March 2000

The Politics of Sociotechnical Intervention: An Interactionist View

Karin Garrety
University of Wollongong, karin@uow.edu.au

R Badham
Macquarie Graduate School of Management

The Politics of Sociotechnical Intervention: An Interactionist View

Abstract

In this article, we apply concepts from symbolic interactionism - a well-established tradition of interpretivist sociology - to investigate the social and political processes involved in a sociotechnical intervention. The intervention was designed to elicit operator involvement in an experimental trial of an advanced manufacturing system at an industrial site in Australia. The interactionist concepts of social worlds, boundary objects and trajectories are used to explore the interrelationships among the theoretical, practical and contextual elements of intervention. We believe that these concepts are flexible intellectual resources that can extend and enrich our understanding of the politics involved in the shaping of work and technology. Such an understanding is necessary if the fields of user participation and sociotechnical design are to move beyond the production of normative discourses and methods into effective interventions in the complex social environments in which technical decisions are made.

Keywords

technology development, politics, social worlds, boundary objects, symbolic interaction

Disciplines

Business | Social and Behavioral Sciences

Publication Details

This is an electronic version of an article originally published as: Garrety, K & Badham, R, The Politics of Sociotechnical Intervention: An Interactionist View, Technology Analysis & Strategic Management, 2000, 12(1), 103-118. Technology Analysis & Strategic Management can be found here through Taylor & Francis journals.

The Politics of Socio-technical Intervention: An Interactionist View

Karin Garrety and Richard Badham

Abstract

In this article, we apply concepts from symbolic interactionism – a well-established tradition of interpretivist sociology – to investigate the social and political processes involved in a socio-technical intervention. The intervention was designed to elicit operator involvement in an experimental trial of an advanced manufacturing system at an industrial site in Australia. The interactionist concepts of social worlds, boundary objects and trajectories are used to explore the interrelationships among the theoretical, practical and contextual elements on intervention. We believe that these concepts are flexible intellectual resources that can extend and enrich our understanding of the politics involved in the shaping of work and technology. Such an understanding is necessary if the fields of user participation and socio-technical design are to move beyond the production of normative discourses and methods into effective interventions in the complex social environments in which technical decisions are made.

Introduction

Many managers, consultants and academic researchers have argued that, in order to be both competitive and humane, workplaces need to be organised in ways that optimally integrate human and technological resources. Sociotechnical systems theories have been developed as one means of addressing this problem. As Gareth Morgan has pointed out, these theories have traditionally drawn strongly on organicist metaphors of organisations as 'open' sociotechnical systems. Some of the most important assumptions underlying these normative expert-based sociotechnical theories and practices are:

1. The 'objectivist' assumption that it is possible to form a common objective understanding of the relevant sociotechnical system. Sociotechnical practitioners assume that they and their organisational 'clients' can, and should, reach this common understanding;
2. The 'organicist' assumption that an organisation can be viewed as an organic system with a common 'goal' or 'purpose' that can be identified to guide the sociotechnical intervention;
3. The 'bi-polar' view of organisational transformation as a shift between one universal type - 'Taylorist', 'Bureaucratic', 'Design Principle 1' etc. - and another 'post-Taylorist', 'team based', 'Design Principle 2' type which more effectively addresses both economic and quality of working life considerations.[1]

While there is now increasing recognition among sociotechnical theorists and practitioners that the (re)design of organisations is a political process, there are few case studies which critically examine the assumptions listed above.[2] Most empirical studies of sociotechnical intervention concentrate on the end-results of (attempts at) (re)design. They assess such factors as the psychological satisfaction of the workers, the usability of the technology and/or the degree of teamwork achieved.[3] Other case studies are little more than illustrations of method.[4] They minimise or ignore the complex social dynamics through which sociotechnical methods are introduced, customised and applied in practice. The social negotiation of the 'system' and the organisational 'goals' relevant to the (re)design are often important elements of these dynamics. As Stephen Barley has observed, there were more studies of the actual work of sociotechnical practitioners written in the 1950s and 1960s than there have been in more recent decades.[5] Moreover, many case studies have been written by sociotechnical practitioners themselves, in an unreflexive manner that fails to consider the possibility that they themselves may have only a partial view of the action. Vested interests in perceiving and presenting 'success' stories are often unacknowledged.

As sociologists with an interest in politics, we are, by contrast, interested in foregrounding and exploring vested interests and partial perspectives, including our own. One of us (Badham) is a university-based sociologist and sociotechnical practitioner, while the other (Garrety) is a sociologist of science and technology with an interest in symbolic interactionism.[6] Both of us are interested in exploring how constructivist, interactionist sociology can illuminate the complexities of normative action in the 'real' world, and how the insights generated can inform this action.

One of the most fundamental tenets of symbolic interactionism is that meanings are created, and recreated, through social interaction. Herbert Blumer's 1969 formulation of the three basic premises of the approach still provides a useful (though gender-imbalanced) introduction:

> The first premise is that human beings act towards things on the basis of the meanings that the things have for them....The second premise is that the meanings of things is derived from, or arises out of, the social interaction that one has with one's fellows. The third premise is that these meanings are handled in, and modified through, an interpretive process used by the person in dealing with the things he encounters.[7]

The emphasis on the creation of meanings through interaction has strong parallels with the social construction of technology (SCOT) approach pioneered by Wiebe Bijker and Trevor Pinch.[8] Like interactionists, they also investigate and highlight the interpretive flexibility of objects and social phenomena. The creation of stable artifacts is not a pre-ordained process, propelled by the inherent 'rightness' or efficacy of the object itself. Rather, it is contingent, an outcome of complex social and political negotiations.

The interactionist tradition is, however, much older and broader than the SCOT approach.[9] We believe that concepts developed within the interactionist tradition can be used to enhance contemporary constructivist approaches to the politics of technological change. In particular, we believe that the concepts of social worlds, boundary objects and trajectories can be used to open up and explore the politics of sociotechnical intervention. We will first introduce and explain these concepts, then outline how they can be used to explore and challenge the assumptions, listed above, that frequently lie beneath sociotechnical systems theories and methods. We will illustrate our framework using a case study of a sociotechnical intervention in industry in which we, and our colleagues, were involved.

