Published in: *Systemist*, Jan-Feb. 1995, Vol. 17, No. 1, pages 44-53, [ISSN 0961-8309]

INFORMATION SYSTEMS: OPENING THE BLACK BOX

Susan Gasson,

Warwick Business School,
University of Warwick,
Coventry CV4 7AL

INTRODUCTION

The impact upon organisational effectiveness of different approaches to the management and provision of information systems is a subject widely seen within the academic community as of critical importance to the success of organisations, yet managers and developers of organisational information systems appear largely unaware of these concerns. The development of information systems is seen, within organisations, as relating to primarily technical tasks, rather than to the wider issues of organisational work systems (Hornby et. al., 1992). Klein and Hirschheim (1987) argue that challenges to the narrow, purely technical, view of the information system as computer system, based on positivist, scientific traditions, can be seen as a reflection of wider social changes, but the growth and internalisation of these criticisms has been slow and focused mainly on an appreciation of user relations problems (Friedman and Cornford, 1989).

No clear conclusions have emerged from extensive research by both social scientists and computer scientists on reasons for the failure of information systems to benefit organisations. Brynjolfsson (1993) suggests four reasons why the organisational use of IT has not measurably improved productivity: (i) that traditional measures of value may not properly account for the inputs and outputs of information-using industries; (ii) that there may be significant time lags between investment in IT and benefits from its use, due to the learning-curve of both users and managers; (iii) that any benefits from using IT in an industry may be gained at the expense of those not using IT, so there are zero aggregate benefits; and (iv) that managers are investing in IT inappropriately, as they lack specific measures of returns from the use of IT.

The lack of clear conclusions may also be because researchers have approached the research problem via a bifurcation of interests: Social Scientists have studied the cognitive, behavioural and interpretative aspects of Information Systems, treating technology as an independent variable, whereas Computer Scientists have researched technical and knowledge-related aspects of the problem, treating the organisational context of work as an independent variable. What is required is to establish a middle ground, where the socio-technical approach is extended to examine the inter-relatedness of technological and social issues, rather than treating the two areas as two separated systems in equilibrium (Corbett et. al., 1991).

THE NATURE OF THE INFORMATION SYSTEMS DISCIPLINE

Land & Hirschheim (1983) define an information system as a social system, which may or may not use information technology (IT) to support its operation, while Galliers (1987) brings in an element of *purpose*: information as the basis for decision-making or action. These definitions of an information system move the basis of research away from the purely technical or the purely organisational, to the context of information system management, use and design. Ives et. al. (1980) propose a model for Information Systems research, which is given in figure 1. This model concentrates upon three aspects of information systems: use, development and operation, each of which is grounded in the organisational context.

