility was necessary, as council members do not have a permanent office in the city hall.

To help council members to gain experience with the system, the project team offered hands-on training courses. Council members had to bring in their personal notebook so that they worked in their personal environment. The training courses comprised a multi-step training scheme, starting from simple information retrieval tasks and progressing towards more complex functions for cooperative work. The training was linked to participatory design efforts that enabled individual political factions of the council to redesign their work while leveraging the different ways of the CUPARLA system to inform, communicate, coordinate or work cooperatively.

Lastly, the project team defined several incentives for using the system on a regular basis. This entailed differential access to resources (e.g. premium vs standard computer equipment) as well as access to a regularly updated archive of council documents to provide users with an easy-to-understand benefit. Furthermore, the project team sought to foster competition for being the most active users of CUPARLA among the individual members and the political factions.

In total, these measures of implementation management stimulated regular use of the system in the majority of council members. As a pilot project, however, the project also evaluated these measures and their importance for affecting council members' attitudes towards using the system, thus providing valuable lessons for implementing similar systems. The results underscore the importance of a comprehensive implementation management. Council members think the training and the initiative of the implementers as highly important for motivating their own use of the system. Also, the access to current documents from the city administration is seen as a key benefit of the system.

Linked with data on actual use of the system, the evaluation furthermore shows how the appropriation of CUPARLA progressed over time and which external interventions and contingent factors influenced the intensity of use. Equally important, the evaluation reveals patterns of system use among the members of the local council that indicate when council members access the system during the week and within a given day. Linked with the evaluation of the implementation measures these observations provide a detailed view of the contingent factors necessary for realizing the innovation. As the case of CUPARLA demonstrates, these factors extend beyond the design of the technology as such.

Organizational design and impact: The project team prepared several workshops in which the factions could identify improvements or, alternatively, a redesign of their organization, meeting processes, and work on their core agenda. Additionally, the project comprises a thorough investigation of the effects of using the system on council work. Compared with the example of CASTLE, the project thus also addresses the second type of research question that pilot projects can answer, that is, their effects on users, organizations and society. So CUPARLA could show that the quality and flexibility of council work increased, particularly for the individual council members and the political factions, while there were fewer effects on time. Generally, the introduction of the system led to higher costs for the individual workplace of the council members and political factions and slightly higher costs in the overall council processes because the traditional paper-based processes were run in parallel during the pilot project. For more details on the results see Schwabe (2000).

Framework and theory results: The observations of the appropriation of the CUPARLA system prompted theorizing about implementation as well as the development of management frameworks. For example, Schwabe and Krcmar discussed in detail how competition on different organizational levels (individuals, groups, organizations) could foster use of an innovation (Schwabe and Krcmar, 1998). The same authors also examined a typical progression of using CSCW tools to support low trust, less complex tasks to highly complex tasks requiring high trust (Schwabe and Krcmar, 2000).

Again, the CUPARLA project demonstrates the socio-technical character of pilot projects. The contingent factors necessary to introduce the CUPARLA system into a local council comprise functional technology and a wide range of specific implementation measures. While the project produced results related to technology and theory, it predominately provided a rich understanding of potential implementation measures in the particular domain of local councils, of the patterns of use of a CSCW system in this context and of the effects of such an intervention on council work.

However, like the CASTLE project CUPARLA indicates that is not only the technology and its appropriation in the context of use that define the socio-technical nature of pilot projects. Instead, to render a technical system usable to a given target group it is often embedded in a bundle of services that support its use and provide information resources as a content of the system to make it more attractive to use. This leads to our concluding discussion of the outcomes of pilot projects in general. While they have so far been seen as contributing to technology adaptation and organizational innovation they have not been discussed as contributing to the development of services. This link to service development is explored in the next section.

Conclusion

The examples of CASTLE and CUPARLA illustrate how pilot projects can foster a wide range of contributions to information systems research and practice. In the best case, they implement a socio-technical innovation in a field that is continually being used beyond the project's lifetime, as the example of CUPARLA shows. We consider this as an important contribution to the practice of IS, underscoring the relevance of the research effort. Furthermore, CUPARLA as well as CASTLE also provided the backdrop for developing more generic frameworks on IS implementation and group support.

Overall, however, pilot projects are a rich source of knowledge on socio-technical design. By realizing and evaluating socio-technical systems they generate first-hand knowledge about ICT-based innovations and its effects on individuals, organization and, possibly, society. They reveal the antecedents and effects of the socio-technical innovations, enabling others to evaluate benefits and risks of implementing it elsewhere. Consequently, such knowledge can serve as a foundation for decision making about widespread implementation of an innovation. Understanding the impact also underpins the resulting domain and design knowledge. When introduced into a field the technical system often needs to be changed to take into account the more holistic requirements that are present in the field, as users need to accommodate the technology in their daily routines. Although a technical system can be thoroughly tested in a laboratory environment, the field setting also reveals its patterns of use, i.e. how and when its functions are used. Understanding the organizational context and the impact of deploying the system furthermore contributes to knowledge on organizational design and context. In short, pilot projects are sources of in-depth understanding of socio-technical designs for a particular domain. These results are well understood and recognized by the extant literature on pilot projects (Schwabe and Krcmar, 2000; Witte, 1997).

In the general discussion of pilot projects preceding the cases we additionally point out that pilot projects clarify the service design required to implement a socio-technical innovation and sustain its use. This is evident in the examples of the CASTLE and CUPARLA projects. For the idea of collaborative telelearning to be realized, the CASTLE project embedded the technological concept in a course design and facilitation services. Without this content and these services, the technology alone would have been of little use to learners. Similarly, the CUPARLA became a successful implemented innovation because of its strong emphasis on implementation measures. Without ongoing support and training as well as targeted measures to increase system use the effects would not have materialized. These measures, however, were effectively services that the project provided to the users of CUPARLA. As they were critical for realizing the innovation, they are closely intertwined with the technological part of the innovation as well as with embedding the innovation in the work of the users and their organizational context.

Why does this service perspective matter? First, services account for a majority of the total cost of ownership of ICT (see e.g. Siegele, 2002). Thus decisions about implementing a particular socio-technical innovation need to take into account the overall costs that accrue from implementing and operating a new system. Second, a thorough understanding of the services that are part of the implementation is necessary for successfully replicating an innovation. Simply transferring the technology or aiming for similar changes may not be enough, as the services deliver the technology in a way that it actually can be leveraged to achieve the desired changes. Third, viewing socio-technical innovation as a bundle of technology-related and service-related features enables the researchers to derive knowledge about the design of ICT-based systems.

What kind of design knowledge does this integrated perspective of ICT and services provide? At the very least a pilot project reveals the technological elements of a socio-technical innovation, the service processes necessary to realize the innovation and the interdependencies between system elements and service processes. For example, the facilitation process in the CASTLE example guides learners through a virtual seminar. It depends on the functions of the CASTLE client that the learners use, that of the tutor client and that of the central server. Furthermore, pilot projects allow designers to gauge the degree of customer integration into service operations. As customers can see and affect service operations customer integration creates interdependencies between service processes and specific requirements for their design (see e.g. Shostack, 1984). Overall, pilot projects therefore generate knowledge about the service architecture (Böhmann, 2003) that shows key interdependencies between ICT systems, service processes and customer integration. Design recommendations that allow an innovation to replicate in a different context need to build on these architectural relationships as these reveal interdependencies between the design of the innovation and thus between critical contingent factors for realizing it.

Pilot projects, however, can also produce more general design knowledge. For a specific socio-technical design, design principles express the contingent factors for its selective implementation. They can be derived by abstracting from the actual design to the level of technical and organizational functions and their interdependencies. In the case of CASTLE one may devise functions such as 'present topic', 'discuss topic', and 'facilitate session'. Assume that there are interdependencies between 'facilitate session', 'present topic' and 'discuss topic', respectively. If in a different context the designers want to omit the 'facilitate session' function they need to be aware that the presentation and discussion of a topic may have to be redesigned as well because both assume that there is a function to guide learners through these other steps. Note that this level of abstraction makes no distinction between technical and organizational functions so that adapting the technology used or the service processes performed may accommodate changes in these functions.

To summarize, pilot projects are a successfully employable method to generate first-hand knowledge on the design of innovative information systems, enabling IS researchers to lead practice with socio-technical innovations. By generating rich knowledge on integrated technical, organizational and service-related design for particular domains of IS applications they incorporate the idea of IS as a design science. Furthermore, they can serve as a backdrop to develop generic IS frameworks or theories. They therefore prove to be a valuable approach for IS research.

4 Forming a contingent, multi-disciplinary and ethical approach to IS development

David Avison, Richard Vidgen and Trevor Wood-Harper

Introduction

The teaching and practice of information systems development had traditionally suggested a very technology-oriented understanding of the process. This was typified by the National Computer Centre (NCC) approach to systems analysis (Daniels and Yeates, 1971) that was used in the UK and elsewhere throughout the 1970s and for much of the 1980s. Our experience in the field suggested that for information systems to be successful this was a very narrow technology-oriented view. Further, the description of the process of information systems development as formal, step-by-step, almost 'scientific', did not coincide with our experience developing information systems in practice, which was, in truth, much more like a trial-and-error exercise. We felt that there was both a major rift between both what was espoused with what was desirable and what was espoused with what was practised.

But this engineering view of information systems development has continued well beyond the 1980s. Most approaches are still either data-oriented, such as Information Engineering (Martin, 1990) or process-oriented (Yourdon and Constantine, 1978) or a combination of both, such as MERISE (Quang and Chartier-Kastler, 1991) and SSADM (Downs et al., 1991).

The main motivation for Multiview was to include human and organizational aspects fully into information systems development. But we also wanted to suggest that information systems development was not a step-by-step, prescriptive process as espoused by the above approaches, but iterative and sometimes applied differently as circumstances dictated. This reflected our real-world experience. Our definition of Multiview was therefore more a contingency framework than a formal set of procedures. Niels Bjørn-Andersen (1988) also expressed concerns about the grand narrative approach to system development in his essay on post-modernism and technology assessment: 'The slogan is the same in post-modernism and in pop-music – citations, references, borrowing, patch-working, theft, re-use, and recycling'. Although being careful to reject a nihilistic approach to IS development informed by post-modernism, Bjørn-Andersen concluded by saying that one might find encouragement (or consolation) in this proposition for technology assessment. We take encouragement from this position in our own work on Multiview.

In this chapter, we provide first an overview of Multiview. Our experiences in practice have led to many changes in its definition, espoused as Multiview1, Multiview2 and WISDM (the latter a version of Multiview appropriate to the development of web information systems). We then discuss those aspects that are most relevant to the concerns of Niels Bjørn-Andersen, that is, a belief that information systems development should embody multi-disciplinary and ethical perspectives suggesting genuine human progress in organizations, not simply naïve technical and efficiency viewpoints, which had hitherto been its main concerns, and the view that information systems development approaches need to be adaptable and adapted according to the particular needs of each organization using them.

An overview of Multiview

A full account of the early definition of Multiview is found in Avison and Wood-Harper (1990) and Figure 4.1 shows its diagrammatic representation at the time. We provide here a brief overview of the five stages. The first stage looks at the organization – its main purpose, problem themes, and the creation of a statement about what the information system will be and what it will do. It is based on soft systems methodology (mode 1), described in Checkland (1981), using the techniques of rich picture building, CATWOE definition and the creation of root definitions, and conceptual models. Possible changes are debated and agendas drawn up for change. The second stage is to analyse the entities and functions of the problem situation described in stage one, sometimes referred to as data analysis and functional analysis respectively. This is carried out independently of how the system will be developed. The functional modelling and entity-relationship modelling found in most methodologies are suggested as modelling techniques.

In the third stage, influenced by Mumford (1981) among others, human considerations, such as job satisfaction, task definition, morale and so on are seen as just as important as technical considerations. This stage emphasizes the choice between alternative systems, according to important social and technical considerations. The fourth stage is

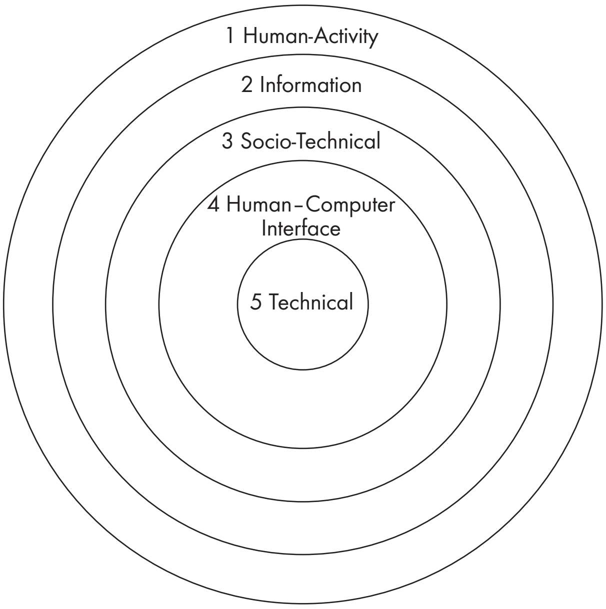


Figure 4.1: The original Multiview framework.

concerned with the technical requirements of the user interface. Choices between batch or online and menu command or soft form interfaces are made. The design of specific conversations will depend on the background and experience of the people who are going to use the system, as well as their information needs. Finally, the design of the technical subsystem concerns the specific technical requirements of the system to be designed, and therefore to such aspects as computers, databases, application software, control and maintenance.

In our case studies using Multiview in many real-world situations using action research, we gained much feedback in its use. Avison and Wood-Harper (1990) describe six cases. We have been informed by many such cases involving ourselves, and others. Each case has led to some modification of our definition of Multiview. We have also been influenced by other writings, and these influences together have led to a newer definition published as Multiview2 (Avison et al., 1998).

The original conception of Multiview posited a three-way relationship between the analyst, the methodology, and the situation. We suggested that parts of this relationship were missing in many descriptions of information systems development, and that methodologies often contained unstated and unquestioning assumptions about the unitary nature of both the problem situation and the analysts involved in investigating it. Despite this criticism of other methodologies, the original definition of Multiview itself offered no further guidance on how any given instantiation of the triad (analyst–methodology–situation) might come about in actual practice.

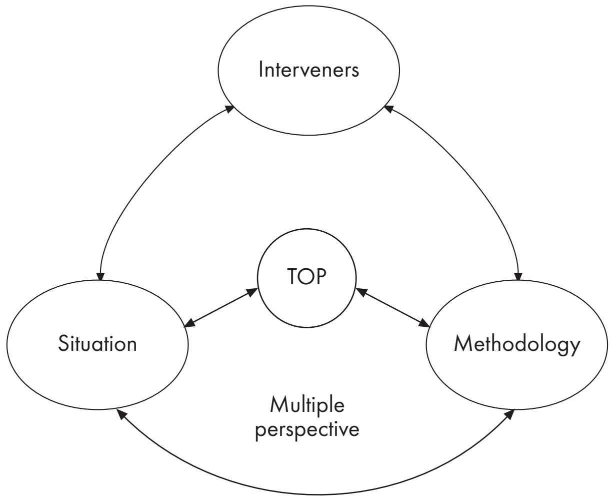


Figure 4.2: The interaction of situation, interveners (analysts) and methodology.

We observed that the multiple perspective approach described by Mitroff and Linstone (1993) can be used to inform the particular occurrence of Multiview2 under any given set of circumstances (Figure 4.2). The Multiview2 stages of technical design and construction (T), socio-technical analysis and design (P), and organizational analysis (O) align well with this approach.

Multiview2 offers a richer implementation of the multiple perspective approach as far as information systems development is concerned. As we have seen, in the original version of Multiview, we implemented such an approach through a five-stage methodology. These five stages were then typically presented as a waterfall structure. In Multiview2 the outcomes of information systems development are posited as consisting of three elements: organizational behaviours, work systems, and technical artefacts, which are reflected in the stages of organizational analysis (O), socio-technical analysis and design (P), and technical design and construction (T) respectively (Vidgen, 1996). The fourth element of Multiview2, information modelling, acts as a bridge between the other three, communicating and enacting the outcomes in terms of each other (Figure 4.3). The proposed new framework for Multiview shows the four parts of the methodology mediated through the actual process of information systems development.

Together with the change in the Multiview2 framework go changes to the content of the four aspects, reflecting the experiences of applying Multiview through action research and developments in IS theory and practice. The major amendments made in the content of Multiview2 are summarized in Table 4.1.

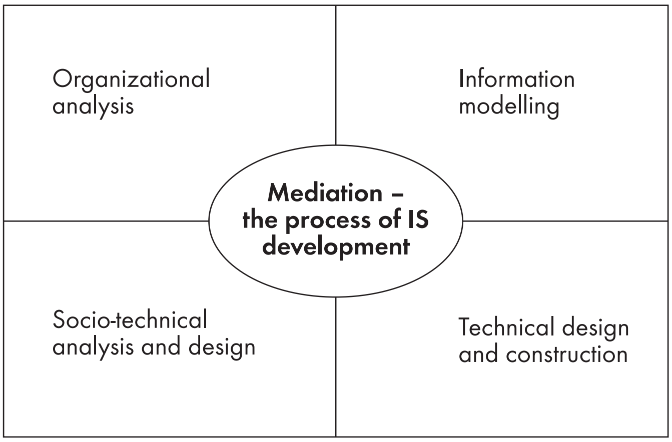


Figure 4.3: The Multiview2 framework.

The T perspective reflects a rational, engineering-based approach to systems development in which the aim is to produce technical artefacts that will support purposeful human and organizational activity. The O perspective is typified by the development of a shared understanding and organizational learning, within the process of information systems development. It can be visualized as a learning cycle including discovery, invention, production and generalization, as well as double-loop learning to bring about the surfacing and challenging of deep-rooted assumptions which were previously unknown or undiscussable (Argyris and Schön, 1978). The P perspective represents the fears and hopes of individuals within the organization, and deals with situations of power, influence and prestige (Knights and Murray, 1994).

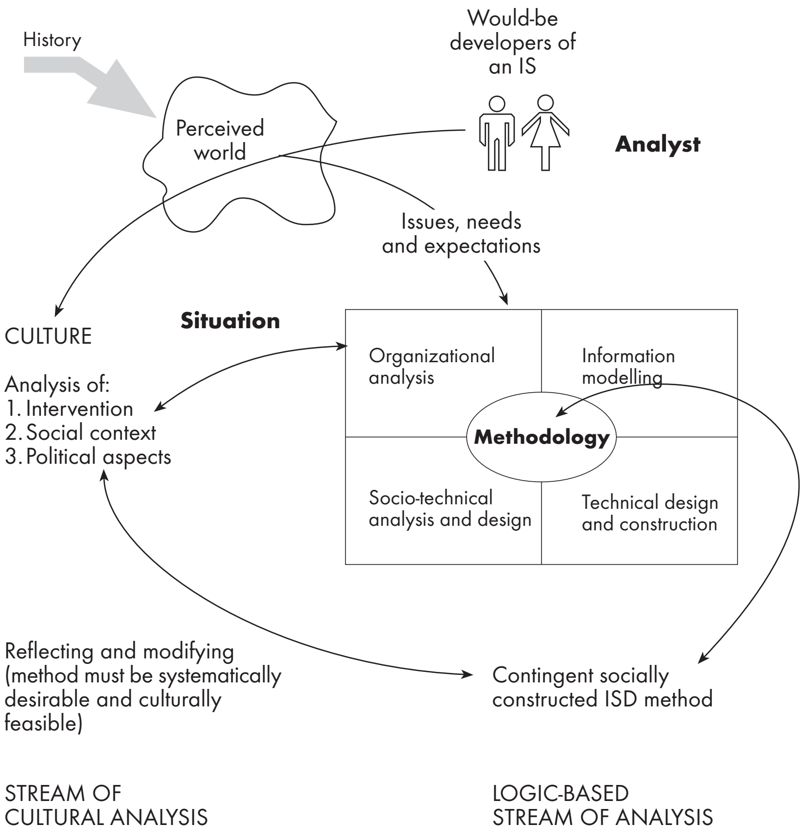
The TOP multiple perspective approach described by Mitroff and Linstone can be used to inform the different views that can be taken of the three sets of outcomes – organizational behaviours, work, and technical artefacts – within any given problem context. As we have seen, traditional information systems development takes a singular T perspective of the system development process. Alternative life-cycle models, such as iterative and evolutionary development, although generally more sympathetic to the O and P perspectives, may still be reduced in practice to a T-dominant view of information systems development in which it is believed that the 'real' requirements are 'captured' more effectively than with a waterfall life-cycle model.

Multiview2 offers a systematic guide to any information systems development intervention, together with a reflexive, learning methodological process, which brings together the analyst, the situation and the methodology. However, although the authors recommend a contingent approach to information systems development, Multiview2 should not be used to justify random or uncontrolled development.

Table 4.1: The rationale of Multiview2

Stage	Change	Rationale
Organizational analysis	Inclusion of strategic assumption surfacing and testing (Mason and Mitroff, 1981)	To strengthen the conceptual analysis of SSM with real-world stakeholder analysis (Vidgen, 1994)
	Radical change and business process redesign	IT as business enabler, rapid change in business environments (Wood et al., 1995)
	Introduction of ethical analysis	Stakeholders can have different moral ideals (Wood-Harper et al., 1996)
	Consideration of non-human stakeholders	To support a symmetrical treatment of social and technological factors (Vidgen and McMaster, 1996)
	Inclusion of technology foresight and future analysis	Consider the impact of the intervention on stakeholders (Avison et al., 1994, 1995) and the potential role of technology
Information modelling	Migration to object-oriented analysis (from structured methods)	The principles of O-O are more compatible with systems thinking than are the process/data separation and data flow metaphor of structured methods (e.g. the notion of systemic transformation and state change)
Socio-technical analysis and design	Ethnographic approaches to supplement ETHICS	Ethnographic approaches to socio-technical design (Randall et al., 1994; Avison and Myers, 1995) aid the analyst in understanding how work is accomplished (Sachs, 1995)
Technical design and construction	Construction of technical artefacts is incorporated within the scope of the methodology	Prototyping, evolutionary, and rapid development approaches to systems development require that analysis, design and construction be more tightly integrated (Budde et al., 1992)

Although Multiview has been in a continual state of development since 1985, the reflections on Multiview in action over the last ten years have suggested this radical redefinition of Multiview into Multiview2 which takes these experiences into account, along with the more recent



Source: Adapted from Checkland and Scholes (1990) and Wood-Harper and Avison (1992)

Figure 4.4: Constructing the IS development methodology.

literature and recognizing the new 'era' of the domain of information systems. Change is the norm, and the rapidly changing environment in which information systems development takes place suggests that there will be a further major redefinition of Multiview in an even shorter time-space. Most recent cases have concerned the use of Multiview in different contexts, for example in developing countries (Kamsah and Wood-Harper, 1999), or for new application types, such as enterprise information systems (Kawalek and Wood-Harper, 2001). The most used of these more recent variants in practice is WISDM, an approach designed for web information systems development (Vidgen et al., 2003).

Our view was that this was not a theoretical exercise. We wanted to see if these ideas would work in practice. Thus our original definition of Multiview was tried out in a number of real-world situations, frequently working with practitioners. These experiences were very different and illustrated the contingent nature of the process. Further, in our teaching we used these experiences to expose the difficulties and practical problems of information systems work, frequently ignored in the texts of the time.

The next four sections look at Multiview from four perspectives, which have been influenced by the work of Niels Bjørn-Andersen: a multi-disciplinary, multiple value perspective, a contingency perspective, a broader view of evaluation, and an ethical perspective. Of course these aspects inter-relate with the approach.

Multi-disciplinary, multiple value perspective

When defining Multiview in the early 1980s, we proposed that the following questions ought to be addressed in information systems development:

1 How is the computer system supposed to further the aims of the organization installing it?

2 How can it be fitted into the working lives of the people in the organization that are going to use it?

3 How can the individuals concerned best relate to the machine in terms of operating it and using the output from it?

4 What information system processing function is the system to perform?

5 What is the technical specification of a system that will come close enough to doing the things that have been written down in the answers to the other four questions?

These five dimensions may now seem obvious to present readers; however, at that time information systems methodologies addressed only question 5 (technical aspects) and question 4 (data and structured analysis) fully, and paid only lip-service to the human–computer interface (question 3) and even then in only some approaches. On the other hand, the issues of questions 1 and 2 were not addressed at all by conventional methodologies.

In devising Multiview, we were most influenced by Checkland's work in addressing question 1 (Checkland, 1985) and Mumford (1981), Land and Hirschheim (1983), and the Tavistock School in general, regarding question 2. It should also be noted that the conventional way of teaching systems analysis in the 1980s was also to concentrate on, in descending order of magnitude, technical, data and process issues. Further, in our definition of Multiview, we could envisage occasions when systems analysis may not lead to computerized information systems at all (Episkopou and Wood-Harper, 1985), very unusual at a time when

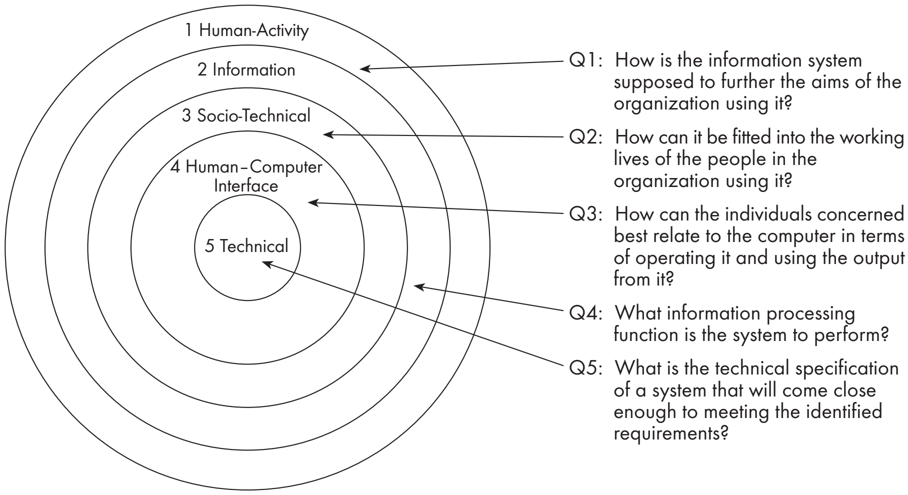


Figure 4.5: The Multiview1 framework.

computerizing was the norm. Figure 4.5 shows how these five dimensions have been incorporated into the five original stages of Multiview.

Questions 1 and 2 meant that the ISD activity could be seen in a broader setting than one of technology and technical rationality. Whereas earlier approaches to ISD had implicitly adopted a mechanistic metaphor of organizations, in Multiview it was recognized that there is likely to be a plurality of stakeholders and interests and that this plurality may well extend to outright conflict. This view of ISD as a process of organizational change raises the issue of how power is exercised – who gains and who loses in ISD? Markus and Bjørn-Andersen (1987) investigated the power of the IS developer and identified four ways in which the developer and user awareness of power might be manifested. Where both are aware of the exercise of power, mutual negotiation is possible. Where the developer is aware of the exercise of power but the user is not, then the situation is one of professional manipulation (a scenario found with medical practitioners and resonant of the 'expert' approach to IS development). Where the user is aware of the exercise of power but the developer is not, the outcome is user resistance, and when both are unaware then unintended influence is the outcome. To achieve an outcome acceptable to both parties, Markus and Bjørn-Andersen argued that power issues need to be recognized. In a later work, a study of Danish and Canadian system developers, Kumar and Bjørn-Andersen (1990) recognized the importance of understanding the values adopted by the IS developer. They concluded that:

> It is our belief that, from an organizational effectiveness perspective, a balanced value orientation is essential to the design and implement-

> ation of successful computer-based information systems. If the value structures or viewpoints of the system's designers are limited (i.e., if they emphasize only a limited subset from the range of technical, economic, and socio-political values), then the designers may create system designs which are inadequate or unacceptable from the perspective of the omitted value concerns.

Kumar and Bjørn-Andersen also point out that IS development 'methodologies, with their potential for economic, technical, and organizational changes, have built-in value biases reflecting the value priorities of the culture in which they are developed' and suggest that if there is a mismatch between the underlying values of the ISD methodology and the culture of the situation in which it is deployed then the methodology will not be accepted and furthermore that systems developed using methods with different value orientations from the situation's culture will not be acceptable.

Although Kumar and Bjørn-Andersen articulated clearly and persuasively the need for the developer to be sensitive to a range of values (and for these values to be reflected in the development methodology) they provided little by way of practical guidance. In Multiview2 it was recognized that the multiple perspective approach described by Mitroff and Linstone (1993) could be used to operationalize a multiple value approach that would sensitize the developer to a broader range of values than just technical and economic ones and also raise issues of power through an explicit recognition of political factors. Checkland (1990) also argues that politics is a power-related activity.

Figure 4.3 illustrates how in Multiview2, further influences from the domains of applied psychology, organizational theory, anthropology and others have influenced Multiview in its redefinition as Multiview2.

Contingency

The incorporation of contingency theory (Lawrence and Lorsch, 1967) in Multiview was a response to the then commonplace idea that there could be a single and best way of conducting IS development. Contingency theory suggests that it is 'horses for courses', that ISD success depends upon a range of factors, such as the size and history of the organization, the environment, the technology employed, the expectations of users and other stakeholders, the scope and scale of the development initiative, and the resources available. Multiview is thus a framework that can be used to promote a good match between a situation and an ISD process.

In his 1984 study, Bjørn-Andersen (1984) suggests the use of a contingency approach to information systems development. In this regard, Multiview can be seen as a framework whereby aspects are chosen as appropriate to the particular circumstances of the application. In our case studies using Multiview in many real-world situations using action research, we gained valuable feedback in its use. In Wood-Harper et al. (1985) we illustrated its original definition using one such case and in Avison and Wood-Harper (1990) six such cases are described. We have been informed by many such cases involving ourselves, and others. In reporting on our experiences of using Multiview across a range of projects we have identified a series of lessons learned.

One of the most important of these is that the traditional waterfall model is inappropriate for describing information systems development in practice. As evidenced by our field work, information systems development does not, in practice, exhibit the step-by-step, top-down nature of conventional models. Indeed, none of the applications of Multiview have exactly followed the framework as espoused in the main text (Avison and Wood-Harper, 1990). The users of the approach will almost certainly find that they will carry out a series of iterations that are not shown in the framework. Further, in some of the real-world cases undertaken, certain phases of the approach were omitted and others were carried out in a sequence different from that expected.

Thus the Multiview framework is not a 'guarantor of truth'. Images within the views of the approach are interpreted and selected depending on context. For example, in two cases described in the 1990 text, the social options of the socio-technical phase were either omitted or not fully explored. The appropriateness of using some techniques also varied greatly in our experience of using Multiview.

Even participation – one ethical basis of Multiview – is contingent. We believe that a high level of responsible participation is a positive ingredient of successful information systems development. Nevertheless, our experience suggests that the role of the facilitator is frequently that of 'confidence booster' rather than that of adviser or applications developer as usually described. The role of the facilitators proved crucial in most applications on both the people and the technical side of information systems development. However, participation is not always possible. For example, it depends on the organization's structure and the attitudes and experience of the people concerned.

The approach is interpreted by users/analysts. People view each situation differently depending on their education, culture and experience. Users of Multiview (and conventional methodologies as well) interpret the approach and the problem situation uniquely. There is no such thing as a 'typical situation', 'typical user' and 'typical analyst'. All this suggests that Niels Bjørn-Andersen and others are correct in that a contingency approach to information systems development is more appropriate in practice than more conventional approaches.

Multiview2 offers a systematic guide to any information system development intervention, together with a reflexive, learning methodological process, which brings together the analyst, the situation and the methodology. However, although the authors recommend a contingent approach to information system development, Multiview2 should not be used to justify random or uncontrolled development. The approach enables an exploration of information systems development using the framework provided by Multiview.

The terms 'methodology' and 'method' tend to be used interchangeably, although they can be distinguished insofar as a method is a concrete procedure for getting something done while a methodology is a higher-level construct which provides a rationale for choosing between different methods (Oliga, 1991). In this sense, an information systems methodology, such as Multiview2, provides a basis for constructing a situation-specific method (Constructing the Information Systems Development Methodology), which arises from a genuine engagement of the analyst with the problem situation (Wastell, 1996).

Broader view of evaluation

According to Hawgood and Land (1987), evaluation can be used to: justify a new system; compare different projects competing for scarce resources; provide a basis for project control; assess project performance and provide a learning experience. Avison and Horton (1993) suggest that evaluation, in a broader form, should be high on the agenda before, during and following the implementation of an information system. Evaluation can be viewed as a social and political process. Concentration on the economic and technical aspects of a system may cause organizational and social factors to be overlooked; yet these can have a significant impact on the effectiveness of the system. Possible areas for study that are often overlooked include functionality, the relevance of the information produced, operational factors, the structure of the organization, the infrastructure which supports the system, ergonomic considerations and social factors such as job satisfaction and the use of skills. Other possible beneficial effects of evaluation are an improved understanding of the system, greater use of the information provided, and better communication between users and developers.

Evaluation is clearly rather broader in scope than a hard financial analysis of alternatives to support a 'go/no go' investment decision. Much of Bjørn-Andersen (1988) – and Bjørn-Andersen and Davis (1988) as a whole – concerns itself with alternatives to the traditional ways in which computer applications are, even now, frequently evaluated; in particular, comparing money costs with short-term monetary benefits. Avison and Horton (1993) suggests many forms of evaluation that measure different aspects of an information system: impact analysis, measures of effectiveness, achievement of objectives, user satisfaction, usage, utility, achievement of satisfactory standards, usability, computer systems performance, and process evaluation.

The authors of Multiview argue that there is no single, best approach to evaluation (just as there is no single, best approach for all information systems development) but the choice needs to be made to suit specific applications and organizations. The choice of evaluation approach and the methods and techniques to be used will depend on such factors as the purpose of the evaluation and the way in which the results are to be used; the parts of the system and of the organization which are to be included; the timing of the study; the level of resources which will be provided; and who is to conduct the evaluation and the views which will be represented.

But a contingency approach to evaluation does not imply ad hoc planning. The planning of evaluation needs to be stressed. This requires the points which require decision and the factors which make one approach more suitable than another in a given situation to be identified. Approaches may be combined and the analysis of the situation will suggest the most appropriate approach or combination of approaches.

But there is also a form of evaluation in the learning of the action research itself through which Multiview was developed. As Baskerville and Wood-Harper (1996) point out, Lewin's (1951) model of action research included iteration of six phased stages: (1) analysis, (2) fact-finding, (3) conceptualization, (4) planning, (5) implementation of action, and (6) evaluation. It is this evaluation phase that may lead to further improvements in Multiview as well as the applications that have been developed using it.

Conclusion: an ethical approach to information systems

An over-riding concern of Niels Bjørn-Andersen, as evidenced in his publications relating to power, contingency, and evaluation, and, we hope, Multiview, is the high regard that we place on the importance of ethical values to information systems work. This is evidenced by our inclusion of much of the ETHICS methodology (Mumford, 1981) and the later inclusion of ethics analysis (Wood-Harper et al., 1996). For example, we address the questions: how best can an information system be fitted into the working lives of the people in the organization that are going to use it and how can the individuals concerned best relate to the machine in terms of operating it and using the output from it because we regard these as very important issues? Further, we think that the people in the organization have a right to determine the solutions to these questions. It should not be the responsibility of the developer (nor the researcher) but mainly that of the people affected by the information system.

Kumar and Bjørn-Andersen (1990) concluded that the techno-economic (a dominant T perspective) value orientation of system designers is an obstacle to the adoption of organizational and socio-political design practices. They proposed three strands: education and training, revisions to the reward structure of developers, and the development of ethics and codes of practice by professional societies to give a higher concern to socio-political dimensions. Multiview has been used to support, in part at least, the first of these aims, namely the education of future developers, most notably through degree programmes in the Copenhagen Business School, the University of Salford, and the University of Bath. This is a central and enduring contribution of the Multiview framework for IS development.

Similarly, we have a broader view to the question of evaluation than economic efficiency because we regard other issues as equally important: user satisfaction, usability, ergonomics, in short, organizational and social factors generally. This is also an ethical issue: we want information systems to impact favourably on the social infrastructure of the organization, not just the technical aspects.

The fact that Multiview is a contingency approach also hinges on an ethical issue: an information systems development methodology (as for an information system) should not be imposed on anyone, but adapted as appropriate to the people developing the system and the organization as a whole. Why should we impose this when organizations and people are so different? There is never one best way for everybody, but an appropriate way, developed and chosen by those concerned, for that application in that organization. In order for there to be many such options and to incorporate many viewpoints, this implies that Multiview assimilates the ideas from many disciplines, it has many perspectives. Indeed, the authors of the approach have a multi-disciplinary background, but we have also incorporated ideas from many disciplines. We continue to be influenced by others, and for that reason alone, but also because of our varying experiences of using the framework in practice, we expect the approach to evolve further.

5 Analysis and design of information systems: a knowledge quality perspective

Salvatore Belardo, Donald P. Ballou and Harold L. Pazer

Introduction

From the beginning of the computer era systems analysts have been bedevilled by the difficulty of producing systems that satisfactorily meet user needs. All too often systems developed at considerable time and expense are not used, primarily because the result does not meet the user's expectations and requirements. It is clear that one of the most significant factors in this failure is ineffective communication between the user group and the development group (Holtzblatt and Beyer, 1995). Accordingly, any action that enhances the effectiveness of the knowledge transfer process between user and developer would be a major contribution to developing systems deemed to be successful. Traditionally the development team has strong IS skills but is not necessarily familiar with the knowledge domain of the client. Conversely, the user group may have superficial knowledge of IS, but this is not sufficient to judge which development options would meet their needs. In general, the development and user groups have different mental frameworks, and so a statement that is perfectly understandable and meaningful to one party is either not absorbed by the other, or worse, is misinterpreted. Essentially, the quality of the knowledge transfer between the user and development groups is deficient.

This chapter examines the knowledge transfer problem between developers and users from the perspective of the effectiveness or quality of the information transfer. We focus on knowledge transfer during the systems analysis stage of the systems development life cycle. Effective knowledge transfer between the client and developer during the systems analysis phase is critical (Montezemi, 1988). If it is not done well, then there can be little hope that the project can be completed successfully (Marakas and Elam, 1998). There are of course many reasons why projects can fail, but it is necessary that the requirements that come out of the systems analysis phase be correct. Ensuring effective knowledge transfer during this phase is the purpose of this chapter.

It is important to note here that we are not proposing another systems development methodology. There are already many excellent methodologies found in the literature and practice including STRADIS, SSADM, IE, ETHICS, and UML to name a few. Avison and Fitzgerald (1995) and Tudor and Tudor (1995) as well as others have classified these methodologies according to frameworks that highlight history and themes of each and the issues both hard and soft that are encountered when the various methodologies are used. While each development methodology must begin with an analysis-like first stage, the success of this stage and ultimately the success of the final system depends to a large extent on the knowledge that each group (end users and system developers) has of the other's domain and their ability to learn quickly. While knowledge and learning are implicit in several of the methodologies cited above, none of them have focused on both knowledge and learning as a means of assessing the potential for successful systems analysis.

We introduce concepts and techniques that facilitate tracking the effectiveness of knowledge transfer between the client and developer throughout the systems analysis phase. With these it is possible to identify the need for any midcourse corrections. Strategies are described for handling effective knowledge transfer in the context of several disparate environments. For this we first examine the nature of knowledge in the developmental context and then introduce a set of ideas and concepts that facilitate understanding knowledge transfer problems between developer and user. The primary reason we wish to be able to evaluate the level of knowledge transfer between the developer and user is to provide a framework that facilitates making team assignments that enhance the likelihood of a successful systems analysis phase.

Clearly an ideal or optimal knowledge transfer strategy varies substantially depending upon the characteristics of both the development team and the user group. What is not so obvious is how to encompass such situations into a general framework that can provide guidance as to what knowledge transfer strategy is most appropriate across a wide variety of characteristics possessed by the development and user teams as well as diverse project environments.

Knowledge, like the related term information, has many definitions. Sveiby (1997) found a number of definitions in the literature where the term knowledge was described in terms of awareness, sapience, practical ability, wisdom, certainty, and so forth. Davenport and Prusak (2000) describe knowledge as a fluid mix of framed experiences, values, contextual information, and expert insight that provides a framework for evaluation and incorporating new experiences and information. Alavi and Leidner (2001) describe knowledge as information possessed in the mind of individuals. Nonaka (1994) and Huber (1991) contend that knowledge is a justified belief that increases an individual's capacity to take effective action. One useful way to understand the term is to think of it in terms of unique categories. Many scholars have distinguished between two types of knowledge, tacit and explicit. Lubit (2001) describes explicit knowledge as the type that is conscious and can be put into words. Tacit knowledge on the other hand is that which develops when unconscious inductive mental processes create a representation of the structure of the environment showing the relationship between important variables. Lubit (2001) notes that people can have unconscious abstractions with which they can learn about the underlying complex structure of systems without being conscious of doing so or being able to articulate their understanding.

An underlying premise of our work is that the degree of conformity between the developers' and users' tacit knowledge for the other's domain has a substantial and critical impact on the nature and effectiveness of the explicit knowledge transfer. This statement is implicitly supported by an extensive and longstanding body of research (e.g., Boland, 1978; Curtis et al., 1988; Vandenbosch and Higgins, 1996; Dorsey and Koletzke, 1997). The issue is framed succinctly in the work of Denzau and North (1994), who state, 'Individuals with common cultural backgrounds and experiences will share reasonably convergent mental models, … and individuals with different learning experiences (both cultural and environmental) will have different theories (models, ideologies) to interpret that environment… [Having] similar models enables [individuals] to better communicate and share their learning.' For our work it is necessary to fix the concepts of tacit and explicit knowledge. By tacit knowledge we mean the mental model used by an individual to process information produced by others or to absorb observations (Polanyi, 1966). Thus individuals may very well interpret or react differently to the same stimuli depending on their mental model. Explicit knowledge is a framework or structure that transforms data communicated between parties into information (see, for example, Lyles and Schwenk, 1992). Depending upon one's mental model, the explicit knowledge provided by one party could be interpreted by another as intended or could be badly misinterpreted, as determined by the receiving party's tacit knowledge. Thus the level of tacit knowledge each side has of the other's domain affects the correctness and rapidity of the explicit knowledge transfer.

IS professionals use the terms data, information, and knowledge on a routine basis with the full realization that they do indeed represent different concepts (Huang et al., 1999). Our use of knowledge is in the context of Bloom's taxonomy (Bloom, 1956), to be examined later, which in essence provides a graded measure of one's knowledge. Essentially it is a scale that can be used to evaluate the level of explicit knowledge possessed by an individual. As such it can be equated with explicit knowledge. Explicit knowledge, in turn, can be thought of as providing a structure that transforms data into information.

Knowledge transfer environments

It is reasonable to expect that the knowledge transfer approaches appropriate for each combination of the developer's tacit knowledge of the user's domain and the user's tacit knowledge of the developer's domain differ significantly. As the project proceeds, the developer's knowledge of the user's domain grows, and conversely. However, knowledge on the part of the user of the developer's domain, although certainly helpful, is not critical for a successful systems analysis phase. For this reason we do not explicitly model growth in the user's knowledge of the development team's area of expertise. Not modelling this has the additional benefit of simplifying the presentation of the concepts and our methodology. As a result of this modelling decision, the development team has the responsibility to close the knowledge transfer gap. Accordingly it needs to be constituted so as to accomplish this within the timeframe allotted for analysis.

To facilitate understanding of how to optimize knowledge transfer for all situations, we use as our foundation Bloom's taxonomy (Bloom, 1956), which serves as a benchmark for evaluating the levels of explicit knowledge transfer. To aid in measuring and tracking the developer's knowledge of the user's domain, we cross-dimension the Bloom categories with several descriptors or dimensions of knowledge. This gives IS managers who are responsible for building a development team a tool for assessing initially the potential for effective knowledge transfer for a particular choice of individuals, given that development team formation must be done in the context of the environment.