Social Worlds

The SCOT approach was influential in pointing out that there are often several 'relevant social groups' taking an interest in a particular technological artifact. Pinch and Bijker defined the relevant groups as

> institutions or organizations (such as the military or some specific industrial company) as well as organized or unorganized groups of individuals. The key requirement is that all members of a certain social group share the same set of meanings, attached to a specific artifact .[10]

The concept was 'heuristic' rather than rigid, and a matter for empirical investigation rather than a priori assumption. As Pinch and Bijker pointed out, there is no 'cookbook recipe' that can be used to identify these groups and their members.[11]

The concept of social worlds provides a similarly flexible and useful means of exploring the aggregated aspects of social interaction. It is a broader concept, however, not specifically confined to collections of actors interested in technology. It also focuses more explicitly on the interactive aspects of the construction of meanings, both within and across social worlds, than does the SCOT concept of relevant social groups.

In the symbolic interactionist scheme, social worlds are defined as more or less voluntaristic, formal or informal collectives in which people share meanings, material objects and joint activities. In keeping with the interactionist focus on interaction and communication, social worlds are characterised as 'recognisable form[s] of collective action' rather than as fixed social structures.[12] They are 'universe[s] of regularized mutual response', that may or may not coincide with more formal organisational boundaries.[13] As with the relevant groups in the SCOT perspective, there is no 'cookbook recipe' that can be used to identify and categorise them. The level of analysis - macro, meso or micro - and the groups deemed to be relevant, will depend on the sociological problem under investigation. On an institutional level, for example, the workforce of a factory can be conceptualised as a social world. The degree of commitment to the world's activities exhibited by individuals will of course vary, but there will be at least some common identity and history, and some shared knowledge and assumptions about the objects and activities that link them together. On further investigation, large social worlds usually fragment into smaller ones. In any factory there will be subworlds, both formal and informal - work crews, levels in the hierarchy, and informal groups of friends who meet to socialise and share information.[14]

In this paper, our focus will be mostly on institutional social worlds, defined by people's occupations. Although every situation is different, it is possible to make some initial assumptions about the types of social worlds usually involved in expert-led sociotechnical interventions. We will define these interventions as sets of activities deliberately contrived to bring diverse people and technologies together for the explicit and formal injection of some type(s) of humanistic value(s) into the (re)design of a sociotechnical system. They often involve university-based experts, consultants, machine operators, factory managers, software developers and engineers. Including all these social worlds in the analysis encourages us to explore alternative definitions of the entities at stake, whether they be new technological artifacts, sociotechnical systems, or sociotechnical interventions. We cannot assume at the outset that all the worlds will share the same interpretation of the relevant objects and actions, least of all the interpretation created and upheld by sociotechnical experts.

This explicit exploration of multiple perspectives is an attribute of the social worlds approach that sets it apart from the actor-network scheme of Michel Callon and Bruno Latour.[15] As several people have pointed out, the latter tends to privilege the viewpoint of the central, usually most powerful actor(s), at the expense of accepting and exploring the ambivalence and ambiguity inherent in many social situations.[16] The empirical focus of the social world perspective also guards against simplistic a priori assumptions about configurations of power and knowledge, as exemplified by stereotyped Bravermanian class analyses.[17] On its own, however, it is not enough. We also need to inject a processual element if we are to understand the ongoing, ever-changing nature of the interactions within and among social worlds.

Trajectories

Processual approaches have become increasingly popular in the analysis of technological and organisational change.[18] Without an appreciation of process, the politics of situations become fixed in reified social structures. Processual analyses, on the other hand, allow investigation of the dialectical relationships between human actions and social structures - the ways in which people in different social worlds create structured patterns of interaction and expectation, and the ways in which these structures, in turn, shape our actions, and our interpretations of objects and events. Our daily working lives are usually constituted out of complex, yet somehow coherent, sets of ongoing activities that have a collective, interactive character. In studying how people in hospitals carried out their work, the symbolic interactionist Anselm Strauss and his colleagues developed the concept of the trajectory.[19] In a definition that is broadly applicable to a wide range of social phenomena, Strauss wrote:

> I shall use *trajectory* in two ways: (1) the course of any experienced phenomenon as it evolves over time (an engineering project, a chronic illness, dying, a social revolution, or national problems attending a mass or ‘uncontrollable’ immigration) and (2) the actions and interactions contributing to its evolution. That is, phenomena do not just automatically unfold, nor are they straightforwardly determined by social, economic, political, cultural or other circumstances; rather, they are in part *shaped by the interactions* of concerned actors.[20]

The interactionist concept of trajectory is complex and not without ambiguity, as Strauss himself acknowledged. It comprises both plans, and the alteration, abandonment and/or intensification of plans that occurs as trajectories evolve through interaction over time. The inclusion of plans ‘consciously designed to shape interaction as desired’ under the subconcept of ‘trajectory scheme’ makes it suitable for studying sociotechnical interventions.[21] In the sociotechnical field, there are many schemes (methods, software packages) available to guide action. These may shape the trajectory, but they do not *constitute its totality.* Other people are also involved. They may have different or conflicting trajectory schemes in mind, and they may interpret objects and events differently from the sociotechnical expert(s). It is the interrelationships between schemes and the contingencies that occur along the way that constitutes the politics of a project.

Boundary Objects

Our worlds are composed of objects. For interactionists, these are ‘anything that can be indicated, anything that is pointed to or referred to’.[22] They can be roughly categorised into physical objects (machines, human bodies), social objects (experts, a workforce) and abstract objects (sociotechnical theory, exploitation, industrial democracy). When we are analysing the ways in which people in different social worlds negotiate common trajectories, it is useful to look for boundary objects. These are:

> objects which both inhabit several intersecting social worlds *and* satisfy the informational requirements of each of them. [They] are both plastic enough to adapt to local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites.[23]

The concept was developed as an extension of - or an alternative to - the view of objects contained in actor-network theory. As we noted above, the latter tends to fix objects in their identity, as ‘actants’ that are either part of (or not part of) the network created by the most powerful actant(s). By contrast, Star and Griesemer were interested in describing and investigating situations in which objects accommodate and retain heterogeneous meanings.

