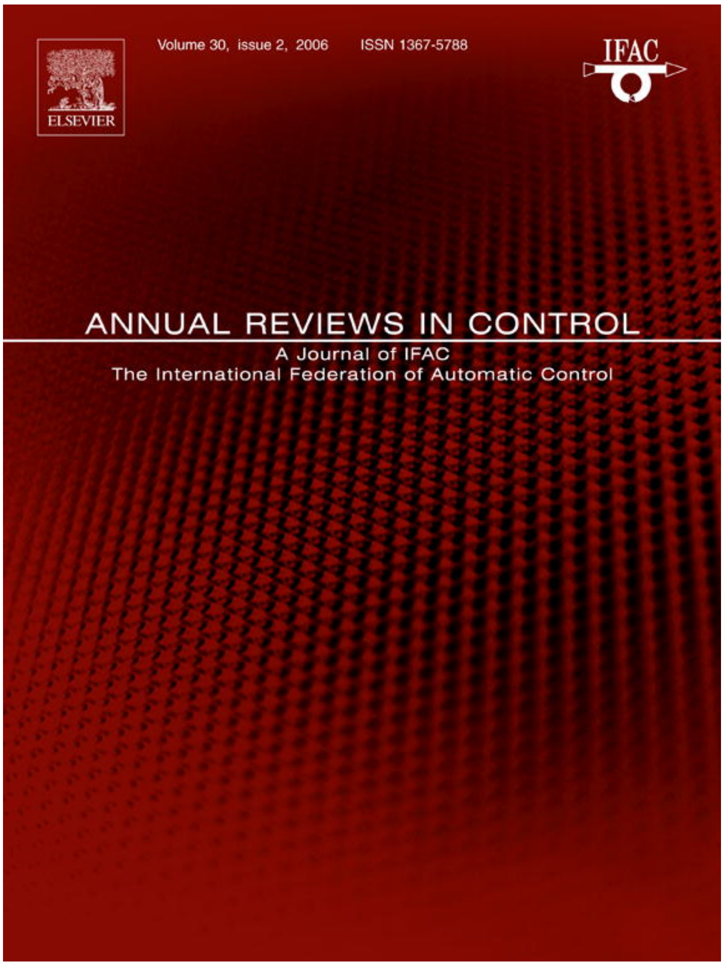
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Modes of reasoning in theories of the social impact of advanced technology A critique of ERP systems in healthcare

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Abstract

Human-centred systems has a long theoretical tradition within the automation and control community stretching back at least into the 1970s and particularly in manufacturing systems. As automation and control systems are increasingly important outside the factory many researchers are revisiting core concepts within this tradition in order to address concerns in these other contexts. One particularly important sector is health care which, in recent years, has implemented a range of AMAT-type solutions not least of which are enterprise systems. This paper reviews the application of enterprise integration systems to health-care and, in doing so, unpacks several theoretical tensions. The paper proposes a re-assessment of human-centred systems (HCS) thinking as a way to address these tensions in automatic healthcare systems.

Keywords: Human-centred systems; Health informatics; ERP

1. Context

This paper provides a survey of concerns of researchers in the area of automation based upon human skill and demonstrates how human-centred thinking can be employed to address these issues. It is particular concerned about the deployment of large-scale systems originating in CIM-based initiatives in the health sector.

Researchers in control and automation have remained deeply concerned about human-centred systems issues. This paper is in the spirit of Mansour (2002) excellent review of tensions between the human and the technical. In that paper he sets out global perspectives and demonstrates the need to return to HCS concepts. Mansour illustrates this through global analysis of human systems in international political and religious systems. This global theme is revisited with a somewhat different perspective on human-centred-ness by Dimorovski et al. (2006).

In this paper the author focuses upon applications with particular emphasis in healthcare provision as a way of tracing general HCS considerations. The concerns within health care are a microcosm of a broader range of issues arising in the 21st century and associated with the increasing ubiquity of automation and control systems in a wide range of organisational contexts. These systems are giving rise to a new wave of concerns associated with tensions between the technical and the human addressed in this paper. The application of manufacturing systems approaches to health informatics is used here as a vehicle for unpacking this discussion.

The concerns appear in a wide range of journals and other less formal literatures. The technological and rationalist programme to which HCS, in its earliest incarnations, was an informed systematic response remain highly problematic as systems and their contexts become increasingly complex (Stapleton, 2001). Information systems researchers maintain their call for informed systems approaches which can counterbalance serious problems associated with technological determinism and adopt more socially informed approaches to technology development and our understanding of how humans work (Dhillon & Backhouse, 2001; Johnstone & Tate, 2004; Kesseler & Knapen, 2006). Technology development research continues to call for 'revised' perspectives of development practises and theory, a call which has echoed since the 1970s (cf. Bell & Thayer, 1976). For example, in his empirical study of technology development processes Goulielmos (2004)

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demonstrated that there is a serious need for a revised theoretical treatment of technology development based upon human-centred principles which reflect the levels of complexity involved in such processes.