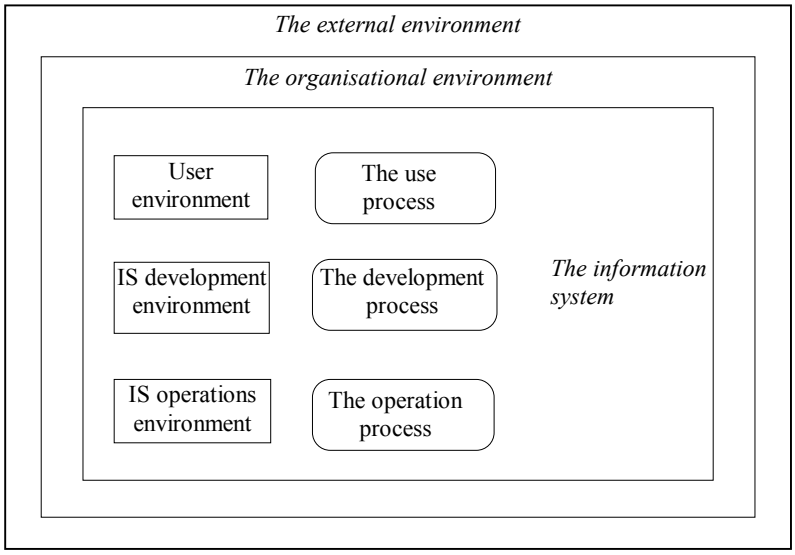


Figure 1: The Ives Et. Al. Model For Information Systems Research

However, recent thinking in Information Systems has come to be dominated by the management aspects of the organisational use of information systems, which constitute such a large body of literature, particularly with respect to strategic issues, such as business process re-engineering, but are only implicit in the Ives et. al. model. It is interesting that much of the business process redesign literature omits consideration of the technical system altogether, concentrating upon the analysis of those activities necessary for business operation, rather than the integration of technology necessary to support them, perhaps reflecting its authors' root in the field of social science.

The centrality of management processes in much Information Systems thinking is reflected by the MIT90s framework, given in figure 2, which places management at the centre of the model. This model is based upon the Leavitt organisational "diamond" (Leavitt, 1972), however, the integration of the separate "people" and "task" elements into a single entity, the substitution of a separate "strategy" element and the central position given to management processes shows the shift in emphasis in Information Systems during the 1980s, from the content of information systems to the processes by which they are managed, in particular the management of change. This may be the defining factor, in the current direction of Information Systems research: the concentration upon those processes by which an information system is acquired and managed, rather than upon any desirable content, or form, of the system.

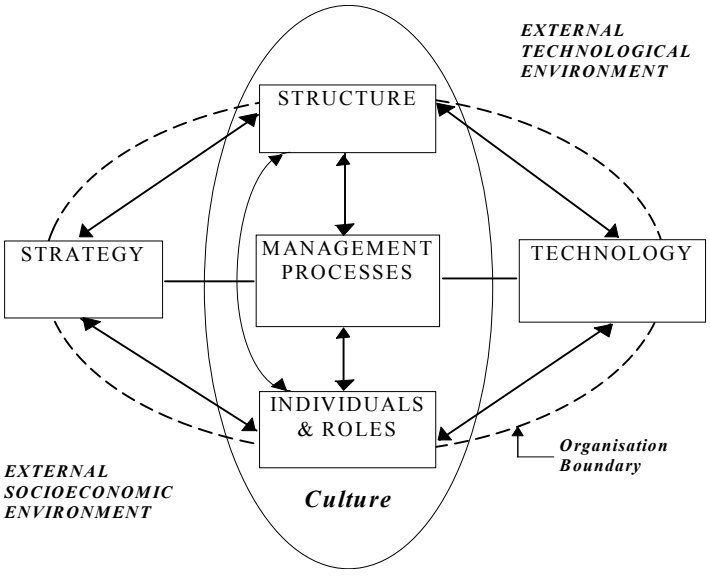


Figure 2: The MIT90s Framework (Scott Morton, 1991)

However, the socially-constructed nature of technical artefacts and the centrality of design to the use of such artefacts is well-documented (Wilkinson 1983; Mackenzie & Wajcman, 1985; Scarbrough & Corbett, 1991). By concentrating upon management to the exclusion of design, Information Systems research omits consideration of the social construction of information systems. Wilkinson (1983) provides a good example of how the management of computer-based systems may be limited by the socially-constructed nature of technology design. Managers in one of his four case-study firms found that they were unable to obtain computer-integrated manufacturing technology which gave shopfloor workers access to programming functions, as no commercial provider of such equipment had envisaged its being used in such an emancipatory manner.

INFORMATION SYSTEMS: THE SEARCH FOR A PARADIGM?

The strength of the discipline of Information Systems lies in its wide scope: its roots lie in many academic disciplines and it therefore lacks the fixed paradigms of other, more established disciplines. In practice, as reflected in the placing of Information Systems teaching and research in academic institutions, Information Systems straddles the boundary between computer science and social science: whilst Information Systems is seen as lying within the ambit of Social Science in some UK academic institutions, it is within that of Computer Science in others. This dichotomy permits a wide range of philosophical and methodological approaches to research in Information Systems. The literature base from which Information Systems research draws is therefore much larger than most other disciplines (this brings its own problems, as it is difficult to be familiar with current research in so many different areas).