Focussing on social worlds and boundary objects allows a more finely nuanced and 'ecological' understanding of collective activity than that proposed by the actor-network theorists.

When applied to technological artifacts, the concept of boundary objects shares many assumptions with the SCOT approach. Both reserve judgement on the true nature of technological artifacts, in favour of analysing the ways in which the actors in the situation themselves negotiate 'closure', that is, stable objects with fixed meanings. The concept of boundary objects encompasses a broader range of entities, however. In analysing the politics of sociotechnical change, we find it useful to apply the term to a range of discrete and tangible 'things' that provide foci for interworld communication and collective action. In many cases it is possible to identify a primary boundary object - a particular technological artifact or organisational plan around which all the activity is (supposed to be) focussed. Secondary boundary objects are also created. These are subsidiary things that facilitate collective work around the primary object. They may include documents, such as contracts, standard operating procedures, newsletters and web pages. In their more abstract and social forms, boundary objects merge with trajectories. Examples here include conferences and workshops, which are discrete 'things' that bring people from diverse worlds together. The important attribute is that they act as 'common information spaces'.[24]

Examining Sociotechnical Intervention with Symbolic Interactionism

Symbolic interactionism is an interpretivist, empirical tradition of sociology that has explored many of the complexities of life in the twentieth century. Sociotechnical theory and practice provide interesting topics for research along these lines, as they constitute situations in which individuals (consultants or experts of some kind) deliberately try to change the 'meanings' and configurations of objects and relationships in social worlds that use technology. As outlined at the beginning of this article, sociotechnical work is frequently guided by assumptions. In idealised versions of their work, theorists and practitioners see themselves as creating a 'common understanding' of the system that is the object of the intervention. The system's 'purpose' is identified, and a utopian vision of a 'journey' towards a new and better organisation is created.[25] Assumptions such as these, however, do not exist in some space free of human agency. They are themselves meanings created through interaction. We can use the concepts of social worlds, boundary objects and trajectories to unpack and critically examine the assumptions that guide sociotechnical work. This will allow a more empirically informed understanding of the micropolitics involved in:

1. the social construction, across different social worlds, of the 'sociotechnical system' that is the (boundary) object of the intervention;
2. the negotiation of a joint trajectory that reflects first, the trajectory schemes of people in different social worlds, and second, the effects of any evolving conflicts, exertions of power, and accommodations of diverse interests; and
3. the location of sociotechnical interventions within a complex set of evolving work trajectories, rather than a simplistic 'radical break' between and inhumane past and a humanised future.

We will illustrate these issues through a case study of a sociotechnical intervention in an industrial site in Australia. The intervention was designed to inject humanistic values into an experimental trial of an advanced manufacturing system.

A Case Study: A Sociotechnical Project in Industry

Setting the Scene - New Technology and the Identification of Risk

Our account will begin with a description of the major social worlds involved, and of the events that led up to the intervention. In this case, we will delineate the social worlds according to physical location and institutional affiliation. According to these criteria, there were three main worlds - the technology developers, the academic sociotechnical experts and the people who worked at the technology test site. The technology developers and the people at the test site all worked for a large multi-national company, based in Australia. Most of the AMS technologists were based at the company's R&D headquarters, although a few also spent considerable time at a laboratory situated close to the test factory. The two company sites were separated by more than 1,000 km. The university was between these two sites - about 250 km away from the test factory. Physical distance affected the pattern of interactions. Spontaneous visits were difficult, if not impossible, and meetings in person had to be carefully planned. However, though note-taking at meetings, exchange and examination of documents, taped and untaped interviews, e-mail messages, phone calls and so on, we were able to achieve an understanding of the worlds of the others - their main activities, their guiding assumptions, their formal and informal goals, and the pressures under which they carried out their work. Through technological connection and the pursuit of a joint trajectory, it is possible to know more about a factory 250 km away than it is about an academic department next door.

The AMS research project was intellectually and organisationally complex. It had several components and the technologists carried out extensive consultations with computer experts in Australia and overseas. The overall aim was to create a technological system that could sensitively control a continuous manufacturing process. The AMS to be trialed in the factory consisted of a series of interconnected computers that could collect information from several points along the process. The computers were designed to communicate with each other, and to produce information suggesting optimal equipment settings that would take the state of the whole process into account.

In 1994, when the research project was first set up, the company was doing well, and planning to expand. However, in the years since then, it had experienced difficult times. The technologists came under increasing pressure to prove the economic value of their projects to senior company executives. Every three months they were required to justify their work to a high-level Steering Committee. These were stressful occasions. For example, when one senior figure said at one of these reviews, 'I'm not convinced you're looking for value in the right spot', the developers responded with a flurry of discussion and reassessment, and a search for new ways to organise and present their project.

During the 1990s, in response to economic uncertainty, people within the company were continually reorganising their own formal structures and procedures. One of their innovations was to conduct risk review workshops for new technology projects. In 1996, as the technology developers prepared for the trial, they conducted a risk review at company headquarters. Senior executives, representatives from the proposed test site, and the technologists themselves listed everything they could think of that might go wrong with the trial. Many possible risks were generated. Company documents show that many of the risks faded in importance after the workshop. Some, however, were significant enough to provoke action. Under the category of 'human factors risks', there were fears that the AMS 'won't be simple enough for staff for handle', that its 'continued use [would lead to] operator deskilling' and that there would be 'inadequate preparation of end-users'. After the workshop, the technology developers summarised these worries into a single statement of risk - that 'end users do not adopt the technology'. In a later conversation, the leader of the technology developers told us that 'human factors' remained on the agenda because of a comment made at the risk review by one of the company's senior managers, who was also on the AMS Steering Committee. He said that one criterion of 'success', in his view, would be if 'the factory personnel would not let you pull the technology out after the trial'. It was to enhance the possibility of this happening that the team leader contacted Richard Badham and invited him to become involved.

Our university-based research team is one of several in Australia that take an interest in sociotechnical theory and practice. Badham, the university team leader, has a long-standing interest in the interactions between humans and technology at work. Within the group, or closely affiliated with it, are people with a diverse range of academic backgrounds - sociology, work psychology, engineering, organisational learning and occupational health and safety. We derive our salaries from both the public payroll and private industry, a situation which requires some juggling of commitments. We are expected to produce scholarly discourses and analyses, and to be useful to industry by conducting training courses and sociotechnical interventions. We therefore devote considerable time and energy to gaining access to industrial sites so that we can gather allies, run projects, and collect material for research.