Recent research on the relationship between automation technology, business processes and work practices has also noted significant problems in connecting technology and human organisation. In a major study in Denmark of 24 ERP implementations the connection between the social and the technical was seen to be very weak, leading to significant problems in the systems implementation. The primary reason for this was seen to be a fundamental assumption which disconnects human organisation and technology deployment (Koch & Buhl, 2001).

It is evident that anthropocentric and human-centred systems approaches remain an important (if, at times, rather neglected) aspect of successful automation projects. Indeed, Brodner (2006) highlights the 'productivity paradox' associated with large-scale manufacturing systems which arises from the techno-centric approach to specifying these systems (Brodner describes this as an outcome oriented 'product-centred' view). He notes that these problems can be explained by a fundamental conceptual problem which ignores human aspects of these systems. In their analysis of the relationship between human resource management and technology deployment aspects of change initiatives across three detailed case studies, Bondarouk and Kees Looise (2005) note fundamental disconnects between these two aspects of the initiatives in all three cases. They explain this not just in terms of practical problems but describe the difficulties associated with the disconnection as a 'conceptual' gap. They also identified worker innovation as an area which experienced most problems. The issue of worker innovation is particularly important in the 21st century as companies realise that innovation in processes and products is the key for continuing competitive advantage (Jones & Tilley, 2003; von Stamm, 2003). This connection between humans and their technology is evident in many of the most successful large and small manufacturing firms in both traditional and advanced technology industries (see for example case studies of Chapparel Steel, Dutton Engineering and 3 M as set out in Bessant, 2003).

We notice from this literature that a wide variety of industries are still appealing for more human-centred approaches, beyond the traditional manufacturing sector upon which much HCS thinking was originally focussed. For example, recent research indicates that researchers from the construction industry (Arayici, Aouad, & Ahmed, 2005 to human resources (Pollitt, 2005) to transportation (Carmien, Dawe, Fischer, & Gorman, 2005) are looking to systems engineering for methodologies which are human-centred in approach.

In recent work on systems modelling researchers are concerning themselves more and more with how to provide a human-centred view of knowledge utilisation in the workplace (cf. Kotos & Vouros, 2006; Murphy, Stapleton, & Smith, 2004). In the related area of requirements engineering "user-centred" and "client-led" approaches such as CLIC attempt to 'bridge the gap' between user needs descriptions and technology specification (Champion, Stowell, & O'Callaghan, 2005, p. 213). This 'gap' between the user's world and the technological world is indicative of a more fundamental gap between science and the humanities, which has its roots in the earliest traditions of the enlightenment.

1.1. Historical development of human-centred systems thinking

Since the advent of modernity, there has existed a tension between the desire to emancipate human beings from the manacles of tradition and bring enlightenment, and the application of logical reasoning to co-ordinate and control the world. A result of this tension is massive information technology systems which operate according to machine-based logical reasoning and are utilised to control, on a huge scale, human and non-human behaviour, and the human problems associated with these technologies. In many ways human-centred systems (HCS) thinking is a counterpoint to this idea, arguing for prioritising *people* over *organisation* and *organisation* over *technology* (Brandt & Cernetic, 1998) and pulling the tension, between emancipation and control, back into balance.

The fundamental principles behind the ideas of this paper are not new. Indeed, this paper is a call to revisit these principles, in order to understand how the issues that are currently appearing can be addressed coherently. The writings of HCS thinkers of the 1980s and early 1990s represented by Cooley (1987), Suchman (1987), Zuboff (1988)[1] are particularly important. Major influences also include the anthropocentric systems movement of the 1990s (Brodner, 1991; Wobbe, 1992) and the various streams of thought which appear in the European tradition of HCS thought as set out in Gill (1996a). This work continues into more recent times in research by Dietrich Brandt (cf. Brandt, 2003; Brandt & Cernetic, 1998) and set out in an edited edition by Clarke and Lehaney (2000). Human-centred ideas can also be found in American research exemplified by philosophers such as Dreyfus (2001) and Sizek (2001).

These authors try to build a 'bridge' between the human and the technical. We will return again to this 'bridge at the end of this section.

1.2. Automation based upon human skill and healthcare provision

In the opening section of this paper we saw that Automationa and Machine Assisted Thinking (AMAT) systems and information technology-based control systems are now becoming widespread outside of the manufacturing environment. One example of this is the utilisation of computer-integrated manufacturing type systems such as enterprise resource planning. Whilst these systems promise (and sometimes deliver) a great deal, more and more concern has arisen about their suitability for human-oriented service sectors such

[1] For a detailed treatment see Gill (1996a, 1996b).

as health care. According to the OECD (2005) report almost all OECD countries have engaged in significant reform initiatives involving the implementation of large-scale IT. For example, in 1999 the government of the Republic of Ireland made significant investment in the modernisation of its health service which is largely state funded. In delivering this they invested in two large scale information systems: Personnel, Payroll and Related Systems project (PPARS) and Financial Management Information Processing System (FISP). The project involved SAP and Deloitte as external agents for the Irish Department of Health. The idea was to deliver an integrated information system for 140,000 staff in the health sector. Between them, PPARS and FISP have cost 180 m euros and have both been recently scrapped. For a small country like Ireland such a scenario has huge political and social implications. One hundred and eighty million euros amounts to a national scandal, and the services that could have been provided by such a budget amount to the construction of a small hospital.[2] If the above scenario was to occur in a developing country it would be a catastrophe.

