The Social Construction of Technology and Information Systems

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Key words: IS Research Methods, Theory, Culture

ABSTRACT

This paper deals with the use made by information systems researchers of Wiebe Bijker's work on the social construction of technology. In order to use Bijker's method of analysis, it is necessary to make an adjustment to cater for the organisational setting of most information systems, and it is necessary to move the focus of an analysis from "innovation" to the issue of "success or failure". Three case studies, based on published research papers, are presented and considered with respect to these adaptations of Bijker's method. The paper concludes with a note on the limitations of this method of analysis.

1 History of an implementation

In a lucid and wide ranging essay addressed to fellow historians of Technology, Rosalind Williams describes the experience of interrupting academic life at MIT to serve a five year spell as dean of students and undergraduate education, (Williams, R. 2000). This led to re-evaluation of her view of the nature of engineering in general and the role of information technology in particular. The essay describes insights gained as a member of a steering committee overseeing the introduction of a $41.8 million financial system using SAP R/3. This experience challenged her previous assumptions about engineering and technology. Instead of a profession with a self-conscious moral purpose and a concern with the material aspects of human progress, there was “reengineering”. This was concerned with information technology, and was driven by market forces to create "the capitalist version of endless revolution [in which] technological change is carried out by …team leaders, process owners, facilitators and the like … who are certainly not engineers by any conventional definition". This process seemed to be driven by the impersonal agency "technology" which manifests itself as software. "The new releases will come and we will have to adopt them". When the facilities of SAP R/3 do not match MIT's detailed requirements, the costs involved of changing the software are such that the normal staff attitude is that "at MIT .. in the trade-offs between culture and technology, technology will win".

Historians of technology have for many years rejected the primacy of technological determinism when accounting for innovation. Instead, their standard account emphasises the control exercised by the social context in which innovation occurs, and it makes use of a set of ideas normally referred to as "the social construction of technology". William's experience of IT innovation prompted her to question the value of this orthodoxy of her fellow historians of technology. Interestingly, the significance of context for innovation has long been recognised by information systems developers (Mumford, 1979, Baroudi et al, 1986) and information systems researchers have been directly influenced by historians of technology. The work of Wiebe Bijker has been particularly influential, (Pinch, T.J and Bijker, W.E. 1984, Bijker, W.E., Hughes, T.H and Pinch, T. J.1987, Bijker, 1995).

This paper presents a brief summary of Bijker's ideas on the social construction of technology. But since innovation, in the sense of the emergence of a new product or a new industrial process, is rarely the concern of information systems research, some

minor qualifications to Bijker's interpretative method are needed. After discussing the consequence of moving from the broad context of technological innovation to the organisation contexts of information systems, and arguing that the success or failure of the introduction of an information system can be treated as an analogue of technological innovation, three case studies are introduced. The case studies are information systems studies that use, but not exclusively, Bijker's ideas. These case studies are then analysed with respect first to their treatment of success and failure and then in respect to their organisational settings. The paper concludes with a discussion of the significance of Williams' revisionist doubts for information systems research.

2 Social Construction of Technology

Bijker's work is inspired by a desire to show that innovation is not an autonomous process that translates scientific discovery to new kinds of products or new industrial processes. In contrast, he takes the view that there is something essentially social about technological innovation. The explanatory framework that he uses starts from the commonplace observation that there is a connection between the groups of **actors** who create technology, (the engineers, marketing people, etc) and groups composed of such actors as consumers or potential consumers of the technology: both are refereed to as **relevant social groups** (Bijker, 1995, p4). This connection is influenced by the values, skills and goals of both parties, and these in turn may be influenced by technological innovation. Both are necessary. Without the acceptance of customers or clients innovation is impossible. Equally, the actors who create technology cannot do so without a supporting social context.

Bijker uses the term **interpretative flexibility** to describe the situation from which an artefact could emerge as a technological innovation. Here, the relevant social groups may interpret the situation one way rather than another, and so determine the character of a technology or possibly dismiss it as a failure. It is the existence of interpretative flexibility and the exercise of choice or competition by social groups which justifies the claim that innovation is socially constructed. The potentially gradual process during which group members, by rejecting some interpretations in favour of others, reduce the interpretative flexibility of a situation is referred to as **closure**. As closure proceeds, an analysis of the ways in which an artefact is talked about can reveal a movement away from the language used to discuss hypothetical possibilities towards the language used for absolute certainties. Bijker calls this linguistic phenomenon **stabilisation;** and he views closure and stabilisation as two aspects of a single process.