Badham first heard about the AMS project in 1995, before the risk review workshop that identified the human factors risks. He tried to convince the technologists back then that their system would be considerably enhanced if they explicitly took note of the broader views (common in many sociotechnical circles in the US and Europe) that 'intelligence' in technical systems consists of the mutual development and integration of human as well as machine intelligence. The technologists initially expressed interest but did not perceive any direct opportunity, at that time, for pursuing these ideas in their project.

The risk review workshop generated concerns about human factors risks that made an intersection between the worlds of academia and industry more viable. For people in both worlds, a joint trajectory aimed at a valid trial of the AMS was desirable. However, it took some time to work out the details of this trajectory. The technologists had their own firm trajectory schemes, that is, their plans for conducting the technology trial. For them, the human factors risks were a residual problem, to be removed somehow by academic expertise. In informal conversations and interviews, we were able to gain a fuller understanding of the meanings they attached to these risks, and to their avoidance. At one stage, their team leader said that 'the operators basically couldn't care less' about technology trials. Nevertheless, she wanted to avoid the possibility of 'sabotage'. She and her team did not want to just 'throw the technology over the fence' as some of their colleagues were accustomed to doing, with deleterious consequences. They also wanted to avoid a situation where the test factory 'would have to employ a computer scientist' to operate the AMS. Basically, they wanted us to ensure that the operators would be compliant and competent enough to produce a valid trial of the AMS. We, on the other hand, were interested in a more fully-fledged sociotechnical intervention, one that would encourage a more explicit consideration of the needs of operators, both in this trial and more broadly within the test factory and the company as a whole.

People within the company are accustomed to handling their interactions with outsiders through contracts. In this case, the production of the contract, as a formal joint trajectory scheme, was a difficult and protracted process. The task of writing it was largely left to the sociotechnical team leader, who tried to construct a set of statements that would address the concerns of the people in the company, while also satisfying the academic interests of himself and his colleagues. The final document stated that the academics' main task was 'to reduce the risks of user opposition or lack of involvement' in the forthcoming trial. Added to this was a list of more tangible expected outcomes, or 'deliverables' as they were called. These included the application and testing of 'human factors and organisational methodologies', the writing of case study reports and guidelines on 'best practice' in the human factors field. The exact nature of the deliverables remained quite unclear despite long discussions. Although the contract could be seen as an attempt to create a formal trajectory of desired activities and outcomes, it was, in effect, more important as a secondary boundary object. By facilitating negotiation and communication, it allowed the joint trajectory to be set in motion.

The People at the Test Site

While Badham was negotiating the contract, the academics and the technologists began to make contact with the people at the test factory. The site was chosen by the developers because its manufacturing process was suitable for trialing the operations of the AMS, not because the men (they were all men) at the test site wanted it. Indeed, it was never intended that the AMS remain at the site after the trial. This situation led to some ambiguity regarding the notion of 'users'. Sociotechnical theories privilege the needs of the end-users of a technology, who are assumed to be the people who will interact with it as an integral part of their day-to-day work. However, in this case, the operators in the factory would only 'use' the AMS for a few months. It could be argued that, in this case, the main users and beneficiaries of sociotechnical expertise were not the people in the factory, but the technology developers.

Despite the ambiguity, the sociotechnical team tried to steer the project in a direction that could benefit the workers at the test site. Like the rest of the company, the test factory was experiencing financial pressure, and there were persistent rumours about job losses and factory closure. Attitudes towards new technology were ambivalent. In the past, technology upgrades had meant job losses. Nevertheless, the factory was old, and much of its technology needed upgrading or replacing if it was to remain viable and competitive. The workers had also had their own bad experiences with technology being 'thrown over the fence'. In 1988, they had been sent on a holiday while the factory was upgraded. No-one told them what was happening. When they came back, they found that a newly installed product tracking device did not work. They tried to fix it, and, in their own words, 'created a monster'. The factory was so chaotic, they could have 'sold tickets to the circus'. This incident was still notorious almost a decade later, when we arrived to discuss the benefits of taking greater care with the human-technology interface.

In meetings called to plan the trial, the academics tried to explore ways in which the people at the test site might benefit from it. Since they would not get to keep the technology, statements about possible advantages of an AMS were somewhat vague and illusory. The test site managers said that better technology might help to do things such as improve production in areas where humans were too slow to respond to changes in real time, to define what was being controlled and when, to ensure that batches of product were 'within the same range', and so on. Later, however, at one of the sociotechnical workshops organised by us, the test site manager told the workers that when he first heard about the trial, he thought that it would be 'a pain in the arse'. Nevertheless, he and other managers and supervisors were willing to go along with it because it fitted into their own career trajectories. Cooperating with corporate research would be viewed favourably by managers higher up in the company hierarchy, thus enhancing career prospects. It could also help the factory to gain more money for future technology upgrades. Finally, it fitted in with various collective work trajectories that were being undertaken with the men on the shopfloor. There were team-building exercises underway, aimed at gaining greater commitment from the workers. As the sociotechnical intervention unfolded, it became evident that the factory managers saw the AMS trial as yet another in a series of activities that were supposed to make the workers feel more involved in the business overall.

Negotiating and Renegotiating the Primary Boundary Object

In this case, the AMS itself was the primary boundary object - the object without which the sociotechnical project would not have happened, and around which the interworld negotiations revolved. To survive as a viable object worthy of further investment, it had to be comprehensible and potentially profitable in several subworlds within the company, namely, the technologists, senior management and the operators who were about to test it in the factory. Our task was to work with people from the various social worlds and subworlds involved in the project (technology developers from Australia and the US, managers and employees from the factory) to ensure that the boundary object would remain robust and plastic enough to move freely among them. To this end, we created secondary boundary objects (human factors standards, workshops, workshop training material) to facilitate communication around the primary object. However, as sociotechnical experts, we were not satisfied with a narrowly defined trajectory scheme aimed at 'selling' the technology to the operators, without greater involvement in the more basic design of the system. We wanted to help shape this and future AMSs in directions that were influenced by concepts from sociotechnical and participatory design. We wanted to discuss the AMS in a way that encouraged greater user participation and exploration of alternative technological arrangements. In doing so, however, we found that our planned trajectory interfered with the customary work practices and assumptions of crucial plant personnel.