Importance of shared context

A common context is critically important whenever two or more individuals wish to communicate. Yet the words or symbols that we use may be interpreted differently by our interlocutors depending upon their own experience or point of view. For example, if you were to show a red dot to an Indian, a Japanese, or a taxi driver, each might interpret the symbol quite differently; the Indian might see a religious symbol, the Japanese, a flag, and the taxi driver perhaps a stop light. Their experiences colour their interpretations.

The German physicist Werner Heisenberg demonstrated, in what has become known as the double slit experiment, that what we see is really a function of where we stand. Heisenberg posited that what we see is not nature *per se*, but nature exposed to our method of questioning; he thereby provided a clue as to how we might remedy the communication problems that result from lack of a common context.

This inability to communicate tacit knowledge manifested itself in an experience when one of the authors taught an introductory course in Expert Systems. In the course, each student had to choose a domain problem for which an expert existed. The students were US Airforce officers, one of whom decided to try to build an expert system that emulated an expert Electronic Weapons Officer (EWO) on an F-4 Phantom jet. The student found an expert EWO who had successfully evaded co-located surface-to-air missile defence measures while on assignment in Vietnam. The student began eliciting the heuristics that the experienced EWO had employed by asking seemingly appropriate questions. When the student asked how the EWO had avoided being shot down, he gave a detailed description of how he processed signals, both visual and aural; the student was able to elicit 238 rules. When these rules were assessed by other EWOs, it became clear that this was too large a set of rules to process in the stress-filled conditions that normally accompany such activities. It was further determined that many of the 238 rules were similar to those that the expert had learned at the Airforce Academy – important, but probably not what actually saved him and his pilot.

It wasn't until a pilot who had flown with the EWO in Vietnam was found, that it was possible to construct a proper interview that resulted in 18 truly unique rules. The pilot was able to give his own interpretation of experiences he had shared with the EWO, thereby creating a common context.

Creating a common context

In this chapter we contend that the primary purpose of communication is to learn or to teach. Whether it is communication between a marketer and a consumer, or between a systems developer and an end user, communication can be dramatically improved if we look at the communication process from a learning perspective. As Denzau and North (1994) state, 'mental models will evolve to reflect the feedback derived from new experiences – feedback that may strengthen and confirm our initial categories and models or that may lead to modification – in short, learning.' Immanuel Kant, the great German philosopher, stated that we learn in one of three ways; by experimentation, by speculation, and from what other sources of knowledge tell us (Infield, 1963). When a scientist performs an experiment, he/she uses the standard scientific method. Anyone familiar with this method regardless of origins or domain will easily be able to understand what the scientist is trying to communicate. This is because both are familiar with the methods of experimental design and statistical analysis. All scientists know the significance of reliability, validity, and statistical significance.

When we learn by speculation, or reasoning, we are better able to communicate what we know when we employ *critical thinking*. This method, not unlike the scientific method, enables us to structure our learning so that when we attempt to communicate what we know, we can do so in an accurate understandable and defensible way. When we think critically, we in effect ask ourselves exactly those questions that would be asked by others with whom we would like to share our knowledge. In this way, we in essence create a common context.

Similarly, when we learn from what others tell us our ability to learn can be dramatically improved if the source of knowledge has anticipated the questions that we should be asking. The point is that what we learn is greatly influenced by the questions that we ask, and it is through rigorous inquiry that we can create a common context where none has previously existed. In order to understand the questions that can help establish a common context and facilitate communication we recommend Bloom's taxonomy.

Bloom's taxonomy: the Rosetta stone to understanding communication

More than 40 years ago, Benjamin Bloom and a group of scholars began seeking means to improve individual learning. They concluded that, while it was extremely difficult to determine how individuals actually learned, it was, nevertheless, possible to determine individual learning objectives and goals and to measure a learner's performance relative to these goals and objectives. The result, commonly referred to as Bloom's taxonomy is a factored list of individual skills that consists of three domains: cognitive domain, affective domain, and motor skills domain. This taxonomy has been successfully employed by master teachers in various disciplines to determine how much a learner knows. While the three domains of Bloom's taxonomy are all important, in this chapter we will focus on the cognitive domain. The affective domain deals with covert internalized feelings and actions. As a result, affective behaviour is less observable and testable than the overt behaviour associated with the cognitive domain. The motor skills domain deals primarily with physical activities requiring coordination, and, as a result, has little to do with the focus of this chapter.

The cognitive domain comprises intellectual skills and lists six levels of ability in ascending order: knowledge, comprehension, application, analysis, synthesis and evaluation. At the lowest level is knowledge, which we will call vocabulary. It is rote learning ranging from the recall of specific facts to knowledge of conventions and theories. Vocabulary can be thought of as an individual's personal database which merely serves as a link to other types and sources of knowledge.

Comprehension encompasses meaningful integrated learning. At this level the learner has made the material part of his or her own frame of reference. Individuals who have not achieved this level of learning typically cannot explain an idea or concept in their own words. They tend to rely on buzzwords and jargon or use surface terms without understanding the underlying theoretical or conceptual principles. They are not able to provide vivid examples or descriptions to which others, unfamiliar with the domain, might be able to relate. Without this level of learning, individuals are unable to evaluate their own performance or to apply ideas in slightly different situations.

Application involves using abstractions or theories to solve new problems or find new ways to solve old problems. It involves restructuring or reclassifying a given problem in accordance with the individual's cache of knowledge. It implies that an individual is so familiar with the relevant concepts and ideas that he/she is able to predict the effect of a given change on the system.

Analysis is important for enriching the various steps of problem solving processes like the case method. Analytical skills enable the learner to discern unstated assumptions and understand how the various parts of a construct fit together. For example, in performing credit analysis, an experienced commercial loan officer would know how and when to use the 5Cs of credit (capacity, capital, character, conditions and collateral).

Synthesis takes place when the previous levels are combined into a new integrated whole. It requires the learner to draw upon his/her previous knowledge and comprehension and organize it in a novel way that provides an independent and effective solution to unfamiliar problems. At this level, the learner is able to adapt his or her knowledge to other uses. The application of Bloom's taxonomy to the problem of improving the quality of knowledge exchange is an example of synthesis.

Evaluation, finally, is simply about making judgements that will determine the worth or value of a proposed solution. Being able to choose among the many ways to solve a problem requires an extensive knowledge of the problem under consideration, of the right tools and techniques needed to address the problem, of the criteria employed, and of the relative weights for these criteria.

Just as Bloom's taxonomy can help a master teacher evaluate the knowledge that a student has acquired, it can also be employed to assess whether the systems developer and end users possess the same knowledge.

Dynamics of knowledge transfer

If the goal of the knowledge transfer process is to apply a relatively stable technology to a slowly changing problem environment, then the problems are more easily managed. This is true both because knowledge accumulated during past interactions is more likely to be still relevant as well as because the time pressure to complete the current design before it is outdated will be minimized. An example of this situation would be developing a database application to help monitor the production of breakfast cereals.

Near the other extreme, consider the design of a system to monitor the electronic marketing of Christmas toys. The fact that the analyst had experience a number of years ago in developing a marketing system for board games, may provide little knowledge of current relevance. Likewise, the marketing manager's previous experience with an early electronic marketing application may be largely outdated by rapid evolution of the Internet. The pressures on the knowledge transfer process are increased by the highly time-dependent nature of the Christmas toy market as well as the short half-life of Internet innovations.

In more dynamic environments, the rate of knowledge acquisition as described by the learning curve of the design team becomes increasingly relevant. Among the factors that influence the shape of the learning curve are group size, tacit knowledge, and relevant explicit knowledge from previous experience. A family of such learning curves will be presented and discussed later in this chapter.

Modelling participant knowledge states

While the six levels of Bloom's taxonomy are useful in measuring quantitative aspects of knowledge acquisition, the picture will be incomplete unless the quality of this knowledge is also accessed. Four quality descriptors that have been discussed extensively in the information quality literature (Ballou and Pazer, 1985; Wang and Strong, 1996) are also useful in the measurement of the quality of explicit knowledge (Huang et al., 1999). These are accuracy, completeness, timeliness, and consistency. While these will be employed in quality evaluation of all six of Bloom's levels, they will be explained in the context of the first and last of Bloom's six levels, vocabulary and evaluation.

First, for vocabulary, of those terms relevant to the design environment that the individual thinks that he/she knows, what proportion is correctly defined? This is a simple measure of accuracy. The ratio of the terms thought to be known by the potential participant to the total number of terms required to describe the environment is a measure of completeness. Two concepts are required to evaluate timeliness. The first is the age of the knowledge held by the potential participant. The second is the shelf life of that knowledge. If the individual's vocabulary of relevant terms is based on course work undertaken ten years previously, some terms with a long shelf life may still be current while others with a short shelf life may be completely outdated. The final measure, consistency, allows knowledge to be viewed in an environment-specific manner. For example, a vocabulary of relevant terms which was accurate and complete for the development of a military application may prove insufficient to effectively communicate with potential users of a similar system in a social services agency.

Second, for evaluation, the extent to which the criteria, measurement, and weights are correct is a measure of accuracy. The proportion of the relevant solutions, criteria, and weights which are employed is a measure of completeness. The extent to which these factors are current when viewed in the context of the shelf life of this knowledge defines timeliness. The degree to which comparable evaluation criteria are used for each alternative is a measure of consistency.

Knowledge quality evaluation model

By evaluating an individual's or group's status on each of Bloom's six levels according to the four quality measures, a model with 24 distinct cells is obtained. While there are some situations where this level of detail is desirable, for the purposes of this exposition we make use of some natural groupings of the dimensions to yield a more manageable model.

It can be observed that the first two quality measures, accuracy and completeness, are linked in that they both relate to the quality of the group's preparation. The remaining two, timeliness and consistency, are similarly linked in that they allow this preparation to be evaluated in the context of a specific current environment.

Grouping adjacent elements along Bloom's knowledge continuum with the first two being strongly related to educational background, the second two related to previous design experience, and the final two related to managerial experience not only simplifies the model but also provides data collection guidelines as follows:

Vocabulary/comprehension: Team member's educational background as documented by graduate and undergraduate specializations as well as seminars and training courses should provide useful predictors of these dimensions.

Application/analysis: Experience by members of the team as employees in the design environment or as members of design teams which developed applications for similar environments should be a good predictor for these knowledge levels.

Synthesis/evaluation: Managerial experience in the application environment or experience as a team leader for the development of systems for similar situations should be highly correlated with knowledge at these levels.

Table 5.1 presents a simple but useful model for the simultaneous evaluation of the quantity and quality of explicit knowledge. It is useful for profiling the explicit knowledge of potential team members as well as for accessing the aggregate knowledge level for the design team as currently configured in order to identify quality deficiencies. The model can also be employed to monitor the progress of improving both the quantity and quality of explicit knowledge over time.

The actual evaluation for each of the above six cells could be either quantitative (e.g., percentage of ideal) or qualitative. For the sake of simplicity we have chosen to illustrate use of the evaluation model using a three-point ordinal scale (L=Low, M=Medium, and H=High). Other research conducted by two of the authors in conjunction with a colleague suggests that more detailed scaling of information quality evaluations does not appreciably increase the quality of decisions based on this information (Chengalur-Smith et al., 1999).

Knowledge quality evaluation example

We now present a case study based on some work by one of the authors who was involved on the development team side. This case study applies the methodology presented above.

Table 5.1: Knowledge quality evaluation model

Knowledge levels	Quality, accuracy and completeness	Timeliness and consistency
Vocabulary and comprehension		
Application and analysis		
Synthesis and evaluation		

A state agency has responsibility for disbursing funds to meet various commitments mandated by the legislature. Some of these result from ongoing programmes, others result from ad hoc ‘member’ bills introduced by legislators to benefit constituent groups. The budget officer for this agency oversees and tracks all receipts and expenditures for the agency and especially the fulfilment of commitments made by the legislature to various groups throughout the state.

The budget officer’s job is complicated by the fact that the funds to cover the commitments come from a variety of sources. In spite of the various restrictions on use of these funds, she does have considerable flexibility with many of the accounts, and as permitted, she can move funds from account to account. She felt the need to have available for her planning and control purposes a PC-based system that would support tracking and managing of all flows of funds, facilitate entry of expenditures and receipts, provide the reporting functionality she needed, and permit ad hoc, what-if querying.

To develop and implement this system, the agency contracted a local consulting group. This office submitted a low bid, and as a result, it had to use junior consultants to do much of the work. At the project’s start, only one member of the development team had any prior experience in this environment and that was as a junior member of another design team. This member served as a resource to the rest of the team to help build vocabulary and some comprehension. The other members of the team of analysts identified for this project had no prior knowledge of the functions of the State Agency or of its Budget Office and relatively inconsequential knowledge of the specific accounting issues involved in state agencies. On the client side, the knowledge transfer situation was considerably better, as the budget officer, although not an MIS specialist, was familiar with system analysis and the development life cycle as well as such technical components as relational databases and normalization. Thus, the primary knowledge barrier that had to be overcome was the absence of domain knowledge on the part of the development team.

Clearly for this project to be successful the development team had to acquire sufficient user-domain knowledge not only to understand the desired functionality of the proposed system, but more importantly understand the flows of funds. Anticipating the difficulty of bringing the development team up to speed on the nuances of the budgeting issues, the budget officer initiated regular meetings with all team members solely for the purpose of explaining the functioning of the Budget Office in general and, in particular, the intricacies of the flow of funds. After almost a dozen such sessions, the budget officer was confident that their understanding was sufficient for them to proceed with the development of the system. It should be noted that the focus of the first phase consisted primarily of knowledge transfer.

At the end of the knowledge transfer phase the team had acquired vocabulary with a fairly high degree of comprehension. Knowledge of application and analysis were moderate. All of the above were high in timeliness and consistency since they were recently acquired in the design environment. Nevertheless, an evaluation at this time of the rate of acquisition of explicit knowledge on the part of the development team indicated that the project completion deadline would not be met. After analysis it was determined that in order to meet the project completion deadline it was necessary to enhance knowledge transfer through the addition of a senior analyst with experience directing projects in similar environments. Thus high levels of knowledge of synthesis and evaluation were added to the mix. However, not all of this knowledge was current or directly applicable to this design environment.

Application of Knowledge Quality Evaluation Model

The Knowledge Quality Evaluation Model will now be applied to the Budget Office design environment described in the above case.

Table 5.2 describes the situation at the project's start when only one development team member had any prior experience in the Budget Office environment and that was as a junior member of another design team. This member served as a resource to the rest of the team to help build vocabulary and some comprehension but had little to offer at the more advanced knowledge levels.

As shown in Table 5.3, at the end of the knowledge acquisition stage, the team had acquired vocabulary with a fairly high degree of comprehension. Knowledge of application and analysis were moderate. All of the above were high in timeliness and consistency since they were currently acquired in the design environment. The team, however, continued to lack experience at the synthesis and evaluation level.

It was determined as the team began the actual design of the system that a mid-course correction was required. As indicated in the case study it became necessary to add a senior analyst with experience in directing projects in similar environments to the team. Thus high levels of synthesis and evaluation were added to the mix. However, not all of this knowledge was current or directly applicable to this design environment. The situation after this mid-course correction is summarized in Table 5.4.

Modeling the knowledge transfer rate

The effectiveness of a system design team is related not only to the initial explicit knowledge that they bring to the project but also to the

Table 5.2: Knowledge quality evaluation model – initial profile

Knowledge levels	Quality, accuracy and completeness	Timeliness and consistency
Vocabulary and comprehension	M	M
Application and analysis	L	L
Synthesis and evaluation	L	L

Overall rating of capacity for knowledge transfer = L+

Table 5.3: Knowledge quality evaluation model – end of stage 1

Knowledge levels	Quality, accuracy and completeness	Timeliness and consistency
Vocabulary and comprehension	H	H
Application and analysis	M	H
Synthesis and evaluation	L	L

Overall rating of capacity for knowledge transfer = M

Table 5.4: Knowledge quality evaluation model – mid-course correction

Knowledge levels	Quality, accuracy and completeness	Timeliness and consistency
Vocabulary and comprehension	H	H
Application and analysis	M	H
Synthesis and evaluation	H	M

Overall rating of capacity for knowledge transfer = H–

tacit knowledge possessed by the members of the team. As indicated earlier, by tacit knowledge we mean the mental model used by an individual to process explicit knowledge, information or data provided by others as well as the ability to effectively assimilate observations of the relevant environment.

Figure 5.1 presents four representative scenarios showing the levels of explicit knowledge possessed by design teams over time as a function of initial explicit knowledge, K_0, and tacit knowledge represented by the *curvature* of the knowledge acquisition curve. Point T represents some project milestone and K_T the explicit knowledge acquired by the team at this point in time.

The diagram in the lower left corner represents a case where the team has both low explicit knowledge relating to the specific project as well as low tacit knowledge based on limited previous exposure to the design environment. The level of explicit knowledge possessed by milestone T would be quite low.

The diagram in the upper left corner represents a team also relatively devoid of previous exposure to this design environment but with extensive knowledge about projects of this type.

Even though the knowledge acquisition rate is low, the team possesses substantial explicit knowledge by milestone T largely based on what was initially brought to the table.

The diagram in the lower right corner represents a team which is quite familiar with the design environment but has little explicit knowledge relevant to the specific project. The mental model driven by the team's tacit knowledge allows the rapid assimilation of project-specific explicit knowledge prior to the project milestone in question.

The final diagram represents a team which starts the project both with high explicit knowledge and high tacit knowledge. This team may be well ahead of schedule by the milestone based upon a high starting point coupled with the ability to rapidly assimilate additional explicit knowledge. This advantage, however, often comes with a substantial price tag attached since it may require assembling a design team consisting of well-informed senior personnel.

Contributions of the knowledge quality transfer and evaluation models

To create effective information systems, the design team must acquire a firm understanding of the user's expectations and requirements. In order for the data collected during the design stage to be correctly interpreted and translated into information, which specifies system requirements, an appropriate knowledge base must be established. While this is understood in a general way by successful practitioners, a

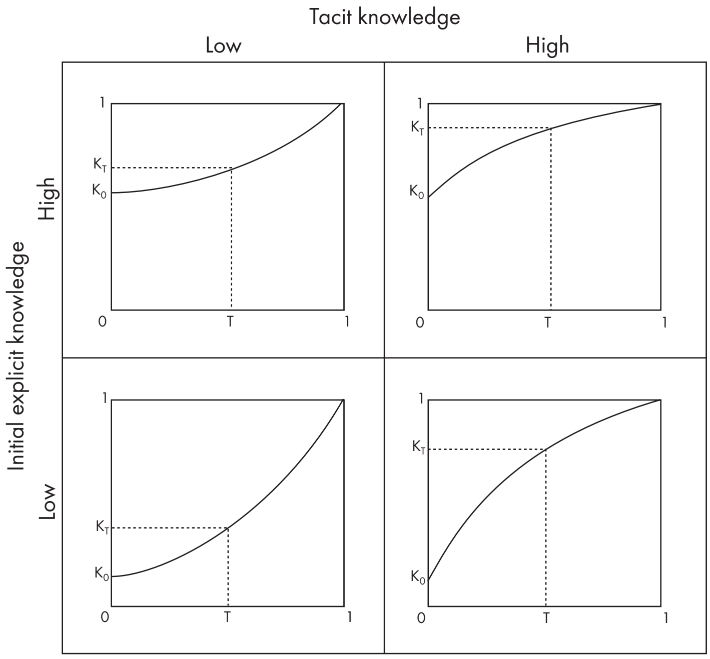


Figure 5.1: Knowledge transfer model.

major contribution of this chapter is to provide a framework for a less macro view of current and target knowledge levels for the design team.

The Knowledge Quality Evaluation Model focuses on three subdivisions of Bloom's taxonomy and two knowledge quality categories to provide a simple six-cell evaluation model. For example, two design teams may both be evaluated at the macro level to bring an intermediate level of knowledge to the design process. However, if one team is strong in terms of vocabulary and comprehension but weak in terms of synthesis and evaluation while the reverse is true for the second team, very different strategies would be required during the knowledge acquisition stage.

If there is flexibility in the make-up of the design team, the Knowledge Quality Evaluation Model can be used to establish a target profile for additions to the team. It is also useful in tracking the level and quality of the knowledge acquired by the design team at each stage of the design and development process. As the team acquires a more sophisticated view of the design environment, it will be reflected by both improvement in the quality measures of timeliness and consistency as well as the team's ability to synthesize and evaluate design parameters and requirements.

The Knowledge Transfer Model focuses on the impact of tacit knowledge on the rate of acquisition of explicit knowledge by the design team. This is especially important when a dynamic design environment requires that the design process be compressed. As indicated earlier, a mental model based on a high degree of tacit knowledge will accelerate the process of translating input data into design relevant information.

In a manner parallel to the application of the Knowledge Quality Evaluation Model to the team building process, the Knowledge Transfer Model can be used to identify when it is necessary to make mid-course corrections in team composition. For example, the addition of a new senior member to the design team in the case that we presented not only addressed a gap at the synthesis and evaluation level but also provided tacit knowledge which accelerated further knowledge acquisition by the team.

Concluding remarks

Viewing the electronic weapons officer (EWO) case discussed earlier, it seems clear that these two models could have saved considerable development time and effort. The initial team profile was similar to the one shown in Table 5.2. Coupled with their limited tacit knowledge, this would have positioned the design team in the lower left-hand corner of the Knowledge Transfer Model (Figure 5.3). The following two strategies could have been used to move the team to the ideal situation represented by the upper right corner of this figure.

First, the design team could have spent a considerable amount of time with the weapons officer building up their explicit knowledge of the project – a strategy not unlike the one employed in the state agency case discussed earlier. The result would be a move to a knowledge state similar to the one shown in the upper left-hand corner of Figure 5.1. Here the position and shape of the curve suggests a dramatic increase in the explicit knowledge possessed by the team as well as a marginal increase in their tacit knowledge.

A second strategy would be to employ someone with considerable tacit knowledge. Such a decision would result in a situation similar to that shown in the lower right-hand corner of Figure 5.1. Here the analysis team gained a substantial increase in tacit knowledge along with a bit more explicit knowledge. In the EWO case the pilot had this tacit knowledge of the domain and as a result was able to help the team increase its fund of explicit knowledge somewhat. As a result, the pilot was able to chauffeur the development process to a more desirable conclusion.

In conclusion, using the Knowledge Quality Assessment Model to evaluate and track the knowledge possessed by design teams and individual design team members could enable managers to make improved resource development and allocation decisions. Additionally, the concepts developed and discussed in this chapter suggest three major avenues for further research as follows:

Development of efficient methodologies for selection and training of team participants in the context of Bloom's taxonomy and the knowledge quality metrics. It seems certain that being able to profile knowledge deficiencies at a more micro level will allow training programmes to be developed which can be tailored to specific needs in a more cost effective manner.

Selection of knowledge efficient team structures responsive to team size and sophistication as well as task complexity and inherent time constraints. It seems likely that optimal team size will in part be a function of the initial knowledge quality profile of potential team members. Also, the optimal point on the centralization/decentralization continuum is likely to be a function of the homogeneity of this profile across team members.

Assignment of knowledge efficient groups in a multi-project environment. The authors are currently extending the knowledge quality assessment model to address the problem of the cost effective assignment of a consulting staff to an array of systems analysis tasks of differing importance and with varying need to 'front-end-load' key knowledge quality components.

In conjunction with the knowledge quality assessment model, the completion of these three research components has the potential to make substantial contributions to the cost effective improvement of the systems analysis process.

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6 Why stuff happens: explaining the unintended consequences of using IT

M. Lynne Markus and Daniel Robey

Introduction

Time and again the results of IT interventions do not turn out as planned. Sometimes, the unexpected results are pleasant surprises, as when organizations discover valuable new uses for data collected by their information systems. Other times, the unexpected outcomes are negative – devastating 'technical' problems leading to inaccurate data, botched transactions, operational nightmares, and even security breaches and fraud. Hoped-for benefits may fail to materialize. Benefits may be realized, but accompanying them are negative social consequences such as stress and overload, depersonalization or reduction in organizational commitment, and deterioration in organizational culture. How much greater would the organizational benefits of IT use be if we could reduce the disappointment of negative outcomes and fully exploit the potential of unexpected benefits?

Good theory about the unintended consequences of IT use is essential if we are to prevent or minimize negative unintended consequences and improve our ability to exploit potential benefits. The purpose of this chapter is to advance those aims by assembling, comparing, and contrasting alternative explanations for the unintended consequences of information technology *use*. The word *use* is important here. Some unintended consequences, such as the absence of intended benefits, can be explained by lack of IT adoption and use. Our focus in this chapter is on unintended consequences that occur *despite or even because of* IT use. Therefore, excluded from the scope of this chapter are the many theories that explain IT adoption but do not explain IT uses and consequences.

The plan of the chapter is as follows. We first present the assumptions and definitions that underlie our approach. Then we examine four classes of explanations for unintended consequences of IT use: explanations rooted in the design of IT, explanations rooted in technology appropriations by users, explanations rooted in complex interactions of technology uses with mental models and tasks, and explanations rooted in complex interactions of technology uses with social systems. Next, we discuss the implications of the different theories for improving the outcomes of IT use. We conclude with suggestions for future research.

Conceptual background – assumptions and definitions

In this section, we address three related conceptual issues that are fundamental to the topic of this chapter. First, what do we mean when we say that unintended consequences '*occur*'? Second, what is the reference point for '*unintended*' or '*unexpected*' consequences – unintended or unexpected *by whom*? Third, what do we mean by '*IT use*', particularly when we say that a particular pattern of IT use is expected or unexpected, intended or unintended?

What does it mean to say that unintended consequences occur?

Technology design and implementation are goal-directed activities. Designers produce artefacts, and other people buy them, with the intention that use of the artefacts will produce certain outcomes relative to pre-existing conditions. For example, the developer of the PC-based spreadsheet program VisiCalc expected that using that program would eliminate drudgery and rework by increasing the levels of automation and accuracy in previously manual tasks like budgeting. The intended consequence was to change a prior state of frustrating, labour-intensive work into an after-state of efficient and error-free labour. Put differently, technology development and implementation are interventions into a socio-technical system that are expected to alter the state of the system.

When we say that unintended consequences *occur*, we mean that some features of the post-intervention situation are different than the features of the pre-intervention situation, but that they are not the originally intended effects. For example, although spreadsheet software increased the speed and accuracy of much white-collar analytic activity, it also substantially increased the amount of analysis performed. Spreadsheet software was wildly successful and regarded as the personal computer's 'killer app'. More people engaged in spreadsheet analysis than formerly, and they ran more analyses than they had before. People who had had to rely on information systems professionals to produce complex management reports could now produce their own. A new era of 'end-user computing' dawned in organizations, characterized by a contest of control between IS professionals and users. Individuals and departments began using spreadsheet templates as 'production systems,' developed by amateurs without proper methods or testing. Subsequent research showed that a surprisingly large number of such templates contained errors (Panko and Sprague, 1998).

When we say unintended consequences like these occur as a result of IT use, we do not necessary mean that the use of IT directly caused the unintended consequences. Indeed, the purpose of this chapter is to present alternative hypothesized relationships between IT use and unintended consequences. For example, unintended consequences could be *indirect* effects, as in the case of telework, where declines in employees' attachment to their employers occur as an indirect side-effect of IT's primary impact: lessened face-to-face contact with co-workers. We also do not mean that unintended effects are entirely new. They may be features of the pre-intervention situation that were amplified or reduced as a direct or indirect result of IT use. Regardless how they occur, we consider unintended effects to be *related in some important way* to the use of IT. They are not 'spurious results'. The new or more noticeable effects in the post-intervention situation *would not have been observed* in the absence of IT use.

The spreadsheet example illustrates what Tenner (1996) has called 'revenge effects', which result from 'the tendency of the world around us to get even, to twist our cleverness with technology against us'. For example, the availability of productivity software enables us to change documents easily and encourages us to make more changes, ironically consuming time the technology was intended to save. Examples of revenge effects abound: the ease of 'dialling' pushbutton telephones led to our pushing many more buttons owing to the spread of voice-response systems; in the arena of domestic technology, the availability of washing machines led to much more frequent washing of clothes; videoconferencing technology was expected to substitute for business travel but actually increased it (Rice and Associates, 1984); and the widening of freeways has led to more traffic congestion because it encourages more people to drive.

The term 'revenge effects' suggests a situation in which the intended positive effects of technology use are not realized or perhaps are replaced by negative consequences.[1] But some authors have noted that technology use can lead to 'dual outcomes' (Pool, 1978) in which very different outcomes can occur simultaneously. For example, use of the telephone promoted the seemingly contradictory dual effects of skyscraper construction as well as urban sprawl (Pool, 1983). The observation of dual effects draws attention to the possibility that some uses of IT may co-produce inextricably linked positive and negative effects. A recent analysis of portable cellular telephones supports this conclusion by considering dual outcomes to be inherent in cell phone use (Arnold, 2003). Thus, cell phone users are simultaneously mobile

1. Tenner (1996) recognizes, as we do, that some unintended consequences are positive. Naturally, though, he tends to emphasize the negative consequences, as we do also.

and fixed, available and busy, connected and distant, private and public, and independent and leashed. Dual effects have also been observed with technologies such as group support systems (Poole et al., 1991) and CASE tools (Orlikowski, 1992).

As these examples suggest, unintended consequences are not restricted to information technologies, nor are they a particularly recent phenomenon. Indeed, one of the earliest comprehensive studies of the computer's impact on management concluded that 'planned' impacts were almost never observed and that the most commonly observed impacts were 'accidental' outcomes (Bjørn-Andersen et al., 1986). Instead of empirical regularities, the researchers reported results resembling 'shotgun-bullet patterns' that scattered in many directions (Bjørn-Andersen et al., 1986, p. 202). Thus, the problem of explaining, predicting and managing the consequences of IT has been a part of IS research for many years.

Unintended by whom?

The phrases 'unexpected consequences' and 'unintended consequences' beg the question 'unintended by whom?' This question can be challenging to answer for several reasons. First, as Rob Kling often reminded us, some people view IT in optimistic or utopian ways, whereas others take pessimistic or dystopian perspectives. Thus, one's expectations are coloured by one's predispositions. Second, instances of organizational IT use can involve many actors, each of whom can have different expectations or intentions with respect to IT. Examples include the development specialists who work for IT vendors, the organizational executives and IT specialists who commission, purchase, select, develop, and/or implement IT, and the people who actually use the IT, whether they are employees, customers, or business partners. As used in this chapter, the phrases 'unintended consequences' and 'unexpected outcomes' refer to outcomes of IT use that were not planned for, or expected by, at least some of these actors.

This clarification raises several additional issues. First, the various actors involved in any situation of IT use may have different and conflicting intentions and expectations. Although some people might not intend or accurately anticipate the consequences of IT use, other people could. Second, the intentions of multiple actors may be incompatible, so that one actor's intentions can only be achieved when another's intentions are not. Thus, some actors may intend to achieve outcomes that others see as undesirable. Although the intentions or expectations of organizational decision makers and IT developers make a useful starting point in analyses of the consequences of IT use, we do not assume that they are the only points of reference.

For example, Thomas Alva Edison was said to have expected the telephone to be used for broadcasting music from concert halls into people's homes. From his point of view, the non-occurrence of that outcome and the widespread use of telephones to summon emergency personnel and to communicate with friends and relatives might be seen as unintended or even negative outcomes. Furthermore, to limit exploration of the consequences just to the commonest telephone uses would exclude many other important consequences such as telephone fraud. (The label 'phonies' was first applied to telephone con men.) What is important about unintended consequences is not just the achievement or non-achievement of someone's intended outcomes, but also the possibility of significant effects that *no one* intended or anticipated.

What is IT use?

IT use is an important concept because variations in IT consequences are often explained in terms of variations in IT use. Specifically, analysts often explain the absence of IT benefits as a result of technology non-use. And outcomes other than those expected are often explained by technology misuse or abuse. By IT use, we mean a pattern of interaction between people and technology that results in changed work practices, organizational routines, or interorganizational processes.

In organizations, IT use must be considered at two levels (at least): that of the individual user and that of the organization. At the organizational level, the 'same' IT can be deployed in different ways. For example, one organization may deploy data warehousing to provide better management reporting, whereas another may employ the same technology to enable data mining. How organizations deploy and introduce technology has consequences for individual patterns of use. So, for example, if an organization emphasizes the similarities between voice mail and telephone answering machines, people are less likely to use vmail's capabilities for 'sending' (rather than 'leaving') messages to individuals and vmail distribution lists than they would be if the organization emphasized the similarities between vmail and email.

Regardless of how the organization deploys technology, however, there can be consequential variations in how individuals use it. Kraut, Dumais and Koch (1989) describe a case in which an organization deployed a new system that enabled customer service personnel to access several customer information databases simultaneously while a customer was on the call. Managers tried to limit service personnel to one customer call at a time (in the belief that this would reduce customers' time on hold). But customer service personnel, who were measured on productivity, exploited the multiple database features to handle two customer calls simultaneously. Some users also devised a clandestine note-passing network by communicating with each other via a field in the database record intended for other purposes. Despite efforts to eliminate these practices, they persisted, and managers were powerless to prevent them. Thus, organizational intentions and IT deployments were thwarted by divergent patterns of individual use.

This example shows that in some cases, the consequences of IT use may not be as intended because some or all *technology use practices are not as intended*. However, in other cases, the consequences of IT use may not be expected even though the *use patterns conform to expectations*. For example, Markus (1984) described a case in which individuals' use of email to achieve organizational intentions of productivity increases achieved *both* efficiency benefits *and* negative social consequences, such as alienation and deteriorating organizational culture. She concluded, furthermore, that the negative social consequences were inevitable by-products of people using the technology as they were expected to do and had to do in order to achieve the desired benefits. Therefore, attempts to explain the unintended consequences of IT use must consider *both* situations in which organizations do not deploy or people do not use IT as they are intended to do *and* situations in which IT is used as it was intended to be used.

Summary

Unintended consequences are a direct or indirect result of IT use; that is, they would not have occurred without IT use. Unexpected or unintended IT outcomes may be positive, negative (including the absence of benefits), or both simultaneously. Although the expectations and intentions of organizational decision makers and technology designers and implementers form a useful starting point for analyses of IT uses and consequences, they are not the only considerations. Outcomes experienced by other stakeholders are also important, regardless of whether the outcomes were intended or expected. One key theoretical and practical concern is whether dual negative and positive consequences are inextricably linked or whether they can be separated so that the negative consequences can be eliminated. Another key concern is whether unintended consequences occur *because of* unexpected patterns of IT use or *despite* patterns of IT use that are more or less expected.

Explanations of unintended consequences

How and why do unintended consequences occur? Although unintended consequences are regularly reported in empirical studies of IT outcomes, no study we are aware of has focused primarily on them. More often, occurrences of unintended consequences of IT use are noted as ironic anomalies or contradictions but they have not been directly addressed in the theoretical and empirical IS literature. To begin the task of theorizing about unintended consequences, we seek to compile and compare alternative theoretical statements that have the potential to explain the relationship between IT use and the unintended effects. The explanations come from divergent disciplinary orientations, including cognitive and social psychology, human–computer interaction, engineering, and various branches of sociology. Although we identified a sizable number of explanations, we make no claim that our list is exhaustive.

Furthermore, the 'theories' outlined below vary widely in their composition and represent social levels of analysis ranging from the micro to the macro. For example, 'reinvention' is a concept relevant to individual use, and it primarily describes rather explains why the reinvention process occurs. Others, like structuration theory, a temporal theory of agency, and systems dynamics, are meta-theoretic treatises bordering on social philosophies. Still others, notably interaction theory and cumulative effects, are middle-range theories. Consequently, many of the explanations presented are not commensurable, which is unfortunate but probably to be expected given the immaturity of discourse in this domain.

We divided the explanations into four somewhat arbitrary categories. Theories in the 'IT design' category explain different patterns of use, and hence different patterns of consequences, in terms of the quasi-material features or 'affordances' of information technology. Theories in the 'user appropriation' category explain patterns of use in terms of human agency, specifically, how IT users reinvent, adapt, improvise, learn about, and act with information technology. The third category includes theories that emphasize complex interactions between technology use and other aspects of the organizational context of use, such as pre-existing tasks and routines, mental models, and concrete organizational structures such as reward systems. The last category includes theories that emphasize complex interactions between technology use and social systems including cultural belief systems and politics.

IT design

When use of IT results in unintended consequences, the first obvious explanation is to consider how well the technology realizes designers' or decision makers' intentions. If the technology lacks the features and functionality needed for desired outcomes (assuming that users use it as expected), the technology itself cannot be ruled out as a cause of unexpected outcomes. Put differently, unintended consequences may stem either from designers' failure to translate their goals into the design of an information technology or from decision makers' failure to select information technologies that meet their objectives.

The problematic link between design intentions and actual technology capabilities gives rise to the preponderance of IT practice and research. The field of information requirements analysis is devoted to the task of discerning the complete or 'real' objectives that IT developers should achieve. The field of information engineering seeks to ensure the reliable translation of requirements into working code. The fields of human–computer interaction and usability studies target IT features that allow human users to avoid errors and realize desired results.

Although most social scientists believe that IT itself does not *cause* IT use patterns and consequences, many social scientists and technologists believe that attributes of information technology (e.g. ease of use) can exert an *influence*, sometimes profound, on IT's use and consequences. A major proponent of the influential role of technology 'affordances' (i.e. what the technology enables users to do or hinders them from doing) is Donald Norman. Using analogies from everyday things, Norman (1990) explains that artefacts have attributes that suggest intended uses, such as the handle on a water pitcher, and that badly designed artefacts either lack required affordances or mislead users as to how they should be used. An example is a door that must be pushed yet has a handle suggesting the need to pull. Poor design may result from designers' ignorance or from a misplaced sense of aesthetics. In the information systems domain, the role of system features has been discussed by Markus (1984) and Griffith and Northcraft (1994).

An example of how the features of IT can shape patterns of use and promote unintended consequences can be found in Palen and Grudin's (2002) studies of electronic calendar use at Microsoft Corporation and Sun Microsystems. Electronic calendar systems vary significantly in their privacy default settings. The default setting on Microsoft's SCHEDULE+ system restricted the amount of calendar information that others could access; the default setting on Sun's Calendar Manager permitted everyone on the network to read the full contents of others' calendars. Consistent with other studies showing that users rarely modify the default settings on their IT systems, Palen and Grudin found that over 80% of users surveyed in each company maintained the default privacy settings. In addition, they found 'remarkable' differences in IT use patterns attributable to the default privacy settings.

Sun employees used the scheduling system, not just to schedule meetings, but also to learn what was going on in their organization. They could assess whether someone was in her office and whether she would need time to get back from a meeting across town. To schedule a group meeting, Sun employees would identify a possible time by inspecting attendees' calendars and suggesting a specific time to the others in a regular email message (although they could have used the calendar system itself to set up the meeting). By contrast, Microsoft employees checked others' availability then sent an automatic

SCHEDULE+ message with a proposed time. Recipients would then accept or decline the meeting with a keystroke, without a personal explanation. According to Palen and Grudin (2002), this hit-or-miss (and apparently blunt) approach evolved in response to the relative lack of information available in people's calendars. In light of this example, it is easy to see how the usage patterns shaped by IT features could give rise to unintended consequences.

User appropriation

In contrast to explanations of unintended consequences that reference the use of IT's features and affordances, some social scientists have focused on how and why people reinvent and appropriate technologies to serve their own needs and interests, regardless of designers' intentions. In this section, we discuss five theories that explain how or why people appropriate IT in unintended ways.

Reinvention: Everett Rogers popularized the concept of innovation reinvention by users in his classic work on diffusion of innovations (Rogers, 1995, first published in 1962). Most research on diffusion of innovations assumes that the object being adopted remains constant across adopters and the contexts of innovation use (Holmström and Stalder, 2001). However, Rogers and his colleagues (e.g. Johnson and Rice, 1987) used the term 'reinvention' to refer to the degree to which an invention is changed by its adopter after its original development. Thus, word processing can be reinvented in use to serve a variety of purposes that its developers did not imagine (Johnson and Rice, 1987). Database systems can be reinvented as electronic messaging systems by users (Kraut et al., 1989). Even data warehouses (Bashein and Markus, 2000) and ERP systems (Boudreau and Robey, 2003) can be reinvented by users. Because users develop an intimate familiarity with the features and limitations of computer applications, they may be in the best position to appropriate features for novel purposes. Rather than being constrained by technology's affordances and limitations, users find ways to 'work around' them. Workarounds and tweaks of infinite varieties are described in the research on reinvention.

For example, Boudreau and Robey (2003) found users of a new ERP system subverting the intentions of the system's time-out feature, which would automatically log off a user who did not interact with the system for a few minutes. Although users recognized that the time-out feature provided greater security, it limited their freedom to move away from their terminals during work. Users thus devised ways to reinvent the system by asking colleagues to simulate an action in order to prevent their being logged off. Rather than increasing security by shutting unattended workstations down, this practice ironically decreased security by allowed more eyes to view the user's transactions.

Improvisation and enactment: Research on reinvention is not generally insightful into the processes of *how* users appropriate technology to their own uses. Recent related work on improvisation, however, more carefully defines ways in which designs are altered to produce unanticipated consequences. Miner, et al. (2001) defined improvisation as 'the deliberate and substantive fusion of the design and execution of a novel production' (p. 314). This definition describes improvisation in jazz performance where improvised action requires the performer to fuse the composition of novel, coherent ideas with the execution of those ideas. When composition and execution are separated, performance simply executes the plan. Improvisation permits novel productions to be responsive to the immediate context while being grounded in preparation and familiarity with the materials of one's art. According to Ciborra (1999):

> Improvisation feeds upon a recollection and rearrangement of the past that may not coincide with the one planned… since it feeds upon the vision of the situation at the instant of occurrence, thus acknowledging the latest incoming events, interpretations and actions. (p. 89)

There are also different kinds of improvisation (Weick, 1998; Zack, 2000). In jazz, improvisation may involve 'maximal innovation that comes from improvising the entire composition spontaneously: its premise, its harmonic structure, its tonal language, and the actual sounds played' (Zack, 2000, p. 230). Analogously, improvised uses of information technologies could refer both to the radical departures from intended uses and more limited variations and embellishments of a plan (Weick, 1998). For example, Orlikowski (1996) viewed improvization as experimental use in which technological features are adapted and customized by the user to eventually produce new ways of working and organizing. In a longitudinal study of Lotus Notes used by a customer support department to track customer calls. Orlikowski identified three metamorphoses involving both deliberate and emergent changes that produced a variety of unanticipated outcomes. For instance, in the third metamorphosis members of the department had gravitated to such heavy use of the system that their face-to-face interaction decreased significantly. This unintended consequence of a system designed to increase collaboration arose due to the improvisations chosen by users as they interacted with the system.

Both the literatures on reinvention and improvisation tend to regard particular kinds of adaptations as desirable or even necessary (Johnson and Rice, 1987; Moorman and Miner, 1998). However, such evaluations come from particular actors' perspectives. Improvisations and reinventions that subvert safety and security features may benefit users in the short run while sowing the seeds of disruption in other actors' work lives (Boudreau and Robey, 2003). Weick's (1993) analysis of the Mann Gulch fire revealed both effective and ineffective improvisations, and Miner et al.'s (2001) study of product development teams revealed harmful effects of improvisation on long-term learning. As noted in our introduction, the evaluation of unintended consequences is clearly affected by whose intentions are being met and whose are not.