Similar stories have been told of health systems in the USA, Canada, New Zealand and Europe. For example, a recent study of the implementation of similar systems in New Zealand indicates serious problems (Doolin, 2004). Hyde and Roche-Reid (2004) note significant problems in the implementation of a similar system in the UK. On the other hand, technical appraisals of the deployment of ERP systems in healthcare by chief information officers in the public healthcare sector suggest tremendous potential benefits from these technologies if the implementations can be successfully executed (Patton, 2005).

On the one hand senior practitioners and some case studies in healthcare informatics are heralding tremendous possibilities of ERP, whilst other research and practitioners describe horrendous problems associated with these same systems. It is evident from this literature that technical success (in terms of working machine function) does not translate to systems success across an organisation. The key success factors in these studies are social rather than technical. This paper will pay particular attention to the problems associated with these systems in healthcare and unpack the core assumptions underlying their deployment. In doing this, the paper will seek to address itself to the following proposition:

Could HCS be the bridge which addresses the tension between the technical and the social in an analysis of large-scale systems deployment in the health care sector?

In order to achieve this the paper will provide an original synthesis of the issues arising and set out a broad conceptualisation of what it means to be 'human-centred'. It will pull together the various strands of human-centred thinking into a coherent framework for HCS in the deployment of large-scale systems in the healthcare sector.

2. The technical–social debate in healthcare systems

Healthcare management information technologies seek to provide automatic control and effective delivery of information for decision makers within the heathcare sector. In recent years health care management has come under close scrutiny as welfare states try to come to terms with the spiralling costs of healthcare provision in the western world. For this reason, advanced large-scale management information processing systems are being deployed. These systems are called 'enterprise resource planning' (ERP) systems and are based upon solutions originally developed in manufacturing industries for the management of complex manufacturing business data in a supply chain management context (Turban, Leidner, McLean, & Wetherbe, 2006).

Historically, the technology underpinning systems like PPARS have their origins in Material Requirements Planning systems of the 1980s. These systems examined production schedules and, utilising bills of materials and other data structures provided material requirement plans needed to fulfil customer demands upon the production lines. The MRP systems were subsequently integrated into MRP II systems which comprised information processing capabilities for all major manufacturing business functions, including finance, personnel, distribution, sales order processing and other information processing functions around the initial MRP technology. Subsequently, corporate level integration technologies have been implemented which essentially extended the developments of MRPII across whole corporations and, in the last few years, along supply chains.

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Hyde and Roche-Reid (2004) describe tensions between emancipatory and scientific rationalities within health-care at an operational level. However, it is argued by this author that this tension is not only seen at an *operational* level within the health services, but is also evident in the fundamental principles which underpin strategic initiatives, especially in the provision of health information systems.

Some researchers have distinguished health-care from other sectors in terms of its 'human-centred-ness' (Leignick-Hall,

[2] This was widely covered in the media and was a national political scandal in late 2005. Example of reports include Irish Examiner reports in October 2005 (IE, 2005a, 2005b).

1995, p. 1). In this context, these authors recognise that there are particular complexities in healthcare related to the fact that healthcare seeks to produce comprehensive and persistent change in the physical and/or mental well-being of patients.

This paper first examines the role of large scale information technology as a means by which to automate and control certain aspects of health care. Secondly, a critique of key assumptions and tensions is provided. The need to revisit human-centred systems is identified as a means by which to address issues in this space and achieve greater balance in systems development approaches. Let us take some major assumptions underlying the development of these systems, and their basic operation and consider them in the light of health care.

3. Levels of social impact of ERP systems in health-care

In many countries the health sector has begun to implement enterprise resource planning (ERP) systems as a way of managing health information. Indeed, for most of the OECD, this approach is a key element of healthcare reform (Docteur & Oxley, 2003, p. 20). There have been a number of notable failures in these systems as set out in an earlier section and the author proposes that it is now time for engineers and technologists to consider the basic assumptions underlying these systems and their suitability for large scale applications in health-care.

3.1. Motivation

The impact of problems with these systems in health informatics has particular relevance to the social impact debate:

1. *Societal level impact*: In so-called "welfare states" the health sector provides a major national service and the large-scale deployment of technologies therefore has a direct or indirect impact at societal level.[3]
2. *Organisational level impact*: The health sector in many countries is a significant employer and presents a complex set of services which require coordination systems. Research has indicated that in other large organisations where similar technologies are implemented there is invariably a major destabilisation of organisational information processes and concomitant social impact at that level (Byrne, Ryan, & Stapleton, 2001; Dillard & Ruchala, 2005; Stapleton, 2001).
3. *Individual level impact*: Systems design and business process re-engineering are two sides of the same coin (Jayachandra, 1994; Woods, Macdonald, & Stapleton, 2004). How patient information is managed reflects the prevailing conceptualisation of 'patient' and how the patient 'object' is managed through the healthcare process (Carew & Stapleton, 2005). This in turn is related to what patients expect from healthcare providers, something which is often quite different from what a 'customer' might require from a manufactured 'product'.