Relevant social groups are defined by their shared ideas about artefacts. These ideas may include "goals, key problems, problem solving strategies, requirements to be met by problem solutions, current theories, tacit knowledge, testing procedures and design methods and criteria, users' practice, perceived substitution function and exemplary artifacts", (Bijker, 1995, p125), and are referred to as a **technological frame.** This is a theoretical concept, not a cognitive psychological description. Such a frame facilitates the interpretations of interactions amongst actors within a relevant social group, and explains how the interactions are constrained and structured. Technological frames are a link between relevant social groups and artefacts, and just

as they can be viewed as constructing an artefact, so can they be viewed as constructing a relevant social group, (Bijker, 1995, p195).

The final factor in Bijker's explanatory scheme is **power**. This plays a double role in the shaping of technology: semiotic and micropolitical. Semiotic power is the "apparent order of taken for granted categories of existence as they are fixed and represented in technological frames" (Bijker, 1995, p263). It is semiotic power that is realised in the closure and stabilisation of technological frames; and it fixes meanings that enable, constrain and dominate not just relevant social groups but wider social groupings. Micropolical power is exercised in the continuous interactions of relevant social groups and can be traced in the development of their technological frames. It may involve such things as access to capital, patents and licensing arrangements, control of standards and common interfaces. Bijker views an analysis in terms of power as a neat summary of the closure process, rather than an additional theoretical level, (Bijker, 1995, p266).

3 Social construction of technology and information technology

The implementation of an information system would not normally be put in the same category as, say the invention of Bakelite or the mass production of the bicycle. So in attempting to apply the explanatory methods of historians of technological innovation, some justification is necessary. This is to be found in the construction of a parallel between, on the one hand, the society, which is host to a technical innovation, and on the other hand, the organisation, which is host to an information system implementation project.

The study of technical innovations of even the twentieth century, can usually be restricted to a single country, and can focus on a single individual or small group in a single company. Though this is no doubt due, at least in part to natural parochialism, the study of the early innovation of power driven machinery in the textile industry loses little by being Anglo-centric. In Bijker's study of the work of Baekeland's invention, though it recognises his continental background, is primarily concerned with events in a single country, the USA, (Bijker, 1995). In contrast, to choose a random though frequently cited information systems study, Davenport's paper on the implementation of an Enterprise System is restricted to a single company, Elf Autochem, (Davenport, 1998). Though the description is set against the background of other organisations implementing similar systems, and using in part, the same software components, this does not feature in his analysis. Both in the case of Bakelite and Elf Autochem's information system, the innovation and implementation are led by identifiable small subgroups or individuals, and in both cases success or failure involves a group, usually a larger group, of concerned people such as customers, clients and users.

Studies of technological innovation are concerned with success as viewed from a national or societal viewpoint. Studies of information systems are typically concerned with an organisational perspective on success and failure. The concern with the failure of information systems implementation arises because failure is endemic. Davenport, in the paper mentioned above, refers to the horror stories of failed implementations.

Clegg and his co-authors (1997) “drawing (indirectly) on a sample of 14,000 organisations” found that “80-90% of IT investments do not meet their performance objectives”. It is in an attempt to account for success or failure that ideas of the social construction of technology have been adopted. Within an organisation, a new IT system plays a not too dissimilar role to an innovatory technology in society at large. It may change the way some people work, and may even change the way they live. In any case, an information system is an artefact, and at least within the world of an organisation, its introduction is an innovation. The major difference is that the failure of an innovation, to the historian of technology, is usually the failure of an artefact to reach a market. Whereas for information systems, which rarely have to pass a market test, it is often only after users have struggled with a system that failure is recognised.

Bijker is far from being the only theorist concerned with the social construction of technology whose ideas have been taken up by information systems researchers. Latour's work, (Latour, 1991 and 1999), is used alongside Bijker's by the author's of two of following case studies. A range of other influential work is neatly summarised in a synoptic introduction to Mitev's analysis of an airline reservation system, (Mitev, 2000). But as the following case studies demonstrate, Bijker's ideas are a sufficient basis for a discussion of success and failure in information systems implementation.

4 Three case studies

CASE 1 - Accounting for success

Lin and Cornford (2000) take Bijker's "frame" idea as their theoretical starting point. The authors are interested in a dynamic process, called translation, in which the technological frames of those involved in IS implementation are modified by vested interests. They see the technological frame thesis as subordinate to Giddens' (1984) structurational ideas: frames are not static and constructed of preconceptions, rather "people or groups act according to the meanings that technologies have for them, and their actions shape the meanings of technologies for others and for institutions", (Lin and Cornford, 2000). Changes to technological frames are termed translations, in the sense introduced by Latour (1987), who envisages the possibility of a number of interest groups' involvement with a technology resulting in a chain of translations. Lin and Cornford use the phrase "social translation of technology" to describe how the process of managing the implementation of information systems is carried out to the accompaniment of competition between groups, who each strive to make their own interpretation of the system the dominant one. A case study of the replacement of an email system in a bank is used to illustrate the central idea of the "social translation of technology".