Orlikowski's (2000) practice lens offers a potentially useful perspective for studying unintended consequences of technology use. The practice lens incorporates improvisation as one of several possible 'enactments' of information technology. Orlikowski argues that 'every engagement with a technology is temporally and contextually provisional, and thus there is, in every use, always the possibility of a different structure being enacted' (Orlikowski, 2000, p. 412). She defines three types of enactment: *inertia*, *application*, and *change*. Inertia is associated with limited use of technologies, in which users either avoid using technology or engage in perfunctory usage. Application involves the augmentation or refinement of existing work practices in accordance with designers' intentions. Change occurs when organizational members substantially alter their existing work practices in ways that may not be intended, such as the improvisations with Lotus Notes described above. Orlikowski's theoretical propositions deal with the context and consequences for each level of enactment, providing valuable theoretical guidance to researchers seeking to explain unintended appropriations of technology.

Adaptive structuration theory: More formal attempts to understand appropriation and unintended consequences of IT use have drawn from structuration theory, which is covered in more general terms in our section on social-technical interactions. Adaptive Structuration Theory (AST) was formulated by DeSanctis and Poole (1994) to account for micro-level appropriations of information technologies that might deviate from designers' intentions. AST conceives of design intentions as the *spirit* of an IT application, that is, the properly envisioned patterns of use. However, actual patterns of use emerge from the actions of users who might appropriate an application *unfaithfully*, that is, in an unanticipated and unintended manner. In experimental studies using AST, researchers study appropriation *moves* that occur in the social context of use, showing how new structures (patterns of use) become established as a result of multiple users interacting (Poole and DeSanctis, 2004). In effect, AST draws attention to an initial structuring of technology in the process of application design, as well as subsequent structuring of technology in the process of use. In this way, the intentions of designers (and sponsors of application design, such as managers) are seen to result in design parameters, while the intentions of users are seen as variable appropriations of those parameters. Thus, AST offers a more complete theory of how unintended consequences emerge through use.

For example, Poole et al. (1991) studied the effects of group decision support systems (GDSS) on conflict in experimental groups. Their results showed that the effect of the GDSS depended on how the groups appropriated the technology.

> Of the thirteen GDSS groups, six adapted the system in ways that produced impacts that should promote productive conflict management, and seven adapted it in ways that should inhibit productive conflict interaction process or lead to no net benefit. The results of the study support our basic framework, which posits that GDSSs do not directly determine conflict interaction or outcomes. Rather group use of the technology mediates its impact. (Poole et al., 1991, p. 948)

Such results have been supported in a large number of other experimental studies, and AST has also served as a template for understanding technology use in field settings (e.g. Maznevski and Chudoba, 2000).

Communities of practice/situated learning: Another 'appropriation' theory explains unintended outcomes as the result of learning situated in communities of practice. Designers' intentions are often communicated to users in the context of formal training programmes. However, after systems are moved into the social context of practice, learning continues in an informal manner, situated in practice. Lave and Wenger (1991) described situated learning as the view that 'learning is an integral and inseparable aspect of social practice' (p. 31).

Learning from trusted colleagues who understand the details of practice has been (relatively) formalized into a theory of communities of practice (Wenger, 1998). A community of practice is an informal aggregation of individuals engaged in common enterprise and who interact and share interpretations of the technology (Brown and Duguid, 1991; Lave and Wenger, 1991; Wenger, 1998). Communities of practice theory views learning as a process of social participation in which members interact with more experienced members who share tacit knowledge through direct contact (Lave and Wenger, 1991; Orr, 1996). In this way, each community of practice develops a local set of practices that reflect its shared knowledge, values, and beliefs (Brown and Duguid, 1991). For example, George, Iacono and Kling (1995) demonstrated the importance of the social context in their longitudinal study of desktop computing. They found that professional workers learned through their own grassroots computing efforts and resisted the more formal learning opportunities offered by the firm's systems professionals. George and his colleagues concluded that learning often occurs without formal sanctions and may operate independently of formal training. Thus, users may learn practices that were unintended.

Because actual work practices differ fundamentally from the way that organizations describe their operations in manuals and training programmes, situated learning may account for unintended consequences of using technologies. In Brown's (1998) study of work practice at Xerox, for example, situated learning was specifically acknowledged in the author's call to leverage the different uses of Internet technology to support the organization's communities of practice. From this perspective, technical knowledge can be seen as a distributed social resource, transmitted primarily through conversations in the same physical place (Tyre and Hippel, 1997), but situated learning can also occur within virtual teams (Robey et al., 2000). For example, Robey and his colleagues (2000) reported that members of distributed work teams devised 'local' practices though communication media that allowed work coordination across geographic and functional boundaries. Although not located in the same place, team members appropriated the IT tools at their disposal to effect coordination. Thus, members of any community may develop uses of technology that deviate substantially from designers' intentions.

Temporal theory of agency: Human agency is a generalized concept for how people use information technology. Emirbayer and Mische (1998) offered a general theory of human agency by framing agency as a human capacity that is simultaneously oriented toward the past, the future and the present in every given moment.

> The key to grasping the dynamic possibilities of human agency is to view it as composed of variable and changing orientations within the flow of time. Only then will it be clear how the structural environments of action are both dynamically sustained by and also altered through human agency – by actors capable of formulating projects for the future and realizing them, even if only in small part, and with unforeseen outcomes, in the present. (p. 964)

Emirbayer and Mische (1998) conceptualized agency as three elements which enable human actors to shape their responses to situations. The 'iterational' element is oriented to past practice in which actors attempt to situate their thoughts about action in terms of familiar routines. The 'projective' element looks to the future, invoking possibilities for new patterns of action. The 'practical–evaluative' element is the human capacity for making judgements in the present context of emerging demands, dilemmas and ambiguities (p. 971). Thus, choices of action in the present are simultaneously influenced by consideration of past practices and future possibilities. These choices are the result of 'a dialogical process by and through which actors immersed in temporal passage engage with others within collectively organized contexts of action' (p. 974).

The main implication of this view of agency for technology use is that actors' engagements with technologies are simultaneously oriented toward the past, future, and present. Although technologies may engage the iterational element of agency and constrain present action, they may also engage the prospective element and evoke novel actions. As part of their practical–evaluative dilemma, human agents must choose between familiar practices that are no longer required and new practices. From the temporal perspective of agency, therefore, it is difficult to predict users' response to new technologies because the intention of designers is only one of many considerations that users take into account when deciding what action they will actually take.

To illustrate, Boudreau and Robey (2003) used Emirbayer and Mische's theory to explain users' enactments of a newly implemented ERP system. Faced with a mandate to use the system, users initially relied upon their past practices and successfully resisted using the new system. For example, instead of interacting directly with the system, many users printed forms off screens, filled them in manually and sent them to the accounting department for data entry. This behaviour was certainly not intended, but it was sanctioned. The period of inertia in users' practices corresponds with the iterational element of agency, which looks to past templates for current behaviour. Over time, however, users improvised ways to learn how to use the system, in part to compensate for the failure of the formal training programme. Improvised learning represents the projective element of agency, which enabled users to operate the system, but again not in the ways intended by the project's leaders. Rather, as noted earlier, users reinvented the ERP system by enacting practices that in some ways jeopardized system performance.

Complex interactions – mental models and tasks

Our third and fourth categories of theories look beyond technologies and IT use patterns to complex interactions between the IT use and other aspects of the context of use, such as the tasks people perform, the practices by which organizations reward them, cultural belief systems, and organizations' political systems. Both sets of theories are more 'macro' in orientation than the IT design and user appropriation theories. The theories in this section arise primarily from psychological, engineering, and socio-technical perspectives; the following section addresses sociological theories.

Interaction theory and misfits: Perhaps the best-known early theoretical analysis of IT impacts is Kling and Scacchi's (1982) 'web of computing'. This article explained the unintended impacts of IT in terms, first, of the many elements that comprise a complete IT 'package' (e.g. hardware, software, peripherals, support), and, second, in terms of those aspects of the social and organizational context that intersect with the web of IT. The complexity of the interactions between IT and the context of use give rise to numerous 'recurrent dilemmas' (Kling and Scacchi, 1979), in which unforeseen patterns of IT use (e.g. 'workarounds', cf. Gasser, 1986) develop and unanticipated consequences emerge. By focusing on the larger context of IT use, this theory differs from the micro-level theories of reinvention and appropriation described in the preceding section.

In subsequent treatments, the intersections between the computing package and the context of use were formalized as 'interaction theory' (Markus, 1983). Consequences other than those expected by designers and decision makers were traced to interactions between systems and the tasks users perform, aspects of organizational culture, and aspects of the political system, particularly rewards and incentives. For example, when a large organization introduced an office space management system that ranked offices according to square footage per employee (less was better), the organization soon discovered that the reported number of employees exceeded the actual payroll by several thousand (Markus, 1984). Rather than taking the number of employees directly from payroll records, implementers of the system had asked the office managers to supply the number themselves. But, fearing organizational sanctions for lower than average performance on the space management ranking, office managers counted part-time employees, positions approved but not filled, staff on leave, etc. The inflation in the reported number of personnel was an unintended consequence of interactions between the system and the organization's management and control systems.

Researchers continue to observe unintended consequences resulting from lack of fit between systems and the organizational context of use. For example, studies of ERP systems used in national cultural contexts different from those for which they were originally designed showed numerous instances of 'misfits' (Soh et al., 2000) and unexpected 'visibility' benefits that were quickly exploited (Sia et al., 2002). As ERP systems are rolled out into public sector organizations, such as universities, similar misfits have been noted between the occupational assumptions and practices of research faculty and modern business assumptions and practices embedded in the software (Scott and Wagner, 2003).

Systems dynamics: Theories of 'systems dynamics' have long attempted to explain the failure of complex systems to achieve their intended consequences. Kurt Lewin's (1951) classic explanation for the failure of change was formulated in terms of supporting and restraining forces. If the forces inhibiting change outweighed the forces promoting change, either the current situation would remain the same or the situation would change but fail to achieve the intended outcomes.

Enabling and restraining forces were more extensively articulated in general systems theory (Bertalanffy, 1969; Miller, 1978) and industrial dynamics (Forrester, 1961), which applied systems theory to a business context. The three basic principles of systems dynamics are that structure (including human decision making) determines system behaviour, that the structure of organizational systems often involves 'soft variables' (such as perceptions), and that the behaviour of industrial systems can be changed by understanding decision makers' mental models of the system and changing them (Dutta and Roy, 2002).

Lewin's enabling and restraining forces were revisited by Senge (1990), who reinterpreted lack of change owing to a balance of opposing and facilitating forces as 'limits to growth', one of several systems dynamics archetypes. According to Senge, the limits-to-growth archetype involves a cycle of positive or reinforcing growth that is balanced by a negative feedback loop once a certain limiting condition is reached. At that point, growth may stop or even reverse, leading to collapse. An example of the limits-to-growth archetype is the temporary collapse of AOL in the mid-1990s, when the Internet service provider switched to flat rate pricing (Dutta, 2001). The rapid growth in the customer base increased demand for service, which degraded service and caused customers to defect in droves.

Among the other systems dynamics archetypes (Senge, 1990) are:

- 'The balancing process with delay', in which people over- or under-correct the situation because they cannot see immediate results of their actions.
- 'Shifting the burden', in which a short-term solution initially seems to correct a problem, leading people to over-rely on it, neglecting the longer-term solutions that would eliminate the problem.
- 'Eroding goals', a version of 'shifting the burden' in which the short-term solution to the problem is to adjust goals downward.
- 'Escalation', in which two people or organizations aggressively outdo each other, leading to a situation which neither desires (e.g. hypercompetition).

- ‘Success to the successful’, in which one party’s success grows at the other’s expense.

- ‘Tragedy of the commons’, in which individuals overuse a commonly available resource until it is depleted, leading to intensification of effort and further decline.

- ‘Fixes that fail’, in which a solution that is effective in the short term has unforeseen long-term consequences that require more of the same fix.

- ‘Growth and underinvestment’, in which the limits to growth could be eliminated by aggressive and rapid investment which are often not made leading to lowered goals and expectations and poor performance which promotes continued underinvestment.

Systems dynamics and, in particular, the ‘vicious cycles’ created by positive feedback (Masuch, 1985), have been used to explain the unintended consequences of externally induced innovations such as new safety regulations (Marcus, 1988), organizational restructurings such as business process re-engineering (McKinley and Scherer, 2000), and implementation tactics in ERP implementations (Akkermans and van Helden, 2002). Marcus (1988) studied the effects of new safety practices in the nuclear power industry after the Three Mile Island accident. He found evidence of vicious cycles in which prior poor performance promoted ritualistic adoption of new practices, which actually perpetuated poor performance. By contrast, higher performing organizations adapted the innovations to their local conditions, leading to enhanced performance. Similarly, McKinley and Scherer (2000) argued that organizational restructuring produces the unintended consequences of increased environmental turbulence and ‘cognitive order’ (closure, reduction in uncertainty) in executives. These outcomes encourage executives to continue restructuring in a vicious cycle, at least until some limit is reached such as concern for organizational welfare. In a case study of an ERP implementation, Akkermans and van Helden (2002) observed a reinforcing feedback loop between increased interdepartmental communication and increased interdepartmental cooperation. Promoting and sustaining this loop were critical success factors such as top management support, improved project management, and project team competence. Akkermans and van Helden concluded that the implementation success factors identified in the IS literature are not additive in their influence on project outcomes; instead they interact in unpredictable ways, intensifying or mitigating their impacts. These systems dynamics offer many valuable insights into the unintended consequences of IT use.

Cumulative effects: In systems dynamics theories, the factors producing unintended consequences are systemically related. In cumulative effects theories, by contrast, some factors contributing to unanticipated outcomes may be independent of each other. For example, Perrow (1983) argues that accidents involving high-risk technologies such as nuclear power plants are normal, if often unexpected, owing to technological complexity and tight coupling among subsystems. Independent sources of failure can arise simultaneously in technologically complex systems, and the inevitable limits to human knowledge of these systems militate against successful corrective action.

For example, in the Hubble telescope fiasco, Capers and Lipton (1993) identified numerous occurrences and errors, many of them independent of each other. For example, when workers discovered that a band of glass had fused to interior slats, they tried to cut off the fused glass, inadvertently leaving grooves. Later, an inspector discovered unrelated fissures that had to be drilled out. These problems delayed the project making it harder for the contractor, who had underbid the project, to succeed. Workers were forced to work overtime, and their exhaustion probably contributed to a polishing error that dug a groove near the inside of the mirror. Subsequently, a critical measurement was off when a laser hit the one small spot where paint intended to eliminate reflections had worn away. Because of impending deadlines, a shaping problem was corrected with garden-variety tap washers. These and myriad other small problems stemmed from and interacted with the management systems put in place to govern the project. The end result was the delayed launch of a $1.5 billion telescope that did not work as planned.

Similarly, many computer-related risks have multiple causes, sometimes correlated but sometimes independent (Neumann, 1995). Bashein, Markus and Finley (1997) argued that, contrary to conventional wisdom, risks in large IT projects such as ERP system implementations and data warehousing projects may actually *increase* after development projects are completed, owing to the need for system enhancements, integration with other systems, and expansion to new communities of users. Similarly, in their theory of ERP implementation success, Markus and Tanis (2000) argued that failures can result from the interaction of several independent causes, including poor execution of a particularly activity (e.g. project management), unfavourable external events (e.g. economic crises), and conditions inherited from an earlier activity (e.g. overly ambitious project goals). In a first step toward an integrative theory of IT risk control, Markus (2000) identified ten possibly independent categories of IT-related risks: financial risk, technical risk, project risk, political risk, contingency risk (e.g. accidents), the risk of non-use, underuse or misuse, internal abuse (e.g. fraud), external risk (e.g. cracking, denial of service attacks), competitive risk (e.g. competitors' responses), and reputational risk (e.g. public reactions); and nine types of risk control mechanisms: plans, policies, operational controls, automated controls, physical controls, audit and detection, risk awareness, belief systems, and social systems. The potential for unintended interactions resulting from combinations of these disparate elements is quite high.

Complex adaptive systems theory: In the organizational sciences, there is increasing interest in complexity theories as a way to explain complex, non-linear organizational behaviour in a way that complements, rather than replaces, ordinary linear causal models (Anderson, 1999). Complexity theories can help distinguish order in apparently random behaviour (Dooley and Van de Ven, 1999). Complex adaptive systems theory, a descendant of general systems theory and systems dynamics, is concerned with the non-linear results of human and social actions (Anderson, 1999). Catastrophe theory and chaos theory (Thietart and Forgues, 1995) are, like general systems theory, concerned with the *deterministic* interactions among *variables*; complex adaptive systems theory, on the other hand, is concerned with *emergent* interactions among autonomous *individual agents* (individuals or organizations) (Anderson, 1999).

The distinctive characteristic of complex adaptive systems theory is that order at a higher level of analysis emerges from individual interactions at a lower level of analysis (Anderson, 1999). This is in contrast to typical causal models in which the independent and dependent variables are at the same level of analysis. For example, the complex interactions among individuals in an organization can result in ordered aggregate behaviour patterns such as self-reinforcing success and failure or sudden failure after a long period of success. According to Anderson (1999), complex adaptive systems theory has four key elements.

- Autonomous agents, such as individuals or organizations, with 'schemata' or decision rules that govern their behaviour. The schemata or rules may evolve over time and differ from agent to agent; there may even be competing schemata and rules within individual agents, as when concerns with short-run stock prices conflict with concerns about long-term organizational growth.

- Self-organizing networks sustained by the importation of energy. Self-organization means that order and regularity can emerge from the interactions of individuals without the intervention of centralized authority or control. An example is the evolution of 'tit-for-tat' norms in repeated prisoners' dilemma games. Systems are believed only to self-organize in the presence of repeated inputs of energy from the environment. As an example, organizational managers are often observed to 'shake up' their organizations through interventions such as reorganizations and the introduction of IT systems in order to avoid organizational decline in the face of environmental change. In complexity theory terms, the problem of organizational change is to maintain organizational behaviour within upper and lower bounds because performance decays below the lower boundary, whereas chaos ensues above the upper boundary.

- Co-evolution of system and environment up to the edge of chaos. Complex adaptive systems theory is concerned with how agents adapt to and influence their evolving environments. In doing so, agents create a dynamic equilibrium that differs from the self-correcting equilibrium of cybernetic systems. In the dynamic equilibrium of complex adaptive systems, small changes in agent behaviour can result in non-linear (e.g. small, medium, or large) impacts on the higher-level system; dynamic equilibrium is believed to give complex adaptive systems a selective, but temporary, advantage. The key to sustained success then becomes continuous improvisational adaptations.

- System evolution based on recombination. Complex adaptive systems evolve by replacing agents and changing or modifying schemata. New employees are hired to replace poor performers; software is 'enhanced' to respond to changing legislation or business practices; components of IT infrastructure are substituted as older technologies become obsolete and higher performing products become available. The accretion of many small changes alters the trajectory of system evolution.

Complex adaptive systems theory has yet to be applied to understand IT use in any systematic way. However, it has great potential to explain the unintended outcomes of IT interventions. The four principles summarized above can explain how apparently revolutionary changes in IT and business processes may result in small changes in business performance and how relatively small changes in technology and/or organization can yield big performance improvements. They can also explain how small differences in starting conditions or implementation strategies can yield very different results (as dramatic as success versus failure) in similar organizations implementing apparently identical technologies. In addition, they can also explain how today's IT intervention can become tomorrow's legacy system in the absence of ongoing investments in 'recombination'.

Complex interactions – social and technical

The previous section discussed theories of complex interactions that reflect psychological, engineering, or socio-technical perspectives. The theories of complex interactions addressed in this section are more macro in orientation and sociological in origin.

Functionalism: Attempts to explain social behaviour in terms of the functions the behaviour serves for the social group were popular among sociologists in the 1940s through 1960s (Abrahamson, 2001). 'Functionalism' eventually came under attack, because, when functions are understood as outcomes that people hope to achieve, functional explanations degenerate into simple teleological or goal-seeking explanations. In teleological explanations, the outcome is explained by people's desire to achieve that outcome – an explanation that many analysts believe to be simplistic and reductionist (Elster, 1983). Despite these criticisms, some noted social scientists believe that *good* functional explanations play an important role in the explanation of unintended consequences (Stinchcombe, 1968; Douglas, 1986).

What is a good functional explanation? According to Stinchcombe (1968), functional arguments have three main elements: first, a 'structure' or pattern of behaviour that is to be explained; second, the consequence of that behaviour pattern that is maintained by means of a feedback loop from the consequence back to the behaviour; third, forces that threaten to destabilize or change the behaviour pattern. In this formulation, functionalism is similar to the 'limits to growth' archetype of systems dynamics. Elster (1983) articulated the conditions that must be satisfied if a functional explanation is to avoid degenerating into a teleological explanation. According to Elster, a behaviour pattern can be persuasively explained by its function for a social group if and only if:

- The function is actually a *consequence* of the behaviour pattern.
- The function is *beneficial* for the social group.
- The function is *unintended* by the social group – in other words, the function is not a goal that people were attempting to bring about by their behaviour; instead the function is a by-product of people's attempts to achieve some *other* goal.
- The function (or at least the causal feedback loop between the behaviour pattern and the function) is *not recognized* by the people (otherwise, it would be difficult to rule out an explanation in terms of goal-seeking behaviour).
- The function maintains itself by a causal feedback loop that 'passes through' the people in the social group – in other words, whereas the function can be said to be property of the group, it is a by-product of *individual* actions.

Elster was a critic of functionalism. He claimed that few examples of good functional explanations could be found, so he rejected them as inappropriate for the social sciences (Elster, 1983). His chief objection was that he could find no social science analogue to the feedback loop of natural selection that is so important in the functional explanations of biology. He also complained that the function 'does not stay the same' in social science explanations but varies from explanation to explanation, unlike the function of reproductive advantage, which is invariant in biological functional explanations.[2]

Elster's challenges were taken up by Stinchcombe and Douglas. Rebutting Elster's first criticism, Stinchcombe (1968) described several 'social selection' processes by which the feedback loops in functional explanations might operate while still meeting Elster's other conditions:

- The behaviour is selected by the differential survival of social groups that perform that behaviour.
- The behaviour is selected by people who plan to get beneficial consequences of that behaviour (other than the function itself).
- The behaviour is maintained by people because they find its consequences (other than the function) satisfying, even through they did not plan to achieve these consequences.
- The behaviour has pleasant consequences for other people who reward those who engage in it.
- The conditions governing the behaviour rewarded by others are controlled by those who engage in it.

Douglas (1986) countered Elster's (1983) objection that there are few examples of good functional explanations in the social sciences. In particular, she outlined a powerful theory of how latent groups survive, closing an important gap in economic theories of cooperation and conflict, and showed how her theory met all of Elster's criteria. She noted that the functions employed in social functional explanations are often beliefs or thought systems akin to Senge's mental models (Senge, 1990). Whereas Douglas agreed with Elster that the functions vary from one social functional explanation to the next, she argued that the *reason the function is beneficial* often does not vary: the benefits of a thought or behaviour pattern to a group often derive from the fact that the behaviour pattern contributes to the preservation of the group. Douglas

2. Elster's criticisms are similar to Mohr's (1982) criticisms of explanations of organizational behaviour based in individuals' motivations.

also pointed out that, whereas people may like or desire the benefit of the function (e.g. group survival), they may not like or desire the function itself (in the case of Douglas' theory, belief in an evil conspiracy). Therefore, in many functional explanations, people cannot be argued to intend the function (thereby avoiding degeneration into teleology), and they may remain unconscious of the function and its links to their behaviour (thereby addressing one of Elster's key conditions). In this way, Douglas showed how behaviour intended to achieve one goal may achieve that goal but also have undesirable consequences that people are powerless to change. Thus, good functional explanations are potentially very useful in explaining the unintended consequences of IT use patterns.

An example of such an explanation can be found in Markus (1995). In a case study of managers' use of electronic mail, Markus argued that managers used email intensively in order to achieve efficiency benefits. Using email in this way required much effort and adaptation because email has certain deficiencies that must be overcome, e.g. the absence of social cues. (This satisfies Stinchcombe's condition of destabilizing forces.) Through their email use behaviour, people enacted a function – belief that email was the primary medium of communication in the organization. Although this function was beneficial for the managers in achieving the intended efficiency benefits, it also had negative social consequences such as depersonalization. Because the function was beneficial, people acted in ways that preserved the belief that email was their primary communication medium (for example, by answering phone messages via email) – this was the feedback loop that involved individual behaviour. At the same time, people in the organization remained largely unaware of the behaviour patterns they had created and how those patterns contributed to the unintended negative consequences, which could not be disconnected from the benefits.

Actor network theory: Actor network theory (ANT) (Walsham, 1997; Jones, 1999) regards human and material 'actants' as symmetrical influences within social networks. Material agency thus operates on equal footing with human agency. ANT has become increasingly attractive to researchers studying IT's consequences in use (Walsham, 1997; Walsham and Sahay, 1999; Jones, 2000). According to ANT, human and non-humans actors are linked together in a web of relationships, referred to as an actor network. Within an actor network, the interests of various actors are *translated* and *inscribed* into technical and social arrangements. Translation is the process of negotiation whereby actors assume the authority to act and speak on behalf of other actors (Callon and Latour, 1981). Inscription is the process whereby technical objects are treated as a programme of action that coordinates a network of social roles. Actor networks may stabilize, at least temporarily, with non-human artefacts serving as delegates for particular interests, authorized to 'stand in' or 'speak for' human actors (Bloomfield et al., 1997). In effect, software routines in IT applications can become 'frozen organizational discourse' (Bowker and Star, 1994, p. 187), or inscriptions of social interests that are embedded in computer software and display properties of irreversibility (Walsham, 1997).

Despite such stabilization, actor networks may continue to change as new actors bring new social agendas into play. As Callon (1987) argued, the actor network 'is composed of a series of heterogeneous elements, animate and inanimate, that have been linked to one another for a certain period of time … The entities it is composed of, whether natural or social, could at any moment redefine their identity and mutual relationships in some new way and bring new elements into the network' (p. 93). This ability of actor networks to destabilize offers a potential insight into the occurrence of unintended consequence of using IT. For example, Scott and Wagner (2003) employed ANT in a longitudinal study of the negotiations surrounding the implementation of an ERP system in the administration of a university in the US. The ERP project was intended to set new global standards for academic administration, but this goal (shared by a coalition of the ERP vendor and a new vice president recruited from the business world) was deflected by faculty members managing prestigious research projects using traditional accounting practices. As a result of several 'trials of strength', the project took on unintended side effects that established conditions for subsequent controversies. ANT served as a valuable theoretical lens owing to its treatment of both technological and human agency and its capacity to incorporate temporal dimensions of IT development, use and consequences.

ANT's focus on the interplay between human and material actors makes it a valuable theoretical lens for understanding unintended consequences of IT. As Jones (1999) argued, human and material actors operate in emergent fashion, each mutually affecting and transforming the other. 'The particular trajectory of emergence is not wholly determined either by the intentions of the human actors or by the material properties of technology, but rather by the interplay of the two' (p. 297). Thus, ANT draws attention to specific processes of development and use and to the mutual engagement of human and material actors.

Dialectics

Robey and Boudreau (1999) offered dialectical 'logic of opposition' as a general strategy for theorizing about the diversity of outcomes of information technologies in organizations. A logic of opposition explains organizational change by focusing on opposing forces that simultaneously promote and oppose social change. A contrasting 'logic of determination' explains change as the result of the presence of specific predictors. A logic of opposition potentially explains a wider range of organizational outcomes than deterministic logic because it poses change as the result of the interplay between opposing forces, none of which is able to determine outcomes. In this sense it is similar to systems dynamics except at a more macro level. Robey and Boudreau identified four theories, sometimes used in IS research, that employ a logic of opposition: organizational politics, organizational learning, organizational culture, and institutional theory. We restrict our illustration here to a consideration of organizational politics.

Political theory uses opposition as the underlying mechanism for explaining social change (Benson, 1977). Organizations are regarded as arenas in which the interests of multiple stakeholders are often misaligned (Bacharach et al., 1996), producing tensions and energy to change the status quo. However, attempts by one set of stakeholders to change are likely to be opposed by other stakeholders. In most political scenarios, each stakeholder has some ability to influence others instead of being completely dominated. Thus, the outcomes of proposals for change often involve compromises to original agendas. In terms of unintended consequences, users' political resistance can thwart managers' visions of the future and shape the outcomes of technology initiatives so that intentions are not completely realized.

Laudon's (1974) analysis of computing in urban public bureaucracies provides a good example of how unintended consequences result from political opposition. Computers were introduced in public administration in the US during the 1960s and 1970s with the intention that at least some policy makers would make public decision processes more participative. However, the promise of reform was dissuaded by powerful interest groups that viewed computers as a resource to reinforce their political power (Danziger et al., 1982). Thus, rather than supporting more democratic debates over public policy with computer-generated analyses, automation in local governments was used to support established political positions.

Structuration theory: Giddens' (1984) theory of structuration recognizes that the actions of knowledgeable and intentional humans are enabled and constrained by structures, but that structures are produced and reproduced through human action. As Roberts and Scapens (1985) noted:

> Through being drawn on by people, structures shape and pattern (i.e. structure) interaction. However, only through interaction are structures themselves reproduced. This is the 'duality of structure'; it is in this way that structures can be seen to be both the medium and the outcome of interaction. (1985, p. 446)

Structure is understood to be an abstract property of social systems, not something concrete or physical. Thus, social systems do not 'have structures' but rather exhibit structural properties that are produced and reproduced through the human interaction. That is, structures exist only when human agents allow their actions to be constrained by these abstract properties. Social structures thereby condition social practices by providing the context that allows human agents to guide their own actions. Structural properties established by prior human action thus define and shape individuals' intentions and their interaction, which in turn reproduces structural properties. Put simply, structuration theory recognizes that 'man actively shapes the world he lives in at the same time as it shapes him' (Giddens, 1982, p. 2).

Giddens suggests that all human interaction is inextricably composed of structures of meaning, power, and moral order, and he specifies three 'modalities' that link action and social structure: *interpretive schemes*, *resources*, and *norms*. Orlikowski and Robey (1991) analysed the role of information technology in each of these modalities.

Interpretive schemes are shared stocks of knowledge that humans draw upon to interpret behaviour and events. Interpretive schemes 'form the core of mutual knowledge whereby an accountable universe of meaning is sustained through and in processes of interaction' (Giddens, 1979, p. 83). According to Orlikowski and Robey (1991), information technology facilitates a means of representing the interpretive schemes through which users come to structure and understand their world. For example, software can be seen as an interpretive scheme for translating human action into routines. As such, software conditions certain social practices, and through its use the meanings embodied in the technology are reinforced or changed over time.

Resources are the means through which social power is exercised and the structural elements that constitute systems of domination. All social systems are marked by an asymmetry of resources, and the existing structure of domination is reaffirmed through the use of resources. When the existing asymmetry is challenged through human action, the existing structure of domination may change. Orlikowski and Robey (1991) regard information technology as a resource that formalizes information processing in organizations and enables human agents to process information. Thus, information technology affects the distribution of information resources and constitutes a system of domination.

Norms are the rules defining appropriate conduct and legitimate activities within a social system's moral order. Codes for legitimate conduct are generated by the ongoing use of sanctions in social interaction, and established norms comprise structures of legitimation. Norms reinforce social order through traditions, rituals, and socialization. Orlikowski and Robey (1991) observe that information technology enables the formalization of sanctions and the institutionalization of moral order. By codifying norms, information technology helps to constrain behaviour and establish a system of acceptable actions, interests and practices. 'The norms embodied in the information technology constitute a moral order, a system of legitimation that directs action and thinking along prescribed paths, and encourages appropriate responses, shared meanings, and common interaction protocols' (Orlikowski and Robey, 1991, p. 156).

Taken together, these linkages determine how the institutional properties of social systems constrain deliberate human action and how human action constitutes social structure. Giddens calls this linkage the process of structuration.

Structuration theory was employed by Orlikowski (1992) to reveal simultaneous positive and negative effects of CASE tool use in a systems consulting organization. CASE tools were intended to, and did, increase the effectiveness of system developers by encapsulating standardized work routines. Simultaneously, however, CASE tools fostered a 'trained incapacity', whereby systems consultants were unable to perform development work without the CASE tools. Orlikowski's structurational model of technology supports a dialectical understanding of the relationship between IT and organizations, which is 'inherently contradictory' in the model (1992, p. 412).

With its emphasis on social structures that enable and constrain human action, structuration theory appears to be most useful in analyzing intended uses of information technology. However, because the theory draws attention to human agency that produces structures through action, it is also useful in explaining unintended use. Social structures do change as a result of human agency. Structural changes may be attributed to designers' intentions, but other actors may also introduce unplanned interactions that become responsible for structural change. Structuration theory thus accommodates, albeit at a very abstract level, the analysis of unintended outcomes of information technology use.

Summary and conclusions

In this chapter, we reviewed a variety of theories capable of explaining the unintended consequences of IT use, regardless of whether they were developed for that purpose. We grouped the theories into four categories:

1. theories that explain unintended consequences in terms of the design features and affordances of IT,
2. theories that explain unintended consequences in terms of human agency and appropriation, that is, how IT users reinvent, adapt, learn about, and act with IT,

3 theories derived from psychology, engineering, and socio-technical systems that emphasize the complex interactions between IT and the contexts of IT use, and

4 theories of complex interactions derived from various branches of sociology.

(See Table 6.1 on page 90 et seq for a summary and comparison of the theories.)

The limitations of our exposition are several. First, the list is undoubtedly incomplete. A number of economic theories, not reviewed here, also address unintended consequences and could be applied to the context of IT use. Second, our treatment of so many theories at the same time necessarily emphasizes breadth, at the expense of depth. Such cursory treatment might promote inappropriate use of the theories. It is important to note that the theories are not commensurable. They engage different levels of analysis (sometimes more than one). They emerged from different disciplinary traditions with varying concepts and philosophical assumptions, and hence are neither easily combined nor substituted for each other. Some of the theories have engendered considerable controversy in their respective disciplines, and so should not be regarded as legitimate and accepted by all.

What is the value of our brief tour of many different potential explanations of the unintended consequences of IT use? The IS community today is beginning to demonstrate an awareness of the importance of design science and design theories to the field (Walls et al., 1992; March and Smith, 1995; Markus et al., 2002; Gregor and Jones, 2003). Loosely speaking, design science is a generalized body of knowledge for the practical guidance of designers. A design theory for a particular design problem may include 'kernel theories' – academic theories or practitioner theories-in-use (Sarker and Lee, 2002) – that hypothesize means-end connections between methods and outcomes and between design features and impacts when the artefact is used. Because design is a normative activity in which designers attempt to bring about certain desired ends, knowledge about the situations in which the actual outcomes differ from those intended is surely of central importance to designers. Thus, it is vitally important to the IS field to develop our collective understanding how, why, and when IT artefacts have, or do not have, their expected ends. Only then will we have a secure basis from which to improve practice.

This chapter is a first, small step in the direction of an integrated theory of the unintended consequences of information systems. Much work remains to be done in this sadly neglected area of IS research. Considerable IS research has been devoted to explaining why people and organizations use (or do not use) IT and to demonstrating a link between IT use and its *intended* business and economic outcomes. But few studies have examined the links between IT use and outcomes that were *unintended, unexpected or unwanted*. Although a number of IS studies have reported unintended consequences in passing, the topic has received no *systematic* study. Research suggests that unexpected or unintended consequences of IT use are common (Bjørn-Andersen et al., 1986), but their relative absence from the literature implies that we IS researchers believe they are rare. We hope that our efforts will stimulate new IS research on this vitally important topic.

Table 6.1: Explanations of unintended consequence

Explanation	Source discipline	Sample references	Key arguments	IT-related illustrative example
			IT design category	
IT design	Human–computer interaction	Norman (1990) Griffith and Northcraft (1994)	Unintended consequences result from IT design features that do not fully reflect designers' or clients' intentions.	Users of electronic calendar software exhibit different unintended behaviour patterns related to software defaults (Palen and Grudin, 2002).
			User appropriation category	
Reinvention	Communication Diffusion of innovations	Rogers (1995) Johnson and Rice (1987)	Users work around technology limitations and find new uses for technologies. Unintended outcomes result from these reinventions.	Users subvert the security features on an ERP system by enlisting colleagues to simulate operations while the primary user is absent (Boudreau and Robey, 2003).
Improvisation and enactment	Organizational behaviour, Information systems	Weick (1998) Orlikowski (1996)	Unintended consequences occur naturally as IT is used. Users capitalize on unplanned consequences by making more planned changes, triggering yet another cycle.	Users of Lotus Notes improvise uses over time, resulting in unintended reductions of face-to-face contact among co-located team members (Orlikowski 1996).
Adaptive structuration theory	Information systems	DeSanctis and Poole (1994)	Designers' intentions are realized in IT design parameters. Users do not always act faithfully to the spirit of an IT application, leading to unintended consequences.	Experimental subjects use GDSS to manage conflict in different ways (Poole et al., 1991).

Table 6.1: Explanations of unintended consequence (continued)

Explanation	Source discipline	Sample references	Key arguments	IT-related illustrative example
Temporal theory of agency	Sociology	Emirbayer and Mische (1998)	The intentions of designers are only one of users' considerations as they interact with technology; others include past practices and future plans. Unintended consequences emerge from actors' simultaneously past-, present-, and future-oriented engagements with technology.	Users of a newly implemented ERP system successively enact inertia, then reinventions of the system, illustrating the shift from iterative to prospective elements of agency (Boudreau and Robey, 2003).
Communities of practice/situated learning	Sociology	Lave and Wenger (1991) Brown and Duguid (1991) Orr (1996)	Conditions in work settings diverge fundamentally from procedure manuals and other descriptions on which IT designs are based; thus IT artefacts cannot be used as designers intend. Unintended consequences stem from shared informal learning that emerges in practice as IT is used.	Professional workers learn through their own grassroots computing efforts and resist the more formal learning opportunities offered by the firm's system professionals (Georgee et al., 1995).
		Complex interactions – mental models and tasks category		
Interaction theory and misfits	Computers and society Information systems	Kling and Scacchi (1982) Markus (1983)	Unintended consequences stem from misfits between an IT application and important aspects of the organizational context of use, such as the task, the culture, or the political system.	Users of ERP systems in other national cultures from those for which the technology was developed cannot use the technology as intended and must develop workarounds (Sia et al., 2002) leading to a failure to achieve desired outcomes.

Table 6.1: Explanations of unintended consequence (continued)

Explanation	Source discipline	Sample references	Key arguments	IT-related illustrative example
Systems dynamics	Cybernetics Systems theory Management	Forrester (1961) Senge (1990)	Unintended consequences stem from the dynamics of complex industrial and organizational systems, including the role of soft variables such as perceptions and mental models. Many 'wicked' problems/success stories can be traced to vicious/virtuous cycles that people are often unable to recognize.	Implementation success factors are not additive; a reinforcing loop was observed between increased interdepartmental communication and increased interdepartmental cooperation in an ERP system implementation; the loop was supported by other success factors (Akkermans and van Helden, 2002).
Cumulative effects	Organizational behaviour Risk management	Perrow (1983) Neumann 1995)	Crises and failures may have many causes, some related, others interdependent. Unintended consequences emerge in systems characterized by complexity and tight coupling	Risks of large systems projects may increase after initial implementation owing to system enhancements, integration with other systems and expansions to new communities of users (Bashein et al., 1997).
Complex adaptive systems theory	Physical sciences Organizational behaviour	Anderson (1999) Dooley and Van de Ven (1999) Thietart and Forgues (1995)	Behaviour of higher level system (e.g., organization) emerges from behaviour of lower level components (e.g., individuals). Apparently revolutionary outcomes can result from small changes in technology and/or organizational factors. Small differences in starting conditions or implementation strategies can yield very different IT-related outcomes.	None found.

Table 6.1: Explanations of unintended consequence (continued)

Explanation	Source discipline	Sample references	Key arguments	IT-related illustrative example
		Complex interactions – social and technical category		
Functionalism	Sociology	Stinchcombe (1968) Douglas (1986) Abrahamson (2001)	Functional consequences are unintended (and often unrecognized) belief systems and/or behaviour patterns that are maintained by behavioural feedback loops. Unintended outcomes are by-products of a group trying to achieve some other valued objective; even when apparently negative, these outcomes provide benefits to the group, hence remain resistant to change.	Negative social consequences of email use resulted from belief in email as the primary medium of organizational communication and related behaviours, a pattern necessary to achieve desired efficiency benefits from email (Markus 1995).
Actor network theory	Sociology Information systems	Callon (1987) Jones (1999) Walsham (1997)	Both technology and people are actors in social networks. IT applications can become 'frozen organizational discourse' in which the interests of particular parties are inscribed on the technology and exhibit tendencies toward irreversibility.	Unintended consequences result from the trials of strength among actors in an ERP implementation in a traditional university (Scott and Wagner, 2003).
Dialectics	Sociology Information systems	Benson (1997) Robey and Boudreau (1999)	Unintended outcomes emerge unpredictably from opposing social forces.	Computing in urban municipalities intended to bring about more democratic reform leads to the reinforcement of existing political power (Laudon, 1974).
Structuration theory	Sociology Information systems	Giddens (1984) Orlikowski and Robey (1991)	Mutual influences exist between structures (like IT applications) and human actors. Unintended consequences occur when asymmetry in the distribution of resources is challenged by human action.	Systems consultants experience simultaneous effects of using CASE tools more productively while constraining their abilities to solve clients' problems (Orlikowski, 1992).

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7 ERP manuscripts of accounting and information systems

Niels Dechow and Jan Mouritsen

Introduction

Although accounting is not the only discipline to interact with information systems (Somogyi and Galliers, 1987; Preston, 1991), their association has a long history (Anthony, 1965; Christiansen and Mouritsen, 1995). It has grown even stronger and more important with the advent of sophisticated systems for management control known as 'enterprise resource planning systems' (Granlund and Mouritsen, 2003; Kilger and Scheer, 1980; Meissner, 1997; Stahlknecht, 1980, 1982). For years, practising accounting has been facilitated by information technology which has mechanised certain tasks, made complex financial databases available, enhanced the power of analysis, made contingency plans possible, and created new roles for corporate accountants in relation to customers and suppliers. There are also many parallels between information systems research and accounting research. A parallel to information systems analytical concern with structured methods can be found in accounting's concern with financial modelling. There are also parallels between the interests of information systems research in socio-technical and soft systems approaches and the interest of accounting research in users and uses of accounting information systems. Also clearly, the BPR interest in information systems research parallels accounting's concern with Activity Based Management, just as end user computing parallels the development of local accounting and information systems. So there are, and have been, tremendous parallels and associations between accounting and information systems (Christiansen and Mouritsen, 1995). But how is this association constituted?

In this chapter we discuss how accounting and information systems are part of a management control agenda, and we use manuscripts about an ERP system – the SAP R/3 – to analyse this. We further analyse and attempt to dissolve the dilemma that accounting research typically concludes that ERP systems have few – if any – consequences while IS research concludes that ERP strikes back on the firm with tremendous consequences. This paradox, we suggest, can be understood against the conventional boundaries found around the two disciplines. But we also suggest that understanding ERP through the manuscripts about it may allow us to develop a new space for the analysis of its consequences which requires a simultaneous understanding of accounting and information systems. Accounting provides information systems with voice and action, and information systems provide accounting with infrastructure.

The domains of accounting and IS, the prospect of ERP

The starting point of our analysis is Boland's (1999) point that accounting and information systems differ in their domains even if they are both concerned with management control issues. He characterises their differences as follows (ibid., p. 239).

> Whereas accounting is concerned with specific types of representations and the ways to 'get them right', information systems is concerned with representation in general. Information systems professionals are concerned with constructing representations, but they tend to be one-off, ad hoc responses to requests of the managers or staff being served by a system.

The accounting domain reflects on the problems of making relevant what appears to be a well-known set of practices around the balance sheet and profit and loss accounts. The domain of information systems reflects on ever-shifting technologies. Some differences that come to mind, if we elaborate on this contrast, are listed in Table 7.1.