Ethically, it can be argued that engineers, scientists and technologists bear some responsibility (at least) for the technology they create (Hersh, 2004). This is enshrined in the phrase 'how can technology be guilty and we be innocent'. This is consistent with all major theories of ethics, including consequentialist, deontological, and care-based ethics (Stapleton, Hersh, & Duffy, 2005). We accept this idea of IFAC community responsibility and therefore believe it is important to attempt to elucidate some of the primary dimensions of the problem.

4. Assumptions underlying manufacturing management information technologies

It can be argued that the disciplines and processes which accompany large scale information systems can provide benefits to organisations seeking stronger controls. However, the underlying nature of these systems needs to be considered. In this context what do we mean by the term 'technology'? Technology is the material culture of science. Technology is made by humans for humans. But how do material objects gain their meaning? In his treatment of this problem, Sismondo (1996, p. 57–58) distinguishes material worlds from social worlds in terms of 'meaningfulness'. Social worlds (and their objects) are those "whose constitution depends on the continued presence of human actors". Social objects must be meaningful in themselves. Material objects are "*only meaningful when they are incorporated into the social*".

4.1. Functional rationalism and instrumental realism: organisation as machine, humans as data

Functional Rationalism is a term coined in the literature to describe positivist influences in much information systems engineering theory and practise (Bickerton & Siddiqi, 1993). It refers is based upon understanding the world in terms of functions. In the context of information processing in organisations, it treats information processing activities as a mechanical system. Most systems development methodologies are based upon functionally rationalist premises. Indeed, since the 1970s these premises have dominated research and practise in this field (Carew & Stapleton, 2005; Galliers, 1992; Klein & Hirschheim, 1991; Myers, 1995).

Functional rationalism can also be linked to "instrumental realism", especially in visual media technologies of which computer-based systems are an example. Instrumental reality as set out in Ihde (1991), Latour (1999) and related works can be summarised as a view in which our world is mediated by instrumentation. For example, Pasteur brings the bacteria into view through manipulations of his instrumentation (the microscope, cover slips, dyes, etc.). In a sense these objects were created by Pasteur, i.e. discovered, controlled and manipulated, so that somehow they did not exist in the human

[3] In France for example, 75% of all healthcare costs are provided by the state, with private insurance picking up the balance (NJG, 2006 after Docteur and Oxley, 2003). For a detailed treatment of social impact assessment of healthcare provision and an analysis of reforms in OECD countries up till 2003 (the latest report available) see Docteur and Oxley (2003).

mind before Pasteur's instruments were applied in this particular way. Pasteur made them 'real'.

In their recent study of health service provision Hyde and Roche-Reid (2004) link instrumental rationalities to outcome orientations (especially as regards power and money) and a political economy approach to health care. In earlier research across a number of disciplines the techno-centrism of an instrumental rationality have been linked to systems failure (Stapleton, 2001). Webb (1992) shows "that management, in attempting to pursue an instrumental rationality, undermined the achievement of their own objectives." In their study of the implementation of information technologies in healthcare management, Dillard and Ruchala (2005) refer to the use of technology, professionals, and hierarchical organizational structures in ways that divorce collective actions from their moral context as an "administrative evil". The role of technical accounting expertise, manifested as various devices, facilitates "ordinary" human beings' "rational" participation in "administrative evil" through a series of technically competent and instrumentally rational decisions, facilitated by information technology. Dillard and Ruchala (2005) demonstrate the importance of empowering individual human beings in order to circumvent processes associated with this 'evil'.

In human-centred terms the problem can, at least to some extent, be explained theoretically by noting a disconnection between the *people first – organisation second – technology third* paradigm set out at the beginning of this paper. In Dillard and Ruchala (2005) we see a reversal where organisation is first, technology is second and people third (by some distance). Others have argued that functional rationalism in manufacturing has lead to technology first, organisation second and people third. This again is informed by an instrumental rationality in which humans are seen through the lens of a computer monitor, and reduced to data fragments. We shall return to reductionism in Section 4.3.

HCS focuses upon enabling humans to adapt to the technology we are developing or have developed. HCS is concerned with joint-design of technology, work environment and training. This in turn implies a focus upon education (first) and learning (second). These processes enable humans to create sens-ible structures. This approach has been demonstrated as highly effective, for example, in the development and deployment of assistive technologies for the learning disabled (Duffy, Stapleton, Jordanova, Lakov, & Lyng, 2004). It is notable that this human-centred approach refocuses us immediately upon the supports that people need in order to cope with the transformations taking place around them. It assumes a dynamic, unfolding world in which humans must live and work, and sees technology as a means by which structure can be placed upon chaos.

In this reframing of systems engineering, we are no longer just dealing with technical development but 'socio-technical development' sometimes called 'soft-systems development' (Checkland, 1999; Mumford, 2000). Joint-design of both social space and technology function are required.