In August 1997, while the contract was still being written, we had an opportunity to elicit some operator input into the design of the AMS computer interface. This was a rushed operation, as we were informed by the technology developers that there was a brief two week 'window' in which we could obtain some operator input prior to the 'code being written'. To address this issue, two members of the sociotechnical team planned an exercise inspired by the Scandinavian 'envisionment' techniques of Pelle Ehn and his colleagues. Ehn himself was due to join the team later in the year for some joint activities. For the interface exercise, our team members planned a series of workshops at the test site in which the operators could explore 'ideal' computer interfaces. The intent was to feed these ideas back to the technology developers as general user requirements.

At the first workshop, it became evident that none of the operators in attendance had heard of the AMS. They had been told to attend by the plant's senior technical officer, who knew about the AMS, but had not passed on the information. While the session was beneficial for imparting some basic information about the trial, it did not yield much in the way of user requirements for the AMS. However, with the encouragement of the facilitators, the operators generated some ideas about how technology generally could be used to improve their jobs. The meeting was also useful for us, in that we learned a bit more about the operators' world. They complained about poor communication within the factory, and told of fears and rumours of job losses that would accompany news of new technology.

As some of us were travelling the 250 km to the factory for the second workshop, the factory's technical officer phoned our team leader to express his concerns about the envisionment exercise. He said that loose talk about ideal technologies and factory improvements could lead to unrealistic and dashed expectations among the workers. For him, the AMS trial was 'Bill's project (Bill was the technology developer most closely associated with the test factory). It was a fairly narrow technical trial, designed to test whether or not the experimental computers would work in a real life factory. The screen design was, in his view, not important for the experiment.

Despite his reservations, however, he was open to the idea of envisionment and the exploration of alternative sociotechnical arrangements, which he called 'pie-in-the-sky stuff'. In the phone conversation, he and the academic team leader agreed to split the human factors project into two components - the narrow technical trial of he AMS and a broader, more visionary set of activities. It would have to be made clear to the workers that while the narrow trial would go ahead, the technological arrangements generated by the ‘pie-in-the-sky’ activities would, at this stage, be purely speculative. The technical officer agreed that as long as meetings were held with operators to deal with the detailed technical issues surrounding the trial, it would also be possible for the workers from the factory to be taken away from the worksite to explore what he called ‘different set-ups’.

Shortly after the phone conversation, the factory newsletter carried an article written by the technical officer with substantial input from the sociotechnical project team. The article began:

> We all at some stage let our imagination go and think about the future. But how often do we think about future technologies? In particular, how new technologies could help us in the work we do, to achieve the best possible result for the mill?

The article went on to introduce the AMS as a ‘long term strategic project’. Two sets of activities would be involved ‘and these should not be confused’. The first would be the ‘narrow and technical’ equipment trial. The second would look at

> How to make technology relevant to operators’ needs and requirements. This is not about testing equipment. It is about giving a message to researchers and engineers about WHAT PEOPLE IN THE [FACTORY] WOULD LIKE TO HAVE AS TOOLS TO SUPPORT THEIR WORK AND HOW THEY WOULD LIKE THEIR WORK TO BE (emphasis in original).

The workers were informed that the AMS would be removed after the trial, and would have ‘no immediate effects’ on the factory. The second set of activities, however, ‘may give us a clearer idea of what to aim for in the future’.

With a plastic definition of the AMS - one which accommodated both ‘visionary’ and ‘narrow, technical’ elements - representatives from two very different social worlds were able to negotiate the joint trajectory scheme into a form that reflected the socially constructed ambiguity of the technology and the project itself. This allowed the intervention to go ahead in a way that accommodated people’s diverse assumptions, expectations and professional interests.

The Workshops, and Last Minute Changes to the AMS

For us, the major set of activities was a series of workshops (two sessions, each lasting one and a half days), held in October 1997. These were situations specifically contrived to bring together sociotechnical experts, technology developers, and workers and managers from the factory. The aim was to prepare factory personnel for the trial, as outlined in our contract, but to do it in a way that would enable us to introduce and explore some aspects of sociotechnical design. Badham had invited several international experts to help conduct the workshops - Toni Wäfler and Nina Kirsch from the Swiss Institute of Work Psychology, Pelle Ehn from the University of Mälmo and James C. Taylor from the University of Southern California. Preparations for the workshops were quite complex, as these representatives from different sociotechnical subworlds attempted to construct a common trajectory that would accommodate their diverse philosophies and methods.[26] In the end, the major method used was KOMPASS, developed by the Swiss Institute of Work Psychology.[27] The method had been presented at several international conferences. It was systematic and understandable, and appeared to be suitable for a well defined workshop format. The Swiss Institute had an international reputation for theoretical work in job redesign, and had funded substantial projects and applied scientific interventions.

KOMPASS is an abbreviation of the German version of ‘Complementary Analysis and Design of Production Tasks in Sociotechnical Systems’. Although it had been applied in a number of companies, it was still being developed, and had never been used in Australia. In its ideal version (as a trajectory scheme), it consists of a set of modules designed to apply insights from work psychology to the ‘allocation of functions’ between humans and machines in sociotechnical systems. It is quite complex, and will not be explained in its entirety here.[28] As an entity, it has attributes of both a trajectory scheme and a boundary object. It sets out a list of things to be considered, and a series of steps to be followed that should, its proponents claim, lead to optimal sociotechnical arrangements. It also provides a valuable abstract boundary object through which sociotechnical experts can encourage communication and negotiation across social worlds.