Both accounting and information systems research are concerned with representation but there are a number of differences. The stability of accounting's representations lies in balance sheets and income statements with a view to transparency; for IS the objects are more variable but the concern is to connect people. Following Boland (1999), accounting research has been able to focus on refining existing representations and 'getting things right' in relation to balance sheets and income statements while IS has been concerned with 'getting users connected' by means of requirements analysis, system building and project management (Hirschheim et al., 1996).

Whereas the IS domain focuses on implementation, accounting focuses more of its research on the analysis of form and function of various applications based on an ideal of 'transparency'. Applications such as, for example, activity-based costing (Horngren et al., 1999); the balanced scorecard (Kaplan and Norton, 1996); shareholder value analysis (Rappaport, 1997), which each refers to 'getting things right' in terms of activity based cost allocations, balanced performance measurements and

Table 7.1: Accounting and IS representations

Accounting crafting representations for capital markets	◄——►	Informations systems crafting representations of virtual networks
Existing capital markets	Environment	Non-existing virtual networks
Balance sheet, income statement, managerial accounting reports	Context	Requirements analysis, systems design, project management
Getting them right	Purpose	Getting them connected
Form and function of analysis	Focus	Implementations design
Transparency of organizational spaces and products	Ideal	Alignment of people and technology
Activity based costing, balanced scorecards, value based management	Recent applications	Object-oriented approaches, corporate infrastructure modelling tools, distributed architectures

shareholder driven value creation. To the IS field the ideal has been 'alignment' of users and technologies based for example on of socio-technical designs (Bjørn-Andersen, 1977, 1979), object-oriented approaches (Rymer, 1993; Somogyi and Galliers, 1999), corporate infrastructure modelling tools (Henderson and Venkatraman, 1993; Weill and Broadbent, 1998) and distributed (client–server) architectures (Colouris and Dollimore, 1988; Kagermann, 1993). All of these applications intend to improve the alignment of user and technology.

There are thus differences between information systems and accounting domains, and they stand out as clearly differentiable and separated. However, introducing ERP systems, the relationships between accounting and information systems become interesting. ERP systems allow us to take a fresh approach to their relationships. Suddenly, we have empirical propositions that tie the two domains together. At least, in some professional writings about ERP systems, information systems and accounting cannot be separated. Before we start analysing this relationship, however, we first consider briefly how accounting and information systems typically have addressed ERP systems.

Much has already been written about the promises and perils of ERP systems (see for example Davenport, 1995, 1996, 1998a, 1998b, 2000a, 2000b). From the accounting perspective, Cooper and Kaplan (1998a, 1998b) present ERP as a complete calculation machine governing all activities and affairs of the firm. ERP systems embody an integrated costing system with a technology that allows us to produce different (and conflicting) forms of transparency at the same time. Various surveys, however, fail to see this (Booth et al., 2000; Granlund and

Malmi, 2002; Spathis and Constatinides, 2002). These surveys measure the extent to which corporations employ the new accounting techniques such as activity-based costing (ABC), the balanced scorecard (BSC), and value-based management (VBM) and they cannot find evidence of more ABC, more BSC and more VBM than in corporations without ERP. They say that ERP systems use accounting systems traditionally used by the accounting field, and ERP is hardly a complete calculation machine. The expected effects cannot be found.

In contrast, information systems researchers conclude that it is impossible for organizations to escape the effects of ERP. 'Integration strikes back' (Ciborra, 2000; Hanseth et al., 2001), and companies having implemented ERP find not only that they can do new things but also that there are things they cannot do because the system does not allow them. Technology strikes back on the organization, which challenges IS research's concern about the alignment of humans and technology (Dahlbom and Janlert, 1996). The dominating answer to these questions is the 'stage maturity model' of socio-technical alignment (Nolan, 1979; Hirschheim et al., 1988). Ross and Vitale (2000) for example – similarly to the professional community (KPMG Consulting, 1997; Deloitte Consulting, 1998; PA Consulting, 1999) – use this research frame to evaluate ERP systems practice and conclude that no company has yet reached the highest level of maturity and learning, where they will get the benefits of their investment. The conclusion is perhaps not surprising (Benbassat et al., 1984; King and Kramer, 1984; Holland and Light, 2001).

The differences between accounting and information systems research are considerable, but the ERP field brings accounting and information systems research and practice *into new contact* where they together produce new relations between technology and organization. These relations are presented in the ERP manuscripts as stories of meeting points between involvement, transparency and alignment, where ideas of management control systems are laid out.

Our Approach

Our analysis of the relationships between accounting and information systems is based on various manuscripts about one particular ERP system – SAP R/3 developed by SAP AG. These manuscripts are carefully crafted pieces of communication because they lay out how ERP systems can be relevant to potential users and thus customers of such a system. The manuscripts therefore propose how ERP systems have to be managed to be made relevant resources, and they therefore present a view of what has to be in place to make an ERP system work. To facilitate our analysis of these manuscripts, we draw on Latour's (1992) distinctions between different types of manuscripts (see Table 7.2).

Table 7.2: Four types of manuscripts (Latour, 1992)

Descriptions	Define actants, endow them with competences, make them do things and evaluate the sanction of these actions.
Prescriptions	Define what is presupposed from those social and technical actors that are transcribed by the description.
Circumscriptions	Organize resources in the setting of their own limits and demarcations.
Conscriptions	Mobilize well-aligned resources to render their behaviour predictable.

These four types of manuscripts help us to understand the different modes of action that need to be mobilised to understand a text. The two first modes – descriptions and prescriptions – concern the representation of the subject matter to be managed, while the two last modes – circumscriptions and conscriptions – are about the mechanisms of organizational alignment that make a firm coherent. All four are therefore part of a programme of action and we understand that neither of them can function without the others. We use this framework to present our case – the SAP R/3 manuscripts – and we show what happens when accounting meets IS in the association of these four different types of manuscripts. We focus our reading of SAP manuscripts on the relationship between technology, accounting and information systems. We illustrate how, through various management concepts accounting describes and prescribes an action program and we show how information systems circumscribe and conscribe action programs by means of object-oriented modelling techniques and relational database technology.

SAP R/3 Manuscripts on Management Control Systems

Descriptions and Prescriptions

SAP R/3 manuscripts advocate a variety of management concepts such as for example (ABC) 'activity based costing' (Horngren et al., 1999), (BSC) 'balanced scorecards' (Norton and Kaplan, 1996) and (VBM) 'value based management' (Rappaport, 1997). Each of these provides an agenda for management. ABC describes the segmentation of costs and revenues; BSC describes how the firm navigates towards its future, and VBM describes value development. Each concept describes a possible meaning for corporate integration through the ERP system (Dechow, 2001) because they frame transparency and 'getting things right' differently. Where ABC talks about the organization of work, the balanced scorecard talks about the organization of linked performance measures and VBM centres on decentralization and business units (Mouritsen, 1998). They are different narratives (Boland and Schultze, 1995). *First*, they define relevant entities, which in ABC is a cost driver, in BSC is a performance driver and in VBM is an investment centre. *Second,* they endow them with competence to drive costs (ABC), several types of sequentially linked performance indicators (BSC) or residual income (VBM). *Third,* they allow entities to be compared and evaluated; and *fourth,* and finally, they prescribe how managers should make changes to their corporations. Each concept invites ERP as information system to speak up as illustrated by the following quotes on each concept (italics added):

> The Whale Curve Report … is one of the most important management reports generated by an ABC system. *The curve shows the accumulated ABC profit* (profit including process costs) for the elements of a market dimension such as 'all customers of a customer group' or 'all products of a product family'. *The most profitable element of the dimension is at the left end and the least profitable one at the right end*. The accumulated ABC profit is calculated by adding the profit contributed by one element to the profit contributed by all previous (more profitable elements). (SAP AG, 1998, *R/3 System – The Impact of Activity-Based Costing (CO-OM-ABC) on Profitability Analysis (CO-PA)*, p. 3)

> As well as being used to capture cost and revenue data for traditional profitability accounting, *profit centers can also be used to collect balance sheet items*, such as fixed assets, receivables and payables, and inventory. *Used in this way, it becomes possible to calculate shareholder value metrics such as EVA*: profit centers become value centers. (SAP AG, 1997, *Profitability Analysis*, p. 22)

> The Management Cockpit is an innovative approach to management meetings using the concept of an 'Enterprise War Room'. *In a Management Cockpit, the balanced scorecard is displayed with appropriate visuals and graphics on the walls of an ergonomically designed meeting room*. Using the 'Flight Deck' of the Management Cockpit, interactive measurement drill-downs and simulation capabilities support performance assessment and decision making. (SAP AG, 1999, *SAP Strategic Enterprise Management Translating Strategy into Action: The Balanced Scorecard*, p. 15

As the italicized text passages illustrate the management concepts are not only about 'getting things right' as the accounting voice says. The information system can also project them into an organizational role where information on costs, performances and residual income allows the information system to be a resource. This can be illustrated by the association of the balanced scorecard to the Management Cockpit (see Figure 7.1).

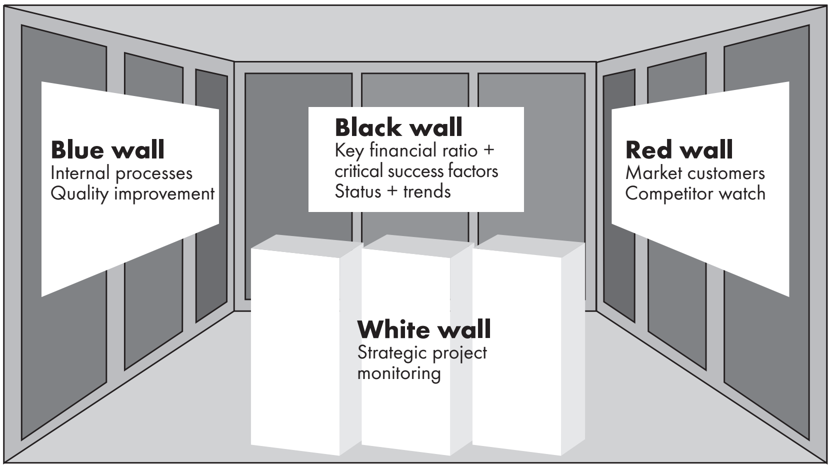

Figure 7.1: The Management Cockpit SAP AG, *R/3 System SAP Strategic Enterprise Management, Enabling Value-Based Management.*

ERP provides functionality since the Management Cockpit can inform. It:

> allows a two-way flow of information: corporate strategists can monitor performance continuously using feedback from the business execution systems, and adjustments to the strategy can be driven down to the operational level via new targets and KPIs. (SAP AG, 1999, *SAP Strategic Enterprise Management Translating Strategy into action: The Balanced Scorecard*, p. 3)

The manuscript illustrates how accounting through 'getting things right' help the information system articulate what it can do. Activity-based costing; the balanced scorecard and value-based management all provide narratives that require the functionalities of information systems. Without the IS functionalities, however, the narratives are worthless, and this functionality is structured in ERP as a configuration across five different system levels (Figure 7.2).

The first level concerns the choice of technology, i.e. the scope and scale of hardware. Once the platform has been chosen four additional levels of configuration work emerge. As Figure 7.2 illustrates, the first two concern an accounting structure and the last two concern a logistics structure. This *technological representation* of ERP is from materials not provided by SAP AG, but from the SAP training academy. The written materials from SAP AG instead introduce the relational database technology through the following analogy.

> We can represent Accounting and Logistics in R/3 as pyramids with three different segments … The segments of the pyramids, in each case,

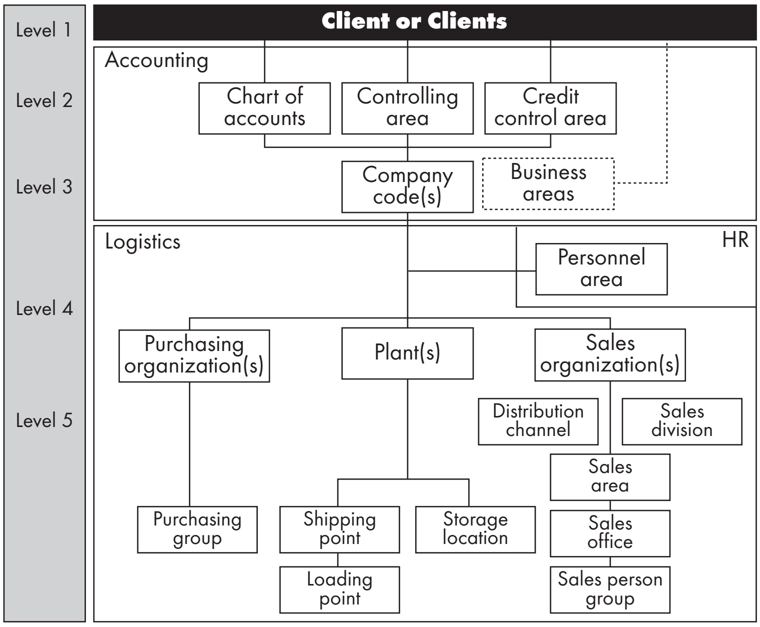

Figure 7.2: The 5-ring configuration architecture of an ERP system based on relational database technology. Based on SAP Academy handout, 1998.

> vary in size. In Logistics, business processes are of decisive importance. In Accounting the focus is on information acquisition for internal and external reporting requirements. (SAP AG, 1997, *BC The R/3 Process Model*, release 3.1G, p. 11)

The difference between Figure 7.2 and Figure 7.3 is interesting. Figure 7.2 provides a sequential story of the technology of ERP while Figure 7.3 presents an atemporal model of how ERP can get things done. The difference is about the constraints of ERP. In the following sections we discuss how these constraints are circumscribed and conscribed by information systems technology. We first look at the ways that IS technologies are used to circumscribe the firm where its local specificity

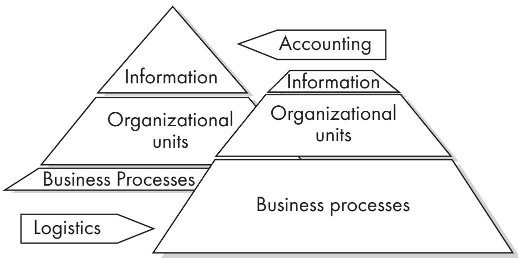

Figure 7.3: The accounting–logistics structure of an ERP-system architecture
Source: SAP AG, 1997, *BC The R/3 Process Model*, release 3.1G, p 11.

is transformed into a global (simplifying) format, as resources become organized by means of a system of graphical system objects.

Circumscriptions

ERP systems have often been emphasized for their ability to turn organizational attention from functions to processes – they circumscribe or organize resources. This has been achieved largely through object-oriented language, which in the SAP R/3 dialect is known as an 'event-driven process chain' and is based on four objects illustrated with each their icon in the graphic below (Figure 7.4).

The four 'objects' each defines one question. The function object concerns the question what should be done; the 'event' object asks the question when should something be done. The question of who should do something is the concern of the 'organization unit' object and the 'entity type' finally asks, what information is necessary to do something.

In the words of SAP AG, business objects accomplish '*a high degree of abstraction without detailed information, allowing project team members to communicate at a business level that does not require special technical knowledge of the system'*. (SAP AG 1997: *BC The Process Model*, release 3.1G, p. 2–6), and the main point here is that the objects circumscribe reality:

> Business people benefit from business objects as a means of abstraction. They are not at all interested in the details of a 'purchase requisition' programming code, for example. Much more important is the fact that business people can continue to use their own language in order to efficiently communicate their business needs. Therefore, business and IT people can both talk about identical business objects from two completely different points of view. Business objects close the communication gap between IT and business… (SAP AG 1996, *R/3 System – SAP Business Objects*, pp. 3 & 4)

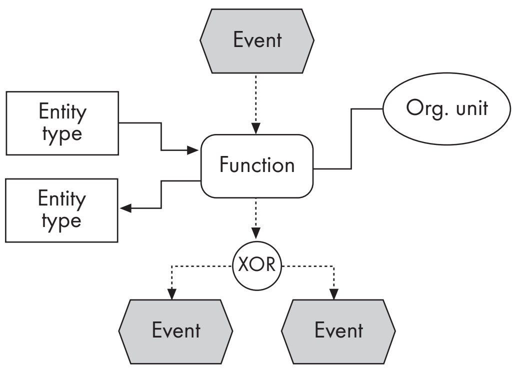

Figure 7.4: The EPC Diagram – An Implementation Technology. Source: Keller (1999)

The EPC diagram presents configuration work as a liberal (horizontal) process, where it is possible to start from many angles as long as the *management* 'functions' (the things that need to be done) are accorded primacy. Through the object of 'organizational units' EPC-diagram integrates with the five configuration levels introduced before (Figure 7.2). But as stated in the quotations, the idea is to keep business people at a distance from the actual configuration work. Instead of learning about relational database technology through the five configuration levels (Figure 7.4), business people merely have to recognize four objects and then business and IT people can talk about identical business objects from two completely different points of view.

The process looks liberal, but via EPC diagrams the reality of the locality is circumscribed into a simplifying, global format. Here, the resources of the locality are generalised according to the logic of the EPC diagram and therefore it is questionable just how far cultivating (Dahlbom and Jalbert, 1996) it can be. It not only allows the local to be made visible; it creates visibility along the simplifying effects of the four objects and therefore also crafts visibility.

> Enterprise models provide effective support for the re-engineering phase, which often precedes configuration of R/3. The intuitive visualization method for representing enterprise models allows the specialist departments and management to be incorporated at an early stage in the project without requiring in-depth knowledge of R/3. This leads to greater reliability when R/3 is implemented, since a binding framework for the entire project phase is provided. (SAP AG – 1997, *CA Reference Model*, release 3.0F, pp. 1–2)

This process serves 'getting things connected'. The narratives provided by accounting produce descriptions and prescriptions to 'get things right', but the object-oriented representation preferred by IS helps to create new possibilities in favour of a new set of connections. This is where information systems stand in for accounting. Information systems help accounting as it handles more of the complexity of the business situation as it provides a lens that may be even clearer in its process and connections than accounting's 'general bottom line' developed via de- and prescriptions. The EPC diagram represents business activities in a process structure as if it was inherent to these activities (Preston, 1991) where often, however, the structure provided is a series of variables with orderly and determinate rules given only by technology.

Conscriptions

The circumscriptions (the enrolment of resources) performed by the EPC diagram have to be mobilised through the relational database where ERP is conscripted (made to be stable) to perform certain actions predictably.

Table 7.3: Three technology scenarios at the first of 5 ERP configuration levels[a]

Control configuration	**Basic** *1 system set up for one company*	**Advanced** *1 system set up for X companies*	**Multiple systems** *1 enterprise with X company systems*
Logistical integration	Within location of business	Focused at the level of strategic business units across legal entities	Only to a limited extent across business units and enterprise
Technologies and process	Standardised to a large degree	Different in various business units	Different in various business units
Markets	Uniform by structure	Varying by structure	Varying by structure
Internal transactions	No internal pricing	Transfer pricing	Market-based customer/ vendor relationships
Operational control	Standard reporting	Independent operative and strategic control	Full BU autonomy: system master data, open items management and controlling
General reporting	Reports for external rendering of accounts	Autonomous SBUs in relation to profitability and cost reporting	Independent
New business	Legal entities should not be planned in short term	Legal entities planable in medium term	Legal entities planable 'any time'

a. Source: Based on SAP-AG, 1997b, *CA, Consultants Handbook*.

In their materials, SAP AG understands configuration work by means of three technology scenarios (see Table 7.3). The 'basic set-up' represents a very efficient but also very inflexible set-up, the multiple-systems set-up provides a maximum of system flexibility, although at the cost of reduced performance (because of multiple data-redundancies across the system) or increased costs (due to the need for larger investments in hardware technology).

Kagerman (1993) refers to these three configuration alternatives as a choice between 'management holdings'; 'financial holding companies' and 'strategic alliances'. As illustrated in Table 7.3, there are three different ways to align corporations through information technology and thus they also display technology in three different roles between 'getting things right' and 'getting things connected'.

Accounting and IS technologies as a manuscript on management control

The SAP R/3 manuscripts integrate accounting and information systems in a proposition about management control. There are tensions in this proposition because it questions established modes of management control and teases with options that are different from existing ones. Firstly, the ERP manuscript proposes a distinction between accounting and information systems and secondly, it also provides a mechanism to overcome this distinction again. To make this operation coherent, the manuscripts produce intermediaries of '*voice*', and '*progress*', '*meta-communication*' and '*integration*' (Sillince, 2001).

The '*voice*' concerns the relationships between the manuscripts and corporate strategy. Strategies often emerge from investments of time and resources to communicate, explain, refine and justify actual courses of action (Mintzberg, 1973, Quinn, 1980, Mintzberg et al., 1998, Weick, 1995). In the SAP R/3 manuscripts, accounting writes strategies for IS. The various management concepts illustrate how integration can be accomplished. ABC, BSC and VBM help SAP R/3 to gain relevance in corporate agendas because here accounting adds 'voice' to the relational database and empowers it to speak a narrative about management.

Accounting's narratives explain the purpose of information systems and assign them with procedures to make them doable. The case of ABC produces unprecedented layers of 'transparency' to see though the complexities of production and service operations. In the case of VBM, the whole idea of 'value creation' is made an operational activity along with its justification as a business objective, and in the case of Balanced Scorecard, a concern to 'navigate' towards the future is manufactured. (see also Dechow, 2001). Each of these management concepts offers a narrative that all can help define a role for the information system alongside its calculations.

The '*progress*' envisaged by the SAP R/3 manuscripts concern their future-oriented offer by which present accounting processes can be changed and made to fit a bright future. There is a degree of plura-vocality (Thachanky,1992) in the text inviting the reader to participate in the construction of the firm's future. By offering a selection of narratives, accounting helps IS, which then in return liberates accounting from its conceptual straight-jacket and allows the story of organization performance to have multiple meanings at the same time (Boje, 1995) creating different possible futures.

In the SAP R/3 manuscript, the object-oriented analysis offers to turn knowledge about 'the managed process' into a sequence based on three simple questions ('what should be done?', 'when should something should be done?', and 'who should do something?') that reflect local business in the abstract tool of the 'object-oriented analysis'.

Object-oriented analysis has been criticized for assuming a too systematic organization (Westrup, 1995), but a process-based view of organization (Willmott and Wray-Bliss, 1995) may further reform work-flow objects (Sacks, 1992) through added divisions so that management narratives of performance effects, such as 'customer satisfaction' and 'zero-defect quality' will translate into interdependent activities. Albeit being incomplete, the objects of the data-based process stand in for the actual work-flows and allow accounting concepts to speak more clearly about the role of actors, their competences and how to sanction them.

Symbolically, the event-driven process chains that inform the configuration of the SAP R/3 system provide a sequential representation of the firm based on the labelling of phenomena into 'functions' (what should be done?), 'events' (when should something be done?) and 'organizational units' (who should do something), which not only simplifies the work of (ac)counting but also allows it to speak with some form of clarity about the effects of working in different ways. Through these questions, ERP creates a possible future by rendering local details of the past opaque. Then it is no longer clear if a computer system is a limited form of organization or if an organization is an expanded form of computer system (Latour, 1995) because in object-oriented analysis, new connections between the elements of the process and the management concept that justifies the workflows can be constructed or old ones can be aligned with new purposes and new futures.

As to '*meta-communication*', the accounting manuscripts help IS with the narratives, and IS in return offers the abstractions that can help accounting to speak more clearly. Pushed into the same manuscript handling the complexity and plurality of the business situation, accounting and information systems act in relation to each other. The manuscripts oscillate between them and this makes ERP a plausible actor, a solution to problems that appears also natural and realistic and perhaps even good (Perelman and Olbrechts-Tyteca, 1969). Such meta-communication is inferred in the manuscripts from the links made between tools and techniques at different levels and in different places, communicated in different ways and last but not least directed at different audiences so that all in the firm from IT manager via accounting staff to CEO can feel the sensibility of the ERP system.

This communication – including voice provided by accounting and the automation provided by information systems – present ERP as coherent. And coherence is a sign of the good: this is when desired purposes and possibilities of implementation are aligned. The social and the technical domains are intertwined. Coherence packages and relates 'getting things right' with 'getting things connected'.

Finally, ERP also '*integrates*' action-to-be. It helps define the contours of a complete calculation machine but it also always reminds us that there are tensions between accounting and information systems as they have to de-, pre-, circum- and conscribe at the same time. It can establish a rather idealised version of the firm and the working of the ERP system through combinations of accounting and information systems. The manuscript creates versions of the world that (Czarniawska, 1999, p. 57):

> in so far as these are relevant and valid, it is not by virtue of correspondence with 'the world', but by virtue of containing 'right' ('entrenched') categories and being acceptable … Such versions of worlds gain acceptability, not in spite of, but because of, their aesthetic features.

The manuscripts tell how technological functionalities are connected with possible effects, and more functionality and integration are answers to most problem. Albeit such answers are ambiguous they allow the reader to see 'getting things right' and 'getting things connected' in various combinations (Dearborn and Simon, 1958). Throughout the manuscripts, the translations by accounting and information systems revolve around action, which cannot be evaluated as right or wrong since there are no specific goals. The manuscripts rarely define ERP towards one specific purpose – such as, for example, manufacturing resource planning – MRPII (Klaus, Rosemann and Gable, 2000). ERP is called a 'standard-system' and this means that each functionality has its own standard. ERP is not the crown of MRP systems but rather a general proposition to develop management control systems.

Producing Management Control Systems

The ERP manuscripts tell us that accounting and information systems are related. They are not a unity. It is a struggle to keep them together because any gain at one point in time can become a problem in a later period. So, the prospect of a complete calculating machine is wrong not only because it is said so by the surveys; it can never be complete because there are always trading zones between various types of accounting and information systems text.

What we learn from manuscripts on ERP is that management control can be many things with an ERP system as we see how it moves between different de-, pre-, circum- and conscriptive text. As illustrated in Table 7.4 each of these texts perform different roles in relation to the 'voice', 'structure' and 'action' of the ERP manuscript. These different texts also mobilise the domains of information systems and accounting in distinct but combinable ways. This allows us to understand how the idea of management control systems is conditioned on the ability of accounting and information systems to stand in for each other.

Table 7.4: The dimensions of the ERP manuscript

ERP manuscript	Event-driven process chains	Accounting concepts	Relational database technology
Voice		Descriptive text	
Structure	Circumscriptive text		Conscriptive text
Action		Prescriptive text	
Representation	Involvement	Transparency	Alignment

This helps us argue why it is really not very interesting to ask the question whether ERP systems work (and then get the answer 'not at all' or 'too much'). It is more interesting to ask *how* ERP systems work and what has to be put in place to make them workable. Sometimes it may have the potential to create a long narrative depending on its ability to integrate management action in the firm. Moreover, this depends on how the ERP system gets into the firm ('implemented' or 'translated'), which brings us to the final point, namely, that each ERP system represents a mini-manuscript on ERP all by itself.

From Table 7.4, it appears that the four types of text are not only related in their role as voice, structure and action embedded in the ERP *manuscript*. They are also related in the technologies of the ERP *system* ('event-driven process chains', 'accounting concepts', 'relational databases') and in the production of 'involvement' (length of the relations held by the ERP system), 'transparency' (object of management processes) and 'alignment' (reproducibility of relations). But there is a significant difference between the generic ERP manuscript and the specific ERP systems employed by industry, which will be known to users of ERP systems, namely that the encounter between involvement, transparency and alignment is irreversible once we turn from the ERP *manuscript* to the ERP *system*. Once technology has been aligned, it can only create certain types of accounting transparency. Once the relational databases have been configured, generic de- and prescriptions can no longer interact with the circum- and conscriptive text of a local ERP system. The 'transparency' (object of management processes) depends on the 'alignment' (reproducibility of relations) provided through the configuration of the relational database technology on which the ERP system is based. The same counts for organizational involvement (the number and length of relations commanded by the system). It may appear as paradoxical in relation to the promises of the ERP manuscript, but at the same time it sheds new light on the meaning of the previously mentioned surveys of ERP practices which show that many corporations find it difficult to gain the benefits expected.

This is partly because the four texts mediate each other in the ERP manuscript, and it is partly because the circumscriptive and conscriptive technologies dominate the promises of the de- and prescriptive management concepts. It suddenly becomes clearer why implementations may run blind even if substantial financial resources have been invested. When, initially, the ERP system writes itself in letters and words on paper it creates promises of an open future. Later, when technology has been laid out and the design choices made, its text is in screen fields, data drills, standard reports etc. that not only can be difficult to change, as they respond to the requirements of the ERP diagrams and database technologies etc. that are rarely similar to the locality of practices.

Conclusion

The ERP manuscript relates accounting and information systems towards the (strategic) idea of management control. It equips ERP systems with voice, structure and action through a set of manuscripts about 'getting things right' and 'getting things connected', which are related. Here accounting is presented in terms of de- and prescriptions and information systems as circum- and conscriptions. Together they formulate a series of possible futures and thus make the information systems strategic debate about what management control is to be about. Therefore, the ERP manuscript is concerned to make information systems a corporate resource through accounting, which again is created as flexible and malleable by the functionalities presented by information systems. We see that in ERP, there is new ground for interaction between accounting and information systems – between 'getting things right' and 'getting things connected'.

8 Technology and the design of work revisited

Jon A. Turner

Introduction

While working on my dissertation, almost 30 years ago, I came across a study of the impact of computer use in Danish banks by Niels Bjørn-Andersen (Bjørn-Andersen, 1977; Bjørn-Andersen and Hedberg, 1977). Niels Bjørn-Andersen asked a fundamental question: what was the effect of using computer systems in routine clerical work? He argued that bank clerks would have little choice in adopting a computer system in their work. Thus, the consequence of using this technology in these jobs was an important practical and social issue. Would the designers of the system take advantage of the opportunity to restructure workers' jobs? Would the new jobs be more challenging ones with routine tasks transferred to the computer system, or would they be poorer with workers deskilled and constrained in the way they worked?

I was so strongly influenced by the question Niels Bjørn-Andersen was asking that I shifted the topic of my research to the same question. My work, dealing with Mortgage Loan Processing Clerks in US Savings Banks (Turner, 1980) and then Claims Processing Representatives in the Social Security Administration (Turner, 1984), complemented and extended the work that Niels Bjørn-Andersen had done and we became colleagues, collaborators and friends.

I thought it would be a fitting tribute to Niels Bjørn-Andersen and also a way to underscore the contribution he has made in the field of Information Systems (IS) research to revisit his original research question in order to see how it has evolved over time. In this chapter I explore how models underlying this research have changed and what we have learned from these studies. I will then compare these models to the way application system and job design are performed in practice. Then, I will propose future directions for this research if we are to understand more fully the interaction between the design of computer application systems, the content of support jobs, and the consequences of these jobs for workers. Part of my motivation for writing this chapter is my own curiosity – have we really learned anything about the question Niels Bjørn-Andersen and I started with so long ago?

Models of technology use in clerical jobs

In his study, Niels Bjørn-Andersen used both interviews and questionnaires for gathering data. The product was two case studies of the implementation of systems and the resulting jobs in two banks. He provided a detailed analysis of the implementation process that had been used and a comparison along a number of dimensions of the new jobs with the old ones. Niels Bjørn-Andersen concluded that the introduction of these new technologies caused unintended changes in work roles and in organizational structures. He also found that these new systems only marginally exploited the potential inherent in the technology for job design.

Niels Bjørn-Andersen's work even at this early stage exhibited three characteristics that continue to this day. He asked a good question. He got there first. And he put together a team that had fun, worked well together and produced a good result.

My study used a cross-sectional design with an explicit path diagram (Dubin, 1976). That is, a set of independent factors describing the technology and its use were linked to dependent factors in this case worker well-being through intervening factors describing the job, and the interactions among these factors were specified. All interactions were conceived as one way. In constructing my model I relied heavily on Niels Bjørn-Andersen's case studies to identify the factors to represent the task environment and the well-being of workers.

An innovation in my model was to represent the 'degree' of computer use as an independent factor. This permitted exploring whether 'heavy' computer users had a different job characteristics profile and different well-being profile than 'light' computer users (they did) and whether particular application system features had an influence on job characteristics (Turner and Karasek, 1984).

For my sample, relatively low-level bank clerks and claims processing clerks, I was able to demonstrate which job characteristics were linked to particular outcomes and the strength of those linkages. For example, it emerged that the most critical job dimension was the amount of control a worker had in performing a task and that this factor influenced both job satisfaction and well-being. I could not have constructed my models without the insights gained from Niels Bjørn-Andersen's case studies. His penetrating critique of the control exercised by the technologists during system implementation made me aware that outcomes could not be analysed independent of the design decisions made during implementation and the resulting technical features of the system.

For this reason, I included a number of system features in my model including the system's processing structure and database size. This permitted exploration of the interaction between various system features and effect on workers. I also was able to capture data on productivity, which permitted comparing the efficiency of various task configurations.

In summary, I reasoned that the impact of technology could be partitioned into two components: one unique to the particular organization that would result from the interaction of organizational culture, goals of the key actors, the implementation process including design decisions, the characteristics of workers directly using the system, and chance events; the other being regularities in implementation and application of the technology resulting from the material aspects of the technology (the things easy to do), constraints embedded in the technology (the things hard to do), along with a general tendency to apply the technology in a particular manner (common practice). My research strategy was intended to reveal the latter – the tendency to design particular application systems for a particular audience in a particular way resulting in a small, but significant, consequence for workers. In retrospect, what effects I found were less important compared to the effects caused by variations in organization-specific factors.

In the late 1980s, Bob Kraut did a careful study of the implementation and use of a records processing system for customer service representatives in a geographically dispersed public utility (Kraut et al., 1989). He described the details of the job prior to the introduction of the system and the details after implementation. Kraut used a pre-test, post-test approach using interviews, questionnaires, and observational methods to compare the same organization before and after implementation. This design equates groups better than cross-sectional designs by naturally controlling for factors that can influence outcomes. It is also multimethod. His model permitted the interaction between the computer system and the job design factors to be two-way. Kraut argued that there was no reason to believe, *a priori*, that the direction of the interaction was from the system to job factors. It was just as likely that the workers could influence the characteristics of the system through their influence over application system designers and through the use of customization features in the system.[1]

In general, Kraut found that workers' jobs were poorer after implementation of the system. Workers suffered some deskilling and their previous training was less relevant. Major job design factors were more negative and worker outcomes were more negative, except that the

1. My rationale in specifying the interaction as being from the system to job factors was that for these systems, which were designed by a central group, and then implemented in many different banks or Social Security Administration regional offices, individual groups of workers had little influence on system design or the characteristics of the system. There were no customization features and workers could not work around the system.

use of the system reduced job pressure, and increased happiness and mental health. And the service representatives perceived that the frequency of work had increased (that is, their productivity increased). Kraut demonstrated that the interactions between computer use and job factors and job factors and outcomes were bi-directional. That is, the system had an influence on workers as well as workers having an influence on the system. This represented an improved model and research design. He concluded that 'identical hardware and software within a single company can have positive effects on one job and negative effects on another, and can even have mixed effects on different aspects of the same job' (p. 236).

While these models were able to represent the interplay between job characteristics and worker outcomes, this did not tell us much about the way these systems were implemented, one of the key issues Niels Bjørn-Andersen set out to investigate. And these models were inappropriate for other classes of workers, especially those who had a choice in whether or not to use a system in their work (such as financial analysts or middle managers). Clearly the appropriateness of any model would have to consider industry/type of work, job level, and features of the system.

Barley's historical and observational study of the introduction of CT (Computer Technology) scanners in two organizations broadened our models of the introduction of technology in the workplace with his probing analysis of structure (Barley, 1986). He observed the 'emergent property of ongoing action' and noted that a full account of structural change requires a synthetic view of structure as both a product of and constraint on human activity. That is, institutional practices shape human actions, which, in turn, reaffirm or modify institutional structure. Barley proposed a sequential model of structuring composed of two dimensions: institutions and actions. Institutions were the settings of social logic which actors drew on to enact their daily lives. Action refers to the actual arrangements of people, objects and events. Structuring becomes the sequential and repetitive movement between these two dimensions. Thus, technologies must first disturb or confirm ingrained patterns of actions through scripts, which in turn delimit the organization's institutional structure.

Barley concluded that technology was an opportunity for structuring organizations. The central paradox was that identical technologies could involve similar dynamics and yet lead to different structural outcomes. He points out that traditional cross-sectional studies that ignore contextual factors would risk concluding that CT scanners had no consequences for organizations because differences in structure would tend to cancel each other out. Barley found differences in uncertainty, in challenges to professional dominance, and in the relative distribution of expertise. He concluded that technical uncertainty and complexity are social constructs that vary from setting to setting even when identical technology is employed.

Robey used a social interpretations approach in a study of the transformation of work through the implementation of information technology (Robey and Sahay, 1996). He noted that the success of technology-enabled organizational change depends on a combination of technical and social influences that are only partially controllable:

> As actors propose, design, develop, implement, and use information systems they endow them with social meanings, or interpretations. These interpretations help to shape the subsequent use of the technology, somewhat independently of technology's material properties. (p. 95)

Focusing on the timing and sequence of events during implementation, Robey found differences in the process of introduction, in organizational transformation and in consequences of the system for workers in two studies of the same technology. He concluded that technology is an occasion for, not a determinant of, organizational change.

Orlikowski has provided the most complete model of technology and organizational change that clarifies much of the previous work (Orlikowski, 1992). She identifies two aspects of the technology construct: 'scope', or what is defined by technology; and 'role,' or how the interaction between technology and organizations is defined. She notes that two views of scope have prevailed: technology as 'hardware', or the ensemble of machines including hardware and software that people use in performing their work. The second view of scope is broader including in addition to tools, or hardware, task, technique, and knowledge. She notes that this second view makes it difficult to investigate the interactions among the components of expanded scope, such as task and knowledge and humans.

She then identifies three models of the role of technology: the technological imperative model which examines the impact of technology on various organizational dimensions; the strategic choice model which sees technology not as an external object but as a product of ongoing human action and design (with substreams of the way technology artefacts are constructed – particularly the socio-technical studies – and a social constructionist view of technology that focuses on how a shared view of the technology arises); and a trigger or structural change model that sets off certain social dynamics that lead to anticipated and unanticipated structural changes.

Orlikowski then proposes a structurational model of technology that stresses two aspects. The first is the 'duality' of technology, the notion that technology is 'created and changed by human action, yet it is also used by humans to accomplish some action':

> Technology is physically constructed by actors working in a given social context, and technology is socially constructed by actors through the different meanings they attach to it and the various features they emphasize and use. However, it is also the case that once developed and deployed, technology tends to become reified and institutionalized, losing its connection with the human agents that constructed it or gave it meaning, and it appears to be part of the objective, structural properties of organizations. (p. 406)

The second aspect is the 'interpretive flexibility' of technology, the notion that technology is potentially modifiable through its existence and that the more general a technology is, the more it is appropriated in different ways. In this manner it comes to have different meanings and effects for different users.

Orlikowski identifies four components of the structurational model of technology:

1 Technology as the product of human action: As an artefact it only comes into existence through creative human action.

2 Technology as the medium for human action: It mediates their activities when they use it.

3 Human action is situated: It is shaped by organizational contexts.

4 Human action shapes institutional properties of organizations: By reinforcing or transforming them.

Orlikowski's formulation of technology can be used to identify and compare various models that underpin research. For example, Niels Bjørn-Andersen's model had components of a technology imperative model (technology as an independent factor) and components of a strategic choice model (technology shaped by design based on socio-technical principles). My model was more of a technology imperative model in that I attempted to separate out regularities attributable to adoption of the technology independent of the specifics of the setting, although decisions of designers were captured in the characteristics of individual systems. In structurational terms Niels Bjørn-Andersen was focused on components 1, 2 and 3 of the Orlikowski model, while I was concerned primarily with 2.

What did we learn? Technology implementation is important in explaining outcomes and consequences of systems. The differences among system implementations and outcomes are greater than the regularities. The regular effects are probably unimportant in the long term, even if they are significant. We have a good understanding of the way certain aspects of a system influence a worker's ability to use the system, the worker's performance, and health consequences. But these models are seldom used in practice. Most importantly, time has taken its toll – the technology/job design problem has changed in fundamental ways.

Changes in systems implementation

In retrospect, a major insight was the attention given to 'business processes' (Davenport and Short, 1990; Hammer, 1990; Davenport, 1993). They have turned out to be a useful level of abstraction that has captured management's attention and changed the focus of system implementation. Firms are now aware of their own business processes and how they compare with best practice. They understand now that improving the performance of their firm is not simply a matter of acquiring computer technology or a particular application system. Rather it is in finding a way to move their business processes closer to best practice.

Most computer application systems today are bought 'off the shelf' (packaged systems). That is, for any given business function (such as accounting, inventory, group life, health benefits, etc.) there are many (~50–100) packages available. Packaged systems now include pre-defined data elements and default data structures along with embedded models of best practice. In addition, large integrated business suites such as Oracle and SAP, which contain modules for almost any imaginable business function, compete with packaged applications. Rather than designing an application system from the ground up, the challenge today is to select the most appropriate application package for a business situation.

Another important change is the rise in general computer literacy and familiarity with the 'Windows' interface. Workers no longer need to be specifically trained in the syntax of the computer interface. They have acquired these skills on their own. Most applications use a Windows graphical user interface. Training is now at a higher level consisting of the information contained in screens and the actions to respond to business events in their particular application area.

Technology advances have also improved the quality of systems. Distributed processing, and especially 'client–server' architectures, have simplified system design and improved performance. The client module can evolve somewhat independently of the database back end. And the Internet is now accepted as a common communications channel to reach clients and for them to reach the firm. Thus, a 'web' presence is built into most applications.

Our ideas about the nature of the job have changed, too. Major design decisions are no longer about the division of labour between worker and the technology. And our meaning of system has become much broader. Service has become customer focused. The role of a service representative has become higher level, often spanning multiple functional areas. Firms want to cross sell their products. Customers want one point of contact in a firm and they want a customer service representative to be able to track information about their problem across multiple interactions. This has given rise to case tracking systems, customer relationship management systems, and workflow management systems. Application systems need to integrate into this complex environment. Computing has given us an almost unlimited set of options for designing the customer service job. We now have the tools to manage the interaction with the customer. 'Information' is the key. This has resulted in a rethinking of the way customer service is provided and the systems that support it. This in turn has greatly modified applications.

It is no longer just about the introduction of technology. It is all about changing business process, the content of jobs and the workers that perform them without introducing unintended consequences. From this standpoint, technology has become a commodity (Carr, 2003).

Application system and task design in practice

For the past six years I have been a participant observer in the implementation of five large application systems at a multi-division insurance company. A string of past system implementation failures prompted the COO to ask me to revamp the company's process for implementing systems and to guide a set of major system implementations planned over a five year period. Five systems have been completed successfully so far and another one is scheduled to go live by the end of 2003.

Being a participant observer has allowed me to see how these systems are implemented in practice and how the design of the application system and the design of work actually takes place. I now have a better understanding of how some of the notions from research and some of the prescriptive literature play out. While this only represents one case, there is nothing particularly unique about the setting. It is a company committed to serving its clients (who are well defined); it holds from 50–70% market share across the various lines of business; it prides itself in its human resource policies and concern for its workers; it strives for consensus and participation in major decisions; it has a clear vision of where it is trying to go (in terms of business strategy and execution of the strategy); and it has the resources to execute the strategy. This chapter has given me the opportunity to reflect on the five implementations, particularly the regularities and the differences among them. But I do not characterize my observations as research.

The importance of the RFQ/proposal evaluation process cannot be stressed enough. Requirements evolve through a dialogue among various interest groups. Almost more important than the requirements themselves is the mutual learning and understanding that comes from the process of working through the requirements. It permits agreement to be reached on scenarios and assumptions and it leads to exploring implications. Requirements are dynamic and they evolve over time; they are not known in advance. And they are never known completely. It is important for executive management to stay engaged in the process so that the outline of the requirements, the business strategy, and the expectations of senior management stay aligned.