4.2. Integration rationalism: technological integration as progress

Integration is a reasoning based upon the premise that integration delivers effectiveness and in turn delivers progress. In the early 1990s it was argued that, there was a contemporary move from an 'era of specialisation' towards an 'age of integration' (e.g. Zeleny et al., 1990). Extensive systems integration which has proven to be one of the most important aspects of information systems development in the past fifteen years. Inter-enterprise systems integration has now been achieved.

Integration rationality is a powerful force within information systems theory because it is driven largely by database integration concepts which are extremely solid and well understood as delivering data processing efficiencies (Grenier & Metes, 1992). This perspective has been questioned since the early 1990s. Other rationalities have been proposed to counter integrative reasoning. For example, writing around the same time as Zeleny, Hirschheim and Newman (1991) proposed an "emancipatory rationality". They argued that:

> "[assumptions about the] rationality of the actors and the social processes they engage in need to be critically appraised.. if the assumptions of economic rationality are closely analysed, it can be seen that they do not reflect the reality of systems development". (p. 29)

Economic rationality refers to the global project of integration (Hirschheim & Newman, 1991). From an organizational information processing perspective integration rationalism assumes that organisations are full of dysfunctions which can be eliminated by integrating functions from the different units. This integrative function of information technologies has been questioned since the earliest days as regards its impact upon integrating social groups. For example, Sproull and Kiesler (1991) demonstrated how the use of electronic communications to provide a more integrated and coordinated organisation can actually have a contrary effect. More recent work has demonstrated serious theoretical problems within systems development with traditional views of development methodology when applied to the contemporary phenomenon of distributed organizations (Mullally & Stapleton, 2006).

Many national healthcare institutions have embarked upon fundamental reform of the healthcare service with varying levels of success (OECD, 2005). One key element in the reform initiatives is the large-scale integration of enterprise level systems using ERP type technology. Whilst there is undoubtedly significant promise offered by such a programme of integration, the healthcare literature also emphasises deep concerns about notions of 'integration' which imply a certain de-humanisation of work and a lack of appreciation of the human activity systems amongst organisational actors which are central to service delivery. For example, in one of the most recent studies a computerised physician order entry system (CPOE) was introduced in order, through the integration of various databases and processes, to reduce physician errors (Patton, 2005). However, alarms were raised when it was shown that the new system actually increased the likelihood of errors and that incorrect medications were being issued. The problem was that the new system did not sit well with the established work practises at the hospital and that the complexities of human work activities had not been fully appreciated or addressed. Part of the reason for this was that the technological-aspects of the implementation had overshadowed important aspects of the human activity system by which the work was accomplished. The study recommended that more communication between human actors within the work process and the vendors of the system was needed in order to ensure good fit between the human activity system and the enterprise technology. It was also apparent that the organisational actors needed to be more empowered within the technology development and implementation process itself. In other studies in the health sector, it has been shown that political factors associated with technology development and deployment amongst healthcare employees can lead to significant problems with the technology and even a complete reframing of the role of the technology within the organisation. For example, Doolin (2004) presents a case of the implementation of a healthcare management system in a New Zealand hospital. This system was ‘‘intended to scrutinize and monitor clinical activity’’. Doolin describes how resistance formed against the system and that doctors would not lie down and become ‘‘passive subjects of a computerised control system’’. Instead doctors found ways of resisting their perceived reduction to data fragments and fought back. Ultimately, the system, which was originally intended to become the major driver of control and automation in the New Zealand healthcare context, was ‘relegated to a less significant role’ as management were forced to ‘‘reinterpret the system’’ in the light of organisational realities. This is an interesting case study in which we see intelligent rational people (doctors) actively resisting the reductionist, integrative machine approach to healthcare. It also demonstrates the the ineffectiveness of integrative, instrumental and functionally rationalist perspectives associated with techno-centrism, and the significant costs involved in making the mistake of ignoring the human as the centre of the project of technology design and deployment. Here we see an emancipatory perspective essentially forced upon the systems context by the actors themselves as they react against the imposition of a technologically oriented solution. This is very reminiscent of similar problems highlighted in the introduction of large scale manufacturing integration technologies (Stapleton, 2001a).

4.2.1. Integrated quality systems perspective of health care provision

One important role ERP systems play in organisations is to monitor and control quality in an integrated way. Here, quality is a key aspect of the efficiency programme mentioned earlier. These systems can help control and monitor quality of inputs, processes and outputs in the system. Traditionally these technologies were introduced as part of a ‘‘world-class manufacturing’’ or Total Quality Management (TQM) initiative. In order to further unpack the integration concept, we will examine ERP as a quality management system in health care provision. Fig. 1 provides a simple systems model of the patient-care process. This is equivalent to a typical high level model we might use to understand a manufacturing process with its inputs (suppliers for example) and outputs to customers.

The model is an open system as indicated by the dotted boundary lines. The context is a hospital which itself has cultural and social dimensions as well as other dimensions such as political contexts, facilities, etc. The model is a control and feedback system in which the outcomes of treatment are monitored in order to assess the readiness of the patient for discharge. The system is a little over simplistic in that it does not model outpatient activities of the health care provider but it will suffice in order to illustrate the important points.