The development of Information Systems as a separate discipline has provided an insight into the 'middle ground' of the bifurcation of interest between social and computer scientists, pulling together many different, and in some cases conflicting, research philosophies. The discipline of Information Systems may be seen as "filling a gap" in the provision of academic understanding with regard to the organisational use of Information Technology, by providing a *holistic* approach to research.

Existing research into the use of technology in organisations can, until recently, be viewed as pertaining to one of two perspectives:

- the social scientists' perspective, which considers the organisational impact of information systems, with the technology seen as a 'black box'
- the computer scientists' perspective, which considers the design issues of information systems in terms of choices made on the basis of technological criteria.

The language used in computer science research is revealing: the mechanistic approach to the human beings who constitute, and act within, an information system is revealed in the name given to the sub-discipline of the "human-computer interface". The human beings are relegated, by the use of such language to a component, of the information system machine. Much of the literature in this field applies itself to the reduction of errors by matching interface design to the cognitive style of the user; there is an implicit lack of recognition of the role of the human as a source of error-correction, rather than a source of error. This emphasis upon human beings as part of a machine tends to scientific reductionism in the design of organisational systems which, according to Corbett et. al. (1991), leads to fragmented jobs for users, with little use of the richness of human capacity. The rule-based functional specification approaches which are employed in designing IT systems do not adequately reflect the flexibility of organisational structures and practices.

The richness of Information Systems as a discipline is that it permits alternative research paradigms, as indicated by the many metaphors in use, which represent the function of the information system: the "brain" metaphor, embodied in the MIT90s model, the "tool" metaphor, embodied in the model produced by Winter & Brown and shown in figure 3, the "machine" metaphor, useful for the analysis of technical/functional support aspects of an information system, the "organism" metaphor, useful for the analysis of flexibility in the "learning organisation" and many others.

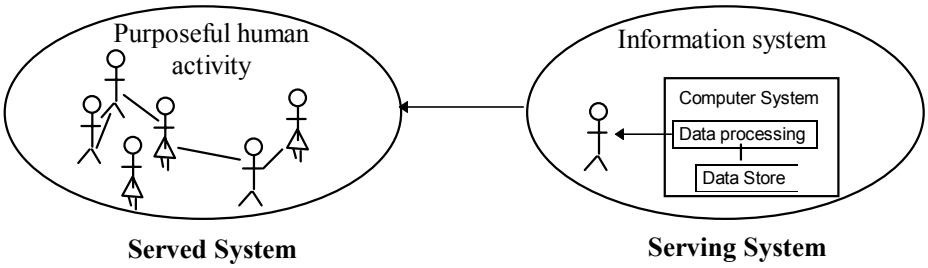


Figure 3: The Concepts of Served And Serving System (Source: Winter & Brown, 1994)

A useful concept embodied in the model presented by Winter and Brown (1994) is that an Information System consists of separate sub-systems, with different organisational objectives and therefore different methods are appropriate for interpreting the requirements and outcomes of the two perspectives on the same information system. This approach of methodological (and philosophical) pluralism is one of the main strengths of Information Systems.

Kuhn (1970) explains the term paradigm as "an exemplar, a particular scientific problem-solution that is accepted as successful and which become the basis for further work". Because the discipline of Information Systems has drawn its members from such a wide base of other disciplines, the range of available exemplars is much greater than in more established disciplines and leads to a much richer perception of the value and problems of Information Systems. Kuhn also gives a second meaning of paradigm, which has come into some disrepute, as there is an implicit lack of flexibility within it: "the entire constellation of beliefs, values, techniques, and so on shared by the members of a scientific community" (Kuhn, 1970). However, interpreted in its widest sense, the "constellation" of beliefs is inspirational rather than confining in its potential for intellectual freedom.