An extensive search for potential systems and vendors is the next step. In any application area, the number of systems and system suppliers is extensive, often in the hundreds and always expanding. One cannot rely on any one source of information, for example a particular set of industry reports. Information needs to be gathered from general to specific. And one can learn a lot from listing to the vendors. How do you know when you have searched enough? When you begin to converge on the same set of systems and vendors. Once the general search is completed, the systems and vendors can be ranked and the poorer ones eliminated. This permits a more detailed investigation of a relatively small set of finalists. One method we have used is a two-stage solicitation: first an interest qualification round followed by detailed proposals. One of the major purposes of the search is to prepare the team for vendor selection.

Vendor selection needs to involve a broad representation of interested parties. Key to this is a formal proposal evaluation method. The important dimensions of evaluation need to be identified and each proposal assessed on the basis of how well they do on each dimension (often closely related to a set of requirements). We make a distinction between objective and subjective dimensions and try to keep them separate. In fact, we term the objective portion 'assessment' and the subject portion 'evaluation'. Interestingly, in all six cases to date the finalists were not obvious in advance and they were never the front-runners.

Another important factor is the organization and staffing of the project teams. It is important to assign the best people in a functional area to the evaluation and implementation teams. This human resource allocation will not take place without the involvement of executive management. And resources need to be allocated to backfill for workers assigned to projects. Team dynamics and processes need to be monitored and a cadre of qualified team leaders developed.

Key to the success of organizational change projects is an oversight or governance mechanism to monitor project activity. The key executives of the firm need to be involved in this process along with all the important stakeholders. Such a process reduces opportunities for politics and it permits real-time resource reallocation and project replanning. It is much harder for project leaders to deceive management as to the true status of a project with oversight reviews keyed to milestones and it greatly reduces coordination costs since everybody is involved in key project decisions. We have learned that having the same group of executives involved in oversight across all projects is a benefit; the same issues tend to arise on each project and the executive team quickly becomes experienced and gains trust in each other in this context. Part of my role has been to design and evolve this oversight mechanism and to act as an 'honest' broker at meetings.

We have refined the notion of a 'model office' where business processes are documented, analysed, and best practices introduced into processes by domain experts, often provided by the application system vendor. How much change to introduce into a project is a risk factor that needs to be decided explicitly. The model office develops and tests all business processes and procedures prior to a system 'going live'. When modifications to a system are produced, they are regression tested in the model office. It is our dynamic test bed. Test scripts and test libraries are developed there. So is all user documentation. And staff training is worked through the model office so the staff can be trained immediately before a system goes live.

Finally, it has become clear that the customer service environment requires a firm's separate application systems to be integrated so that they can share information. Doing this in practice is both a research question and a practical challenge. It means being precise about what data mean in each system and mapping this to a common representation. And it means building a mechanism for exchanging messages among applications and between applications and the infrastructure.

Future directions for research

How does practice compare with the models we were using in our research? Much of what goes on in practice has not been represented in our models. We were looking at different things. What we did was acceptable if you wanted to describe the dimensions of office work and worker well-being, but our models were not appropriate for understanding what goes on during implementation or the dynamics of organization change. Maybe we just modelled the things that we could. Given that so many factors can influence implementation outcomes, how do you decide what to represent in a model?

Barley's and Orlikowski's detailed case studies get closer to what is needed but these are often after the fact or at best not central to the key decisions on a project. Or they may only cover a small portion of a project. But even these models do not capture the real dynamic of serious organizational change. To do this one needs to be present during the process and intimately involved. Of course there are problems here of bias and capture. It is like being at war – nothing beats being fired upon for realism, but it is hard to keep perspective. Too little attention is given to the dynamics of implementation in our research. Unfortunately, I've come to believe that implementation drives everything.

So where would I place my research dollars?

1 In general we need more case studies of actual implementations by participant observers – people trained as researchers but with practical system implementation experience.

2 These case studies need to be the raw material for practical implementation theory building; more than likely, but not limited to process models. We need to build models of the dynamics of implementation.

3 Then, more focused research, maybe involving action research and maybe field experiments, needs to be performed in a coordinated, targeted set of areas.

Specifically,

1 More work needs to be done identifying implementation best practice.

2 More work needs to be done in understanding implementation failure.

Conclusion

It has been a good ride. The challenge in research is to get deep enough to get your teeth around something, but not so deep that you lose your perspective. I fear sometimes that we have favoured depth at the expense of relevance. I am not convinced that we now know much more than when we started, but it certainly has been a lot of fun. And there have been some great arguments along the way. There is still a lot of craft in running successful projects of almost any sort.

In this chapter I have reviewed the models that underpin the technology and organization change literature. I have described some of the processes and activities involved in the practice of system implementation. The two seem quite far apart. Little of practice seems to be represented in our models. I've put forward some ideas for future research as way of starting a dialogue. Niels Bjørn-Andersen always has a good eye for hot research topics. I wonder what he will say.

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9 Are 'human factors' human re-visited

Ken D. Eason

Introduction

In 1984 Niels Bjørn-Andersen gave a plenary paper to the first international INTERACT conference in London. He called the paper 'Are "Human Factors" Human?' (Bjørn-Andersen, 1985) and it was a typically provocative challenge to the assembled international experts to look more closely at the basis of their research. The conference was composed of human factors specialists and computer scientists meeting to discuss the emerging subject of human–computer interaction. Niels Bjørn-Andersen was appalled by the narrow approach many were taking to this subject and he argued that they were 'softening the technology to make it more compatible with human beings'. He asked a very basic question:

> Are we just doing our best to adapt the technology to known so-called 'human weaknesses', to reduce resistance to using the technology or are we working on providing a technology which will be instrumental in liberating the intellectual capabilities of human beings?

Niels Bjørn-Andersen went on to illustrate the many ways in which human–computer interaction research could be used to encourage computer applications with Tayloristic implications for human work. Simplifying the work of the operator, for example, by letting the computer control the work process with the result that savings can be made on training costs. He took the example of task analysis at the keystroke level that could be used to control at a very detailed level the way in which people undertook their work. And he was critical of attempts to make teleconferencing more efficient that did not recognize that these forms of communication, however efficient, were always impoverished compared with the richness of human–human communication. He concluded the paper by proposing that we work towards forms of computer technology that served the attainment of true human values. As an example he identified the alternative strategy of the 'Scandinavian Model for the Office of the Future'. In this model the process of creating new technology would be a democratic one in which the users themselves would design their own systems with computer experts in a consultation role. The outcome would of course therefore depend upon the users but Niels Bjørn-Andersen pointed to eight characteristics he would expect to see in the resulting work systems which included high discretion for users, the possibility of modifying the system, no monitoring and an assumption by the technology that the user had knowledge and skill in relation to the tasks to be undertaken.

This critique held a particular resonance for me and has continued to have for the 20 years that have elapsed since Niels Bjørn-Andersen gave this paper. Throughout my academic and research career, most of it at Loughborough University, I have worked in a human factors/ human–computer interaction community and I have therefore seen the focus on specific aspects of human behaviour at first hand. The main influence on my own work has been the socio-technical systems approach that originated at the Tavistock Institute in London in the 1950s (Emery and Trist, 1960; Cherns, 1976). This approach takes the democratization of the workplace as a central tenet. The aim is to design work systems that integrate human and technical capabilities in ways that serve the human values that Niels Bjørn-Andersen expressed in his paper. My career can be depicted in some ways as a struggle to relate the socio-technical and the human factors frames of reference. In this chapter I am going to reflect on the progress we have made in addressing the questions that Niels Bjørn-Andersen posed both within the HCI research community and more broadly in the way computer applications are introduced into organizations.

In the late 1970s Niels Bjørn-Andersen, Dan Robey and I worked with colleagues in Germany and Austria on a five nation comparative study of the impact of computer-based information systems on management in organizations (Bjørn-Andersen et al., 1986). This study gave us the chance to explore the relation between issues such as the ease of use of forms of human–computer interaction to issues such as the centralization and decentralization of power in organizations. However, it was a research study and the real issue that Niels Bjørn-Andersen was addressing in his paper was the way in which new technology systems were being designed and implemented in organizations. I have subsequently worked on many studies of the way systems are designed and I have operated in many action research roles which have enabled me to contribute to the development of systems. Most of this work has been undertaken in a British industrial context in which democratization of the workplace is often not a central or shared value. I have therefore had an opportunity to explore two issues at first hand:

- What is the relationship between research in human–computer interaction and its adoption in practice?

- What can we do to further human values in the development and implementation of information technology in circumstances where economic and technical goals have primacy?

The development of the human–computer interaction community

The human–computer interaction community is now very large with the major international conferences CHI in the USA every year and INTERACT held in Europe and other parts of the world every other year. There are human factors practitioners in nearly every information technology and telecommunication company and few products emerge onto the market without some consideration being given to human factors issues. But is the work more 'human' in the way Niels Bjørn-Andersen proposed? The bulk of the work is still about specific factors, about technology 'push' and finding ways in which people can use new technology effectively. It is a community that gets very excited about every new technological advance that can be used in human–computer interaction from speech recognition to virtual reality and wearable computers. However, there are encouraging signs that a more holistic approach is being taken by many researchers and that human values are a major consideration. The coming of the personal computer was hailed by this community, for example, as a major liberator for humankind, putting the power of the computer in everybody's hands (Englebart, 1982). CHI in the United States gives titles to its conferences such as 'Wings for the Mind' (SIGCHI, 1989). There has been a major growth in the study of work practices and communities of practice as a prerequisite to establishing the role of future forms of information and communications technology. The HCI community has adopted the ethnomethodology approach in order to study the local culture and work practices of the potential users of technology. It now stresses the importance of finding forms of technology that work with rather than against the many micro-cultures to be found in work communities (Brown and Duguid, 2000). The computer supported cooperative work movement (CSCW), which has strong links with the HCI community, is striving to understand the nature of cooperative work so that technology truly supports the exchanges people need in order to work together.

There are therefore many encouraging signs of movement in a more humanistic direction. However, there has been one piece of learning for me whose significance it took me a long time to realize; HCI specialists may analyse these issues and espouse humanistic ideals but when they look for solutions they look in only one direction. They look to develop new forms of technology, for a technical 'fix' for whatever the human need might be. They do not look for new forms of organization, new human-based work practices etc. And unfortunately, as socio-technical systems theory has taught us repeatedly, you cannot solve any work problem by treating only the technical system; significant organizational, cultural, human learning, power distribution, social system, management style issues etc. may also need to be addressed. The Scandinavian Model of the Office is not just a specification of technology; it is a specification of an integrated socio-technical system. Just treating the technology part of the action leaves open the possibility that it will be used in the way Niels Bjørn-Andersen feared; to support a controlling, simplifying and coercive approach to work organization.

Approaches to the design of information technology systems

Many commentators have noted that the practices by which information technology systems are designed and implemented in work organizations are dominated by economic and technical considerations. They have also repeatedly pointed out that when these systems are implemented they have far reaching human and organizational consequences. So we can also ask whether the human factors community has influenced design practices in a way that gives more emphasis to human and organizational considerations. In passing it is important to acknowledge that other communities, notably those working on information systems research, have been striving to bring more human and organizational considerations into IT design practice. However, in focusing on the human factors contribution, we can note two major developments:

The emergence of human factors and usability practitioners. There has long been a population of ergonomists or human factors specialists working on non-IT issues in organizations. Traditionally they have contributed to specific issues such as the physical environment, the workplaces, equipment and furniture design etc. of people at work. The emergence of the related human factors specialism of human–computer interaction has created an associated set of practitioners often called usability engineers. Most of these practitioners work on a narrow range of issues in systems development and implementation, such as the usability of the human–machine interaction but there are two encouraging aspects to this work. First, there is a wide recognition of the need to engage the user population in any new technical system development. 'Participative ergonomics' (Wilson, 1994) is now, for example, a significant aspect of the practice of ergonomics. Secondly there is a growth of concern with systems ergonomics or 'macro-ergonomics' (Hendrik and Kleiner, 2001) in which the traditional concern with human–machine systems is being extended to the larger-scale design of socio-technical systems.

Human or user-centred design methods. It has long been the practice of human factors specialists to seek to embed their knowledge into guidelines, standards, regulations and methods in order that good practice can be widely disseminated. This has been particularly true in the field of health and safety where, for example, legislation to protect people from physical stresses while working on VDUs has been adopted in many countries. A number of authors in the HCI community have published human or user centred methods for each stage of systems design and implementation and these have been integrated to provide entire methodologies for systems development (Gould and Lewis, 1983; Winograd and Flores, 1986; Eason, 1988). The component methods and the overall human-centred approach to systems development have also been the subject of extensive work in the standards community with the result that there are now a number of significant ISO standards. These include ISO 9241 part 11 (1998) which gives guidance on usability, and ISO 13407 (1999) which establishes human-centred design processes for interactive systems. Suppliers of systems to user organizations are increasingly being asked to adhere to such standards. We should note, however, that, in line with the general approach in HCI, these methods are stronger on the human-centred design of technical systems than they are on the design of work organizations. The methods may start by paying close attention to the tasks and culture of the users' world but that is as an input to technical design; examining the options for rethinking the social systems does not figure as prominently.

The state of the art of IT design practice in the UK

This account gives reasons to be encouraged that we have moved some way towards the design of the kind of systems Niels Bjørn-Andersen envisaged in his paper of 1994. But the acid test is what is happening in the everyday development of IT systems. What has been the overall impact of these and other developments on the way in which systems are being designed and implemented? I recently undertook a review of surveys of IT design practice primarily in the UK (Eason, 2001) that included studies by Hornby et al. (1992), Smith and Dunckley (1995), Heinbokel et al. (1996) and Docherty and King (1998). In total these studies reviewed over 300 cases of systems design. The authors used a variety of survey methods and as a result it is difficult to make a formal comparison of their results. However, they were all concerned with the extent to which human and organizational issues were on the systems agenda and, if so, how they were handled.

Table 9.1 is an impressionistic scorecard based on these surveys to assess the movement towards more user-centred practices in user

Table 9.1: A scorecard for user-centred design

Characteristics of user-centred design	Score card			
	1 Rare	2 To some degree	3 Common but!	4 Common
Systems integration agenda	✔			
User/stakeholder engagement			✔	
Iterative/evolving development			✔	
User requirements analysis		✔		
Usability design			✔	
Socio-technical systems design	✔			
Formative evaluation – usability			✔	
Formative evaluation – acceptability	✔			
Change management/implementation		✔		
Summative evaluation	✔			

organizations. The ten practices listed on the scorecard are those that are commonly recommended by advocates of the user-centred design of socio-technical systems (Eason, 1993). There are, of course, case studies in the UK where all of these characteristics of user-centred design have been systematically pursued. The work of Enid Mumford (Mumford, 1987) in the development of the ETHICS methodology has, for example, provided us with a number of examples of socio-technical systems design in practice. However, the judgements in Table 9.1 are assessments of the main methods used in the everyday practice of systems designers as found in the surveys.

These surveys show that normal practice includes much that is user-centred and suggests there has been considerable movement in this direction in the past 20 years. There is certainly more attention being paid to interface design and usability evaluation of the new technical system although in many cases we might question the adequacy of the practices being adopted (hence the judgement 'common but!'). Most systems that are introduced into organizations now involve some form of user participation although as Hornby and Clegg (1992) have found users rarely seem to be able to make good use of these opportunities. What seems to be largely missing from these developments is the broader organizational agenda; the goal is still to design a technical system rather than a socio-technical system. User participation seems better suited to the evaluation of technical system prototypes, for example, than it does to job design or organizational design. It seems that, despite the overwhelming evidence that social and organizational changes are inevitable concomitants of technical change, there is still little integrated systems development.

A number of explanations have been offered for this phenomenon. The first is that, whilst there is some movement towards a user-centred approach and towards user participation, the economic and technical priorities of management and systems providers are still dominant. Frequently the management agenda is to introduce a new technical system rather than to create a new socio-technical system. The 'management of change' comes after the technical system has been designed and when it is about to be delivered. The focus of the user-centred design is on the creation of a technical system that supports user tasks and is usable. In other words the presumptions of management and the contribution of the HCI community are mutually compatible and support user-centredness in the design of technical systems. There is little about, for example, job design and work organization because they are not perceived as major issues.

It has been argued that many organizational outcomes can be attributed to the operation of the power structure in an organization. According to this argument the senior management, as the investors in the technology, set cost cutting goals, for example, as the rationale for the system development and as a result they expect to see a loss of jobs and related organizational changes. System implementation may then run into difficulties because this is not in the interests of the user community who did not have a voice in system planning but can resist implementation. While there is evidence to support this argument and unequal power distribution among stakeholders in systems development is undoubtedly an important factor, there is also a lot of evidence that many organizational outcomes are unplanned and unintended by any stakeholder, including senior management. They are the result of an inadequate appreciation that the technical system being constructed has far-reaching implications for the socio-technical work system of which it is intended to form a part. Neither the technical staff nor the senior management that commission the work see any reason to do more than plan a technical system and, as a result, social system changes occur by happenstance rather than planning.

In some instances, such as the design of call centres or the 'outsourcing' of significant amounts of work, it is possible that the user management has an agenda for organizational change upon which they would not welcome user participation. However, in my experience, user management often do not see organizational change as necessary or desirable. I once spent a considerable amount of time trying to get a senior partner in a legal firm to understand the organizational implications and opportunities of introducing a networked text processing and file management system (Eason, 1997). He insisted they were very happy with their organizational structure, did not wish to make job cuts and intended to keep everything the same; the technical system would make them more effective and efficient and enable them to provide a more professional service to their clients. In the event, after the technical system was implemented, the distribution of work between lawyers, secretaries and support staff had been fundamentally changed and they had to rethink secretarial responsibilities and reorganize their support staff. They found the organizational implications in the end and made organizational changes but only as a retrofit to a predetermined technical system and only after considerable role confusion and stress had been created among the staff of the organization.

Even when organizational change is on the agenda and the potential stakeholders are given the opportunity to contribute there is a great deal of evidence that the process is rarely effective. Users participating in such processes meet many problems; they may have limited time and opportunity to make their contribution, they may be confused by the technical nature of much of the debate and, if the systems team is working to a tight budget and timescale, they may experience pressure to accept system proposals quickly (Heinbokel et al., 1996).

I draw three conclusions about the current state of play in UK IT systems design practice. First, there are now more opportunities for people to play a significant role in the creation of the work organizations in which they will play a part. Second, these opportunities are mostly concerned with the design of more usable IT systems. Third, when people do have the opportunity to play a fuller role in the development of the socio-technical systems, they often struggle and the systems that result are not necessarily in the form envisaged in the Scandinavian Model of the Office. The focus of much of my work in systems development in recent years has, as a result, been attempts to find ways of empowering all of the stakeholders in their efforts to create integrated socio-technical systems within which they will want to work.

Learning processes in systems development

In the past 20 years I have had many opportunities to work in action research roles in systems development in a range of business domains including electricity distribution (Eason et al., 1995; Eason, 1996), freight forwarding (Klein and Eason, 1991), healthcare (Eason et al., 1996), military systems procurement (Strain and Eason, 2000), postal services (Philpott, 1999), a government department (Harker and Eason, 1999), a city legal firm (Eason, 1995, 1997) and electronic library developments (Eason et al., 2000, 2003). In all of these cases there has been a commitment to engage a wide variety of user stakeholders in the development. There has usually been a recognition that organizational as well as technical change may need to be considered and an opportunity, albeit not without limitations, for the stakeholders to influence the overall socio-technical systems debate. In the remainder of this chapter I want to evaluate what happened in these cases, the obstacles stakeholders faced in making use of these opportunities and what approaches we found useful to help them.

The issue that we faced time and again in these cases was that the stakeholders were ill prepared to take on the demands of this task. They may have been experts in their own work domain but that did not make it easy for them to see the organizational implications of the new technology that was being presented to them or to see what opportunities it created for them to identify new systems which would improve their working lives. One of my doctoral research students encountered this is in a dramatic form. She was working on the implementation of a new technical system into the distribution of the post by the national mail service (Philpott, 1999). In order to make an initial exploration of the organizational implications of this system she presented a socio-technical systems scenario (the new technology system in the context of the current work organization) to groups of students and asked them to review it from the perspective of the main stakeholders. They identified many issues, some positive opportunities but others potentially major threats to work roles. The technical system as planned could, for example, be used to exert much closer control over the work of a number of postal workers. She then repeated the process with the user representatives associated with the development of the system in the postal service. She expected a richer array of issues to emerge because of the greater local knowledge of the users. In fact she found they were unable to see any significant organizational implications of the system proposed. Why? Four factors appeared to be at work. First, there was only a limited time to present the future scenario and discuss its implications with the representatives. Second, the properties of the new technical system were not readily apparent to the representatives. Third, they appeared anxious to be positive; the organizational climate was not one where seeming to be critical of management plans was a sensible personal strategy. Lastly, and the most dominant reason, they were locked into the culture and processes of the organization and found it difficult to see how a technical system would change these or create new opportunities. The students were of course free of the years of experience of the status quo and found it much easier to see other organizational possibilities.

These issues have emerged in a variety of forms in other contexts. The underlying issue is that it is not easy for people to enter into a reflective and perhaps abstract evaluation process to be followed by a creative design process if these activities are not a normal part of their working lives. If this is to work, they have to be supported through a learning process before they can play a full role in the systems development process. That stakeholders and user representatives need to go through a learning process has long been recognized but it has often been cast as a need to develop understanding of information technology. This may be necessary but it is not a sufficient requirement. They also need to be able to explore, for example, the possible links between the technical and the social system and to recognize that a variety of future systems are possible. As a result of our work we conclude that, for users to be able to make their contribution, four conditions for good learning have to be met:

Time and resources. It takes time and it may take methodological and knowledge support for these learning processes to occur. It is difficult for much progress to be made within a development programme with fixed deadlines for the delivery of complete new systems. When users are engaged in systems development therefore 'space' has to be created for them to learn and to contribute. This is more easily achieved within an evolutionary or iterative process of development than in the traditional 'waterfall' design process followed by the 'big bang' form of implementation (Eason, 1988) which typically involves tight and fixed deadlines.

A safe environment for exploration. The normal workplace with its everyday demands and existing relations between people may inhibit people from learning, freely expressing their views, exploring new and perhaps unrealistic ideas or proposing new forms of action. To facilitate these activities they need to be away from the normal setting and in a cultural setting where they feel safe to learn, reflect and explore.

Exposure to socio-technical 'realities'. Stakeholders are being asked to consider future work systems and it is difficult to do this in the abstract. They need some sense of what the reality would be like and that means providing them with experience of some form of what the future might be like. This might take the form of working with a pilot system, trying a prototype, visiting an existing implementation or working with scenarios.

Opportunities to test alternatives with other stakeholders. There are many variants of future systems that are possible and some may have significant implications for some of the stakeholders. They need some way of representing possibilities, of evaluating them from their own stakeholding perspective and of discussing the implications with fellow stakeholders.

Taken together these requirements are for the creation of a temporary organizational forum where normal business can be suspended while the future is properly considered. They are requirements for what has been called a 'transitional system' (Amado and Ambrose, 2001); a place in which it is possible to be reflective, to learn and to explore both as an individual and also as a group. In our case study work we have identified three ways in which some or all of these conditions can be created in the way the future system is made available for stakeholders to work with. Each has some strengths and some weaknesses.

Evolutionary design. To create the maximum amount of time and space and give users a direct taste of the future 'reality' the best solution is often to introduce part of the change early, see what behaviour emerges from it and use this as the guide to future developments. Ideally this is done within an action research framework in which evidence of user behaviour in the new system is collected and fed to a representative body of the stakeholders that can make decisions about the next stage of development. If this occurs in a number of iterative cycles the user representatives have available a growing body of 'real' evidence and are in a well-informed position to make decisions about incremental development. In our cases we found that we could follow this pattern in circumstances where the main user groups were professionals with discretion over whether they made use of the new technical facilities available to them, e.g. the academics, librarians, healthcare professionals etc. who were offered electronic library services. In the electronic journals case (Eason et al., 2000), for example, the initial assumption of the developers was that users would value multimedia electronic publications with embedded video, links to data bases etc. Giving users access to an early form of electronic publications service and evaluating their behaviour with the service demonstrated that what they wanted was text-based publications delivered to their local workstations. The 'bells and whistles' could wait; what they wanted was easy access to documents in the form they knew and understood. This data changed the views of stakeholder representatives and led to a radical change in the systems developers' strategy. The strength of this approach was that the stakeholders were exposed to the reality and had the discretion to respond how they saw fit. As a result the system evolved to meet their needs. The weakness was that there was no significant debate among the stakeholders about socio-technical futures and it was not easy to represent and evaluate a range of options. The process tended to focus on technical developments and organizational change, such as the impact on the librarian's role, was not a focus of attention.

Working with pilot systems. On many occasions it is necessary to introduce a new system into an organizational setting in an almost complete form. There may be opportunities to mount a pilot or trial system in part of the organization and for this to be evaluated before the full system is 'rolled out'. A pilot system of this kind is a very good reality test because, if it is used in an operational mode, it has to be a fully functioning socio-technical system. It provides the stakeholders who use it and others who visit it with abundant evidence of what this particular future would be like. Ideally the experience of such a system is then reviewed by the stakeholders and changes, major and minor, made before the full system is implemented. We have had the opportunity to work with pilot systems in several cases. In freight forwarding case (Klein and Eason, 1991), for example, a pilot system was introduced which linked three branches so they could share information about loads being sent and received. The system worked well at a clerical level but the local management quickly realized it meant cooperation between branches that would affect their autonomy. As a result the technical system that was implemented was a stand-alone system for each branch with no sharing of information between branches. In electricity distribution (Eason, 1996) a pilot system was introduced which made communications between staff in the office and on the road much more reliable. However, the staff soon realized that it made central control much easier and it was withdrawn while a new set of role responsibilities and roles were worked out and a technical system designed to support them. The advantage of the pilot system in both of these cases was the socio-technical reality it made apparent to stakeholders; the implications of these changes had not been appreciated by the stakeholders when they had seen the proposals 'on paper' but they became crystal clear when the pilot was implemented. The disadvantages of this approach are that pilots are expensive to mount and it is difficult to try out alternatives. There may also be substantial investment in the pilot and it may be difficult to stop or vary the system before its wider implementation.

Working with scenarios, prototypes and simulations. If it is not possible to implement something 'for real' an alternative is to represent the possible future system in as concrete a way as possible 'offline'. This may be in paper form by preparing a scenario or a narrative that describes how the future socio-technical system might work. Or it might be a real prototype of the technical system set within a description of how it might function within the work system (Carroll, 1996). A more real but more expensive solution is to mount the prototype in a simulation of the work setting, for example a simulated office, which stakeholders can use to do simulated work. The advantage of these approaches is that it is possible to explore more alternatives and, for example, to really explore different forms of work organization. The disadvantage is that the representation is some distance from reality and stakeholders may not be confident in their assessments of implications. Nevertheless, if they are given opportunities to engage with these representations and to think through the implications, our evidence is that these techniques can be powerful in empowering stakeholders when it comes to real design decisions.

In another electricity distribution case (Eason et al., 1995), for example, a prototype expert system was developed for power engineers and a scenario for its usage was constructed. When this was evaluated the stakeholders became concerned that too much of the decision making was being invested in the computer system with potential safety implications. At the same time an evaluation of the interface of the prototype showed that it had major implications for the way the engineers did their tasks. As a result of these evaluations at different levels, the technical system and the socio-technical scenario were completely rethought so that the expert system became a general purpose, mobile 'assistant' for the power engineer. When the technical system was first proposed and built none of these implications were apparent to the stakeholders.

In another example, Klein (2001) reports the use of a scenario to aid design decisions in a hospital. A scenario had been constructed of a patient who became known as 'Poor Old Henry' because he had many things wrong with him and needed the attention of many hospital services. The stakeholders from the various services were able to use 'Poor Old Henry' to evaluate the impact on them of new developments and because all stakeholders could share in the fate of the patient, the scenario acted as an integrating vehicle in considering how the proposed, integrated system might work.

These examples are different ways in which stakeholders can be helped to appreciate the implications of new system proposals and to begin the process of making their own contribution to the design of their futures. The striking feature of all these cases is that, when they first encountered the new proposals, stakeholders could not see their human or organizational implications. After working with them in these ways they understood what the issues were and felt able to engage in the systems development debate.

Conclusion

So are human factors now more human? I would conclude that they are a lot more human than they used to be but not nearly as much as they might be. The HCI community is now much more consciously humanistic than it was. But it still tends to treat the design of the technical system as the whole story and, however good the tools, they can still be used to exploit rather than empower the end user. We have made considerable progress in rethinking the way systems should be designed and implemented but it is still about technical systems rather than integrated socio-technical systems. It is now much more likely that users will be able to play a part in the design process so that they can take advantage of the new technology on offer. Unfortunately this empowerment is creating its own problems and the opportunity to have a major impact is often lost. I am reminded of the broader issue of the development of democracy. Years of toil not to mention the spilling of much blood have given many countries strong democratic institutions that enable their citizens to exercise control over their governments. And yet, in many of those countries, large numbers of those citizens do not exercise their right to vote. We have come a long way in creating the institutions at work by which people can influence the future design of work organizations. We now have the hard work of creating the conditions in which people are willing and able to take full advantage of these opportunities. The processes I have described by which stakeholders can first learn and then contribute to design are not easy to undertake and we have a lot to learn about how to make them effective. Without them we are in danger of missing Niels Bjørn-Andersen's target by offering the users empowerment without helping them to make use of it.

10 'Human-centred' computing: a new perspective?

Liam J. Bannon

Prologue

I first met Niels Bjørn-Andersen when we were both on the International Programme Committee for an EU Conference on the Information Society chaired by Enid Mumford (Bjørn-Andersen et al., 1982). In 1985, I met him again, this time in California at one of the early human–computer interaction conferences (ACM CHI), and then I spent a period at the Copenhagen Business School with his group that summer, before my travels in Asia. On my return, I again spent a month with Niels Bjørn-Andersen at the CBS in January 1988, where we produced a paper for one of the earliest workshops on CSCW in Europe (Bannon et al., 1988). I had heard Niels Bjørn-Andersen give a talk with the provocative title: 'Are human factors "human"?' (subsequently published as Bjørn-Andersen, 1985) that resonated with my experiences in the human factors field. My work since that time has increasingly come to question the adequacy of our understanding of the human aspect of computing, and the following continues this concern.

Introduction

This chapter discusses the emergence of a more 'human-centred' approach to computing from a rather personal point of view. I would argue that there is a significant paradigm shift in the computing field towards this human-centred approach that has been slowly gathering momentum over the past quarter century, and is now beginning to move from the periphery of the computing field to a more central role. The issues at stake here are, in my view, substantive and may have profound implications for what and how we teach students about computing in the coming years. Thus it is not simply the need to (occasionally) talk about issues of computers and society – often the label of a lightweight course that has been added almost as an afterthought in many computing departments – nor simply the need to incorporate courses relating to the user interface and human–computer interaction. Rather, what is involved is a radical rethinking of the computing field, and a shift in emphasis from aspects of the hardware and software to aspects of the human, social and organizational contexts within which information and communication technologies are both being constituted and used. In this chapter I mention some of the people who have led the way towards a more encompassing view of computing, but focus more on my own personal odyssey in attempting to understand computing as a human activity, and the possible implications for how we design and use information systems, and how we conceptualize 'computing' more generally.

The pioneers

Many people have been involved in the attempt to shift the focus of computing – and informatics more generally – away from a purely technical approach concerned with hardware and software only, to one that considers the human activities of design and use of information systems as being of central concern. Many of these people have come from the Nordic countries. People such as the late Kristen Nygaard, who argued for a perspective on systems development that included the social and political, as well as the technical. People like Peter Naur, whose compilation of papers was published under the title 'Computing: A Human Activity', and which showed terrific insight into the human side of programming and systems development. People like Christiane Floyd, from Germany, who presciently wrote of different paradigms in software engineering. In the US, the late Rob Kling spent many years as an advocate of a more open computer science (CS) discipline he labelled 'Social Informatics'. More recently, a number of senior figures in the field have put their hats in the ring: Bo Dahlbom, with his paper on 'The New Informatics'; Peter Denning, of the US, arguing for a new and more expansive computing profession; Denis Tsichritzis, critiquing much old-fashioned computer science as being akin to 'electric motor' science; Peter Wegner, arguing that interaction is more powerful than algorithms; and Terry Winograd, one of a number of people involved in bringing the larger field of design into computing. All of these authors, despite significant differences in their messages, share a critique of how the field of computing and the academic discipline of computer science has been defined, circumscribed, and taught to students, and all advocate a more 'human-centred' approach, in one form or another. In reflecting on our educational system, Denning (1992) notes: 'A curriculum capable of preparing students for the shifting world must incorporate new elements emphasising design, demonstrated proficiency, effective interaction with others, and a greater sensitivity toward the historical and cultural spaces in which we all live and work.'

The issue here is not simply providing computer science students with a rounded education, but more fundamentally questions the very nature of the discipline, arguing that human activities and interests are part of the core of the computing discipline, whenever we conceptualize, design, build, and test new technologies.

This alternative view of computing has led to the slow emergence of what is beginning to be termed, in some quarters, 'human-centred' computing. The label may appear somewhat meaningless, as who would subscribe to an alternative 'system-centred' computing label, but, just as the label 'user-centred design' in the field of human–computer interaction hit a chord in the 1980s, it may be the case that the 'human-centred computing' label will have a similar re-orienting effect on the field of computing in the early 2000s. Likewise with other new terms that are appearing currently. Concerns expressed in such emerging areas as the 'new informatics', and 'interaction design' are, in my opinion, examples of shifts in perspective, in the information systems and human–computer interaction communities respectively, towards a more wholistic view of human–systems interaction that begins to privilege the human, social and cultural aspects of computing. Note that these are not simply surface changes, nor should they be viewed simply as ancillary issues in relation to the dominant computational approach, but rather they raise foundational issues for the field of computing *per se*. The reasons for this shift in perspective are, I believe, many and varied, with some impetus coming from the very nature of the new technologies themselves, e.g ubiquitous computing. This chapter is not the place to provide a detailed and densely argued case for the evolution and definition of this new perspective.[1] Rather, in what follows, I will provide a personal view on this new perspective, showing some of the topics that it would need to grapple with in a more substantive fashion than heretofore, based on my own research path over the years.

A human activity-centred view of computing

My personal perspective on computing is one that views the technology from a tool, or sometimes a mediator, perspective. This approach focuses on understanding human activity, from a variety of perspectives, all of which seek to provide useful and pertinent observations on human action in the world. What is common among this work is a highlighting of the user perspective, examining how people accomplish their goals – with and through other people, and at times, other media. While technology may play an important role in these human activities, often

1. I am currently engaged in writing just such an article. A recent book covers aspects of this perspective shift (Dourish, 2001).

the use of the technology is as an intrinsic mediating influence, rather than being the goal of the activity. The relevance of this approach to technology development is that it provides a distinct perspective that encompasses many of the key issues being faced by computing technology developers today – issues such as *awareness*, *context*, *interaction*, *engagement*, *emotion*. All of these aspects concern the activities of human actors in a (variety of) setting(s). I have been involved, over the years, in extending the design boundaries of HCI (Bannon, 1985; 1986a,b,c), grappling with issues of context and with alternative frames for theorizing about human–computer interaction (Bannon, 1990, 1991; Bannon and Kaptelinin, 2000) developing our understanding of cooperative work in CSCW (Bannon and Bødker, 1991; Bannon and Schmidt, 1991; Schmidt and Bannon, 1992), understanding the role of work practices in organizational learning and memory (Bannon, 1998; Bannon and Kuutti, 2002), and more recently, in working on a framework to understand the field of interaction design, dealing with issues of meaning, engagement and emotion (Aboulafia et al., 2001). What might appear to be somewhat unrelated topics, taken from one perspective, can be seen to be integrated from another.

This perspective is one that takes the term 'human-centred' to mean more than simply 'considering the user' in technology development, but rather places our understanding of people and their practices to the forefront in the design of new technology. The issue here is not simply one of values, although explication of the underlying values inherent in technological designs is certainly important, but requires us to understand human activity in the world. This perspective is inspired by a number of theoretical perspectives, including phenomenology. Applying phenomenological methodology (and hermeneutics) to design was suggested by Winograd and Flores (1986), whose work has had a significant influence on the development of recent 'human-centred' approaches to computing. Moran and Anderson (1990) have proposed as a specific paradigm for design, the Workaday World, which 'puts the technology in proper perspective', the perspective of the lifeworld (*lebenswelt*) of people working. This paradigm, also motivated by phenomenology, draws on the works of such figures as Husserl, Habermas, Heidegger, Schutz and Luckmann. The notion of 'lifeworld' is defined as the sphere of practical activity and commonsense reasoning (derived from Husserl). It is a description, from the view of a particular 'actor', which captures the experience of that actor, involving three aspects: technology, social relationship, and work practice. Ehn's (1988) notion of 'work-oriented design' within the participative design tradition also draws on this phenomenological account. Ehn argues that a Heideggerian approach to design creates a new understanding of the process of designing computer artefacts that 'help focus on the importance of everydayness of use as fundamental to design'. The

Scandinavian work on participatory design in systems development – from the late 1970s onwards has had a significant influence in 'opening up' the computing and more general information systems fields to aspects of human activities relating to the design and use of technology.

Another of the major conceptual frameworks that we have found helpful in developing our understanding of certain computer-related issues, specifically in human–computer interaction, is what is commonly termed (cultural–historical) activity theory. This framework shifts attention away from the interface *per se* and focuses on computer-mediated activity. We believe that this shift in focus is extremely important if we are to develop truly useful and usable systems that support people in their everyday activities. The framework emphasizes the concept of mediation in all human activities, and its strongly historical approach provides us with a powerful tool for viewing the computer system as yet another, albeit much more powerful and flexible mediational device that is used by people to accomplish certain goals. While the conceptual framework can be at times obscure, it provides a useful conceptual tool for understanding such issues as user goals, mediational means, work context or environment, and collective human activities. What is of interest in this approach is a more theoretical framing of certain issues which are difficult to conceptualize within, for example, traditional information-processing accounts of human behaviour. For example, the problem of context, which has become more and more recognized as a crucial issue for useful theory and empirical work, is built into the very basis of the theory, in terms of activities. 'An activity system comprises the individual practitioner, the colleagues and co-workers of the workplace community, the conceptual and practical tools, and the shared objects as a unified dynamic whole' (Engeström, 1991). The conceptual framework of activity theory can be presented as a set of underlying principles. The basic principles of the approach include: object-orientedness, internalization/externalization, tool mediation, hierarchical structure of activity, and development (Bannon and Kaptelinin, 2000).

In our own HCI work over the years, we have attempted at both a theoretical and practical level to improve the accessibility, usability and utility of technology for people. We have emphasized the importance of viewing the computer as a medium through which people interact, and not simply as a calculator or even a tool (Bannon, 1986c). We have emphasized the fact that people are attempting to accomplish an activity through computers, and not simply 'using the computer' as an end in itself. Thus the issue is not improving instruction for computer users, but making more effective tools and media that help people in different walks of life accomplish their goals. Thus, the problems people have with computers are seen not as a lack of 'computer knowledge' but a failure of designers to understand the nature of the work and the work setting. We prefer to speak of 'computer-mediated activity' rather than 'human–computer interaction' for the same reason. Our work has contributed in the shift from a system-centred to a user-centred design process (Norman, 1986). We have also emphasized the importance of participatory design practices as a way of ensuring that the designs we develop truly meet the needs of people (Bannon, 1990). We also highlight the importance of studying use as a prelude to design (Bannon and Bødker, 1991). We study use throughout the design cycle, through developing mock-ups and scenarios of future use that allow people to experience the future use situation, and then again, in developing early prototypes of systems that can be tested, so that the results of these tests can be fed back into the design process in order to improve the system (Grønbæk et al., 1993).

The situation today

The focus on human activities mediated by technologies throws up a number of issues for further exploration. While issues such as 'context' and 'awareness' have been discussed in different research communities for many years, including such interdisciplinary communities as HCI and CSCW, it has only been in the past five years, with the emergence of the ubiquitous or pervasive computing field, that such topics appear to have 'leaped the divide' and become respectable topics to be discussed in more mainstream computing and communications technology research. Unfortunately, the fact that certain topics have now become legitimate does not imply that the understanding of the topic has progressively deepened. Thus 'context' often becomes reified, and reduced to a 'thing' which can then be explicated in terms of a small set of parameters, such as roles or settings. Personally, and playing devil's advocate here, I do not feel that this kind of approach to 'context' will get us very far. From a more activity-centred viewpoint, one would argue that 'context' is not something that is somehow 'fixed' and 'out there', but rather is itself partially a construction of particular actors in particular settings. This is important, in that it raises questions as to how one can develop mechanisms that will automatically determine relevance and context, if these are concepts that are difficult to formally define.

If we look at the field of CSCW, the focus has been on cooperative work arrangements that emerge as a result of the nature of the actual work being performed. Thus there is an emphasis on field studies in specific work domains. While traditional task and work analysis methods from work psychology and sociology can contribute here, much interest has centred on more qualitative, interpretive, ethnographic studies of work practices in an effort to understand more fully the ‘artful practices’ of ensembles of workers as they accomplish their work activities. While more traditional sociological and anthropological concepts – division of labour, issues of power and control, symbolism, etc. – are of importance to CSCW, there has been particular interest in ethnographic studies, chiefly of an ethnomethodological nature (Button, 1993). This perspective is distinct from earlier critiques of neo-Taylorist management approaches, such as that of Braverman and the labour process school, in its emphasis on the detailed observation and understanding of the mundane practicalities of ‘getting the work done’. The emphasis in these studies is on the work that members do in order to make their work accountable to themselves and each other, focusing on the ‘working division of labour’ (Anderson et al., 1989) as distinct from viewing the division of labour as an analytical category. This work seems of particular relevance to designers of CSCW systems, where lack of attention to such matters as how the work is actually accomplished by members of the working community has led at times to the development of systems that fail dramatically (Harper et al., 1991).

It is my belief that much of the contribution of the past 15 years of research in the CSCW community has been to clarify our understandings of many mundane, and seemingly well-understood terms such as ‘procedure’, ‘awareness’, ‘routine work’, ‘training’, ‘situated action’ etc. Note that this is not simply a terminological exercise, but has huge importance for the kind of technological research agenda that will offer results that are acceptable to the end user population. Thus, many of the ethnographic, workplace studies performed in CSCW have provided very useful resources for the development of more appropriate design scenarios. The anthropologist Pat Sachs draws on both general ethnographic and activity theoretic backgrounds for her perspective on work (Sachs, 1994). Her critique builds on that of figures such as Wynn, Suchman, Blomberg, Orr, Scribner, Hutchins, and herself and others on the nature and organization of everyday work practices. This body of work, through critical argumentation and extensive field work, has begun to have an impact on a number of fields – including management studies, business administration, information systems development, organizational behaviour, job design, human resource management, training, etc. This increasingly prominent view reconceptualizes the nature of work and organizational life, and the role of information technology support. It emphasizes work practices, and the way learning is accomplished within communities of practice. It argues that learning and action are ‘situated’ (Suchman, 1987), and that work is accomplished via artefacts, in conjunction with others. Much of this work has helped to shape the field of CSCW (Schmidt and Bannon, 1992). Sachs (1994) argues passionately and cogently for the need to reconceptualize the nature of work, away from what she terms an 'organizational' view, to one she labels 'activity-oriented'. To synopsize these perspectives the organizational view is still the predominant one in organizations today, grounded in scientific management ideas, focusing on training, tasks, procedures, workflow and teams, in contrast to the activity-oriented view focusing on learning, know-how, networks, conceptual understanding, work practices, judgement, and communities (of practice).