In reviewing this model it becomes apparent that there are significant complexities in patient-care information systems which are not readily seen in traditional manufacturing management processes. When considering the patient's role in this model, we can see four distinct aspects of patient care, especially in considerations of management control system for patient-care (Leignick-Hall, 1993, 1995). These are:

1. Patient as participant: Patients are active participants in the health care delivery process. In a sense, they are part of the treatment process at the heart of the system. They are active members of the service delivery team but are not employees of the organisation.
2. Patient as supplier: Patients are an important resource input to the process.
3. Patient as customer: Systems outputs are aimed at patients as customers who must be satisfied by the quality of service.
4. Patient as Product: Discharged patients are the outcome of the successful treatment process, although some care may be provided after discharge on, for example, an outpatient basis.

If we counterpose any two of these four roles we can see how the reductionism of patients to data is oversimplistic in an ERP system due to the high levels of complexity so that the ERP perspective does not sit well outside of a HCS approach. Furthermore, the idea of database integration does not sit easily with a complex and ambiguous reality of the patient as fulfilling all the above roles.

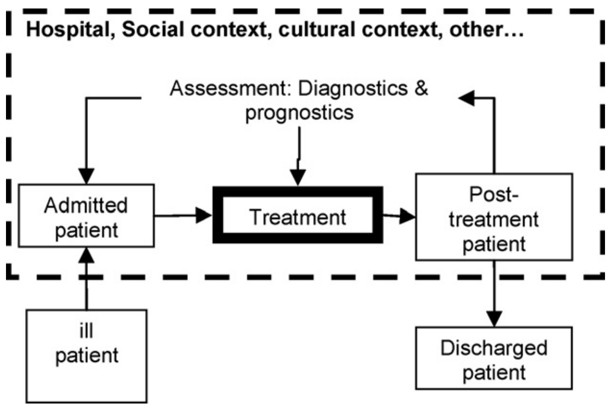

Fig. 1. Simple systems diagram of healthcare provision by hospital.

In the *patient as supplier* role the patient provides a primary resource for healthcare—their bodies. They are the human target of the system transformation and a provider of critical information for the treatment process. Consequently we can see that their role as supplier is both in terms of information and physical resources. To enhance quality through patient/suppliers, Leignick-Hall (1995) argues that we must gain extensive knowledge of patient attributes and clearly communicate expectations and consequences to patients. This requires complex communicative action which cannot simply be achieved through a database approach. The reduction of patients to data, without a concomitant human-centred communicative action approach will result in reduced health care quality. However, whilst health care providers are spending enormous amounts of public money upon new integrated information technologies, a recent OECD report indicates that only about 3% of health budgets are being spent on ways to improve the quality of the input to the system by investing in preventative measures and public awareness of health issues (OECD, 2005).

In the *patient as customer* role, since the patient–supplier is also the customer, the common control aim in TQM of narrowing the vendor base is not entirely relevant. Furthermore, quality measurements of the inputs of the supplier do not have the same meaning as, for example, in the manufacture of a refrigerator. In traditional manufacturing even where a firm is supplying to and receiving supplies from the same company, typically the organisational functions involved are quite different and can be clearly distinguished in the ERP satabase (customer order administration and purchasing for example). Health care is also governed by politically and ethically determined rights of patients so that, for example, just because a patient is a poor quality resource incoming inspection cannot reject him. So, healthcare providers are required to provide consistently high levels of quality of service independent of the quality of the inputs. This in turn suggest that the political sphere becomes very important in the external context as political action in improving general well-being of society will result in higher quality inputs and less pressure upon the health system itself. Thus the system model needs to recognise the importance of various actors in the external environment and the role of health care lobbyists in improving quality of the system through political action. As we have seen earlier, human-centred systems provides a community perspective which addresses itself to this aspect of the system. Thus we see communicative action as described by Habermas (1981) and expounded is a variety of human-centred approaches to systems development, is an important counterpoint to control and feedback mechanisms.

We notice that the system is a feed-forward open system and so is far more complex in inputs and traformations than the traditional feedback system approach outlines here and used to conceive of ERP-type solutions. An emancipatory rationality is needed which focuses upon personal freedom and empowering individuals. More recently Bokeno (2003) argues for an emancipatory approach to organisational adaptation and prioritises communicative action as a central response to change. If we see technology as a change agent (as many authors do) we note that the priority should therefore be upon authentic communication mechanisms between human beings (as proposed by Habermas, 1981). Thus, the HCS tradition counter-poses the 'emancipatory' rationality to an 'integration' rationality and brings into focus both political and communicative rationale in the deployment of large scale systems in health care.