As a sociotechnical method, it does, however, have embedded within it the assumptions we listed at the beginning of this article. In order to identify the relevant functions for allocation between humans and machines, analysts must first define the objective ‘primary task’ of the sociotechnical system under consideration. The primary task is then divided up into functions, which are analysed more deeply for their sociotechnical characteristics. To help (re)designers, the creators of KOMPASS have developed four criteria, derived from work psychology, that define the characteristics of satisfying human interactions with technology. These are:

1. Dynamic coupling. Availability and use of technically provided options regarding time (pace of work), place, work procedures, and required cognitive effort;
2. Process transparency. Opportunities for forming and maintaining mental models of the general nature and temporal structure of production processes and of required interventions and process feedback modalities;
3. Decision authority. Distribution of decision authority regarding information access and process control between human operator and technical system;
4. Flexibility. Variability of function allocation between human operator and technical system and distribution of the respective decision authority.[29]

In planning sessions held prior to the workshops, the experts found that it was not so easy to come to a common ‘objective’ understanding of the object of the intervention. KOMPASS had previously been used to help design discrete pieces of equipment, with clear locations and functional possibilities. The experimental AMS was more diffuse. Its functions were spread across the entire process, making its ‘primary task’ difficult to define. Despite these difficulties, however, the sociotechnical experts agreed that the KOMPASS criteria would be useful for introducing the principles of humanistic job design to both the technologists and the factory personnel.

In the workshops, the ‘primary task’ of the factory as a whole was defined simply as the process through which its product was created. To facilitate discussion, the process was broken into segments, or ‘functions’, and the men at the workshop were instructed to apply the KOMPASS criteria to them. This exercise was useful for learning and for generating discussion, but it was unlikely to result in any sociotechnical redesign in the plant, at least in the short term. For it to do so, the actors in the situation would have to be able to construct powerful and effective work trajectories. The intervention was not set up to do this. The technologists were not interested, and the power of the men in the factory was severely restricted by economic and structural constraints.

Applying the KOMPASS criteria to the AMS was a more challenging task. In preparation for this, one of the technologists spent some time outlining the technology’s capabilities, in both its ‘narrow, technical’ prototype form and its possible futuristic form. The men from the factory were quite impressed, questioning the developer on what the AMS could do to fix persistent technical problems in the plant. The developer gave optimistic responses, which blurred the distinction between the two versions of the AMS that had previously been negotiated between the representatives of academia and the test factory: ‘If the data are there, the AMS could pick it up and do something. If it’s predictable, the AMS can do something’. The ‘function’ of the AMS was, therefore, open to many alternative interpretations. Given the positive presentation by the technologist, workshop participants rated the AMS quite favourably, at least according to the criteria of flexibility and transparency. It received a lower rating for decision authority, as some perceived the possibility of it taking control of the manufacturing process completely away from the human operators.

In its formal manifestations, the end result of KOMPASS is supposed to be a ‘work package’ for technology developers, detailing desirable characteristics that the users would like to see designed into the technology under consideration. In this case, such an outcome was not appropriate. The AMS was almost complete. Nevertheless, there were some last minute changes made to both the technology and the trial. In an exercise that was separate from (but inspired by) the workshops, some workers from the test site were flown, at company expense, over 1,000 km from their home city to the company’s research laboratories to view the new technology prior to its installation in the factory. None of the academics were present on these occasions, and our information about them is derived from what others have told us. They were, apparently, significant in contributing to the success of the trial. One of the factory workers who made the trip told us that ‘to be honest, the thing wasn’t really anything like [the plant]. It was completely devoid of the way we do things. Similar principle, but...’. Bill, the technologist mostly closely associated with the technology trial told us that ‘eight or nine’ details were changed as a result of these visits, making the trial much more effective. One significant change was that plans to use the AMS to control the plant ‘directly’ were abandoned. Instead, the operators were able to accept or reject the equipment settings presented to them by the AMS. We do not know, however, whether or not humanistic considerations (the KOMPASS criterion of decision authority) contributed to this change. When questioned, Bill said simply that direct control ‘would not have worked’.

Outcomes - Success or Failure?

It is not possible to state, with monolithic certainty, the degree to which the intervention ‘succeeded’ or ‘failed’. Judgements about the effects of the intervention (good, bad or indifferent) varied according to people’s different social locations, their expectations, their assumptions and the possibilities for future action (if any) available to them. The technologists’ perception of the intervention were filtered through their strong preoccupation with the technology trial itself. According to them, the trial was a great success. The operators cooperated, and they were able to ‘prove the concept’ of the AMS by demonstrating that when aspects of the manufacturing process were varied, the AMS was able to suggest equipment settings that compensated for the variation. On the whole, the developers judged the usefulness of the intervention according to how it contributed to the success of the experiment, not according to whether or not the AMS became more ‘humane’, or whether the operators’ jobs were made more satisfying. Their appraisal was summed up in the comment that KOMPASS was useful because it was ‘a way of finding out what is not included in drawings of the process’. Despite this somewhat instrumental assessment, however, KOMPASS may live on in the technologists’ world. Bill and the technology team leader both continued to show an interest in human factors methods after both the intervention and the trial were finished. Bill said that his company was becoming increasingly interested in involving users in technology design. KOMPASS, as an already developed method, provided a ‘quick way’ of doing this.

For the people at the test site, the effects of the intervention were more diffuse. As stated earlier, the managers there viewed the intervention as ‘an extension of what the management is doing currently.. in the area of technical projects....Trying to have involvement of people in everything we do...to make them more responsible’. The plant’s senior technical officer said that he found the KOMPASS criteria useful for ‘looking deeper’ into technology, so that workers could be given something that is ‘relevant’ for their tasks. However, he said that people in the factory would not be able to see the benefits of it until there was something concrete to which it could be applied. Given the financial constraints, this was difficult. The men on the shopfloor that we spoke to also gave positive comments, although they could not say how they could use KOMPASS in their day-to-day work. One of them, a maintenance worker said:

> It’s the first time we’ve actually been asked for input. And I will admit that it’s good to get away from the bloody day-in, day-out grind to actually do something different.

Among the academic sociotechnical experts, judgements about the relative success and failure of the intervention were also mixed. By facilitating the communications that led up to the trial of the AMS, we had helped to avert the risk that ‘end users do not adopt the technology’. That is, we had fulfilled the terms of the contract between us and the company. Within this limited mandate, the intervention was, for us, a success. It was also a success in terms of our own research. We gathered material for academic papers such as this one, and expanded our own experience and knowledge of sociotechical methods in practice. However, if we abide by the bi-polar stereotyped views of organisations that permeate many sociotechnical theories, our intervention failed. We were unable to move the organisation into a fully participative ‘post-Taylorist’ mode. Instead, we helped to create a complex joint trajectory in which we wove our plans, our claims and activities into those of others. Whether any aspects of humanistic sociotechical (re)design live on in the company in the future remains to be seen.