The contrast is between the 'documented, visible and articulatable' versus the tacit, silent and 'only-understood-by-the group'. Understanding business process needs to be informed by business practices on the shopfloor, as detailed in Chapter 4 of Brown and Duguid's book, *The Social Life of Information* (Brown and Duguid, 2000) entitled 'Practice Makes Process'. They note the distinction between the concepts embodied in process models and workflow representations versus the tacit, implicit, embodied and unarticulated knowledge inherent in work practices, and point to the importance of the concept of 'communities of practice' (Lave and Wenger, 1991) – the basic social unit in which work gets done and in which these skills are shared, learned, and evolved. As Sachs notes: 'Because the people who design business processes are ordinarily not the individuals who do the hands-on work, and because business process designers tend to think organizationally rather than employing work thinking, the fund of knowledge about details of work process are generally not incorporated into work process designs. (Sachs, 1994).

A look into the future

Despite the rhetoric concerning the Information Society and the scenarios of Ambient Intelligence, what is remarkable is how little human beings have changed their goals, aspirations and even activities over the past half-century. New technologies are appropriated to fit into these more enduring concerns, of working, learning, meeting friends, searching for meaning in our lives. We need a rich understanding of the human, social and cultural world in order to design technological artefacts and environments that people find useful, usable and engaging. We should learn from the failures of certain kinds of proactive, technology-push, applications. People do not want to be inundated with 'information'. Their needs change depending on the situation they are in, so it is difficult to satisfy their needs simply by means of personal profiles or adaptive systems. Again, playing devil's advocate, I would strongly urge that developers explore design spaces that do not assume advances in machine intelligence, nor detailed user models. Computers can work on behavioural data, and reflect this back to people, without needing to 'interpret' its meaning. The interpretation of information should be left in the human realm, what computers can do admirably is collate and present information in a myriad of ways. This is in strong contrast to much of the Ambient Intelligence approach, which appears to smuggle many traditional Artificial Intelligence ideas back into the world of ubiquitous computing, despite the failure of the earlier AI approaches in attempting to model human intentions and behaviour.

As I have indicated throughout this chapter, it is my belief that there needs to be significant research work to provide more integrated conceptual frames for understanding human activity in the world, which can serve as an inspiration and motivation for developing design scenarios involving 'ubiquitous technology' that can in turn orient technological developments. While there is significant work in mobile technologies, one of the few areas where Europe has a lead, much of the work within the ubiquitous computing paradigm appears to lack any clear motivation, in terms of augmenting practical human activities. We need to develop alternative design frames that go beyond such concepts as 'the intelligent home', which almost invariably seem to be led by technological fantasies. In Europe, we have a strong philosophical, sociological and anthropological research tradition that should be able to make a significant contribution to the articulation of more realistic scenarios for life in the future than those derived purely from technological fetishism. We are beginning to see the emergence of an approach to technology that is informed by an understanding of our social and cultural world. This can be seen in our developing understanding of how work gets done, of the importance of human networks, of how knowledge is not viewed simply as a thing to be delivered, of what motivates people. We need to build on this understanding, rather than ignore it.

Concluding remarks

In this chapter I have noted the emergence of a new perspective on computing – human-centred computing – that views computing within a broader frame of human, social and cultural activities. I have outlined my own personal interest in this topic over the years, and other developments that I feel are important to the understanding of this emerging paradigm. My interest in understanding human activities mediated by technology has spanned a number of years and topics, as noted earlier. Early work focused on individual activities (e.g. Bannon et al., 1983), and more recent work examines behavioural aspects of human activities in public spaces (e.g. Ciolfi and Bannon, 2002). The relevance of this paradigm for implementing successful ubiquitous computing environments is beginning to be recognized, with a growth of interest in activity-centred computing, as distinct from application-centred, or document-centred, computing paradigms (see, for example, Christensen and Bardram, 2002). I see the articulation of this activity-based frame for ubiquitous computing as being a major objective for work in my research group, and a substantial contribution towards an alternative ubiquitous computing development paradigm. This work will merge creative exploration of the possibilities of new technologies, in terms, for example, of new physical interfaces and multimodal capacities, with a clear design focus that starts out with issues of relevance for our society today. We are designing computationally enhanced artefacts and environments, from a human-activity theoretical perspective, and testing and prototyping them in a variety of work and play spaces. I, and my team in the Interaction Design Centre at the University of Limerick, passionately believe in creating a future that, while exploiting the innovative nature of the new technologies, is also rooted in a background and understanding and that is sensitive to, and builds on, our unique cultural traditions, and on our human values. We attempt to link these concerns in our work on emerging computing paradigms through our focus on human activities, and on the way they may be enhanced, supported and transcended with, by, and through novel interactive forms. Our design ideas have been influenced by several core themes that we have attempted to incorporate in our design thinking. Listing them briefly here, these are:

- *Human activity* – as a fundamental aspect of human being in the world
- *Materiality of objects* – the central role of material artefacts in human culture
- *Engagement* – the need to excite, motivate, enhance the user experience
- *Interaction* – human play with objects being seen as a narrative activity, not as simple action-reaction (mouse event–action pairs)
- *Multimodality* – incorporating several sensory modalities – visual, tactual, kinaesthetic, sonic, auditory
- *Sociality* – creating artefacts or assemblies of artefacts that allow for collaborative activity
- *Augmentation* – viewing the computer as a medium or tool for human actions, not as an intelligent butler or agent that attempts to model us.

I believe that, in Europe especially, we have a real opportunity to develop a distinct approach to the emerging field of ‘human-centred computing’. This is because of its history and cultural diversity, and its rich tradition in several fields, including anthropology and design, which I believe will play an increasingly important role in further technological developments. The recent formation of the EU *Convivio* Network, the network for human-centred interactive design, is just one more indicator of this trend towards a truly ‘human-centred’ computing.

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11 The study of information technology in developing countries

Chrisanthi Avgerou

Introduction

In the summer of 1984, concern that the benefits of Information Technology (IT) were not reaching developing countries was raised in two different Technical Committees (TC) of the International Federation for Information Processing (IFIP), TC8 on computers in organizations and TC9 on the Social Impact of IT. Each of them set up a task force to examine appropriate action, chaired by Niels Bjørn-Andersen and Subhash Bharnagar respectively. Bjørn-Andersen and Bhatnagar decided to organize a joint conference on the 'Impact of Information Systems on Developing Countries' aiming to explore the status of knowledge in this area, to disseminate useful practical lessons, and to identify major problems that inhibit the use of IT for development. The conference, which took place in 1988 in New Delhi, launched a research stream on IT in developing countries (Bhatnagar and Bjørn-Andersen, 1990). The assumptions on the significance of IT for development it adopted, the kind of knowledge it aspired to produce, and the ambition to involve as many researchers from developing countries as possible created the long-lasting characteristics of a research community on IT and development. Indeed, the conference led to the formation of an IFIP Working Group, WG9.4, on the social implications of IT in developing countries, which kept this research area active with the organization of seven conferences so far.[1]

In the 15 years since Bjørn-Andersen and Bhatnagar launched WG9.4 many other initiatives have contributed to form an arena of debate, research and action, including specialist journals[2] and influential research

1. These conferences produced a stream of the following publications: Avgerou and Walsham (2000), Bhatnagar and Odedra (1992), Korpela et al. (2003), Krishna and Madon (2002), Odedra-Straub (1996), Roche and Blaine (1996) and Sahay (2000).
2. *IT for Development*, the *Electronic Journal on Information Technology in Developing Countries* (EJISDC), and more recently *Information Technologies and International Development*.

centres.[3] Since the end of the 1990s a surge of attention to the 'problem' of the untapped developmental potential of IT in poor countries has been expressed through the discourse on the digital divide in international development organizations (Mansell and Wehn, 1998; UNDP, 1999), academia (Castells, 2001; Norris, 2001), and the popular press throughout the world. Many high profile initiatives have been undertaken, typically aiming to create awareness of the benefits of IT, to raise investment, and to promote policy measures for the deployment of telecommunications infrastructures and the diffusion of IT applications in all societal sectors. Notable examples of such projects include the Digital Opportunity Task Force of the eight major industrial nations, (Dot force initiative, http://www.dotforce.org), the World Summit for the Information Society of the United Nations and the International Telecommunications Union (WSIS initiative, http://www.itu.int/wsis) and the World IT Forum of the International Federation of Information Processing (WITFOR programme, http:// www.witfor.lt). Amid all these, WG9.4 continues to provide a forum for the presentation and discussion of IT innovation efforts in developing countries and combines knowledge relevant for practice and the socio-theoretical study of emerging concerns.

In this chapter I discuss the current state of the field of knowledge on IT and development, mainly taking stock of the conferences and publications produced by the WG9.4. Having attended all conferences and chaired the Group for six years, I have followed its development, its persistent concerns and achievements. My review of the profile, and the contribution of the IFIP WG9.4 research in this chapter, is based mainly on my understanding of the efforts of the Group as an 'insider'. I refer selectively to papers published in the proceeding and the debates taking place during the conferences in order to clarify and substantiate my arguments.

The chapter is structured as follows. In the first section I trace the unfolding of this research domain since its formation and identify its most salient epistemological features: the change of its themes and issues from a largely instrumental transfer of knowledge from the mainstream information systems research to focusing on topics of specific relevance to developing countries and its mix of instrumental and analytical approaches; the emergence of its concern with the difficulties facing the successful implementation of IT applications in developing countries; and the significance attributed to the diversity of socio-economic context within which IT is used. In the second section I discuss the way this research is confronted by and makes efforts to grasp the thorny issues of IT and development. I explain why the study

3. For example, the Centre for International Development, Harvard University, and the Center for Research on Information Technology and Organizations, University of California, Irvine, CRITO.

of the pervasive obstacles met in the implementation of IT infrastructures in developing countries comes to be confronted with the validity and effectiveness of the current efforts of 'development' in general. Furthermore I argue that research on IT in developing countries necessitates theoretical investigation of the notion of development and empirical study of its practice. In the conclusions I highlight an inherent contradiction between the wish of the Group to contribute 'constructive' knowledge on how developing countries can use IT successfully to improve their life conditions and the evidence accumulated by its research that IT is loaded with non-feasible – and often for many largely irrelevant or even undesirable – developmental visions and socio-economic actions.

Contours and features of a research field

A good start in tracing the main features of the research field on IT and development launched by the New Delhi conference is the challenging remarks of one of its participants at the end of the 2002 WG9.4 conference in Bangalore on 'ICTs and development' (Krishna and Madon, 2002). In her informal assessment of the conference, Odedra-Straub concluded with a sense of disappointment that 'nothing much had changed' since the early conferences of this Group that she had organized or attended.[4] The feeling that nothing much has changed in the discourse on IT and development is not rare among researchers in this field. Unlike the exuberant research in the general information systems field, which addresses phenomena of ubiquitous technology-mediated socio-economic transformation, studies of IT and development witness slow technology diffusion often making no substantial difference in the conditions of organizations, societies and economies.

In general, there are different interpretations regarding the nature of the problem, but the main concerns articulated by Odedra-Straub frequently surface in the WG9.4 conference debates, and therefore I take her views as a starting point in my review of the object of study of this Group's research on IT and development and its knowledge contribution. Specifically, Odedra-Straub's main comments were that no progress is suggested in the themes and issues addressed at the conference; that while case studies of pilot projects continue to convey

4. Mayuri Odedra-Straub was one of the main contributors in the field until the mid-1990s (Odedra, 1990; Bhatnagar and Odedra, 1992; Odedra et al., 1993; Odedra-Straub, 1996) and her attendance of the Bangalore conference was a re-entry into the field after some years' absence. She published her opinion in: 'A way forward… Report on the IFIP WG 9.4 Conference, Bangalore, India' (2002). *Electronic Journal of Information Systems in Developing Countries*, **10** 1, pp. 1–2.

positive messages about the way IT can assist development, case studies that report on experiences of implementation show mostly difficulties and obstacles. Moreover, she observed, the debate is still unproductively preoccupied with culture, policies and strategies, and even with the meaning of development rather than deriving useful lessons on how failed projects can be avoided and how successful uses of IT can be replicated and sustained.

I will argue here that indeed the conference proceedings and the other publications from the WG9.4 conferences, while they came gradually to focus better on application areas on relevance to developing countries, provide empirical evidence that demonstrates a gap between the perceived potential of IT for development and the initiatives taken to exploit this potential on the one hand and the realization of such potential on the other. However, I will further argue in this section that far from being scholastic indulgence, theoretical investigation of the socio-economic conditions within which IT is mobilized to assist in development is of paramount importance and contributes to understanding the observed problems of implementation experiences reported from the field.

Themes and issues

The fundamental tacit assumption behind the contributions at the New Delhi conference in 1988 was that IT can propel improvements in the life conditions in the so-called developing countries. This was a taken-for-granted position, hardly in need of explanation. To the extent that authors felt the need to justify it, mostly as an introductory rhetorical device rather than a matter of analysis, they referred to the experience of the use of computers and their perceived impact in industrialized countries (Bhatnagar, 1990).[5]

The themes discussed at that conference and the recommendations for action reflected those that were studied at that time by information systems academics and practitioners in the industrialized countries. For example, Mohan, Belardo and Bjørn-Andersen (1990) argued that business organizations and public administration in developing countries should think of IT not as devices that speed up data processing but as systems capable of supporting managers in their problem solving and decision making. They conveyed the then emerging arguments on the 'strategic' nature of IT and recommended

5. While the developmental potential of IT was considered obvious to the conference participants, many authors identified as a main obstacle for realizing it those 'others', such as government officials or practising professionals and managers, who either are unaware of the possibilities of technology and should be informed about it, or their personal interests are served by perpetuating conditions of underdevelopment and should be made to change.

the adoption of relevant methods, such as 'critical success factors'. Similarly, Rao (1990) introduced the notion of decision support system (DSS) and demonstrated its merits in a case study concerning the design of irrigation networks; Goonatilake (1990) argued about the relevance of computer-aided production management (CAPM); Sanwal (1990) made recommendations for end-user computing in the government sector; Heeks (1990) assessed the significance of fourth generation programming languages for the Indian software industry; Bell and Wood Harper (1990) argued for the adoption of suitable systems development methodologies.

The transfer of themes and perspectives from the general information systems field continued in the conferences and publications of the following years. Not surprisingly, new technologies that came along and salient topics in the research agenda of the information systems field – such as business process re-engineering, outsourcing, and improvisation – featured in several articles of IT and development research. But, with few exceptions,[6] the IFIP WG9.4 research community has avoided advocating the merits of the latest IT products, applications, and practices for developing countries. In general, most transferred themes had an ephemeral presence in WG9.4 conferences, no matter how major they were in the general information systems field. For example, there has not been a stream of research on DSS advocating their relevance and value in the decision-making conditions of the organizations in developing countries heralded in the first conference. Business IT strategy (Elliot, 1996), microcomputers in government administration (Oyomno, 1996), artificial intelligence applications (King, 1992) are examples of topics that were introduced in subsequent conferences but did not sustain continuity of attention.

Instead, a number of thematic streams of relevance specific to developing countries became clearly visible over the years. Some, such as on geographic information systems (Madon and Sahay, 1996; Borges Albuquerque de Vascocelos and Sahay, 2000; Puri, 2002) and systems development methods appropriate for developing countries (Korpela, 1996; Korpela et al., 2000a,b; Soriyan et al., 2002), rely on the longitudinal research of individuals or small teams of researchers. But, more importantly, specific major areas of focus have emerged among the miscellaneous contributions and came to be debated in multiple sessions of recent conferences (Sahay, 2000; Krishna and Madon, 2002): software industry, information systems in the health services, information technology in education, and more recently information telecentres. Each of them is sustained by a substantial number of researchers and is diverse in terms of geographic origin of the researchers, their empirical material, and research issues.

6. For example, King (1992).

Meanwhile the main orientation has gradually shifted slightly away from advocating the value of technologies and deriving good practice lessons for achieving such value. There is a discernible reorientation towards the study of efforts in developing countries to implement new technologies and technology-mediated practices and to sustain them, particularly since the 1998 conference in Bangkok which had as a main theme 'implementation and evaluation of information systems' (Avgerou and Walsham, 2000). Nevertheless, this change of orientation from deriving and disseminating lessons on what IT offers to the process of development to investigating the messy and very often unsuccessful efforts to utilize IT in developing countries is a contentious issue, as Odedra-Straub's comments above suggest.

Research orientation

At its outset, the WG9.4 research was concerned with identifying the obstacles that impede the realization of the developmental potential of IT but its aspiration was to work out suggestions for overcoming them and to offer guidance for effective courses of action by governments and organizations. The main obstacle to using IT in developing countries was obviously economic; computers were too expensive for the organizations of developing countries to afford. A set of chapters in the form of 'country reports' made clear the issue of scarcity of technology, providing indicative statistics that showed the extent of this problem.[7] Yet, this was not seen as an insurmountable problem. Three solutions are discernible in the pages of the conference proceedings: technology advances on a trajectory of more powerful, more versatile and much cheaper machines; development of industrial capacity for the production of technology within developing countries; and elimination of government tariffs on the import of IT products that kept prices in developing countries higher than in industrialized countries.

I consider it remarkable that this group of researchers was not paralysed at the observation that computer technology was prohibitively expensive for countries in conditions of poverty as other institutions did. Until recently most international development organizations showed almost no interest in the way computer technology could assist their interventions in developing countries and the academic field of development studies could not see the relevance of complex and expensive technologies for the problems confronting poor countries. Brushing aside the overwhelmingly adverse economic considerations, the IFIP Group was one of the first research fora in the

7. For example, Okuwoga estimated that by 1989 Nigeria, a country of 106 million people, had about 1000 computers (Okuwoga, 1990) and Odedra's research suggested that in 1987 Kenya, with 22 million population, had 300 mainframes and 2000 microcomputers (Odedra, 1990).

1980s to direct attention towards questions concerning how developing countries could exploit the potential of computer technology as it started slowly but at an increasing pace to be diffused from its place of initial construction – the industrialized countries – to the places in most need of economic growth and social change.

However, by addressing the question 'how to' exploit the developmental potential of IT, the fledgling research community adopted initially an instrumental orientation. Little analytical effort was made to understand the way IT was implicated in the socio-economic development process. Instead, contributors were keen to make action recommendations. A distinct feature of the ethos of the WG9.4 research community has been its effort to produce constructive knowledge intended to facilitate the development process. Thus the trend was set for contributions that demonstrate the potential developmental impact of IT and provide guidance of how such potential can be achieved. This is often supported with empirical evidence drawn from the initiatives of IT-mediated interventions in organizations and communities. For example, several of the articles on the emergent theme of telecentres for rural poor communities tend to advocate their intended benefits and discuss the beginning of projects for setting them up, or the early period of their operations rather than their outcomes and their developmental effects (Best et al., 2002; Cecchini, 2002).

With the mission to contribute constructive knowledge, it remains a matter of concern for the Group how sparse evidence exists on successful implementations of new technologies and organizational practices in developing countries (Heeks, 2002). Instead of being able to show the way IT can assist the development struggle, case studies of information systems implementation continue to provide disturbing evidence of problematic technology-driven interventions (see for example Kitiyadisai, 2000). To wit, the concern that triggered the formation of the Group in the first place proved persistent and obstinate to remedy by developing good practice knowledge. Instead of contributing to making IT a tool for development the research of this Group has witnessed that increasing mobilization of resources and wider diffusion of IT and telecommunications are not being accompanied by developmental benefits (Heeks and Kenny, 2002).

That IT has become a factor for divergence between the rich and the poor is now common knowledge and indeed of widespread concern for development organizations (Bjørn-Andersen et al., 1982). For most of them the solution is to intensify the technology diffusion process and to emulate the socio-organizational practices that proved effective in promoting the developmental effects of IT.[8] The WG9.4 community has, through its research, recognized the need for a distinctly different

8. See, for example, Kirkman et al. (2002).

approach. Few of its contributions aim any more at transferring best practice from industrialized, technologically advanced economies. There is scepticism for knowledge and practices that promise to assist 'leapfrogging'. Even the concept of 'catching up', widely associated in development economics with technology innovation, has little use in the WG9.4 publications. Instead, one of the fundamental aspects of the research fostered in WG9.4 from its very beginning is emphasis on understanding local context. In his concluding remarks of the proceedings of the New Delhi conference, Bjørn-Andersen stated: 'And this is what the conference and indeed the book is about: *context*' (Bhatnagar and Bjørn-Andersen, 1990, p.280, italics in the original). The significance attributed to context featured repeatedly in calls for papers and titles of recent publications (Avgerou and Walsham, 2000; Sahay, 2000), thus being one of the distinguishing characteristics of the Group.

The study of context

Attention to context is common in information systems studies, mainly as a pragmatic consideration of contingencies that determine effective action towards perceived imperatives that drive the use of technology, such as competitive advantage (Porter and Millar, 1984). With such a notion of context the direction of socio-economic change brought about by the new technology is predetermined by a techno-economic rationality that has demonstrably led to the impressive growth of the technologically advanced successful economies. Simply, in order to be effective in pursuing this rationality, policies and strategies on IT and socio-economic change need to take into account the social, cognitive, technological, and economic contingencies of a particular national or organizational context.

However, even from the New Delhi conference it was clear that the context in the study of information systems in developing countries comprises radically different socio-economic conditions that could not be easily accommodated in the contingency models that guided IT innovation in the economically advanced economies. Several authors, particularly the authors of the 'country reports' chapters, emphasized the fundamentally different structural socio-economic characteristics of developing countries, such as the existence of large rural populations, and the pressing needs for improving social services such as health and education (see, for example Avgerou, 1990 and Okuwoga, 1990). In comparison to the information systems literature of that time that almost totally subsumed the study of the development and use of IT to the business imperatives of the industrial organization, the highlighting of the magnitude of the rural subsistence economy and the significance of non-economic sectors for development marked a fundamentally different concept of context, in which technical/rational analysis of information systems practice could hardly be practised. Failure of introducing IT in contexts that do not comply with the techno-economic rationality that is taken for granted in information systems research was already evident in the reported case studies (Avgerou, 1990).

Thus another defining characteristic of this research has been to seek to understand the contexts that confront information systems development in developing countries in terms of their historically formed cultural and political conditions. Several researchers found it useful to adopt Pettigrew's analytical framework that allowed them to probe in the social fabric within which IT projects were embedded (Walsham et al., 1990; Madon, 1992). Initially no alternative theoretical perspective about technology and social change was offered – on the contrary, authors tended to make comparisons with 'successful' cases in other contexts and sought to derive lessons for action accordingly (Robey et al., 1990). But any analysis that associates IT with socio-cultural processes bears the seeds of subversion of the underlying deterministic techno-economic assumption about IT and development. An increasing number of theoretical articles in the WG9.4 publications has discussed the way culture and local socio-economic conditions are implicated in the perceived value and the efforts to develop and use IT applications.[9] Attention to social context in developing countries has been theoretically strengthened by drawing from a new stream of research in information systems that uses social theory, as became clear in the 2000 conference on 'Information Flows, Local Improvisations and Work Practices' (Sahay, 2000).

In other words, social analyses and attention to culture is a research effort to explain the multiple, pervasive and persistent problems that have impeded the realization of the developmental potential of IT. It is less suitable as an approach that derives lessons of how to overcoming these problems. Scepticism about the value of such analytical research is justified if one continues to aspire mainly to an instrumental research perspective aimed at facilitating competent use of technology and to disseminating lessons for practice. It is still early to see if the situated analyses of locally relevant application areas identified above – on health, community services and education – contribute to meaningful and sustainable uses of technology and improve life conditions. But they certainly contribute a wealth of understanding about IT interventions in socio-economic conditions that differ from the ones within which IT has been originally constructed.

Fundamentally, the investigation of the obstacles faced by the initiatives to introduce IT in the developing countries raises questions about the underlying IT and development ideology. And this is why the debate on 'development' is, I believe, a meaningful endeavour for researchers in the WG9.4 community. I will argue in the remainder of

9. See, for example, Van Ryckeghem (1990, 1996) and Walsham, (2000).

this chapter that without understanding whether the socio-economic changes that comprise development and towards which IT is expected to contribute are feasible or indeed desirable across the world, the constructive knowledge on IT in developing countries has no basis for assessing whether it is relevant or not.

Questioning the development notion that IT is mobilized to support

The landscape of international development has changed significantly since the 1980s. Already at that time there was concern that Africa had 'lost a decade', that is, it had faced negative growth, and slipped into recurring famines, wars, and endemically corrupt governments. Nevertheless, there were encouraging examples of industrialization and growth by technology innovation elsewhere, notably Singapore, Korea, and Taiwan (Hobday, 1995; Wong, 1996). Theoretically, the debate on development was still pursued as the confrontation of Marxist inspired views – that saw the problem of poverty in large parts of the world as a consequence of colonialism and dependency due to an unfair trade system – and modernization that advocated the spread of liberal socio-economic systems of the West (Hunt, 1989). Despite the disrepute brought to the planned economies by the bankrupt and brutally authoritarian regimes in Eastern Europe and the Soviet Union, socio-economic development was largely considered a responsibility of national government. More importantly, in both these ideologies industrialization and technology innovation were undisputed means for development.[10] National IT policies and government action to promote IT as a force for development were part of the development mechanisms, as demonstrated by the attention given at that time to the IT policy in Japan and the literature comparing national IT policies (English and Brown, 1984; Evans, 1992; Evans et al., 1992).

Since then Africa has continued to slip in deprivation, Latin American countries have faced repeated crises and the experiences of the South East tiger economies have not been emulated elsewhere. Two examples of impressive regional growth have emerged, Bangalore in India and Shanghai in China, but they remain islands of prosperity with little evidence that their successes are 'trickling down' benefits to the huge impoverished regions of their countries. Theoretically, in the currently dominant discourse of 'globalization', development is the result of internationally unrestricted market forces, and one of the most controversial issues is the extent to which governments should interfere

10. Alternative views, such as the appropriate technology movement and basic needs approach to development have always been marginal in relation to the dependency and the modernization theories.

with the global open market. According to the dominant current thinking about development, governments are needed in an open market regime to provide the institutions that serve the market – e.g. the legal mechanism to enforce property rights, education mechanisms to create required competences – but it is feared that they tend to meddle with and restrict unnecessarily the valuable market forces (World-Bank, 2002). One of the trickiest jobs of international development institutions is to judge the extent to which governments in developing countries should be allowed to keep in their hands control over the institutions of their societies, such as regulated banking (Wade, 1990; Stiglitz, 2002).

But the discourse on globalization involves more fundamental and multifaceted controversies than the one on market versus government. Pushing to its limits the logic of 'development' as economic growth that is achieved by emulating the institutional conditions of western modernity, it sparks widespread discontent and triggers voices from alternative value systems (Rahnema and Bawtree, 1997). With the challenge of a homogenizing globalization, the diversity of the ways people live their lives becomes more prominently visible. The dichotomy market or government is broken by the movement of the civil society that legitimates the action of a plethora of mediating NGOs (Kaviraj and Khilnani, 2001).

The influence of such ideological matters is discernible in the WG9.4 research. For example, at the first conference on New Delhi, recommendations for action were addressed primarily to country governments, an orientation that has changed in more recent conferences. In that conference the most significant actor in making context-specific choices and indeed the protagonist in the effort of IT innovation was seen to be the national government: for education, taxation policy, infrastructures, etc. Although a number of papers presented the rationale about the significance of IT for the competitive advantage of business organizations (for example, Mohan et al., 1990 and Goonatilake, 1990), as it was discussed in the general information systems literature of that period, the argumentation was addressed primarily to government policy makers rather than to business managers. This may have been a consequence of the recognition that one of the problematic features of developing countries was the lack of professionally trained management (Bhatnagar, 1990). Still it is significant that only 15 years ago government was seen as the main actor not only for the shaping the institutional conditions for the development of technological capabilities in its policy making capacity but also as a legitimate provider of IT infrastructures, services and applications.

Since then the research of the WG9.4 community came to assume a market environment with less government and with other legitimate actors, such as NGOs and international aid agents. Even though relatively little research effort has been devoted to issues of IT and competitiveness in professionally managed business organizations as is typical in the information systems research,[11] there are many signs that the market is taken for granted as the appropriate context for exploiting the potential of IT. For example, one of the main concerns of telecentres is their sustainability as profitable business enterprises. While most telecentres are created with sponsorship from government and international development agencies, they are not seen as public services in the way broadcasting, telecommunications, or postal services used to be, but are expected to operate as competitive business concerns. Similarly, no distributive policies to benefit wider population from the success of localized software industries are discussed. Studies of government IT policy that featured large in the first few conferences of the Group are relatively marginal in its latest conferences, apparently reflecting the diminishing attention to government as an actor in IT and development. Instead, international aid organizations and non-governmental organizations (NGOs) became prevalent as influential institutional actors in the diffusion and utilization of IT in developing countries (Madon and Sahay, 2000; Frasheri, 2002).

It is at least a plausible hypothesis that the socio-economic order set by western modernity, which development in the current era of globalization aspires to achieve, is not universally acceptable. If so, the pervasive failure of IT implementation projects and the difficulties in utilizing IT to provide the infrastructures of modern society in developing countries may be a manifestation that the universal development ideal is not meaningful in all societies. The free market economy, the democratic minimal government, the disassociation of economic activities from personal and family affairs, the entrusting of organizing of all types of collectivities on professionally trained managers may not be valued universally. Yet, IT enters all societies loaded with promises of enabling such modern social institutions. And the commonly observed difficulties of implementation and unsustainability are likely to suggest deeply rooted silent resistances to the institutions of advanced modernity.

If indeed the core problem is the unconvincingness of the socio-economic development logic that IT is mobilized to support, the constructive facilitatory research orientation that is the core value of the WG9.4 research is going to continue to be faced with disappointed results. Thus, the investigation of the ideology of development and the role IT may play in societies which are suspicious of or unable to appreciate the currently dominant development ideal is not a futile pre-occupation.

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11. However, attention has been given to IT and management in SMEs, which are thought to be of crucial importance in developing countries and more deeply embedded in local cultural conditions, see, for example, Lind (2000) and Volkow (2000).

Conclusions

In conclusion, my review of the series of the IFIP WG9.4 conference proceedings suggests the following distinct characteristics of this research stream:

1 A mission to produce constructive knowledge that aims at facilitating the utilization of IT for the improvement of life conditions in developing countries.

2 Challenging of evidence that IT implementation is met with too many obstacles and too often fails to deliver effective information systems, let alone to contribute to socio-economic improvements.

3 An effort to investigate the nature of this challenge by turning attention to the socio-cultural contexts within which IT interventions are attempted.

A tension surfaces between the first – the commonly assumed mission – and the third – the findings of the investigation of the reasons for its witnessed difficulty of realization. Probing into the social context of IT initiatives tends to reveal the limitations of instrumental knowledge when confronted with mismatched visions and mistrust to the modernizing forces. Apparently technical mechanisms deployed by IT projects are shown to threaten to subvert deeply rooted social orders and the contrary: silent acceptance of technical change often hides resistance that annihilates plans for far-reaching change. In other words, information systems research in developing countries has stumbled upon questions about the meaning and consequently the feasibility of the development end that IT is expected to support.

I believe the main value of this research community and its distinctiveness amid the many others who are committed now to promote the IT-for-development cause is its awareness of this tension. IT is a powerful technology and it is worth persevering to make it available in developing countries in relevant application areas. But it is not entering in the developing countries as a neutral tool, it is loaded with specific prescriptions for organizing business, government and society at large. In the historically developed alternative social arrangements in developing countries, the process of IT adoption and the kind of changes IT is mobilised to support are neither self-evidently an improvement of their life conditions nor feasible to pursue. The debate on development and the developmental use of IT are closely linked and it is the investigation of this link empirically and theoretically that I find of crucial importance in the WG9.4 research.

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12 Growth-nodes in a knowledge-based Europe: a research roadmap

Ramon O'Callaghan

Introduction

This chapter develops an agenda for research about knowledge management processes and the use of related information and communication technologies (ICTs) to foster 'growth nodes' and emergent strategic growth opportunities within European regions. The chapter is based on a project sponsored by the European Commission under the Information Society Technologies (IST) Programme.[1] The working hypothesis at the outset was that the development of future competitiveness in the European Union will occur through the emergence of interconnected regions or growth nodes with above average economic growth and successfully resolved issues of inequality and enhanced social welfare.

The reason for examining regional and interregional growth nodes was to understand their potential role in regional development. The project employed the term 'growth node', rather than 'cluster' or 'growth pole', because the focus was not only on interrelatedness *within*, but also on interrelatedness *between* different clusters, an attribute that seems to distinguish them from the traditional cluster. The core idea is that synergies from intra- and internode interrelatedness and competition can foster social and economic development. The focus on ICT-enabled growth nodes, it is expected, will display changes in the extent to which physical proximity remains a central feature of regional development.

Spatial proximity may be complemented by 'experienced proximity' in cases where use of ICTs leads to a reduction in the need for physical proximity to stimulate innovation and learning, entrepreneurship,

1. Code named G-NIKE (for Growth-Nodes in a Knowledge-Based Europe), the project studied regional and interregional IT-enabled growth nodes in order to understand their role in regional development. It was a collaborative effort of: Universitat Oberta de Catalunya (UOC), Spain; the London School of Economics, UK; European Institute for the Media, Germany; Tilburg University, Netherlands; and the University of Tampere, Finland.

social cohesion and economic growth. The G-NIKE research roadmap sets out the essential elements of a future comprehensive research programme that will provide answers to several key questions: Can growth nodes be expected to emerge as a result in part of the widespread application of ICTs? How effective are growth nodes in meeting European policy goals? What factors contribute to the success of growth nodes and what are the implications for policy?

The aim of the G-NIKE project was to shed new light on how and why growth nodes emerge and on the measures that are most likely to support them and that are in line with European policy goals. These goals seek to balance the strengthening of competitiveness, sustainable growth and improved social cohesion throughout the European knowledge-based economy. The G-NIKE project specifically addressed the following questions:

1 How will the deployment and use of new ICTs modify our understanding of what constitutes a viable and sustainable growth node?

2 What new 'rules of the game' will be required to foster the growth of ICT-enabled growth nodes equitably under a regime of intensifying interregional competition?

3 At what policy level – supranational, national, regional, and urban – will such rules be formulated, implemented and monitored?

This chapter establishes the importance of a strategic research roadmap that is responsive to these questions and the conceptual framework that underpins the growth node concept. In a later section, the growth node concept is located in the academic literature related to questions of regional dynamics and development and the important role of innovative technologies in enabling new patterns of information flows, knowledge management and learning. The G-NIKE research roadmap is set out on page 191. The roadmap indicates the questions that must be answered and the research strategies that will be needed if Europe's regions are to benefit from the potential of ICT-enabled growth node development that meets European social and economic goals. The final part of the chapter considers the implications of the proposed research for policy making at European, national and sub-national levels.

The need for a strategic research roadmap

The launch of the European Commission's Sixth Framework Programme (6FP) saw many new challenges emerging in areas such as e-work, e-business, and knowledge management. New models and scenarios are needed to shape future policies aimed at fostering an economically vibrant and socially desirable European knowledge-based economy. Future policies and actions will need to take into account the European Commission's social objectives that were central to the Lisbon, Stockholm and Göteborg strategies. The task for the G-NIKE roadmap project and other projects funded during the final stages of the Commission's Fifth Framework Programme (5FP) was to create guidelines and the appropriate constituency to:

1 identify the research challenges in respective areas to assess Europe's competitive position and potential;

2 derive strategic roadmaps for applied research driven by visionary scenarios; and

3 build constituencies and reach consensus with stakeholders at all relevant levels, including researchers from industry and academia, technology providers, business and public administration end users, consumer organizations, policy makers and standardization bodies.

The decision to focus the G-NIKE roadmap project on growth nodes and their synergistic features was strongly influenced by the fact that the European Union is faced with the economic integration and absorption of the accession countries. In the coming decades it will be essential to create the conditions conducive to enhancing Europe's international competitiveness while, at the same time, ensuring that any regional inequalities are not exacerbated.

Monetary union is placing the tools of monetary adjustment at the supranational level. This is giving rise to an intensification of competition between the regions of Europe. Although the governance of interregional competition presently continues to be at the level of the nation state, increasingly it will need to involve Europe's emerging supranational institutions and Europe-wide policy and regulatory processes. These policies and processes will need to foster both competitiveness and fairness. The more winners that emerge, the fewer will be the losing regions that need to be compensated.

From the G-NIKE perspective, fast-growing geographic clusters of innovative organizations throughout Europe are in the process of emergence. Initially a mix of economic agglomerations, enabling technologies and institutional forces combined with the entrepreneurial frameworks of the stakeholders in a cluster create an innovative environment. Over time, however, this mix of forces may generate a culture that suppresses innovation. This may render clustered firms and other organizations more susceptible than non-clustered organizations to external shocks to their environment and to unexpected internal developments.

If public policy makers proactively encourage the integration of advanced ICTs and their application to link geographically clustered firms with other organizations beyond their immediate regional surroundings, there may be substantial opportunities for a departure from this conventional pattern of regional development. The spread of global, national, regional and local ICT networks and information flows may fuel an ‘innovative milieu’ and act as a catalyst for social learning processes that give rise to successful and enduring economic and social development, an emergent outcome that the G-NIKE project describes as a ‘growth node’.

A strategic research roadmap is essential to establish a basis for investigating the conditions under which a positive cycle of social learning is likely to emerge. The motivation for the G-NIKE roadmap is to provide a basis from which to assess whether certain clusters and regions in Europe are involved in a process of enduring growth node evolution and others are in a phase of transition that will enable this evolutionary pattern to emerge in the short or medium term. As new geographic nodes of economic activity emerge they tend to attract talented labour and other resources.

Advanced ICTs provide a new means of linking up local places and regions within a ‘network of networks’. Inclusion in these networks requires an adequate local technological infrastructure, a system of ancillary firms and other organizations providing support services, a specialized labour market and a structure of the services required by the professional labour force. The G-NIKE focus on the dynamics of emergent complex adaptive systems provides a means of discovering the factors and policies that may encourage a divergence from the historical experience of clusters, that is, a cycle of ‘hot spot’ followed by ‘blind spot’ development.

Positive synergies are generated partly by the dynamics of social networks within a given territorially bounded place and partly by the global interconnectedness of that place with many other places. Both social and technical networks seem to play essential roles in whether agglomeration economies emerge out of networking synergies and their interactions with the features of a given cluster of economic and social activity.

Throughout the 1990s a substantial amount of research was undertaken on the emergence of regional clusters and on the characteristics of local innovation systems in Europe. Numerous policy initiatives in Europe were aimed at stimulating European leadership in the production and use of advanced ICTs and at developing a socially cohesive and equitable market that would become increasingly competitive on a world scale. The results of these European policy initiatives have been disappointing in that regional inequalities continue to persist. Many observers have pointed to the potential of ICTs to enable a ‘de-specialization’ of economic activity and to stimulate European economic growth and social development, but there has been very little systematic analysis of how policy might more effectively foster these networking synergies.

There is an urgent need for the features of the kinds of 'innovation milieu' that would enable European stakeholders to benefit from the potential of ICTs and the emergence of sustainable European growth nodes to be more fully understood. The G-NIKE research roadmap addresses this need by providing the concepts, methodologies and tools that will be necessary to examine whether growth nodes are emerging, or are likely to emerge in the near term, in Europe partly as the result of rapid innovations in ICTs and their widespread application throughout Europe.

The next section explains the growth node concept in greater detail and sets out the G-NIKE conceptual framework which provides the basis for a research roadmap that could be implemented to examine key questions and hypotheses about the nature and dynamics of growth nodes.

Growth node conceptual framework

This section presents the principal features of the conceptual framework that underpins the G-NIKE approach to the analysis of the emergent properties of growth nodes.

The idea of a 'growth node' is positioned in the G-NIKE roadmap as *a further evolution of the cluster concept* that emphasizes external networking dimensions as well as the cross-industry, knowledge transfer and social learning conventionally associated with clusters. A growth node is defined as:

A high-performing geographical cluster of organizations and institutions, networked to other clusters, i.e. other nodes, and amplified by ICTs.

The distinction between clusters and growth nodes is based on the emphasis that is placed on internal connectivity in the case of clusters and on both internal and external connectivity in the case of growth nodes. This distinction is shown in Figure 12.1.[2]

The term 'growth node' encompasses both the interrelatedness *within* clusters and the interrelatedness *between* them. Clusters are treated as nodes within a wider network. Insofar as these nodes are found to be emerging, they are expected to exhibit a high degree of connectivity internally (with organizations within the node) and

2. The concept of a node in a regional context was initially developed by the French geographer, Vidal de la Blanche (1910), who borrowed the concept of nodality from the British geographer Mackinder to indicate the major crossroads that generate change of all kinds and which, as a result, have the greatest power of organization.

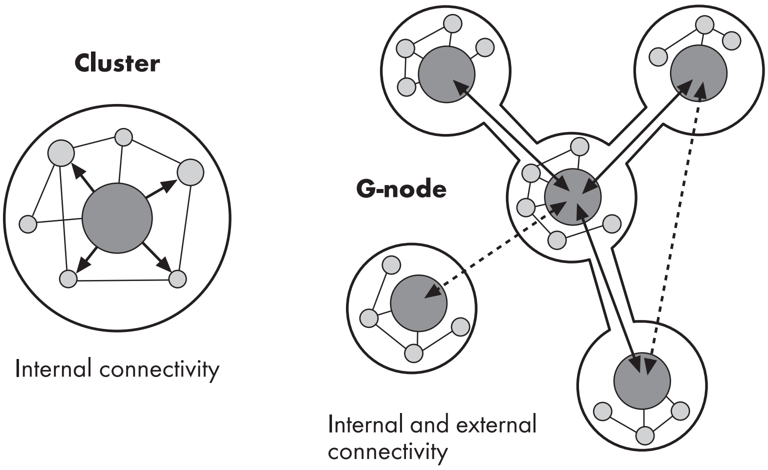


Figure 12.1: Characterising growth nodes.

externally (with other nodes and/or organizations in other regions). In practice, the internal and external interconnectedness may be very uneven, creating major challenges for policy makers.

A growth node can be seen as an aggregation of interconnected organizations concentrated within a particular region, but competing and collaborating on world markets (or in markets outside that region). Their coherence is likely to be based on knowledge sharing throughout the network and by a high rate of firm start-ups. It is believed that intra- and internode interrelatedness and competition as well as collaboration will foster economic growth (hence the name 'growth' node) and social cohesion.

The use of diverse combinations of ICTs within and between growth nodes is also expected to affect the meaning and importance of physical proximity within any given node and the extent to which virtual connectedness comes to substitute for or complement traditional forms of activity.

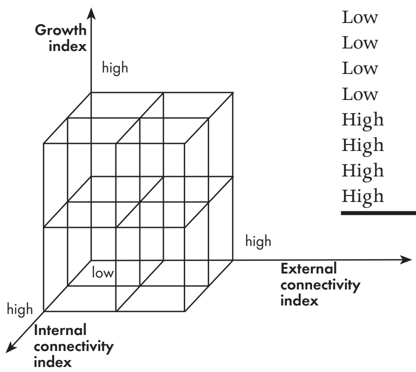
Europe's existing clusters of industrial activity and areas that are seeking to establish a stronger presence in European and global markets are likely to undergo a transition from relatively low or high degrees of internal connectedness to a situation in which they develop greater external connectedness

The synergistic effects of internal and external connectivity, augmented by ICTs, could give rise to growth nodes. Growth nodes are an evolution of regional clusters and imply a special emphasis on internal and external networking. However, if the growth node concept is to be useful for policy, it must be shown to be feasible to make it a reality. The G-NIKE research roadmap provides the means to demonstrate that it is possible.