4.3. Reductionism, units and cells: humans as assemblies and disassemblies

In the last section we see the reductionist approach of techno-centric perspectives emerging from our discussion of the techno-centric integrative rationality to which it is very closely related. In this section we shall spend a little time exploring reductionism as an assumption in its own right, bearing in mind what we have seen in the other rationalisms. When viewed from a human communications perspective several post-structuralist writers have questioned the idea that the integration of vast information spaces actually achieves the objective of 'true' integration. Instead, it is argued that so much data now swirls around these systems that the human condition itself has been described as fragmented (Stapleton & Murphy, 2003) and in a simulacrum (Baudrillard, 1994). Associated with this has been the 'decline in meaning and the rise of information' (Borgmann, 2000). This is further developed in Brodner's (2006) study of ERP failures in which he argues for a more human-centred 'sign-processing' approach to our understanding of large scale information technologies. In the view proposed in this paper humans are embodied, they act and in acting, they shape the world around them. Social action includes systems design and development and implementation, and recognises the adaptive processes by which these socio-technical (or perhaps techno-cultural) systems of meaning develop. This echoes recent developments in the philosophy of technology (see for example Ihde, 2002).

As Carew and Stapleton (2005) point out, the disembodiment of the patient-doctor contact due to the use of ICT in healthcare is a major concern. Using tele-care services to deliver healthcare remotely or simply using EHR information to make diagnoses instead of physically visiting patients contribute to such disembodiment. This again is an instrumental reality rather than a physical, in time and context, reality. Dreyfus (2001) speaks critically of the lack of embodiment due to tele-presence. He notes that "tele-presence can never give us a sense of the reality of far-away things, nor can it convey a sense of trust of distant human beings" (p. 98). Instrumental reality creates the sense that we are close in the sense of pulling some object into our frame of control (e.g. Jupiter's moon or *E. coli*). We can never truly get a grip on the reality, as the true context cannot be felt artificially from a distance through instrumentation. Healthcare professionals cannot fully understand the reality of the remote patient due to the lack of context, which can only be established by physical embodied presence. They may miss implicit signs, which are only available by being physically present with the patient.

The reductionist rationality also poses the transaction as the basic processing unit (Stapleton & Murphy, 2003). How do we map manufacturing systems concepts such as a production unit, customer order or other transaction units to hospital work? In this view the hospital is made up of work cells (e.g. the Accident and Emergency work cell) which processes incoming ''materials'', i.e. sore elbows, broken legs, damaged minds along a ''manufacturing'' system until the elbows (for example) are transformed into ''healed'' elbows and ''shipped'' out. The metaphor is very powerful because it provides an excellent way of thinking about the hospital as an information-based control system. However there are deep flaws in applying manufacturing control systems theory in this way. This approach is intrinsically hierarchical and invokes the bill-of-material in manufacturing as a central concept in the organisation of data about products. Can human health really map into a concept in which humans bodies and minds are assemblies and subassemblies for processing through a work cell routing? This paper argues that it is far too Reductionist and explains the difficulties associated with the implementation of systems like PPARS and FISP (Stapleton, 2003).

Counter-posed to this fragmentation is the notion of 'holism' which is particularly well developed in socio-technical and soft-systems theory and applied in health informatics (for example see Atkinson, Eldabi, Paul, & Pouloudi, 2002; Checkland, 1999). This paper argues that systemic structures which develop and deploy other systems (engineering design and development methods for example) must adhere to Ashby's (1957) Law of Requisite variety, i.e. they must incorporate the necessary level of complexity is that they might deal with the diversity of the system context.

Reductionism also limits our understanding of what it is to be in an organisation—how organisations work, how they employ knowledge in their work and how information is used to underpin these processes. Organisations are not made up of one practice but comprise communities of practice. These communities form spontaneously out of a common sense of purpose and often go unnoticed even though they have an enormous influence upon how organisations function (Hayes & Walsham, 2003; Malone, 2002). These communities use informal mechanisms to share knowledge in the work context which are not taken into account in formal modes of reasoning. Thus, in many ways, the notion of organisations as communities of practice is diametrically opposed to the rationalities we have addressed here. Communities of practice invoke diffusion, connectivity, groups and expansion rather than a functional, integrative reductionism.

In Sodomka's (2006) excellent study of quality of service in health care, she demonstrates how adopting a community perspective with an emancipatory approach to involvement in the delivery of the service. This approach was implemented as part of a new systems approach to the provision of healthcare in Georgia in the USA. The patient- and family-centred approach to healthcare was designed into the fabric of the organisation and its technological infrastructure (through information sharing channels for example). Here we can see the results of a holistic approach to the provision of a solution which incorporates both social and technological systems. As Sodomka puts it herself.

> 'Patient- and family-centred care is an approach to the planning, delivery and evaluation of health care that is governed by collaborative partnerships among health care providers, patients and families. The concepts of patient- and family-centred care are woven into the infrastructure of an organization – in strategic plans, vision and values, facility design, patterns of care, information-sharing processes, family support, charting and documentation, human resources management, professional education, and quality and safety improvement processes. The key is to partner with patients and families who are trained as formal advisers. Patient- and family-centred care is much more than a nice gesture. This model of care provides a framework and strategies for achieving quality and safety goals, enhancing market share, lowering costs, and strengthening staff satisfaction. (p. 1)'

In this context some authors have recently begun to highlight the importance of patient-education as a way of improving service quality (Haugh, 2005). This is another counterpoint to reductionism to data fragments in that it helps to develop the knowledge needed for patients to critically engage in the provision of their own care as part of the service delivery team. Learning is again an important theme in HCS and was recognised from the earliest days as a means by which workers might be empowered in increasingly automated environments (Cooley, 1987).