Walsham (1993) identifies three main paradigms of Information Systems research: positivist, interpretative and critical, which he equates with three of the four paradigms identified by Hirschheim and Klein (1989) in information systems development literature. In the context of the Burrell and Morgan (1979) model, which analyses ranges of assumptions about knowledge and the world, the paradigms are presented in figure 4.

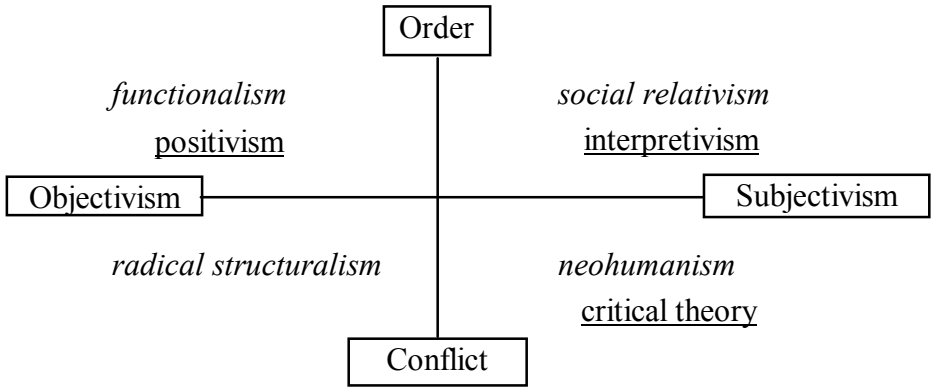


Figure 4: Information Systems Paradigms (source: Hirschheim and Klein,1989, adapted from Burrell and Morgan, 1979)

In figure 4, terms in *italics* refer to paradigms identified in IS development literature by Hirschheim & Klein (1989); underlined terms refer to paradigms identified from research literature by Walsham (1993).

Whilst Walsham does not identify an extant body of research in the fourth quartile of this model, there is a large body of research which performs a political analysis of the impact of IT on work (for example: Markus & Bjorn-Andersen, 1987; Corbett et. al, 1991). Hirschheim & Klein (1989) argued that most research was focused only on the functionalist paradigm, but it is arguable that **all** of the paradigms identified can be found within the ambit of Information Systems research.

It is in the appreciation of all of the above paradigms that the strength of Information Systems lies, together with the constant dialogues between them, which means that the discipline does not stagnate or take a fragmented view of the use of IT in organisations. MacKenzie and Wajcman (1985) identify three factors in the social construction of technology:

1. the influence of *social factors* on the design and configuration of the physical objects;
2. the term 'technology' refers to *human activities* as well as objects: a computer without programs and programmers is useless;
3. technology is formed by *knowledge*: objects are useless without the knowledge of how to use, repair, design and make them.

This conceptual framework for a socially-constructed information system may be considered appropriate as the basis of a holistic model of Information Systems research. This model, given in figure 5, integrates the importance of management with the role of technical objects supporting human activities, and accords with a systemic understanding of the nature of Information Systems (Checkland, 1981). The role of management is moved from the central position depicted in the MIT90s model, to become one element in the holistic appreciation of the processes of Information Systems management, creation, support and use, in an organisational context.