Constructs are needed for identifying, characterizing and measuring growth nodes, their incidence and their effects so that a typology such as that shown in Figure 12.2 can be used to classify the emergent properties of European regions. Cluster attributes that exhibit the features of nodality and that may give rise to sustainable regional growth are likely to comprise the following:

- *Externality:* density of interactions with partners outside the growth node;
- *Reach:* geographic scope of the growth node – regional, national or international;
- *Knowledge intensity:* interactions that are strongly knowledge-based;
- *Employment structure:* high proportion of knowledge workers within total employees; and
- *ICT infrastructure:* an extensive network infrastructure for linking players internal and external to the node.

Systematic analysis of these and other attributes is necessary to indicate whether a candidate agglomeration of economic activity or cluster exhibits nodality and, hence, can be considered to be in the transition towards growth node evolution. The various degrees of potential connectivity are suggested by the matrix shown in Figure 12.2 together with the types of regional economic activity that they might be expected to support.



Growth index	Internal connectivity	External connectivity	Type
Low	Low	Low	Agglomeration
Low	Low	High	Science park/network
Low	High	Low	Cluster
Low	High	High	Node
High	Low	Low	Growth agglomeration
High	Low	High	Growth science park
High	High	Low	Growth cluster
High	High	High	Growth node

Figure 12.2: Growth node technology.

A crucial issue for the analysis of growth nodes and their dynamics is to develop an understanding of how and why the transition from one position to another in the quadrants shown in Figure 12.2 is likely to occur. The sustainability of potential European growth nodes will depend upon a set of emergent outcomes that are associated with a range of key ingredients and enabling processes including knowledge management and learning and institutional change as well as the catalytic effects of the widespread application of advanced ICTs. Figure 12.3 shows some of these ingredients, enabling processes and outcomes.

In the growth node conceptual framework the *ingredients* are the building blocks. They must be present for a growth node to develop. The *enabling processes* must also be in place together with the *catalyst of* ICT use if a region is to undergo the transition to a growth node. *Emergent outcomes* are growth nodes or complex adaptive systems that perform strongly, achieving sustainable growth, strong social cohesion and enhanced competitiveness in line with the European Union's policy objectives.

This section has explained the growth node conceptual framework, introduced a growth node typology that builds on this conceptual framework. The next section locates this conceptual framework in several strands of the relevant academic literature.

From 'clusters' to 'growth nodes'

The G-NIKE focus on growth nodes builds on existing academic research on the dynamics of regional development and on the features of systems of innovation that are present in a given geographical place. The G-NIKE research roadmap is concerned with assessment of the nature and dynamics of ICT-enabled growth nodes in Europe, nodes that are understood as a form of augmented cluster. The working hypothesis is that Europe's future competitiveness depends upon the emergence of interconnected clusters or growth nodes with higher than average economic growth rates, including success in achieving equity and improved social welfare.

This hypothesis was derived from a review and synthesis of existing research on industrial cluster formation and its impacts which is summarized later in the chapter; on the role of social capital, learning and networking in fostering economic growth and social cohesion; on the central role of various systems of innovation; on the role of ICT-enabled infrastructures in fostering networking synergies; on efforts to identify and measure regional activities and networks; and on ways of creating inventories of knowledge assets.

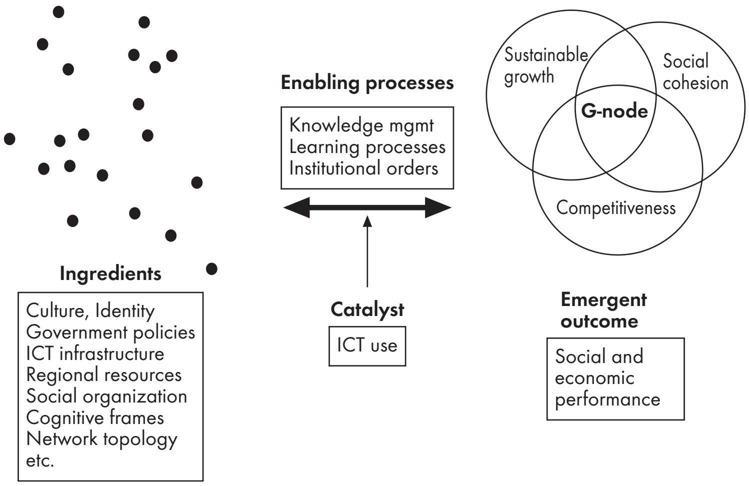


Figure 12.3: Growth node ingredients, enabling processes, and emergent outcomes.

Cluster formation and life cycles

Most experts define a cluster as a geographically bounded concentration of similar, related or complementary businesses and other related organizations (or institutions), with active channels for business transactions, communication and dialogue, which share a specialized infrastructure, labour market and services, and which face common opportunities and threats. Porter's development of the cluster idea is broad enough to be applied to service and manufacturing industries and to high-technology agglomerations as well as to concentrations of lower technology industries (Porter, 1990, 1998, 2001a).

The idea that national economic success depends, in part, on the development of localized concentrations of industrial specialization can be traced to Alfred Marshall (1991). He argued that Britain's economic growth and leadership during the nineteenth century were founded on the development of localized industries. The origin of industrial specialization in a particular locality may be due to the presence of natural resources and materials, to nearby markets, or may simply be an 'accident of history'. Once established, such geographical specialization tends to become self-reinforcing through the operation of what Marshall called 'localization economies', namely:

1 the attraction of various intermediate and subsidiary industries providing inputs to the localized firms;

2 the creation and growth of a pool of skilled and specialist labour;

3 the development and deployment of specialized machinery among local firms involved in different aspects of the industry in question; and

4 the spillover of knowledge and technology between local firms.

To these Marshall added the notion that localized concentrations of industrial specialization are also characterized by an 'industrial atmosphere', that is, a set of formal and informal customs, traditions and practices associated with the industry and institutionalized in the social and cultural fabric of the area concerned. Together, these 'localization economies' increase the competitiveness of the industry and area in question, with consequent advantages for production and trade.

Economists such as Krugman (1991, 1996) and Helpman (1998) rediscovered the value of Marshall's insights reflected in the development of 'new trade theory' and a focus on the nature of economic growth under conditions of 'increasing returns'. According to new trade theory, economies of scale, increasing returns and imperfect competition are empirically more important than constant returns to scale, perfect competition and comparative advantage in shaping patterns of international trade. Regional economic agglomeration and specialization can maximize the potential offered by technological, market and other externalities. The argument is that the more geographically localized an industry within a given country, the more internationally competitive that particular industry is likely to be (Porter, 1990, 1998; Krugman, 1991; Fujita et al., 1999).

While economic geographers and economists have highlighted the neo-Marshallian bases of industrial localization (the role of input–output linkages, the reduction of transaction costs through agglomeration, local labour supplies and technological spillovers), others have emphasized the role of 'soft' externalities. These are the local social, institutional and cultural foundations of 'clusters', and other 'untraded interdependencies' among the firms making up a local cluster. Spillovers of knowledge – both tacit and explicit – and the associated notion of 'collective learning' play a crucial role in promoting innovation and entrepreneurial dynamism in clusters (OECD, 1999; Keeble and Wilkinson, 2000). The concept of 'learning regions' emphasizes the fundamental importance of knowledge spillovers in high-technology clusters.

Porter also argues that, while co-location is not sufficient for cluster formation, it 'supercharges' and magnifies the power of domestic rivalry which is the major spur to continuous innovation and improvement. He defines clusters as geographic concentrations of interconnected companies, specialist suppliers, service providers, firms in related industries and associated institutions (for example, universities, standards agencies, and trade associations), in particular fields that compete but also cooperate (Porter, 1998).

Clusters are said to be associated with stronger economic growth in three main ways: (1) they raise productivity by allowing access to specialist inputs and employees, enhancing access to information, institutions and public goods and facilitating complementarities; (2) they increase firms' capacities for innovation by more rapidly diffusing technological knowledge and innovations. Moreover, competitive pressure within each cluster increases firms' incentives to innovate. Thus, they could be described as a type of 'learning' region, showing high rates of technological and organizational innovation but retaining their adaptability to unexpected exogenous changes (Asheim, 1997; Morgan, 1997); and (3) they stimulate higher rates of new business formation, as employees become entrepreneurs creating spin-off ventures, since barriers to entry are lower than elsewhere.

The distinction between an agglomeration and a cluster is not always clear-cut. Cities can be said to be agglomerations of economic activities, but these activities do not necessarily form any clusters. The cluster concept entails an industrial dimension. A cluster can be viewed as specialist firms with mutually supporting interactions which derive from (and also reinforce) the particular specialization. Such interactions depend traditionally in large part on spatial proximity – i.e. agglomeration. Thus, every cluster is in a sense an agglomeration, but not every agglomeration is a cluster. According to Rosenfeld (2002a,b), clusters have the following characteristics:

- *Clusters are based on systemic relationships* among firms and related organizations. The relationships can arise from common or complementary products, production processes, core technologies, natural resource requirements, skill requirements and/or distribution channels.

- *Clusters are geographically bounded*, based largely on the distances that people are willing to travel for employment and by the distances that employees and owners of companies consider reasonable for meeting and networking. Range is influenced by transportation systems and traffic but also by culture, personal preferences, and family and social demands and ties.

Clusters have life cycles, which progress from an:

- *embryonic stage*, which can be generated by innovations, inventions, or inward investment, to a

- *growth stage*, where markets have developed sufficiently to spin off and attract imitators and competitors and to stimulate entrepreneurship, to

- *maturity*, which occurs when the processes or services have become routine, imitators enter the market, and costs become a key competitive advantage, to

- *decay*, when the products become fully replaceable by lower cost or more effective substitutes.

- *Clusters are not defined by organizational membership* and, while an association provides members with many real benefits, free-riders can be parts of the clusters. By virtue of their location and common needs, they may realize the same non-exclusive external economies as members of the cluster associations.

- *Clusters produce externalities*, the hard externalities that produce a larger pool, greater variety and lower prices for supplies and components, specialized and customized services, skilled labour and potential partners, and the soft externalities that produce access to tacit knowledge of technologies, markets and opportunities to network and to aggregate interests and needs.

- *Clusters are defined by relationships*. Ultimately, they are self-selecting based on how individual employers and institutions in a region define their missions, set their priorities, use their region's resources and form relationships.

Many authors have presented typologies of clusters that outline the different forms that clusters may take (Jacobs and de Jong, 1992; Jacobs and de Man, 1996). Effectively, there are six main types:

- *Vertical production chain*. The first type is a vertical production chain in which adjacent stages in the production chain form the core of the cluster. Chains from suppliers to customers may be indicated by input–output analyses.

- *Aggregation of connected sectors*. A second and more popular definition of clusters is that used by Porter, namely a large aggregation of connected sectors, which are also typically successful exporters. These large-scale clusters have the advantage of crossing conventional industry classification boundaries and may provide a useful anatomy of a national economy. In Porter's analysis such clusters are often (but not always) geographically concentrated within a nation. A close geographic concentration can also span national boundaries.

- *Regional cluster*. This refers to an aggregation of connected sectors concentrated within a particular region and competitive in world markets (Bergman, 1998). Their coherence can be based on anything from pecuniary externalities to knowledge sharing and spillovers leading to a high rate of firm start-ups. The south-east of England could be seen as a relatively large-scale example of such a cluster in the service industries (Coe and Townsend, 1998).

- *Industrial district*. A fourth and more specific type of cluster is the industrial district. Industrial districts are local concentrations of small and medium sized enterprises, which are specialized in stages of the production process (Beccattini, 1992). Impressed by the export success of the Third Italy, some authors such as Piore and Sabel (1984) have argued that these firms pursue a strategy of flexible specialization. However, their definition has been broadened in several ways. The constituent firms may supply several production processes and may not always be flexibly specialized. Many industrial districts depend on and include large firms, so that there can be a variety of industrial districts depending on size and structure of relations between the constituent firms (Markusen, 1996). The notion continues to imply a localized concentration of specialized firms, which is embedded within a local community and which benefits from high levels of trust and collaborative relations (Harrison, 1994; Saxenian, 1994). Hence, it is argued that industrial districts tend to compete on quality and innovation.

- *The network*. The network is closely related to the industrial district, and is argued by some to be a type of cluster. Networks have been defined as a specific form of relationship between economic (and social) actors, which are neither markets nor hierarchies but are based on mutual dependence, trust and cooperation (Malecki and Tootle, 1997). They are not necessarily geographically concentrated, but some authors such as Cooke and Morgan (1994, 1998) argue that they work best when localized.

- *The innovative milieu*. A final type of cluster refers to local concentrations of high-technology industries. In leading high-tech regions it is argued by Castells and others that an elusive synergy of economic and institutional factors produces an innovative milieu, marked by high rates of knowledge diffusion and learning (Castells and Hall, 1994; Keeble and Wilkinson, 2000).

Porter posits that in a globalizing world the forces leading to cross-industry clustering and involving a knowledge base and social aspects have intensified. It is against this observation that the G-NIKE growth node concept is positioned. A key advantage of clustering is access to innovation and knowledge, but this generally is assumed to require geographic proximity. Such proximity is closely associated with the accumulation of social capital, strong social learning processes, and the advantages of networking.

However, Porter also argues that fast-growing, innovative, geographically clustered firms often turn into 'blind spots'. Pouder and St John (1996) have shown how rapidly the fortunes of 'hot spots' can be reversed, leading to the deterioration of formerly vibrant and innovative regions, including both urban and rural agglomerations. Many others have examined the factors contributing to the cycles of prosperity and decline in regions.[3] The economies of agglomeration eventually appear to erode unless unexpected synergies occur as a result of the capacity to benefit from internal and external connectedness with other regions.

The G-NIKE conceptual framework outlined in section 3 also builds substantially on existing research on the nature of social capital formation, social learning processes and networking; the dynamics of innovation systems, and the role of enabling ICT infrastructures. These three areas of research are highlighted briefly in the next three sections.

Social capital, learning and networking

Research suggests that several key factors are essential for sustaining a region's social development and economic growth potential. Moss Kanter (1995; 2001), for example, suggests that these include innovation, imitation and competition, entrepreneurship, networks, social capital (connections), specialized workforce, industry leaders, talent and tacit knowledge. Analysis of the contribution of social capital to economic development has its roots in Europe in northern Italy.

Putnam (1993) developed an analytical framework for the social foundation of clusters in the early 1990s when he compared the economies of northern and southern Italy. Saxenian (1994) compared the Silicon Valley and Route 128, high tech areas in the United States, during the same period. Their research suggested that intermediaries and gatekeepers such as business associations, chambers of commerce and community-based organizations play a key role in the development of successful regions.

Social capital, which is a core asset of many clusters, has both advantages and disadvantages. Strong social networks can expose

3. See Rees and Stafford (1986), Scott (1989), Bania et al. (1992), DeNoble and Galbraith (1992), Maarten de Vet and Scott (1992), Castells and Hall (1994), Saxenian (1994), Lomi (1995), Pouder and St John (1996), Malecki and Tootle (1997), Porter (2000), Berger and Locke (2001), Porter (2001a,b), Castells (2002) and Steinle and Schiele (2002).

members to new processes and markets, non-public bid requests and innovations, and organizations that are outside the networks miss out on many social and economic opportunities. Clusters create a capacity to network and learn, but the more they are defined – and correspondingly limited – by formal membership, and the more social and business activity depends on personal networking, the less the chances for outsiders to benefit from the accumulating knowledge base (Cooke et al., 1998; Cooke, 2001).

Equity issues also are important considerations in the analysis of the dynamics of regional clusters of activity. Access to learning networks may be limited by the interests of large companies, creating problems for small and medium sized enterprises. A number of 'less favoured' regions in the European Union have sectors that are specialized in traditional industries with little innovation and a predominance of small family firms with weak links to external markets (Landabaso et al., 1999). In contrast, the most successful clusters in the United States include lead firms that are members of global networks and are exposed to global market opportunities (Rosenfeld, 2002a). Poorer regions and smaller companies have limited access to benchmarking practices, innovations and markets and are likely to be increasingly disadvantaged unless measures are taken to enhance the learning environment.

In knowledge-based economies, economic growth depends substantially on technological innovation and knowledge spillovers. Clusters can facilitate the sharing of knowledge – particularly tacit knowledge, which is embedded in individuals and the routines of organizations. As emphasized in the discussion of the conceptual framework for growth nodes in the preceding section, this kind of knowledge cannot spread as freely or easily from place to place as codified knowledge (Cortright, 2000). The need to create structures to support and accelerate learning within and between regions has encouraged the establishment of learning cities and learning regions (see, for example, OECD, 2001). Within clustered economies, invariably there is more interfirm mobility and thus more active exchange of information and knowledge among firms and other stakeholders.

In some cases, the success of regions has been found to be attributable, not to the clustering of firms, but to the intensity of interfirm collaboration and to the specialized services created by government and trade associations that give small companies access to external economies of scale (Piore and Sabel, 1984). The northern Italian network of small firms became a model for other regions seeking to allow small firms to survive and prosper in increasingly competitive global markets. Government agencies have found that networks can be a cost effective way of aggregating demand and delivering services to small firms.

The G-NIKE growth node concept represents an evolution of the regional cluster concept with a new emphasis on internal and external networking. In this context, nodality, that is, the interplay of internal and external interactions, may become an important attribute of a cluster where stakeholders are seeking to avoid the diminishing prospects for growth over the life-cycle of a cluster. A growth node can be seen as an augmented cluster. A cluster tends to thrive on the basis of its internal interactions or connectivity whereas a growth node benefits from the synergies arising from the interplay between its internal and external connectivity as explained in the G-NIKE conceptual framework. In addition, with a strong focus on knowledge management and social learning processes, the G-NIKE conceptual framework provides a basis for systematic analysis and a detailed account of how learning actually occurs. There are many discussions in the existing literature of the important role of learning in the development of clusters, but they do not integrate the emphasis on internal and external connectivity or the enabling features that may give rise to growth nodes. The Information Space or I-Space and the social learning cycle models outlined in the next section represent a way to build on existing research in this area.

Knowledge management and social learning in growth nodes

The social and economic performance of an emergent growth node will depend on the nature of the enabling processes shown in Figure 12.3. These enabling processes are influenced strongly by the nature of information flows within a complex adaptive system. One attempt to conceptualize these relationships involves a framework for understanding the social learning cycles that occur within what Max Boisot (1995, 1998) defines as an Information-Space or I-Space. The I-Space framework rests on distinctions between data, information and knowledge. While the diffusion of data goods is entirely dependent on the physical characteristics and capacities of a communication channel, the diffusion of information goods depends both on the physical characteristics and capacities of a communication channel as well as on the efficiency of the coding scheme employed to extract relevant information from the data. Effective diffusion depends on senders and receivers having mutual coding schemes. Knowledge goods provide a context within which information goods can be interpreted. As indicated in Figure 12.4, this framework suggests the following propositions:

The more easily data can be structured, transported and converted into information, the more diffusible it becomes; and

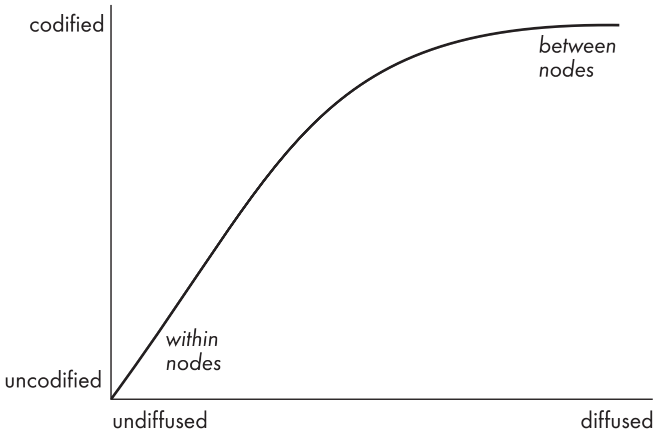


Figure 12.4: Growth nodes and information flow.

- The less that structured data requires a shared context for its diffusion, the more diffusible it becomes.

- Figure 12.4 also indicates how the information flows between nodes are likely to be more codified than the information flows within nodes.

The diffusion of information goods depends on the physical characteristics and capacities of a communication channel as well as on the efficiency of the coding scheme that enables relevant information to be diffused between different nodes in a network. The activities of codification and abstraction are closely related to learning and competitive advantage is likely to accrue to those who learn how to progress through a social learning cycle from data to information, and then from information to knowledge.

Different locations within the I-Space represent different information environments characterized by variations in the degrees of codification and diffusion. Learning involves a clockwise cyclical movement in the I-Space from one information environment to another as indicated in Figure 12.5 and a social learning cycle generates new knowledge within a given population.

The social learning cycle is composed of four stages:

- *Scanning*: this involves surveying the environment to identify threats and opportunities which are evident in the data that are generally available in a population and converting them into patterns that yield unique and as yet undiffused insight. Scanning may be quite rapid when both the data on which it builds and the patterns that result are well codified. But often radically new knowledge emerges from fuzzy data that gives rise to fuzzy patterns of learning.

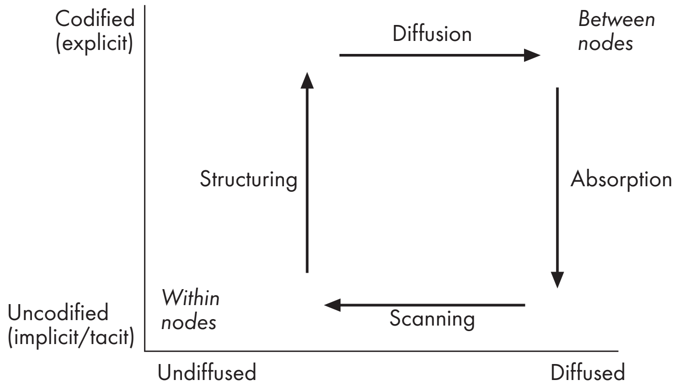


Figure 12.5: The social learning cycle.

- *Structuring*: this is the process of giving structure and coherence to the insights generated by the scanning process. By increasing the degree of codification of initially fuzzy patterns, the associated uncertainty is reduced making it easier to manipulate the patterns in a problem-solving mode, thus increasing their utility. Articulating a pattern in this way is an activity that is best carried out in small groups, since less work is then needed to generate consensus as to the relevance and meaning of the pattern.

- *Diffusion*: structured, that is, codified information will diffuse more extensively within a given population per unit of time than unstructured information. This may or may not be desired since diffused information loses its scarcity value and barriers may be needed to allow the diffusion process to be controlled.

- *Absorption*: information may be available to a population through efficient diffusion processes but might never be absorbed. Whether it gets absorbed depends on whether the recipients have mastered the codes necessary to understand it and whether they are then prepared to invest time in using and applying it. If they are, then over time they build up a context of uncodified knowledge that frames and contextualizes information. If the attempt at contextualizing new information fails, which it might if the new information is incompatible with the recipient's prior contextual knowledge, then another round of scanning may be initiated.

Effective knowledge management as an enabling process for a growth node involves creating, maintaining and exploiting knowledge assets so as to maximize their value over a given time span. The more heterogeneous the nodes and links in a network, i.e. the less one node or link can act as a substitute for another in the network, the more specific and idiosyncratic the resulting knowledge will be and the less likely it is that learning will occur easily across a network.

A social learning cycle can take various forms reflecting the different blockages that impede the learning process. Depending on the nature of these blockages, members of clusters are likely to adopt one of two strategies towards information flows.

They may engage in information hoarding. In this case they recognize that diffused information has no economic value. Agents may attempt to slow down the social learning cycle by refraining from codifying or abstracting too much and by building barriers to the diffusion of newly codified information – by means of patents, copyright, secrecy clauses, etc. Slowing down the learning cycle allows them to extract value from information in a controlled way.

Alternatively, they may engage in information sharing. In this case, they generally recognize that diffused information prepares the ground for further learning and knowledge creation. Agents will willingly share their information and watch how others use it. They are likely to gain first-mover advantages by being the first to initiate a new social learning cycle and to extract value from the process by participating in a succession of cycles. The skill lies in understanding the dynamics of specific social learning cycles and selecting the strategies and policies that fit them. Initiating a new social learning cycle also requires strong capabilities for exploiting the full potential benefits of ICTs.

Regional innovation systems and learning

Authors such as Boekema (2000, 2002), Edquist (1997), Freeman and Soete (1997), Lundvall (1992), Nelson (1993) and others have developed insights into the nature and dynamics of national or regional innovation systems. These systems are defined in various ways. Some authors give greater emphasis to the particular nature of systems of norms and routines that become institutionalized in ways that give rise to innovative performance. Others emphasize the specific make-up of institutions and policies within a country that may be necessary to stimulate innovative performance with respect to technological development and economic growth. Research in the early 1980s initially focused on country-level innovation and developed theoretical insights into the key role of scientific and technical knowledge and its circulation as the foundation for higher than average rates of innovation in different sectors of the economy.

In the 1990s, the emphasis shifted to the kinds of innovation systems that exist at the macro-regional level, i.e. in the European Union as compared to other regions such North America, or at the sub-national level where regional clusters had been fostered. Some authors began to refer to 'learning regions' based on their growing understanding of the way distinctive combinations of both institutions and policy and certain norms and practices (always culturally informed) give rise to high performing clusters at the regional level.[4]

There is a large body of research that is addressed to whether there is a core set of institutions, policies and learning processes that is present in various contexts and bounded geographical places where economic growth is very strong. This research also examines the nature of labour mobility and employment practices, the skills bases that give rise to innovative behaviour, the roles of entrepreneurs in stimulating innovation and a host of related issues. Empirical research in this area suggests that there are some common features that characterize high performing systems of innovation. However, it also shows that the particular contexts in which governance regimes emerge differ considerably. This suggests the need for a research framework that emphasizes the variety of transition paths towards the sustained strong performance of any given region. The G-NIKE focus on regional innovation systems as complex adaptive systems with unpredictable emergent properties offers a means of examining both the common features of innovation systems as well as the variety in their features. A key result of several decades of research in this area is the observation that institutions (as organizations and as practices) matter. Understanding their specificity and the ways in which they change through learning and knowledge exchange is central to any analysis of the properties of growth nodes.

Economists working in the tradition of the 'new institutional economics' have also begun to highlight the importance of institutions. In particular, North (1990) has argued that institutions play a major role in the process of economic development. Theoretical and empirical research in this area calls attention to the role of transaction costs in shaping institutional choices about whether to internalize many features of the innovation process within firms or to externalize parts of this process beyond the boundaries of the firm. Principles of 'internalization' may apply to territorial organizations as much as to economic ones (Coase, 1937; Williamson, 1975). Williamson and others suggest that problems of bounded rationality and opportunism may lead to the need for face-to-face transactions and, hence, to the phenomenon of spatial agglomeration. Thus, geographical agglomeration may result when transactions are internalized within a given region rather than scattered about in a wider space. These transactions may produce synergies that are the result of the dynamic

4. See Lundvall and Johnson (1994) on the economics of technological innovation field, and Cooke et al. (1998), Boekema et al. (2000), Boekema (2002) and Rutten and Boekema (2002) on the economic geography field.

interplay between actors within their social networks, potentially enabled by the use of ICTs. In essence, both territorial as well as economic organizations face internalization/externalization decisions.

Learning and networking within regional systems of innovation are inescapably dependent upon the specific institutional mix that becomes embedded within a network. The system of innovation may foster a variety of 'strong' and 'weak' ties and cultures that interact in ways that influence the sharing of local and distant information resources and the extent to which learning progresses and enables efficient and effective knowledge management. Cultural features may be distinguished by the way that members of networks structure and share information in the course of transacting with each other (Douglas, 1973; Hall, 1976). Trans-organizational social networks can generate synergies through personal exchanges that may be enabled by specific combinations of the use of ICTs and by organizational openness as a result of numerous collaborations (Castells, 1996).

In this field of research as in the case of research on social capital formation and learning, increasing attention is being given to how the application of advanced ICTs influences the nature of economic development at the national level and at the regional level. Investment in ICT-enabled infrastructures is regarded today as an essential feature of strategies aimed at promoting both competitiveness and cooperation among firms and other stakeholder organizations.

ICT-enabled infrastructures

Clusters may have the potential to emerge as growth nodes when they engage in intensive use of diverse combinations of ICTs to support activities within and between clusters. The application of advanced ICTs is expected to enable a 'de-spatialization' of economic activity. In the existing literature ICT infrastructures, including hardware, software and service applications, are expected to offer new opportunities for codifying information, which may enhance learning and innovative activity in a region.

The use of ICTs is also associated with the 'mediated co-presence', that is, communication and information exchanges that are mediated by technology in a way that creates a sense of social presence when actors are spatially dispersed. As a result of their investment in ICTs, enterprises and other organizations of the future are expected to become increasingly fluid, amorphous and dependent on transitory structures based on alliances, partnerships and collaboration within clusters. ICTs seem to play a major role in enabling inter-organizational networking, but their specific role in any given cluster is not well understood. The G-NIKE conceptual framework treats ICTs as a potential catalyst of new forms and intensities of internal and external connectedness that require empirical investigation, the research so far having offered several different accounts of the role of ICTs in the knowledge management and learning process.

There are conflicting views about the way that the use of advanced ICTs influences information sharing within a complex ICT-enabled network environment. Some suggest that certain kinds of tacit knowledge can now be codified using today's technologies so that information can be processed at a distance. It may be possible to increase the extent to which tacit knowledge can be codified as innovations in ICTs lead to new kinds of e-business services. If greater stocks of knowledge can be circulated across electronic networks and used in ways that effectively support learning, the importance of geographical clustering and physical presence may be reduced. Information flows may become spatially unbounded in a world that is interlinked through the implementation of ICTs (Cowan et al., 2000).

However, others argue that knowledge cannot be shared or absorbed independently of the processes through which it is generated. Utilizing information requires tacit knowledge and skills that are intrinsically bound to physically present social processes. These skills entail the cognitive capabilities of agents and the organizational contexts in which they interact (Cohendet and Steinmueller, 2000; Steinmueller, 2000). They argue that the defining feature of tacit knowledge is that it cannot be articulated or codified for the purpose of exchange. It includes the specific knowledge that is mainly held and shaped by individuals and emerges through institutionalized routines, conversations, memories, stories and repeated interactions, rather than as a result of explicit rules that can be codified.

Some proponents of the concept of 'learning regions' argue that the transmission of new knowledge occurs more easily among geographically proximate actors (Johnson et al., 2002). The 'knowledge spillover' hypothesis suggests that physical proximity helps to reduce the costs of knowledge transmission by facilitating interpersonal contacts and the interfirm mobility of labour (Verspagen and Caniëls, 2001). The degree to which geographical proximity facilitates the sharing of knowledge seems to combine with institutional, organizational and technical proximity in fostering effective processes of collective learning. How the use of ICTs influences virtual or experienced proximity is a key factor in the extent to which firms and other organizations located within regions are able to benefit from their external connectedness.

The sharing of information using ICTs is an area of controversy that will remain difficult to resolve unless there are improvements in the extent to which information flows and knowledge management processes can be monitored using both quantitative and qualitative research strategies. If advanced ICTs support a type of networking that differs from the traditional communication and information exchange, this may become visible in the changing nature of inward-focused transactions within a region and in a region's outwardly bound transactions, i.e. interactions with partners outside the boundaries of the region.

One factor that is likely to influence this dynamic is whether a particular ICT application enables the accumulation of capabilities for comprehending and utilizing information. ICT applications differ in the extent to which they '(a) can overcome various communication constraints of time, location permanence, distribution, and distance; (b) transmit the social, symbolic, and non-verbal cues of human communication; and (c) convey usable information' (Lombard and Ditton, 1997, 2000). ICTs that are high in 'social presence' seem to enable users to adjust to physical cues in a mediated environment. Visual communication applications seem to create greater social presence than verbal (audio) applications.

For example, the high resolution images of a video-conferencing system often elicit reports of enhanced 'communicative' presence. Presence-evoking ICTs also enable people to accomplish certain tasks more effectively and efficiently (Rice, 1992, 1999). There is, however, so far little research that indicates which types of ICTs are most likely to become effective as a means of supporting knowledge exchange in virtual environments (Mansell and Steinmueller, 2000).

In addition, interorganizational ICT architectures with standardized interfaces, flexible access and shared elements may produce significant benefits for members of a regional cluster. Temporary alliances, partnerships and collaboration with partners within and beyond clusters are likely to require new interorganizational network infrastructures. The dynamic aggregation of services to facilitate interactions between business partners and other institutions may be of special interest to smaller firms since it could allow them to more fully engage in networking.

The adoption of Internet-based technologies for business, where business services and software components are supported by a pervasive software environment, has been designated a 'business digital ecosystem'.[5] Research on self-organizing processes within complex adaptive systems as suggested by the G-NIKE conceptual framework is important to complement technical research on issues such as pervasive, adaptive, self-configuring and self-healing network software architectures. Other important areas of work include research on the

5. The key elements are software components and agents, which show evolutionary and self-organizing behaviour, i.e. they are subject to evolution and to self-selection based on their ability to self-adapt to the local business requirements. See Nachira (2002).

processes of registering software applications; distributed security and federated network identity; software component sharing in integrated networks; multi-agent behaviour in complex systems; and cooperation mechanisms and business process modelling.

Identifying regional activities and networks

The identification of the key components of potential growth nodes requires a set of metrics for measuring activities within and between regions. A well-known model for describing the elements of a cluster is Porter's four-point diamond (Porter, 1990). The model includes indicators of firm structure and interfirm rivalry, local demand, support industries and the 'factor conditions', such as skills, infrastructure, R&D, capital, etc., required to stimulate innovative cluster activity.

Porter's 'diamond of competitive advantage' can be extended to include spatial features.[6] Various methodologies have been developed that enable measurement and comparison of the performance of different world regions. For example, the World Economic Forum (2002) has assessed the effects of European policies and reforms by reviewing the Lisbon objectives at the level of countries and regions, based on eight dimensions of competitiveness (see Figure 12.6).

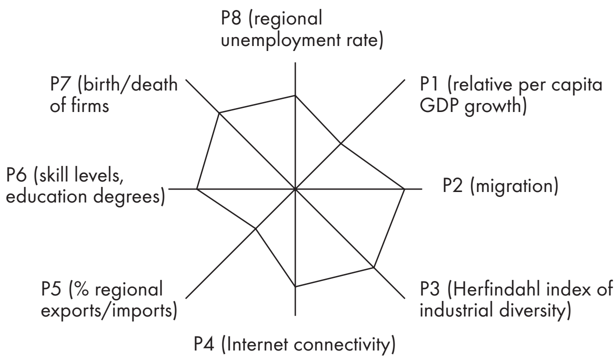


Figure 12.6: Region metrics and measurements.

Such measurement techniques employ measures of outcome/ performance. However, they provide little insight into the elements,

6. In pre-industrial times, given the lack of transport facilities, a network element was sparse, fragile, slow moving and barely visible. The spatial agglomeration itself was what mattered: the Venetian republic, Genoa, London, etc. See (Pirenne, 1937; Le Goff, 1986; Favier, 1987). With economic and demographic growth, networks became denser and more visible and some links were bolstered by the building of infrastructure.

operations or dynamics that give rise to differences in performance between regions or to changes over time.

Methodologies for identifying clusters are based on scales, industrial concentration, value chain indicators and metrics for measuring other systemic relationships. The development and implementation of such methodologies requires decisions about the logic for combining firms into clusters. This logic could be based, for example, on common products, similar processes, value-added chains, core technologies, skill requirements or proximity to natural resources.

The most common basis for defining clusters is to use related groups of industry sectors. The difficulty in relying too heavily on standard industry sector codes is that many companies have a wide range of products and multiple core competencies. An extremely important source of information about clusters is expert opinion. Existing research often relies heavily on surveys, interviews or focus groups as a complement to the results of the quantitative analyses.

Analyses of clusters often start from measuring the numbers of establishments and employees by sector. Economic data are used to identify the dominant clusters. Common measures also include location quotients comparing the local concentrations of industry sectors included within a cluster to concentrations of the same sectors for the entire economy; input–output tables estimating supply chain linkages, and growth rates.

Graphics tools are used for visualizing and comparing clusters based on selected parameters and indices such as job growth and wages and growth rates or number of establishments (National-Governors-Association, 2002). Other measures focus on rates of innovation and stocks of knowledge. They may compare the proportion of workers in occupations classified as knowledge-intensive, or patent rates per organization and employee in different clusters.

Each approach has advantages and limitations. In order to develop metrics and measures for the G-NIKE growth node concept, it will be essential to consider indicators that can be used to establish the extent and shape of interaction of a given region with the outside world, that is, between key nodes in complex networks. One means of developing insights into the nature of such interactions is to develop inventories of localized and distant knowledge assets upon which the members of nodes in a network are able to draw. This is the approach suggested by the G-NIKE research roadmap.

Inventories of knowledge assets

The value of clustering appears to be linked to the access to specialized services and resources offered to firms and other organizations (DRI/

McGraw-Hill, 1995). There have been attempts to develop inventories of what these resources are and where they are located (Enright, 2000). Listing the assets available to and used by members of a cluster is a prerequisite for understanding how it functions. Key assets include education programmes that match the workforce requirements of the cluster, consultants that are familiar with the cluster's industries and the R&D that is relevant to the cluster. They also include the freight-forwarders and exporters who know the markets; the banks and accountants who have developed relationships with the cluster; and the trade, labour and professional associations that provide the networking opportunities.

Knowledge assets that are deployed strategically within a region become a source of competitive advantage for that region. The I-Space model (see section 4.3 above) can facilitate the strategic analysis of a region's portfolio of knowledge assets. These can be located in the I-Space as a function of how codified and how diffused they are. The higher up the I-Space the knowledge asset is located, the more directly usable it is and, hence, the greater its potential economic value. The further to the left in the I-Space it is, the scarcer it is and, again, the greater its economic value (see Figure 12.7). The strategic challenge for a region is to invest selectively in a portfolio of knowledge assets that, over time, can be moved and maintained in the upper left-hand region of the I-Space. This requires a mastery of the social learning cycle with respect to its knowledge assets.

Figure 12.7 suggests that as knowledge becomes more codified and widely diffused, clusters of economic and social activity are likely to become more attractive and have a stronger competitive position. In order for these circumstances to prevail, it is essential that the value of knowledge assets be taken into account by stakeholders in a region.

A major challenge in this area is to examine clustering in order to develop an insight into the real interdependencies, i.e. the cluster dynamics, that produce the flows of ideas and innovations and create the synergies. Research so far has generally examined samples of network relationships, to establish, for example, to whom companies turn for help with business problems; where they could go to see benchmark practices; what services and resources they regularly use; who they trust sufficiently to collaborate with; in which business or professional associations they are active; or perhaps on what advisory boards or councils they serve, see Macdonald (1992, 1998), for example.

Clusters depend on relationships and connections and it is to be expected that growth nodes will exhibit features and systematic relationships based on increasing levels of trust. The role of trust is likely to vary in the case of three main types of relationships. The first type of relationship is with the specialized services and resources and the labour pool available, which normally involves contracts and

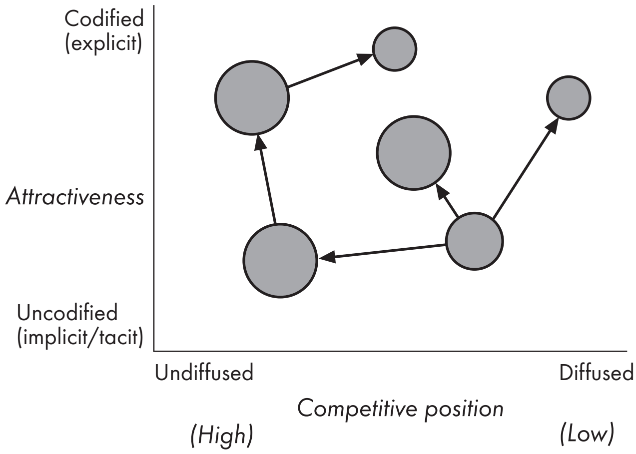


Figure 12.7: Valuing knowledge assets in the I-space.

therefore calls for the lowest level of trust. The second type is the set of transactions conducted among local firms associated with buying and selling products or services. The third type is untraded transactions which involve sharing information, experience and tacit knowledge. This reciprocal relationship often results in innovation and requires a high degree of trust.

The easiest relationships to map are the sector-based supply chains, for which data are typically available from government agencies. The more difficult relationships to map are the supplier and institutional relationships. These require knowledge about the sales of products and services and the location of specialized support functions. Most mappings are very general, showing cluster members as boxes but giving little precise information about the strength of the linkages. The most difficult relationships to map, but the most interesting, are the flows of tacit knowledge and innovation (Granovetter, 1985, 1995). This mapping requires information from individuals about forums for associative behaviour and the conduct of their professional relationships.

If members of business associations can be identified and special resources and services can be inventoried, then it is possible to approximate their relationships and to map clusters in much greater detail than is possible using other methods. The most common map is a flow diagram in which boxes symbolize key parts of the cluster, the companies, suppliers, services, supporting institutions, and trade, business and labour associations. Connections are often represented by directional arrows. Sometimes the thickness of arrows is used to indicate the intensity of the linkages.

By mapping the intensity of connections, it is possible to examine how tightly clusters are bound internally; the degree to which any cluster is connected to and dependent on organizations outside the region or other regional clusters; which intermediaries are most effective; and where improved information channels could be most useful. Such maps would help regional authorities to establish baseline information and to benchmark against other clusters. They could be used to identify the most active and leading members and networking opportunities, to expand cluster membership and to pinpoint effective intermediaries. Information needs could be identified using such maps and regions could be benchmarked against each other in ways that would draw attention to distinctive learning paths.

Existing research also highlights the fundamentally important role of learning and the way systems of innovation operate at the regional as well as the national level. ICTs are being applied in ways that compensate, to some extent, for physical distance from suppliers, R&D centres or equipment manufacturers. In addition, they offer practical ways to identify and measure regional activities and to inventory knowledge assets.

The research roadmap in the next section indicates what we would need to know in order to further our understanding of growth nodes.

Research roadmap

The aim of the G-NIKE research roadmap is to identify the steps that are essential for the study of ICT-enabled growth nodes. The goal is to develop a better understanding of their role in social and economic development in Europe and to derive policy implications. To achieve this objective, the roadmap is structured along seven steps, each of which addresses a basic question.

Figure 12.8 displays the seven step research agenda of the roadmap, highlighting the research issues, projects and products that would be developed as a result of the implementation of the roadmap.

The seven key steps in this figure are explained here, followed by an explanation of the proposed projects and expected research products.

Step 1 – Developing the conceptual framework

The first stage in the G-NIKE research roadmap implementation is to explain the growth node concept in greater detail than was possible during the preparation of the roadmap itself. What are the attributes that characterize a growth node? Stakeholder feedback indicated the need for better definition and clarification of the growth node concept compared to the cluster concept.

Completion of the first step of the G-NIKE research roadmap should lead to a more fully defined conceptual framework that builds on that described in section 3 above. The framework must be integrative and

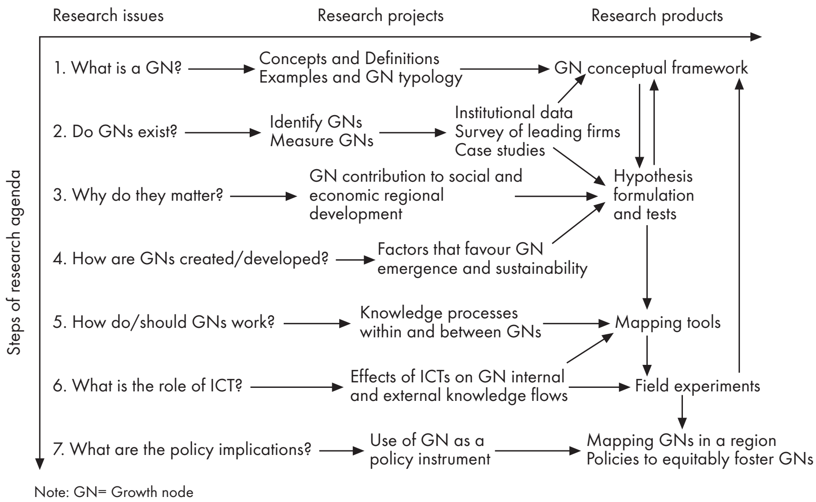


Figure 12.8: G-NIKE strategic research roadmap.

constitute the foundation for subsequent steps in the roadmap. It should identify and describe key issues and formulate basic hypotheses. It will further develop a means of identifying and measuring growth nodes. This will provide a basis for assessing the social and economic impacts and the factors leading to growth node emergence as well as the role of ICTs. It will explain the focus on interorganizational knowledge management processes and on social networks within and between growth nodes.