Conclusions

In combination, the concepts of social worlds, boundary objects and trajectories provide a useful framework for examining the inter-institutional politics of sociotechnical intervention. The interactionist tradition, from which they are derived, is avowedly empirical, and aimed at grasping and analysing the complex realities of contemporary social life. It therefore provides a powerful means of examining what happens when experts, equipped with finely honed sociotechnical theories and methods, attempt to intervene and change the routine technology design practices in a company. No matter how convincing humanistic job design principles may be in their abstract forms, they cannot, in themselves, *compel* action along the directions desired. Instead, a great deal of inter-institutional negotiation is required to construct a set of activities that satisfy, more or less, the diverse interests of the actors involved.

The actor-network theorists have taught us that good ideas and methods do not passively diffuse throughout society under the weight of their own virtue. They have to be carried by agents (human or otherwise), and other ‘actants’ have to be disciplined and/or enrolled into the network. Symbolic interactionism places a similar emphasis on the empirical details of the construction of patterns of meanings and actions. However, it is much more accommodating of multiple meanings and ambiguous outcomes.

There is no one objective ‘sociotechnical system’ that is the object of a sociotechnical intervention. Instead, different ‘systems’ are invoked by different actors at different times for different purposes. Sometimes, the object of the intervention described above was the sociotechnical arrangement of the test factory itself, or various sub-sections of it. For the factory management, the objects of intervention were the sentiments and work practices of the workers themselves, irrespective of the technology. For the technologists, it was a more narrowly defined set of interactions between the operators and the AMS. Even the latter, as a seemingly well-defined, interconnected set of computers, was open to multiple interpretations. It was a long-term strategic research project, a ‘narrow, technical’ object, a possible means of obtaining better process control in the test factory, and a springboard for exploring alternative technologies in the imaginary factories of the future.

The existence of multiple ‘systems’ as objects of intervention reflected the diversity of formal and informal ‘goals’ towards which people directed their activities, and against which they justified their actions and statements. In traditional sociotechnical theory, interventions are supposed to be organised around a primary ‘goal’ or ‘task’. In the case described above, however, the intervention was directed towards a variety of other goals, that bore uncertain relationships to the task of the test factory. As we have already outlined, these goals varied considerably according to people’s institutional locations. The resultant joint trajectory was a complex mix of people’s formal and informal trajectory schemes, modified through interaction, and constantly reshaped by exertions of power and influence, accommodations and compromises.

Viewing sociotechnical interventions in terms of social worlds, boundary objects and complex trajectories has consequences for theory and practice. As Björn Gustavsen recently noted, many experiences with sociotechnical (re)design have shown that ‘it was hard to make the theory fit reality and give rise to meaningful action at the workplace level’. Gustavsen summed this up as ‘the problem of grand theory and everyday events’.[30] The framework presented in this article provides one way of explicitly acknowledging and exploring the contingent relationship between sociotechnical theory and everyday events. Theory, as exemplified by methods such as KOMPASS, can be retained within the conceptual space provided by trajectory schemes and boundary objects. The contingencies, the power struggles and everyday politics of doing sociotechnical work can be explored through analysing the routine assumptions, commitments and pressures operating in the institutional social worlds taking part in the intervention. The resultant trajectory is a complex mix of plans (theory) and ongoing interaction among people in these different worlds (everyday events). If politics is the art of the possible, then sociotechnical work becomes a matter of retaining, as far as is feasible and appropriate, the integrity of worthwhile boundary objects and trajectory schemes, among the hurley-burley reality of institutional trajectories that make it difficult to translate theories and methods into concrete and tangible sociotechnical (re)arrangements.

Notes and References

1. G. Morgan, *Images of Organization* (Newbury Park, London, New Delhi, Sage, 1986), pp. 44-48.
2. R. Badham, 'Human Factors, Politics, and Power', in: W. Karwowski (Ed.), *International Encyclopedia of Ergonomics and Human Factors,* (New York, Wiley, forthcoming); S. Parker & T. Wall, *Job and Work Design. Organizing Work to Promote Well-Being and Effectiveness* (London, Sage Publications, 1998)
3. A few examples are B. Ives & M. H. Olson, 'User Involvement and MIS Success: A Review of Research', *Management Science*, *30*, 1984, pp. 586-603; M. Lawrence & G. Low, 'Exploring Individual User Satisfaction within User-Led Development', *MIS Quarterly*, *17*, 1993, pp. 195-208; H. Barki & J. Hartwick, 'Measuring User Participation, User Involvement, and User Attitude', *MIS Quarterly*, *18*, 1994, pp. 59-82 and J. E. Hunton & J. D. Beeler, 'Effects of User Participation in Systems Development: A Longitudinal Field Experiment', *MIS Quarterly*, *21*, 1997, pp. 359-88.
4. For examples see J. C. Taylor, 'Designing an Organization and an Information System for "Central Stores": A Study in Participative Socio-Technical Analysis and Design', *Systems, Objectives, Solutions*, *2*, 1982, pp. 67-76 and E. M. Trauth & E. Cole, 'The Organizational Interface: A Method for Supporting End Users of Packaged Software', *MIS Quarterly*, 1992, pp. 35-53.
5. S. R. Barley, 'The Alignment of Technology and Structure through Roles and Networks', *Administrative Science Quarterly*, *35*, 1990, pp. 61-103.
6. While it is impossible to draw a clear line between 'participant' and 'non-participant' observation, we can say that Karin Garrety, as a sociologist standing a little outside the action, had a less participatory role than Richard Badham, who played a major role in organizing and carrying out the intervention.
7. H. Blumer, *Symbolic Interactionism. Perspective and Method* (Berkeley, University of California Press, 1969), p. 2.
8. W. E. Bijker, T. P. Hughes & T. J. Pinch, *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge, MIT Press, 1987).
9. Symbolic interactionists trace the origins of their approach to pragmatist philosophers such as William James and John Dewey, who were active in the United States late in the nineteenth century. For histories and summaries of the approach see D. N. Shalin, 'Pragmatism and Social Interactionism', *American Sociological Review*, *51*, 1986, pp. 9-29; S. Stryker, 'The Vitalization of Symbolic Interactionism', *Social Psychology Quarterly*, *50*, 1987, pp. 83-94 and N. K. Denzin, *Symbolic Interactionism and Cultural Studies. The Politics of Interpretation* (Oxford UK and Cambridge USA, Blackwell, 1992).
10. Bijker *et al.*, *op. cit.*, Ref. 8, p. 30.
11. Bijker *et al.*, *ibid.*, pp. 9, 50.
12. A. L. Strauss, *Continual Permutations of Action* (New York, Aldine de Gruyter, 1993), p. 223.
13. T. Shibutani, 'Reference Groups as Perspectives', *American Journal of Sociology*, *60*, 1955, p. 566.
14. For more literature on social worlds see A. Strauss, 'A Social World Perspective', *Studies in Symbolic Interaction*, *1*, 1978, pp. 119-28 and A. E. Clarke, 'Social Worlds/Arenas Theory as Organizational Theory', in: D. Maines (Ed.), *Social Organization and Social Process. Essays in Honor of Anselm Strauss* (New York, Aldine de Gruyter, 1991), pp. 119-58.