HCS research argues that the delivery of a quality service using complex technological infrastructures requires high levels of alignment with employee work practices and a strong sense of ownership of the change initiative in which the technology is embedded (Brandt, 2003; Brodner, 1990). In health care this fact that has been demonstrated in studies of nursing (for example Fernandez & Spragley, 2004).

5. Synthesis

It is apparent that the various assumptions explored here indicate tensions between the logically rationalistic programme of science and technology, and the humanistic perspectives associated with solving problems on the human side of technology. A mature theory of technology development and deployment should not ignore either perspective, as Cooley (1987a) argued, an argument which remains as valid today as it did in the 1980s.

It is possible to synthesise these arguments into a table of bi-polar oppositions as shown in Fig. 2. It is evident that the bi-polar tensions are addressed by a human-centred approach to systems engineering methodology. The primary poles, i.e. technical versus social can perhaps be better described in terms of Cooley's (1987) polarisation of scientific and human knowledge. Human-centred systems concepts draw us towards the right side of the figure, without ignoring the importance of the issues on the left. In trying to address all these issues socio-technical research has proposed joint-design of human and

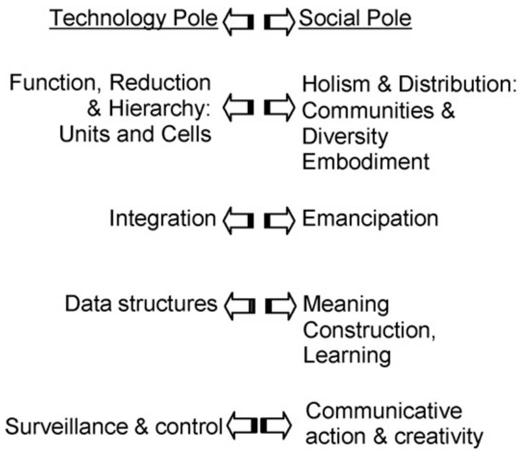

Fig. 2. Bi-polar tensions in modes of reasoning.

technical systems. Certainly, if the figure is even partially valid, HCS approaches are never more important than now. In spite of this, the main trajectory of systems development research remains profoundly technology oriented.

6. Conclusion

The author deals with concerns arising from the tension between the technical world on the one hand and the social world on the other. This debate is used as a point of departure for a discussion of the need for a richer perspective of "rationality" as regards the social impact of technology and automation based upon human skill. It is intended that this in turn will foster further debate which will provide some ethical and philosophical guidelines for developments in this area. It is also intended that the theoretical synthesis will provide practical guidelines as to how to manage problems arising in the deployment of automation systems to augment healthcare work.

The central proposition set out at the beginning of the paper was:

Could HCS be the bridge which addresses the tension between the technical and the social in an analysis of large-scale systems deployment in the health care sector?

In order to address this proposition the application of large-scale information technologies to control health services is outlined. The discussion suggests that there is a fundamental need to rethink this project in view of the tensions set out above. It is readily apparent that HCS provide unique and extremely helpful insights in addressing the conceptual gap discussed in Bondarouk and Kees Looise (2005) and which is a manifestation of the tension between the technical and the social. In particular, it is argued that human-centred approaches to technology development and deployment are more critical than ever, if we are to avoid a potential crisis in health service provision. It shows how human-centred-ness provides a way of rationalising the problem and developing potential solutions.

Of course the polarities presented here are both simplistic and limited. However, they do present an original synthesis of theoretical aspects of healthcare automation systems, particularly as seen in the information technology systems being deployed. Although the fundamental principles behind figure one are developed elsewhere, it is evident that Fig. 2 presents an original synthesis of these ideas and the basis for further work into the technological development of automated control systems which deploy information technologies on a large scale within health services in the OECD. There are many other polarities which impact upon this interface between the human and the technical. This paper draws out and organises some of the key dimensions and tensions. This emphasises the need for more theoretical work beyond the human–computer interface paradigm which is the main paradigm of HCS at the moment. HCS research needs to concentrate on work design, human–machine symbiosis, anthropocentricity in the ways in which technologies shape work and working relationships. This takes us far beyond the HCI concern with web-based graphical user interfaces (as important as that work is).

It is apparent that there is a need for automation and control mechanisms and technologies in complex service provision such as healthcare. The dimensions of the theory behind these structures are set out in Fig. 2. However, there is also a need for an emancipatory approach which frees humans to be humans in the organisations in which they live and work. HCS is one of the few rationalisms which balances these two poles, and can lend insight into how best to achieve this balance.

In short HCS can help us to rationalise the serious problems associated with the deployment of advanced automation and control technologies in healthcare. This is critical if OECD countries are to avoid a major crisis in national healthcare provision.

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