Step 2 – Identifying growth nodes

Stakeholders participating in the G-NIKE project emphasized the need to identify, operationalize and measure growth nodes in a practical way. The growth node typology presented in section 3 facilitates the identification and classification of potential growth node candidates. It provides a framework for interpreting results and for supporting experimentation and policy intervention.

There is a need to distinguish growth nodes according to their history and to understand their evolutionary path. This was a clear message from stakeholders. The typology is based on the three key attributes of a growth node: growth, internal connectivity and external connectivity. It can be used to classify growth node candidates and differentiate growth nodes from clusters (and other territorial structures, e.g. science parks, agglomerations). In this step a number of existing clusters (and their attributes) in several European regions would be analysed in order to assess their potential for designation as 'growth nodes'.

The identification of growth nodes could be based on thresholds applied to the three key variables (internal and external connectivity, and growth). Institutional data at the European, national and local levels and surveys of leading firms in different clusters would be used to analyse external connectivity. Surveys would also be needed to collect data on internal connectivity, focusing on members of professional communities. Several regions would be analysed to collect data about a relatively large sample of potential growth nodes.

The research roadmap calls for the development of an innovative and robust methodology in order to support the analysis of clusters and growth nodes from complementary perspectives. To identify growth nodes in Europe, a number of European regions would be analysed. *A growth node European map* providing a means of benchmarking and highlighting examples of excellence would be developed.

Step 3 – Assessing growth node effects

From a policy perspective, the relevance of the growth node concept is based on the presumed positive effects of nodality on regional development. The social and economic impacts and growth mechanisms would need to be analysed and compared across regions of Europe.

The working hypothesis would be that growth nodes perform better than other forms of regional agglomeration such as clusters. A second hypothesis would include the proposition that growth nodes foster collaborative rather than competitive relationships with external clusters, thus contributing to a region's learning capabilities. Growth nodes may foster more radical innovations than clusters. The aim would be to differentiate growth node impacts from traditional cluster impacts.

Step 4 – Establishing growth node factors

This step involves determining how growth nodes can be brought into existence, further developed and sustained. What are the key growth node success factors? This requires identifying and evaluating the structural factors and recurrent evolutionary paths that are associated with growth node success or failure. The impact of these factors would be analysed to explain patterns of regional development.

If growth nodes are instances of complex adaptive systems out of which emergent phenomena arise unpredictably from dense and complex interactions between the diverse elements that compose them, many different attributes or ingredients might explain the distinctions between better performing clusters and growth nodes.

Future research on growth nodes may not validate the basic hypothesis that growth nodes exhibit superior performance to clusters. If this proves to be the case, the growth node typology developed in section 3 would be modified so that the ingredients can be related directly to performance indicators as shown in Figure 12.9.

The growth node typology would then be derived from groupings of

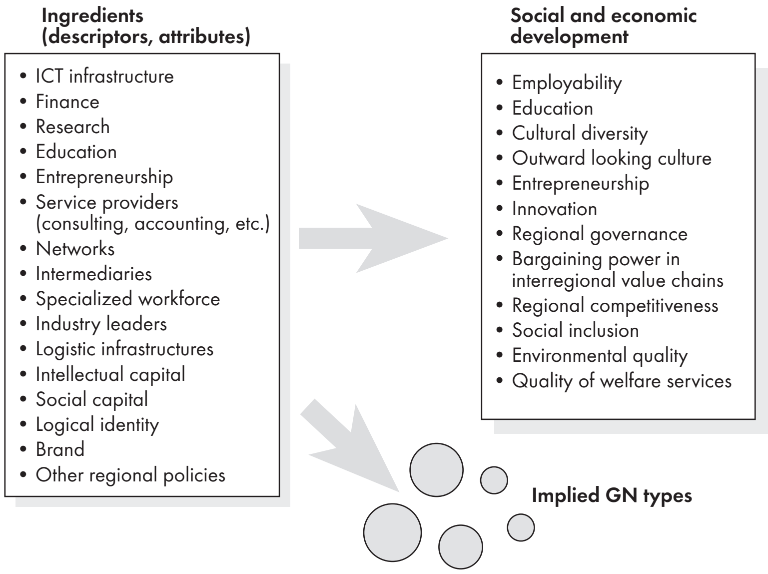


Figure 12.9: Ingredients, performance and implied growth node types.

attributes or ingredients exhibiting various levels of performance. This would be accomplished using cluster analysis techniques.

This approach would involve econometric analyses of hypotheses and potential relationships using quantitative data. In addition, a set of key process factors would be taken into account. From among these process factors, particular attention would be devoted to the relationship between ICT adoption and local development. The analysis would be complemented by a series of in-depth case studies of specific growth nodes.

The results would make it possible to characterize and illustrate different regional growth patterns with particular attention being given to the relations between the growth nodes, clusters and neighbouring regions.

Step 5 – Understanding growth node operations: knowledge management processes

A key premise underlying the growth node concept is that knowledge is a crucial asset that is shared and created though a process of collective learning. A knowledge management perspective is essential to analyse the formation of communities of practice, the conditions that enhance the exchange of ideas, the processes that foster learning and innovation, and the entrepreneurial culture appropriate to the emergence of growth nodes. A growth node is conceived of as a hub of localized learning that facilitates the diffusion of externally acquired knowledge and fosters innovation.

Focusing on the role of knowledge management processes requires analysis of inter-organizational knowledge management processes and social networks within and between growth nodes. In this step a set of specialized tools to help identify and assess some of the key intangible resources available for the development of growth nodes would be developed and applied.

The tools – knowledge mapping, learning mapping, institutional mapping and simulation – would enable policy makers to assess knowledge scanning, knowledge structuring, knowledge diffusion and knowledge absorption capabilities as integral components of the social learning cycle.

The growth node concept could become a policy tool for regional development. In order to apply the concept it would be necessary for policy makers to support the development, application and exploitation of growth node mapping tools. This involves assembling a suite of tools for mapping knowledge flows, learning processes and institutional orders so that their emergent properties can be examined.

- A *knowledge mapping tool* would allow identification of a growth node's critical knowledge assets and assessment of their strategic potential. This tool would allow a region's competitive position in the knowledge economy to be gauged and suggest possible avenues for strategic development.

- A *learning mapping tool* would support analysis of the learning profile of a growth node in terms of its scanning, structuring, diffusion and absorption capacities. This tool would allow assessment of how effectively the region is able to create and exploit knowledge assets.

- An *institutional mapping tool* would help establish the extent to which local institutions and cultures are facilitating or impeding the learning processes that lead to the successful exploitation of knowledge resources.

In addition, a *simulation tool* would consist of an agent-based model that would support a study of the circumstances under which agents create and share knowledge. The simulation would allow an analysis of the way that agents structure and share knowledge under different spatial conditions. The tool would be applied to learn more about how knowledge flows within and between growth nodes; how these knowledge flows facilitate or impede learning; how these knowledge flows give rise to certain institutional structures; and how these institutional structures, in their turn, shape subsequent knowledge flows.

The tools would be implemented in the field to develop an integrated way of using them and to assess their utility in practice. The application of the tools would allow a progression from: (1) an assessment of a given region's knowledge resources (knowledge mapping); to (2) an identification of the learning strengths and weaknesses that give rise to such knowledge resources (learning mapping); to (3) an understanding of the institutional context that facilitates or impedes such learning (institutional mapping).

Step 6 – The role of ICTs in fostering growth nodes

The research roadmap addresses the question of how ICTs are changing the nature of the relationships between spatial proximity and 'experienced proximity' through both internal and external interconnections. How will ICTs affect traditionally perceived needs for physical proximity and introduce virtual proximity as a complement to physical proximity?

This step examines the effects of ICTs on two of the growth node concept dimensions – internal connectivity and external connectivity, that is, the role of ICTs in knowledge use and knowledge development in and between regions.

Important elements in a growth node system are organizations whose relationships involve physical flows of goods and payments as well as informational and knowledge flows. These flows are related to processes taking place between organizations. Transaction-oriented processes are related to (spot) buying, (re-)ordering, selling and/or delivery of products and services. Collaboration-oriented processes are related to processes of collaboration and negotiation prior to a contract, but also to other forms of knowledge exchange (as in research, product development, etc.).

With the rise of network organizations, there appears to be a stronger emphasis on collaboration which, in turn, suggests changes in the way information flows between organizations must be managed and suggests new ways in which ICTs can assist in growth node emergence. Both narrowband and broadband networks could support two main categories of ICT application:

- ICTs for community building (people as actors), e.g. computer supported cooperative working (CSCW), email, video-conferencing, knowledge-exchange tools, etc., and

- ICTs for transaction support (organizations as actors), e.g. Internet-based applications, extended Enterprise Resource Planning (ERP), Customer Relations Management (CRM), (XML-)EDI (eXtensible Markup Language-Electronic Data Interchange), and product life-cycle management.

Research in this area would need to identify which ICTs are being used and measure the extent to which they are being used in internal and external interactions. Their roles in knowledge development processes would need to be analysed, drawing distinctions between smaller and large organizations. Case studies, surveys and field experiments would be conducted.

A mapping and diagnostic tool for assessing the role of ICTs in growth node emergence would need to focus on external and internal networking or connectedness and on the way ICTs support collaboration and transaction support processes (see step 6). Figure 12.10 shows the relationship between various ICT applications and external and internal networking.

Analysis of the dynamics of knowledge diffusion in clusters suggests that knowledge is unevenly absorbed by localized firms. This raises questions about the role of social and geographical proximity as means of localized collective learning. Social learning may occur only within limited knowledge circles tying together professionals of different organizations who belong to the same community. The G-NIKE research roadmap envisages research to differentiate between intra- and extra-cluster connectivity and the roles of ICTs. The research roadmap calls for field experiments and the selective use of Social Network Analysis to analyse interorganizational interactions (Festinger and Katz, 1953; Wasserman and Faust, 1994).

Step 7 – Policy guidelines

Industrial policy has emphasized the role of clusters as important sources of competitiveness in a region or country. Cluster theories have contributed to the analysis of the strengths of clustered firms from static and dynamic points of view. The former focuses on Marshallian externalities and agglomeration economies (Beccattini, 1992). The latter shifts attention to knowledge as a crucial asset that is shared and created through a process of collective learning (Camagni, 1991; Belussi and Pilotti, 2001). In building on the latter, growth nodes are seen as a locus of localized learning that facilitates the diffusion of externally acquired knowledge and fosters innovation (Feldman, 1999; Maskell, 2001).

Growth nodes in Europe are involved in learning races that blend cooperation and competition. If these are not to erode social cohesion, they will need to be managed and for this to happen, they must be thoroughly understood. Ideas concerning the importance of creating structures that support and accelerate learning have been transformed, in the context of the 'new economy', into strategies designed to create learning cities and learning regions (Boekema et al., 2000). In this step, the understanding of the experiences of growth nodes would be translated into practical policy guidelines for European small and

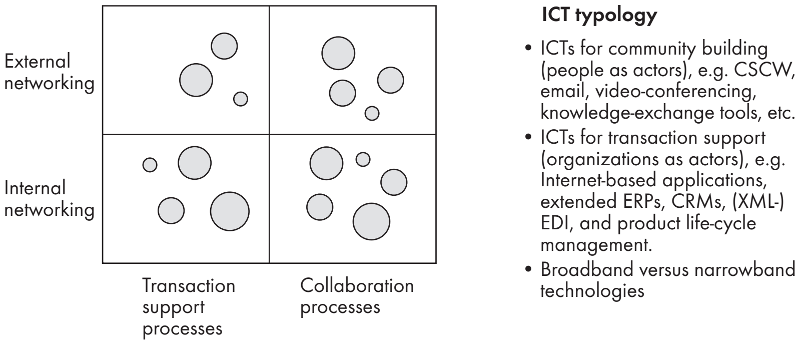


Figure 12.10: ICTs in growth-nodes: mapping and diagnostic tools.

medium sized enterprises, business organizations, local and regional authorities and ICT and service providers.

It will also be necessary to clarify the level at which growth node policies should operate. The stimulation of clustering is a local or regional matter, but the stimulation of growth nodes requires interregional coordination. Therefore, the allocation of resources to foster nodality is likely to be at national or European level.

The policy guidelines generated by the G-NIKE research roadmap's implementation might include, for instance:

- Clarification of what is meant by growth nodes and their role in the future development of the European Union;
- How to use the growth node typology, the ranking of success factors, the selection and measurement tools for relevant ICTs;
- Policy approaches to ICTs in a growth node context (infrastructure investment, R&D priorities, usage support, roles for government and local authorities);
- Information about what has been learned about the basic characteristics and developmental dynamics of European growth nodes;
- Insights into the use that stakeholders can make of this increased understanding in efforts to promote the development and further success of European growth nodes and the diffusion of the results of that success to the less favoured regions of the expanding European Union.

The production of policy guidelines should be the result of a collaborative process between research teams and other stakeholders. The research and policy processes would be interlinked throughout the process of G-NIKE research roadmap implementation so that learning occurs for both stakeholders and policy makers.

Implications

The G-NIKE growth node concept has several key features. A growth node feeds on its connectivity to other nodes – growing or otherwise – outside its immediate hinterland. Its internal organization focuses more on economies of scope than on economies of scale. Growth nodes should be distinguishable from clusters by the density and reach of their external connections, features that can foster emergent outcomes that differ from those associated with other types of agglomeration. Some clusters in Europe may be candidates for growth node status, but many will be only sparsely connected to the outside world.

The G-NIKE project demonstrates how important it is to examine the policies and the levels of policy intervention that are most likely to foster emergent growth nodes in Europe. The cluster concept has found a ready audience among policy makers at all levels, from the World Bank, to national governments, to regional development bodies, to city authorities. Stakeholders from all these organizations are keen to develop a new form of industrial policy or activism in which the focus is firmly on the promotion of successful, competitive, knowledge-based economies.

Governments and other policy bodies clearly have a role to play in facilitating and supporting the development of competitive industrial clusters. The G-NIKE approach to growth nodes does not indicate that governments can create clusters or growth nodes through a set of specific policies or actions. Rather they should contribute to providing the business, innovative and institutional environments that are vital for their success.

Cluster-informed policy generally seeks to identify the clusters in a region or country. By focusing on various regional production and innovation systems, policy makers identify market imperfections, find pressure points, predict system failures and determine what kinds of interventions will have the greatest impacts. The most common policy levers are those that alter the way agencies organize and deliver their services, work with employers, recruit businesses and allocate resources. Cluster-based policy often involves: (1) recognizing and promoting a cluster; (2) targeting reverse investment to a region; (3) improving the workforce; (4) organizing and aggregating demand; and (5) organizing the delivery of services.

However, if public policy makers can proactively integrate advanced ICTs to link local geographically clustered firms and other organizations beyond their immediate regional surroundings, there may be substantial opportunities for a departure from conventional patterns of regional development. Global, national, regional and local ICT links and information flows may fuel an 'innovative milieu' and help to provide the catalyst for a social learning cycle that gives rise to successful and enduring growth nodes.

Growth nodes differ from clusters in their nodality and in the enabling role of ICTs to provide both internal and external connectivity. ICTs provide a means of linking up local places and regions. Inclusion in the network requires an adequate ICT infrastructure, a system of ancillary firms and other organizations providing support services, a specialized labour market and a system of services required by the professional labour force. Thus, policies that encourage and facilitate the adoption and usage of ICTs by small and medium sized enterprises are likely to be essential.

The growth node concept enables researchers and stakeholders to clarify the conditions under which emergent growth node outcomes are likely to depart from the hot spot/blind spot cycle. The complex adaptive systems framework opens the possibility for the discovery of key factors and policies that will encourage divergence from historical pathways that have characterized regional and local clusters.

Implementation of research following the G-NIKE strategic research roadmap would result in clarification of the growth node concept and its role in the future development of the European Union; practical instruments for policy makers including a typology, ranking of success factors, mapping tools and a better understanding of the role of ICTs; new policy approaches to ICT investment and use in a growth node context; insights into the characteristics and developmental dynamics of European growth nodes; and conclusions being reached about how best to promote the development of European growth nodes.

The G-NIKE roadmap project raised three important questions at the outset. The process of developing the research roadmap has provided some tentative answers to these questions, but it has also reconfirmed the urgency of implementing the research called for by the roadmap.

First, the project addressed how the deployment and use of new ICTs might modify our understanding of what constitutes a viable and sustainable growth node. There is relatively clear evidence that the spread of global and local networks is creating the potential for a new dynamic that we designate as nodality. What is not clear is what mix of ICT production and application in any given cluster will give rise to the emergent properties of growth nodes.

The G-NIKE research roadmap clarifies how new insights in this area can be generated – but it also shows that the necessary research will require investment in producing appropriate data sets and in further conceptualizing the foundation principles of growth nodes as augmented clusters. Failure to recognize these principles will bring the risk of continued application of regional development policies that are no longer fit for the European economy – an economy of disparate regions, which could benefit enormously from the catalytic effects of informational networking strategies within a global knowledge-based world.

Second, the project was designed to consider the new 'rules of the game' that will be required to equitably foster the development of ICT-enabled growth nodes under a regime of intensifying interregional competition. It is clear from the preliminary work that was needed to prepare the roadmap that regional and local policy makers as well as those working at national and European levels are searching for new means of governance that will not only foster competitiveness in global markets, but also achieve sustainable growth within the framework of the European social model.

Many regions are confronting the decline of longstanding industrial sectors without having identified the means to dynamize 'new economy' developments on a scale sufficient to ensure sustained growth and a favourable process of social cohesion that is equitable for all. The G-NIKE project indicates the need for urgency in finding mechanisms to counter the threats of rising unemployment and increasing divides within regions that could see their efforts to encourage successful clustering eroded by the cycle of hot spot/blind spot development. The G-NIKE research roadmap calls for a rethinking of past strategies that is consistent with what many now believe to be an era of increasing uncertainty, heightened risk and a new economic dynamic that makes 'winners' out of those who can find the resources to compete and collaborate effectively not only within clusters, but also far beyond the boundaries of localized economic activity. Implementation of the G-NIKE research roadmap would provide new theoretical and practical insights to formulate action focusing on the rules of the game that will be essential to achieve greater equity in the regions of Europe.

Third, the G-NIKE project aimed to provide a research roadmap to point the way towards answers to questions about the policy level – supranational, national, regional, and urban – at which any new rules must be formulated, implemented and monitored. The preliminary evidence is that if growth nodes are instances of complex adaptive systems that undergo a continuous, if uncertain, social learning cycle, which feeds on internal and external connectivity and knowledge flows within and between nodes, then policy must become far more joined up at all levels. This can be facilitated by actions being taken to foster the institutional regimes that are appropriate to creating conditions for growth and equitable development of regions in their particular contexts and in the light of their industrial and cultural histories.

The way to accomplish this is not through the application of 'one size fits all' policies at all levels. It is instead through policy making and actions based on an informed understanding of the dynamics of each region and how these compare with developments in other regions. This requires a fundamentally programmatic approach to empirical research across the regions of Europe, one that is designed to highlight the nature of knowledge-based economic growth and social cohesion developed in the 'space of flows' that characterizes Europe in the twenty-first century.

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13 Knowledge-as-relation: an IT outlook on the future of academic institutions

Lars Mathiassen

Prologue

Information technology (IT) is an important enabler of the transformation from industrial society towards knowledge society. As this transformation influences most aspects of our lives it keeps IT researchers and educators busy and alert. New problems and challenges are constantly added to their agenda. The IT discipline is, though, just another part of society and the question is how the discipline itself and the way it is organized change as the knowledge society emerges. The following addresses this question by providing an IT outlook on the future of universities, engineering schools and business schools. The argument focuses on the general relationship between IT, knowledge and academic institutions and it therefore has to be adopted and further developed depending on institutional and cultural settings. This chapter is based on three sources. First, it draws on history through an analogy to the Middle Ages and the changes implied by the introduction of the written word. Second, it provides an IT outlook by identifying fundamental and distinguishing features of this particular technology. Third, it presents possible scenarios of the future by contrasting two different theories of knowledge. It discusses key issues related to the future of our discipline and the institutions we work in. The intention is not to predict the future. Rather it is to stimulate debate about the questions that we face in moving our discipline forward. The scientific sources supporting the argument are presented in the epilogue.

The drama takes place right in front of William of Baskerville's eyes. A monk is brutally murdered in a northern Italian monastery in the Middle Ages. William who is visiting from England sets to work on solving the mystery and goes about uncovering events with his logical thinking and systematic methods. Just as he believes he has solved the case, another monk is murdered. Entirely new questions are raised and William must reject his theory. He goes about it again in a scientific manner, but as he draws closer to a new conclusion, yet another murder occurs. It is only after several murders that William finally uncovers the plot. But it is too late. The monastery is destroyed in a tremendous fire, and all traces of the feud are swallowed up by the flames.

William of Baskerville is the main character in Umberto Eco's novel *The Name of the Rose* that has been read by many and the film seen by even more, with Sean Connery in the role of the English monk turned detective. *The Name of the Rose* is eerily fascinating and intense. It is well written and conveys the atmosphere and the spirit of the times in an Italian monastery of the Middle Ages convincingly and with authenticity. The deeper reason for the book's popularity, however, is that it sheds light on the fundamental conflicts in transforming the society of the time.

The monastery commands an excellent library with writings that have enormous significance in the struggle over Truth and Doctrine. The monastery also has the only copying technology of the time, the monks' meticulous transcription of the words of the learned. But who should have access to the original writings and which works should be copied? Who should control the knowledge that determines the great questions of the time? William of Baskerville's rational attempts at crime solving are confronted with an ongoing power struggle over the relationship between knowledge and technology. The original sources, the transcriptions and the transcription room go up in smoke, and in spite of William's persistence and his scientific approach, he fails to reveal the plot before it is too late.

For an IT researcher, *The Name of the Rose* is both intriguing and inspiring reading. The tensions between knowledge and technology and between power and rationality stand at the very centre in today's transition from a traditional, industrial society to a knowledge society. What role will IT play in the society of the future? How should IT research and education be organized? What role will academic institutions play and how should they be organized? In what ways will IT leave its mark on the structure and operation of these institutions? What lessons can we draw from the feuds of the Middle Ages as we face these questions today?

Originals and programs

Technology will continue to play a crucial role. In the fourteenth century monastery, the drama takes place around a fundamental technology, the written word. Handwritten books preserve viewpoints and give them authority, and the monks' efforts in transcription rooms make it possible to spread these viewpoints to a chosen few. Well over 100 years later, Johannes Gutenberg makes it much easier to copy and to spread the written word on a larger scale, and over the next few centuries printing technology is refined. But it is not until the middle of the twentieth century that a new breakthrough is made with the development of the first computers. Physical representations and mechanical manipulations of characters are replaced by electronic representations and state transitions. This immediately has two important consequences for knowledge work in society.

First, the original and the copy become one and the same. Electronic media renders copying superfluous. For example, if a patient journal is stored electronically anyone with electronic access can in principle read, and for that matter write, in the same original. There is no need for assistants to transport case records around hospital corridors. Moreover, today's mobile technology makes it possible to access the original over any distance and from any location.

Second, computers are programmable. We apply computers to automate or further develop knowledge work. We program the computer to carry out specific tasks and to adapt it to particular contexts. The simple, but very powerful idea is to store the program itself as data for the computer to interpret and execute based on its set of simple data processing instructions. This unique technological capability has gradually been improved through development of layers of programming languages and application software. It has provided enormous amounts of work for IT specialists the world over and has meant that a highly trained and skilful IT workforce has been in constant demand. By the same token, the computer's programmability unfortunately seduces us to launch ambitious projects that are often difficult to manage, and that either become runaway projects or lead to poor solutions that we then must live with.

Even though the computer and IT in general play primary roles in the transformation to knowledge society, it is not the technology itself that is interesting. The pivotal issue is how IT is used to support business processes, problem solving, and human interaction and communication. It is through the practical use of IT that we learn what works in practice and what new innovations are needed. The use of the written word and later printing technology changed the role that knowledge plays in society. Similarly, the use of IT is radically altering the concept of knowledge within research, education and life in general as individuals, institutions and organizations become increasingly connected through complex and ever changing networks.

Objects and relations

Through the centuries, the written word and the book have accustomed us to think about knowledge as objects that can be formulated, written down, stored in libraries, and later retrieved and reused by others. Knowledge-as-object expresses a powerful perspective that lies at the root of the development of industrial society, its machines and modes of production, the strong focus on goods and consumption, and the corresponding system of markets and economic transactions. But the current, ubiquitous use of IT alters the way in which we handle and share knowledge. This process gives prominence to a different knowledge perspective whose roots predate the written word.

As a participant in a workshop, one's thoughts are stimulated, ideas and opinions come together, and in the enthusiasm over how rewarding a discussion has been experienced, one can easily get excited and commit to writing the summary. Sitting in front of a blank document a couple of days later, though, is a less exciting experience. In spite of having taken copious notes, it is difficult to recreate the insight, the inspiration and the comprehensive overview that was created during the workshop. There is a world of difference between the two situations. A part of the explanation is owed to the fact that it is often difficult to formulate thoughts in writing. But the deeper explanation is that knowledge is not simply objects that can be described, stored and transmitted. A successful workshop is an intense experience of knowledge creation between people that, only with difficulty, can be understood in a knowledge-as-object perspective. Such experiences are an expression of the complementary knowledge-as-relation perspective, where human synergy is in focus and where knowledge is created, recreated and changed as a dynamic relation between concrete actors in a given context.

The first several years of computer use have primarily relied on knowledge-as-object, and by doing so, have helped us to streamline knowledge work by focusing on the storage of standardized information, the automation of routine work and the management and monitoring of structured processes and activities. But with that as a foundation and with the help of user-friendly interfaces and advanced network technology, other types of systems have emerged that support cooperation, communication, play and entertainment. At the outset, the computer was a machine for automation of information processes. But today we have developed it into a powerful medium for human interaction, with functions such as email, mobile communications, games, e-business and virtual teams being concrete expressions of the knowledge-as-relation perspective.

Technology and services

The written word and later printing technology have had an enormous influence on society's organization and development over several centuries. Seen in that light it is not inconceivable that the last half-century's IT development – in spite of the accelerated pace with which innovations appear – has revealed only a first, vague image of the knowledge society that later will become more clear as the replacement for industrial society. The rediscovery of knowledge-as-relation as a complement to knowledge-as-object provides a useful perspective for reflecting on this future development. What are the implications for the IT profession? Will there still be a demand years from now for highly trained IT specialists? How is research and education within IT best organized? And what is the role of IT researchers in influencing institutional and national policies?

The IT field can be understood as the interplay among three lines of activity. First, there are the services we use which are supported by or realized through the help of IT. Second, there is the communications technology, the twenty-first century infrastructure, that link the networks of the globe together. These technologies give us access to services and they span many levels of data transport, as well as different forms of interfaces and forms of interaction. Finally, there is the software technology that focuses on our ability to program new solutions. Software technology includes solution technology for the development of, for example, databases, intelligent agents and multimedia systems and process technology for the creation of projects through which solutions are designed, programmed and brought into practical use.

The growth of IT-based services is by nature varied and manifold. It requires support from a wide range of research and educational activities where the ambition is to develop expertise that will enable the understanding, use and critical evaluation of the technology's possibilities and impact within different domains. There is no reason to be restrictive in supporting societal exploitation of IT as long as we also develop critical thinking over the possibilities that IT offers. Already today there is a manifold of IT-related activities within the classical engineering disciplines and disciplines within business schools. Similarly, IT has found a place at universities in many of the natural sciences, the humanities and the social sciences. This multi-disciplinary distribution and growth of the IT discipline should be strengthened. The continuing growth of useful services demands that knowledge-as-relation between IT and a wide range of other disciplines continues to develop. Many different disciplines will in this way influence the development of IT on their own terms, and by so doing, support a many-sided and critical debate over the use of IT.

The development of communications technology spans a wide spectrum of problems and must therefore be supported by multi-disciplinary efforts. At one end of the spectrum are the engineering disciplines within computer hardware, signal processing, data transport, networks, and communications equipment. At the other end of the spectrum are the humanities and the psychological and engineering disciplines related to human–computer interaction, speech recognition, image processing and multimedia. Mathematically based disciplines also have significance for the study of complex, distributed networks and for the development of technologies for the encryption and protection of data. In this area there is a need for a range of professional specializations with corresponding educational programs. As the supply of services grows and as IT becomes steadily more enmeshed in societal activities, the demand for well-functioning, easily accessible interfaces will also increase. Efforts supporting cooperation and interaction across humanistic, engineering and psychological approaches will therefore continue to be in high demand.

Software technology is the engine that drives the use of IT forward. It deals with programs and programming at every level (from basic networks to services), with the ability to use the enormous and ever changing supply of specific solution technologies, and not least, with the ability to organize and carry out complex, cooperative processes across organizational and professional boundaries. Software expertise is by nature knowledge-as-relation between technical possibilities and concrete problems. It is in many ways independent of whatever specific technology is to be converted to new programs. Also, it remains central, even though standard solutions are developed, because these must be continually adapted, integrated and developed in concrete usage contexts. A considerable, highly qualified, specialized workforce must therefore be educated and maintained within software technology, systems development, and IT management over the next several years. The core expertise must have a solid, technical foundation combined with a social, managerial capability to convert technical possibilities into practical uses.

The architecture of the IT discipline

The IT discipline needs to be integrated and specialized at the same time. It should be developed as an integrated element in most disciplines within technical and natural sciences, the humanities, and social sciences. IT should infiltrate all programs within academic institutions in a user friendly manner with the aim to upgrade IT literacy at all levels. This integration will support development of a variety of competencies related to IT-based services. In addition, there should be a number of specializations within communications and software technology. In order to be able to attract well-qualified students, there must be a diverse offering of educational programs with a high degree of mutual flexibility. Combinations across industry and academic programs as well as across disciplines should be the order of the day, and the offer of lifelong, research-based education through close cooperation among universities and companies will support continued efforts to develop and maintain an attractive and qualified workforce within IT.

The flexibility offered by college level and graduate level education fits well with the developmental needs of the IT profession. The volume of IT-related bachelor level programs needs to be increased, spanning in the one extreme highly specialized IT programs and in the other extreme programs in which IT is seen as a tool or service to support another discipline. These programs should be followed up with an equivalent supply of specialized, graduate level programs. This structure offers the flexibility needed with specialized graduate level programs within IT as a superstructure for a manifold of undergraduate programs.

Do we need more IT faculties and IT universities to strengthen the IT discipline as a specialized knowledge area? Or is a more decentralized organization desirable? The answer is simple when seen in terms of the IT discipline's internal logic. We need a decentralized strategy with IT integrated into many disciplines combined with a select set of specialized fields, such as software engineering, computer science and information systems. There are always important variations depending upon the institutional context. But a decentralized strategy supports the integration of IT in many different areas of society and it facilitates innovation across established disciplines. There seems to be only one reason to support a centralized strategy: the politics of change. A centralized strategy is in some situations the most effective way to overcome institutional barriers to changing the IT discipline within research and education.

Rigour and relevance

The agenda of the IT discipline reflects the problems that emerge through the use of IT in society and solving these problems often requires multi-disciplinary approaches. The discipline therefore lends itself towards knowledge-as-relation strategies that can help bridge practice and research and facilitate collaboration across disciplinary boundaries. Such a strategy is, though, not in keeping with the dominating values and traditions within IT research and education. This is primarily because universities, engineering schools and business schools have their roots in the knowledge institutions of the Middle Ages that, like the monasteries, were developed around the written word with knowledge-as-object as the overriding philosophy.

In the knowledge-as-object perspective, the ideal is to develop and preserve generic knowledge that can be reused to enable action in different situations. Research is understood to precede its use. It is a prerequisite for informed practices. Practitioners master their profession through scientifically based education and they continuously select from their toolboxes knowledge objects that apply to particular problems. Researchers develop new knowledge objects and guarantee their quality. The basic norm for good research is the rigorous application of scientific methods as ensured through collegial evaluation. We use scientific peer-reviews to make sure that published knowledge is developed according to the discipline's research methods and adds to the discipline's current knowledge bank.

In the knowledge-as-relation perspective, the ideal is to develop knowledge that is useful in specific contexts. Important parts of the research process take place as concrete problem solving. The ideal is the reflective practitioner who, with the discipline's general knowledge and methods as ballast, produces knowledge that is unique to and useful in specific contexts. Research then is not reserved for the few, but is instead an inherent quality of a reflective practice. The quality of knowledge is thus determined through its use, and the basic norm for good research is relevance. The development and evaluation of knowledge takes place in interaction between research and practice, e.g. through interaction or cooperation between researchers and practitioners. Still, the researcher must adopt scientific methods and relate the findings to existing bodies of knowledge within the IT discipline.

The knowledge-as-relation perspective's ideal for relevant knowledge does not discount the classic ideal of rigour. But the practices and traditions that have evolved through the years, with their starting point in the knowledge-as-object ideal, conflict with the criterion of relevance in crucial ways. The predominant career model among researchers is one based on publication of scientific articles in contexts where researchers are their own overseers and where rigour is emphasized at the expense of relevance. Writing for or with practitioners does not count. Working with practitioners is considered substituting the traditional role of the researcher in favour of that of business consultant or popular intermediary.

Much relevant knowledge has a generic form; there is a continually expressed need for basic research in selected areas; and good research is characterized by rigour. The challenge lies therefore in transforming today's situation where the identity and organization of IT research is mainly based on the knowledge-as-object ideal toward a situation where the basic philosophy is knowledge-as-relation supplemented by selective use of knowledge-as-object. A practical litmus test for whether the transformation takes place is whether universities, engineering schools and business schools put into practice the ideals and recommendations about knowledge and IT that they disseminated through their research and educational programs.

Bureaucracies and networks

The persistent efforts of the monks to control access to the written word had to, in light of copying technology, be abandoned in favour of a more liberal, societal distribution of knowledge. Similarly, in light of the increasing use of IT, many conditions at today's research and educational institutions must be changed if these institutions want to maintain their position as power centres in the knowledge society.

The knowledge-as-object tradition is based on a conspicuous, societal division of labour between those who develop new knowledge and those who use it, and between those who work in one discipline and those who work in another. Against this background, the central institutions of knowledge such as colleges and universities, international research associations, and professional interest organizations, have developed a strong, bureaucratic character. The predominant structure is hierarchical, there are relatively sharp and rigid divisions between the parts, and tradition-bound norms and cultural rules regulate actors' behaviour. Bureaucratic forms are, as is well known, enormously effective and efficient in stable surroundings. However, they are unsuitable and directly prohibitive in situations characterized by uncertainty and change.

The knowledge-as-relation perspective by nature cuts across individuals and institutions. Practices are fundamentally interactive. Actors meet across backgrounds, experiences and organizational memberships in order to share and develop new knowledge. Energy and innovation are found in the convergence and confrontation among actors, existing knowledge and problems. Such practice creates and presupposes dynamic networks as a breeding ground. It is not who you are and what you know that primarily determines your identity as a researcher. It is whom you know and work with that constantly develops and keeps current your professional identity in a dynamic process over time. The network is the organizational form that corresponds to knowledge-as-relation and provides the swift feedback between an idea and its realization that is so crucial for innovation and learning.

Knowledge networks will not replace the classic divisions of academic disciplines. The bureaucratic divisions are in their own way a prerequisite for the network's success because they deliver and maintain essential, specialized knowledge. But when disciplines meet and exploit each other in networks that cut across research and practice, and across disciplines themselves, unique opportunities arise for critical reflection on the individual discipline's relevance, and an important foundation is created for the discipline's evolution and its interplay with practice. The role of the network is not simply to transfer or communicate knowledge. It is a framework for interaction, on equal terms, across institutions and divisions, and it develops and maintains relations based on trust and mutual learning. Networks will not limit themselves to structuring the relationships of institutions to their surroundings. They will significantly influence and redefine the core activities of institutions within research and education. A greater number of research projects and a larger proportion of educational programs will come to be organized as networks in which researchers and students at institutions, together with skilled practitioners in the business world, solve concrete problems and develop new knowledge. This will serve to alter the fundamental driving force of the educational process and temper the traditionally sharp divisions among researchers, students and practitioners.

Knowledge gaps and learning

For the monks, God was the centre and the church and the monasteries were God's tools on earth. In that way, the knowledge strategy had a clear focal point and its goal was the people as receivers of the Truth. But how did this actually relate to the people of the fourteenth century? What did ordinary people believe in and what problems did they encounter in their daily lives that gave them a basis for wanting to know and believe? What variations were there in life conditions across Europe at the time that determined differences in values and philosophies of life? The monks did not pose this question and therefore their strategy had only a limited effect. As researchers and academics we also have a tendency to place ourselves in the centre and see knowledge from this viewpoint. Students are receivers of our knowledge and companies are buyers of our graduates, users of research-based knowledge and sources of new studies. But is that really a valid picture? What are the needs of today's companies in terms of knowledge and learning, what variations in knowledge needs are there across regions, and in what ways are demands made on research and educational institutions as central actors in the knowledge society?

In the knowledge-as-object perspective, companies are faced with the gap between the knowledge they possess and the knowledge that exists outside the company primarily in the form of state-of-the-art knowledge or best practices. In principle, new knowledge has a global reach and the challenge for the individual company is to create learning processes where employees seek out and learn all that is new and where the company invests in technology that can deliver solutions and processes based on the latest research. In this perspective, the company concentrates on developing the expertise of its employees and in investing in new technology to benefit from the common, global process of knowledge creation.

In the knowledge-as-relation perspective companies are faced with an entirely different type of knowledge gap. It is the internal gap between what a company's employees know and what they practise in the unique context in which the company operates. What do the employees already know about the Internet and how does the company use the Internet in connection with its business? What do the employees know about project management and how does the company organize and manage its own projects? It is this gap between the espoused theories and the theories-in-use that is a rich source for organizational innovation. Confronting the two, the company's internal problems are revealed and the fundamental assumptions on which the company's practices are based are critically evaluated. The resulting learning processes lead to practical expertise and technical solutions. But they do not confine themselves to this. They activate and develop knowledge resources that exist internally in the company, and they invite active cooperation with other actors and institutions that have relevant knowledge and that can organize company-specific, learning processes.

The academic institutions of the future must be more open and interact more closely with the surrounding society. This will benefit society as well as universities, engineering schools and business schools. Academic institutions will continue to produce graduates who contribute to society's development. But the knowledge society is not simply about knowing what only a few know. When the original and the copy are one in the same, when everyone has easy access to the latest knowledge, then the crucial expertise is not to know, but to be able to convert that which is known to practical action in a given, unique context. Academic institutions must, therefore, open themselves up and develop new and more interactive forms of cooperation in order to maintain their central role in the knowledge arena. Academic institutions will continue to be parts of international, global networks. But new networks and forms of cooperation must be established to develop and strengthen their position as knowledge institutions with a regional profile and a responsibility for local, societal development. To succeed in this effort avenues must be sought to overcome institutional and governmental barriers that serve as impediments to being high functioning members of networks.

Tradition and change

When one believes as the monks that the Truth flows from God, it is not only harmful but also heretical to open up a dialogue with the people about the Truth. This position gave the monks great strength but also blindness that, in a fourteenth century northern Italian monastery, proved to have fatal consequences both for some of the monks and for the monastery as a whole. As an outsider, William of Baskerville was able to reveal the inner logic that drove the monastery toward the abyss and that enabled a powerful group of monks to forcedly maintain a monopoly on knowledge and control over the transcription technology. This insight first came, though, when it was too late to change the monastery's knowledge strategy and organization.

In the debate over the academic institutions of the future and over the development of new forms of research and education we can still think constructively and in a forward-looking manner. But there are also in this context strong institutional forces that are opposed to a more open and interactive practice with knowledge-as-relation as the primary philosophy and knowledge-as-object as the secondary strategy. Suggestions for new forms of organization that challenge researchers' position as overseers and leaders of their own practice and that introduce external actors as direct participants in shaping the academic institutions of the future are by many researchers considered as a step backward and are met with great scepticism: How can academic institutions maintain their credibility if such a development is supported? How can academic institutions avoid serving narrow interests?

The knowledge-as-relation ideal undoubtedly leads to greater coherence and mutual influence between research and practice. We should, therefore, not abandon the classic virtues of academic institutions. Credibility must, like rigour, constantly characterize good research and academic education. The challenge lies in shifting the balance and introducing new practices that strengthen the relevance of research and education and that give academic institutions a more active role in the development of the knowledge society. It is this delicate balance between tradition and change that must be the guiding principle for the academic institutions of the future. Those institutions that do not develop such practices and fail to find the right balance between tradition and change will hardly be central players in the knowledge society.

Epilogue

This chapter is based on research about knowledge, IT and the relationship between research and practice. There is an extensive and ongoing debate about the future of academic institutions (e.g. Delanty, 2001; Gibbons et al., 1994; Readings, 1996). Delanty suggests that 'it is the task of the university to open up sites of communication in society rather than, as it is currently in danger of doing, becoming a self-referential bureaucratic organization' (2001, p. 7). Gibbons et al. (1994) discuss along the same *lines two complementary models of academic institutions in the knowledge society, Mode 1 and Mode 2, that are based on a distinction similar to the one between knowledge-as-object and knowledge-as-relation. This latter distinction plays a key role in the knowledge management literature as, for example, described in Hansen et al. (1999) and Swan et al. (1999). The debate over rigour and relevance has recently been the focus of attention in MISQ (Benbasat and Zmud, 1999; Davenport and Markus, 1999; Lee, 1999; Lyytinen, 1999) and experiences with close collaboration between researchers and practitioners within IT are discussed in Mathiassen et al. (2002). The tension between bureaucratic and organic forms of organization is classical and well described in Mintzberg (1983). Argyris and Schön (1978, 1996) emphasize the relationship between espoused action theories and theories-in-use, and Schön's concept of the reflective practitioner (1983, 1987) makes use of this philosophy to discuss the relationship between research, practice and teaching. The significance of local context for the use of IT is elucidated in several sources (Brown and Duguid, 1991; Ciborra and Lanzara, 1994; Dahlbom and Mathiassen, 1993), and the consequence of this for the development of reflective IT practices is discussed in Mathiassen (1998) and illustrated by Mathiassen et al. (2002). Finally, we know very well that the development and adoption of IT in society is intrinsically linked to change and issues of power (Markus, 1983; Markus and Bjørn-Andersen, 1987; Wareham et al., 1998). The question we urgently need to address is: How can we apply this knowledge to transform the academic institutions we work in so they maintain their key position in the emerging knowledge society? Our response to this challenge must depend on institutional and cultural settings and any successful effort will depend on collaboration with other stakeholders. But we cannot avoid taking a position ourselves when it comes to balancing a concern for knowledge-as-object versus knowledge-as-relation. The purpose of this chapter has been to stimulate reflections on this key issue.*

Acknowledgement. Special thanks to Bo Dahlbom, Saskia Hansen, Lena Holmberg, LeeAnn Iovanni, Maxine Robertson, Elisabeth Rossen, Jacky Swan and the editors for inspiration, criticism and help in preparing this chapter.

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