Three interest groups and their technological frames are identified: the office information systems group, the users, and the management. Competition between the office information systems group and the users centred on the choice of mail software. The user prioritised ease of use, while the information systems group were concerned that the replacement software should be a good fit with the bank's IT infrastructure. The office information systems group used two tactics to bring about translations in the other interest groups' technological frames and so win the competition. Firstly they used their superior technical knowledge of IT to gain acceptance, during discussions with users, for their choice of mailer. Secondly, they also managed to

specify the selection criteria so that they were favourable to their own choice. The management group and the office information systems group had similar technological frames and so exhibited broad agreement. The office information systems group won increased support by the simple stratagem of choosing a name for the project that seemed to promise slightly more of what was desired by the management than the project could actually deliver. This seemed to have paid off, and the project was viewed as a success.

CASE 2 - Accounting for an ambiguous result

Orlikowski and Gash (1994) discuss people's understanding of information systems by reference to a concept, "the technological frame", based in part on the work of Bijker (1987), but also in part derived from a wide range of work concerned with "cognition". They stress the significance of context, the "specific uses in a given setting", to the understanding of the use of a technology. They also emphasise the lack of uniformity amongst technological frames of various groups involved with the design and use of a technology. This arises because "technologies are social artefacts, their material form and function will embody their sponsors' and developers' objectives, values and interests, and knowledge of that technology". The use of the concept is illustrated by a case study dealing with the introduction of Lotus Notes to a large firm of professional consultants.

A detailed qualitative analysis stops short of declaring the introduction a success or a failure; but it revealed a marked contrast between two groups of employees: the technologists, a group of 40 people reporting to the chief information officer, and the users, consultants and administrative staff of all levels. The technological frame of the users crystallised round the notion that Notes was a form of personal productivity tool, and contained a recognition of "its electronic mail features and its potential to substitute for existing technologies such as fax and telephone". The technologists, in contrast saw its main role as that of supporting group work as "a platform for information sharing, electronic communication, document management and on-line discussions". Had the technologists, who were responsible for rolling out the system, anticipated the formation of the users' technological frame, they could have attempted to have influenced its formation through training programmes or propaganda. Then perhaps they could have brought about "the fundamental changes in the business practices and culture of the firm", that had been their original aim.

CASE 3 - Accounting for failure

Wilson and Howcroft (2000) focus on the use of ideas about the social construction of technology to inform the process of information systems' evaluation. They point out the danger of jumping to premature conclusions about what criteria should be used in an evaluation. The choice of criteria is crucial. It is too easy for an evaluation to become an attempt to demonstrate a return on investment under the direction of those who had actually made the original investment. Bijker's notion of "relevant social group" is used because different groups will "not only define technological problems differently but also disagree over definitions of what constitutes success and failure" (Wilson and Howcroft, 2000). The authors also use Bijker's term "interpretative flexibility". They use it to describe differences between relevant social groups, and to explain how different social groups assign success or failure to particular technical

solutions. The concept of "technological frame" is not used, but there is a reference to the process of stabilisation of a technology, and although there is no mention of Bijker's ideas about power, the case study presented could be analysed in terms of both "semiotic and micropolitical power".

This theoretical framework, augmented by Latour's contributions of problemization and translation, was used to investigate the evaluation of an hospital information system used to plan the care of patients. Two evaluations are described. The first one was influenced by the belief that lack of commitment and involvement on the part of users was a key problem. The evaluation was combined with attempts to persuade the users of the system of the benefits to be derived from it. It thus used manipulations of the assessment criteria to "downplay negative comments and promote positive ones". The author's analysis identifies two relevant social groups: the nurses and the Nursing Information Team. This second group included the Project Nurse and the Director of Nurse Managers; both were closely allied with the supplier of the system. Only this group found the system to be beneficial, and the evaluation showed that it was the users, not the system, that were at fault. It neatly illustrated the role of both "micropolitical and semiotic power" as at least temporarily the system is determined to be a success. However, in the following three year period, the nurses continued to find the automated system unsatisfactory. It was used for less than half the patients, and nurses preferred to use pre-printed care plans rather than use the information system to generate individually tailored plans for patients. In the light of the nurses' disaffection, and the burden of software support and maintenance fees, a re-evaluation of the system was carried out. This time the detailed objections of the nurses were taken into account, and the system was condemned as a failure and was "switched off".

5 Analysis of Success and Failure

The three examples given above illustrate the potential usefulness of Bijker's analytic framework for information systems research. In all three cases, the authors are interested in the issue of success and failure of implementations. Both Lotus Notes and the Nursing Information System examples would probably be placed in Clegg's category of "IT investments that do not meet their performance objectives", whereas the email system of the second case study was considered a success.