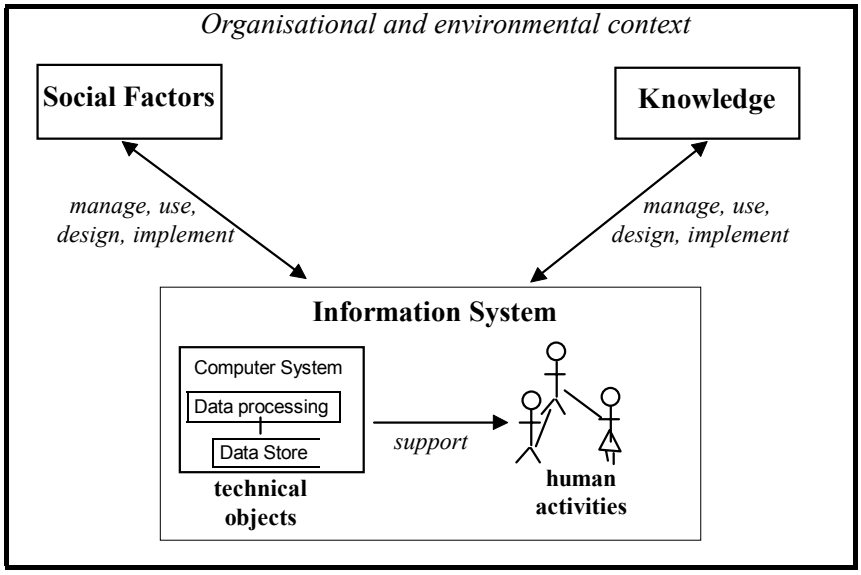


Figure 5: Potential Model Of Information Systems Research, Based Upon Principles Of The Social Construction Of Technology (*derived from* MacKenzie & Wajcman, 1985)

THE FUTURE OF INFORMATION SYSTEMS AS A DISCIPLINE

While the school of "strategic management" in Information Systems is currently ascendant, this may largely be due to a concern for the lack of evidence that IT makes any real contribution to organisational profitability or effectiveness. However, there are other areas which give equal cause for concern.

Jayaratna (1988) argues that the shift in information systems environments to more automated development tools leading to deskilling of developers, the power-balance shift away from the system developer as 'expert' towards a more knowledgeable user and the increasing user ownership and control of information, have exposed some of the weaknesses of information systems methodological knowledge bases, particularly in organisational systems areas such as the integration of information systems with other organisational dimensions (e.g. choices in work design).

The limitations of systemic research are highlighted by the many disputes over the value of linking Soft Systems Methodology (Checkland, 1981, Checkland & Scholes, 1990) with "hard" systems analysis methods (for aspects of this debate, see *Systemist* Aug.1992). The problems of a single analyst encompassing two (never mind four) paradigms in the various stages of their work are not seen as insuperable but are seen as highly problematic. Additionally, a researcher's background will affect their willingness to adopt a particular paradigm: there is evidence in, for example, the literature on the design of information systems, that an individual's approach to design is influenced to a very large extent by their educational background and by their previous experience of solutions to a particular type of problem (for a discussion of design schemas, see, for example, Jeffries et. al., 1981).

The socio-technical perspective has proven immensely useful in allowing researchers to conceptualise the relationship between organisations and information system technology, but its usefulness is limited because of the limitations of joint-optimisation: that either both factors are sub-optimised to achieve a "satisficing" strategy or that both factors are subsumed to economic optimisation. However, this attempt to combine technical and organisational issues has been criticised for largely treating the technology as given and concentrating upon the design of work systems to the exclusion of the design of the technical system which supports that work system (Rose et. al., 1986; Corbett et. al., 1991).

Although the lack of a central paradigm for research may lead to a state where complementary methodologies are used to give a holistic approach, it may also lead to a state where the selection of a research method is more influenced by a research designer's previous research experience than by the selection of a method which accords with the appropriate paradigm for the *type* of investigation or intervention. Therefore, it is important that Information Systems researchers are aware of the holistic nature of their discipline and aware of the issues which surround their choice of research method and philosophy.

Whilst admitting the problems of researchers adopting multiple paradigms in their research approach, it is felt to be important that the discipline of Information Systems differentiates itself by taking a holistic approach to research problems. The specific value of Information Systems as a discipline lies in the "constellation of beliefs" predicated by Kuhn, rather than in the adherence to paradigm as exemplar. In order to meaningfully add to the sum of knowledge about the use of Information Technology in organisations, it is important that Information Systems researchers, together, open the "black box", in *all* of its aspects.