15. M. Callon, 'Some Elements of a Sociology of Translation: Domestication of the Scallops and the Fishermen of St Brieuc Bay', in: J. Law (Ed.), *Power, Action and Belief. A New Sociology of Knowledge?*, (London, Boston and Henley, Routledge & Kegan Paul, 1986), pp. 196-233; B. Latour, *Science in Action* (Cambridge, Harvard University Press, 1987).
16. J. H. Fujimura, 'Crafting Science: Standardized Packages, Boundary Objects, and "Translation"', in: A. Pickering (Ed.), *Science as Practice and Culture*, (Chicago & London, Chicago University Press, 1992), pp. 168-211; K. Garrety, 'Actor Networks, Social Worlds and Controversy: The Case of Cholesterol, Dietary Fat and Heart Disease', *Social Studies of Science*, *27*, 1997, pp. 727-773; V. Singleton & M. Michael, 'Actor-Networks and Ambivalence: General Practitioners in the UK Cervical Screening Programme', *Social Studies of Science*, *23*, 1993, pp. 227-64.
17. H. Braverman, *Labor and Monopoly Capital : The Degradation of Work in the Twentieth Century* (New York, Monthly Review Press, 1974).
18. P. Dawson, *Organizational Change: A Processual Approach* (London, Chapman, 1994); R. J. Thomas, *What Machines Can't Do. Politics and Technology in the Industrial Enterprise* (Berkeley, Los Angeles & London, University of California Press, 1994); A. M. Pettigrew, 'What is Processual Analysis?', *Scandinavian Journal of Management, Special Issue: Reflections on Conducting Processual Research on Management and Organizations*, *13*, 1997, pp. 337-48.
19. The use of the term trajectory in symbolic interactionism is quite different to its use in the literature on the economics of technology. In the latter, it is used to describe patterns of technological innovation that appear to have a certain quality of inevitability. See R. R. Nelson & S. G. Winter, 'In Search of a Useful Theory of Innovation', *Research Policy*, *6*, 1977, pp. 36-76 and G. Dosi, 'Technological Paradigms and Technological Trajectories: A Suggested Interpretation of the Determinants of Technical Change', *Research Policy*, *11*, 1982, pp. 147-62.
20. Strauss, *op. cit.*, Ref. 12, pp. 53-54.
21. Strauss, *ibid.*, p. 55.
22. Blumer, *op. cit.*, Ref 7, p. 10.
23. S. L. Star & J. R. Griesemer, 'Institutional Ecology, "Translations" and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39', *Social Studies of Science*, *19*, 1989, p 393, emphasis in original.
24. L. Bannon & S. Bødker, 'Constructing Common Information Spaces', in: J. Hughes, T. Rodden, W. Prinz & K. Schmidt (Eds), *ECSCW'97: Proceedings of the 5th European CSCW Conference*, (Dordrecht, Kluwer Academic Publishers, 1998),. http://www.ul.ie/~idc/library/papersreports/LiamBannon/ECSCW.htm, downloaded 16 December 1998.
25. F. Emery, *The Emergence of a New Paradigm of Work* (Canberra, Centre for Continuing Education, 1978).
26. R. Badham, G. Grote, C. Kirsch, T. Wäfler & K. Garrety, 'Social Science in Action: Sociotechnical Tools and the Art of Collaborative Design', *Technology, Work and Cognition*, forthcoming.
27. James C. Taylor introduced some basic sociotechnical principles at the first workshop. At the second workshop, Pelle Ehn introduced some envisionment exercises designed to explore the more visionary aspects of possible future AMS technologies. KOMPASS, however, provided the major focus for introducing the principles of humanistic job design. In interviews after the workshops, the technology developers and the men at the test factory generally said that they found KOMPASS more useful than envisionment.
28. For more details, see G. Grote, S. Weik, T. Wäfler & M. Zölch, 'Criteria for the Complementary Allocation of Functions in Automated Work Systems and Their Use in

Simultaneous Engineering Projects', *International Journal of Industrial Ergonomics*, *16*, 1995, pp. 376-82 and T. Wäfler & M. T. Older, 'Comparison of Two Approaches Supporting Decisions on Function Allocation', in: F. Avallone, J. Arnold and K. d. Witte (Eds), *Feelings Work in Europe. Quaderni di psicologia del lavaro, no. 5*, (Milano, Guerini, 1997), pp. 234-42.

29. Modified from Table 1 in g. Grote *et al.*, *ibid*.
30. B. Gustavsen, 'Development and the Social Sciences: An Uneasy Relationship', in: S. Toulmin & B. Gustavsen (Eds), *Beyond Theory*. *Changing Organizations Through Participation.*, (Amsterdam & Philadelphia, John Benjamins Publishing Company, 1996), pp. 11, 13.