The two examples that were not clear successes are similar in as much as both systems were installed satisfactorily, and they both provided the intended range of functions. But it was the use of the system that was problematic. From a social construction of technology view, as Orlikowski and Gash point out, the Lotus Notes implementation was not a failure for the users. Rather, the technological frame of the relevant social group of users had stabilised on the technology of 'Lotus Notes as personal productivity tool'. The failure was left for the relevant social group of technologists, and it was a failure in the sense that the technological frame of 'Lotus Notes as a vehicle for computer supported cooperative work' was not sustainable in the context of the implementation. If the closure process were to run its course and terminate, we should suppose that the technologists would also see that what they had implemented was a personal productivity tool.

This ambiguity around success and failure can also be investigated in Lin and Cornford's study. Here, the relevant social group of users' technological frame of 'user friendly email system' did not stabilise. Instead, the group was persuaded to use the technology that corresponded to the office information systems group's technological frame, of 'technically appropriate and reliable email system'. This technology, with minor badge engineering, was also acceptable to the managers. Thus, with this closure, all three relevant social groups should have had the same view of the technology.

The Nursing Information System case illustrates the same phenomenon as the Lotus Notes case: the view of the users eventually prevailed. Though not discussed in Wilson and Howcroft's paper, the nurse's technological frame must have represented the facts that the system did not mesh with their working routines and provided them with no benefits. There was the possibility of the technological frame of the Nursing Information Team reaching a closure which would have led to the system being viewed as a success, and the first evaluation of the system could have been instrumental in bringing that about. However, the nursing group continued to complain about the system, which illustrates that the rival relevant social group, the Nursing Information Team, mustered insufficient semiotic power to stabilise their own technological frame. The continuing financial burden of the system was at least partially responsible for the second evaluation of the system. This could be seen as diminishing the micropolitical power of the Nursing Information Team.

6 **Social Construction analysis within Organisations**

The three case studies demonstrate the fruitfulness of Bijker's ideas even though the authors are not committed to any single version of the Social Construction of Technology theory. In all three the analysis is bounded by the limits the host organisations of the systems: a consultancy firm, a bank and a hospital. In consequence, the relevant social groups are all contained within the command hierarchy of the organisations. Moreover in such organisations, there will usually be some recognition of a standing conflict of interest between various groups. For example, workers in many organisations belong to trades unions. This has several consequences. The users of the investigated system are likely to be a subset of the organisation's workforce, who will be answerable directly or indirectly to the management. The information system itself, like those mentioned in the case study, will most likely be implemented for specific management purposes rather than to satisfy the desires of the users. Finally, the opportunities available to the users to influence the design of systems are likely to be conditioned by their subordinate status within organisations.

The subordinate position of the users means that the technological frames of relevant social groups of users are constrained. The Nursing Information System case study shows this. It was not open to the nurses to socially construct a system that met their professional needs. The system appeared to have been designed to meet the needs of the group containing the Director of Nurse Managers. The users were in effect left only with a choice between declaring the system a success or a failure, but with no guarantee that their collective decision would carry any weight, and even though they prevailed, the timing of the closure process was determined by the Nursing Information Team.

Lin and Cornford's Bank case study illustrates that there is some scope for a relevant social group composed of subordinate members of an organisation to determine the dominant interpretation of a system. Though the success of the office information systems group may have possibly involved some trickery, it did not call on the management to make a serious sacrifice.

The Lotus Notes example is interesting because although the intentions of the technologist, whose initiative would have had the imprimatur of the executive management, were frustrated by the dominant interpretation emerging from the users, the system appears not to have been withdrawn. The alternative interpretation of the users was apparently acceptable to the executive. But of course, had the Lotus Notes system been withdrawn, a verdict would be that the technological frame corresponding to "not fit for intended purpose" would have emerged.

The range of different outcomes of this small number of studies suggests that, even given the organisational constraints placed on information systems, the social construction of technology analysis is valuable. User acceptance is not the only issue that needs to be investigated, nor need the investigation be reduced to discovering exactly how the apex of the command structure has its way with the base. The use of Bijker's ideas provides a means of not just making a simple judgement of success or failure, but of analysing exactly what these two terms might mean within an organisational setting.

7 Conclusion

The studies reviewed above clearly reveal the value of the "Social Construction of Technology" analysis of success and failure in information systems. They also reveal, though less clearly, a connection with Rosalind William's experience with SAP R/3 at MIT. It is not surprising that she turns to a more general economic and sociological explanation of the sense of victimisation felt by MIT staff. "Technological change", she states, "is fuelled by money pouring into product development from interlocking corporations, some of them with virtually unlimited resources and global reach". Bijker's method of analysis works well at the level of concern of information system researchers. It would be unreasonable to expect a method that focuses on the concept of "interpretative flexibility" as a means of understanding the interaction of technology and society to deal, at the same time, with the consequences of large scale social and economic forces.

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