REFERENCES

Avison, D.E., Wood-Harper, A.T., (1990), *Multiview: An Exploration in Information Systems Development*, Blackwell Scientific Publications

Brynjolfsson, R. (1993), "The Productivity Paradox of Information Technology", *Communications of the ACM*, Vol 36, No. 12

Burrell, G. and Morgan, G., (1979), *Sociological Paradigms and Organisational Analysis*, Heinemann, London.

Checkland, P., (1981), *Systems Thinking, Systems Practice*, Wiley, Chichester

Checkland, P. , Scholes, J., (1990), *Soft Systems Methodology In Action*, Wiley, Chichester

Corbett, J.M., Rasmussen, L.B. & Rauner, F. (1991), *Crossing The Border: The Social And Engineering Design Of Computer Integrated Manufacturing Systems*, Springer-Verlag, London

Friedman, A.L., Cornford, D.S., (1989), *Computer Systems Development: History, Organisation and Implementation*, John Wiley & Sons

Galliers, R.D. (1987), "An Approach to Information Needs Analysis", in Galliers, R.D. (Ed) *Information Analysis*, Addison-Wesley

Hirschheim, R. and Klein, H.K., (1989) "Four Paradigms Of Information Systems Development", *Communications Of The ACM*, Vol. 32, No. 10.

Hornby, P., Clegg, C.W., Robson, J.I., Maclaren, C.I., Richardson, S.C., O'Brien, P. (1992) "Human and Organizational Issues In Information Systems Development", Behaviour & Information Technology, Vol. 11, No. 3

Ives, B., Hamilton, S. & Davis, G.B. (1980), "A Framework For Research In Computer-Based Management Information Systems", *Management Scienc*e, Vol. 26, No 9

Jayaratna, N. (1988), "Guide To Method Understanding In Information Systems Practice", International Journal of Information Management, Aug. 1988

Jeffries, R., (1981), ED, Turner, A.A., Polson, P.G., Atwood, M.E., The Processes Involved In Designing Software, *Cognitive Skills And Their Acquisition*, Lawrence Erlbaum Associates, Hillsdale, Anderson, J.R.

Klein, H.K. and Hirschheim, R. (1987) "Social Change and the Future of Information Systems Development", in Boland, R.J. & Hirschheim, R. (eds), *Critical Issues in Information Systems Research*, Wiley, Chichester

Kuhn, T, (1970), *The Structure Of Scientific Revolutions*, 2nd Edition, The University Of Chicago Press

Land, F. and Hirschheim, R. (1983) "Participative Systems Design Rationale, Tools and Techniques", Journal Of Applied Systems Analysis, Vol. 10.

Leavitt, L., (1972), *Managerial Psychology*, University of Chicago Press

Mackenzie, D.A., Wajcman, J., (Eds.), (1985), *The Social Shaping Of Technology*, Open University Press, Milton Keynes

Markus, M.L., Bjorn-Andersen, N., (1987), "Power Over Users: Its Exercise By System Professionals", *Communications of the ACM*, Vol. 30, No. 6, June (1987)

Rose, H., McLoughlin, I., King, R. & Clark, J. (1986), "Opening The Black Box: The Relation Between Technology And Work", *New Technology, Work and Employment*, Vol. 1, No. 1

Scarbrough,H. and Corbett, J.M. (1991), *Technology and Organisation: Power, Meaning and Design,* Routledge.

Scott Morton, M.S. (Ed.) (1991), *The Corporation of The 1990s*, Oxford University Press, New York

Systemist, The Publication of the UK Systems Society, Information Systems Special Edition, Vol 14, No. 3, Aug 1992

Walsham, G. (1993), *Interpreting Information Systems*, Wiley, Chichester

Wilkinson, B. (1983), The Shopfloor Politics Of New Technology, Gower Press

Winter, M.C. & Brown, D.H. (1994), "Thinking Systemically: Information Systems Development, Redressing The Balance", in Lissoni, C. et. al. (eds.), *Proceedings of Information Systems Methodologies Conference*, BCS Information Systems Methodologies Specialist Group, Heriot-Watt University, Aug-Sept 1994