CONCEPTUALIZING AND EXPLORING THE SECOND LEVEL EFFECTS OF ISO 9000

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ABSTRACT

This paper conceptualizes and explores the second level or indirect effects associated with the implementation of a codified knowledge management system in the form of ISO 9000. Second level effects of technology have been observed as manifested in changes in structure, roles and relations as well as values and procedures. Indeed, the indirect effects of technology are pervasive and important to organizations. However, the conceptualization of second level effects is narrowly defined and limited to effects associated with social practice. To study second level effects in such a limited manner leaves key questions unexplored, and to a large extent, unexplorable. Moreover, in the context of knowledge management the question of second level effects is relatively unexplored.

The framework developed in this paper suggests that changes in social practice do not occur in isolation. Instead, social practice reflects, and develops in conjunction with an underlying episteme and indirectly with discourse. Episteme plays the role of acting as the mediator between discourse and social practice. This framework for understanding second level effects is applied on the contractor organization constructing a 5 mile long, multi-billion dollar bridge connecting Sweden and Denmark. A major infrastructure project offers the context to study emergent situations in a recently formed project organization. Using three sources of data: qualitative, secondary and sociometric, this study describes ISO 9000 as implemented at the contractor organization constructing the bridge between Sweden and Denmark. The analysis of ISO 9000 through the lens of the framework demonstrates how a codified knowledge management system effects the very way that people communicate, think and work in a large complex project. In this respect the codification of knowledge is not value neutral. Communication effects were found in terms of who can speak/write, what people can speak/write about and when people can speak/write. Changes in thoughts took the form of different assumptions, values and memory associated with the conduction of work. Social practice changes were noted in the conduction of work and interaction patterns in conjunction

with the management of deviations. Interaction patterns are of interest since they effect the development of individual organizational knowledge. Additionally, it was observed that codification represented a change in knowledge bases: from the reliance of gestalted knowledge to professional knowledge.

INTRODUCTION

Few scholars and practitioners would dispute that the implementation and use of new technology has effects on organizations. What are these effects? Addressing this question, scholars have conceptualized these effects into two categories: first level and second level effects. First level effects refer to efficiency or productivity gains associated with the adoption and use of new technology. This type of effect is functional in nature often expressed in terms of increased output, some measure of time, or financially in terms of return on investment or net present value (Blau et al 1976; Kraut et al. 1988). Second level effects are the indirect effects that technology has on the social systems of organizations. Social systems are groups or organizations consisting of interdependent events, behaviors and people (Sproul and Kiessler 1991). First level and second level effects are related to the extent that investments made with the purpose of obtaining first level effects have offsetting organizational and social consequences in the form of second level effects.

Researchers (Sproul and Kiessler 1991; Chandler 1977; Barley 1986; Sharp 1952; White 1962) argue that second level effects are more important to organizations then first level effects. The importance of second level effects is accounted for by the pervasive and encompassing effect that the use and implementation of technology has on social systems. The second level effects of technology have taken the form of changes in: structure (Chandler 1977; Barley 1986: Orlikowski 1992), roles and relations (Barley 1990; 1986), power (Barley 1988; Thomas 1994), facts and artifacts (Pinch and Bikjer 1987) as well as procedures (Sproul and Kiessler 1991). These findings suggest that technology effects social practice and to an extent how technology can effect social practice (Barley 1986: Orlikowski 1992)[1]. By social practice I refer to the community recognized, and steered procedures, methods or

[1] I view a constructivist perspective of technology (Pink and Bijker 1987) related to structurational since interaction is important to both as well as their view of how reality is constructed

techniques which are done in a given circumstance (Cuff, Sharrock & Francis 1979; Giddens 1984; Wenger 1998). While this stream of research has led to a rich understanding of the second level effects of technology, it is narrow and limited to the extent that the effects of technology have been almost exclusively conceived as and limited to social practice. This paper argues that the effects of technology are not limited to social practice and that the current conception of second level effects of technology leaves key questions unexplored, and to a large extent, unexplorable. In addition, through understanding what the second level effects of technology are, and their interrelationships, we are able to better design or adopt knowledge based technology.

The purpose of this is paper is to develop a conceptual model for understanding the second level effects of technology and thereafter applying this framework on an organization using ISO 9000, a special type of technology and codified knowledge management system. One of the more wide widely used codified knowledge management systems is ISO 9000, a quality standard used by over 350,000 organizations. ISO 9000 is based on the following four principles: (1) formally defining customer requirements. (2) planning and codifying procedures to obtain requirements as well as procedures to control that procedures are adhered to and requirements obtained and, (3) the actual control to confirm that procedures are carried out and requirements are met and, (4) evaluating that requirements are met and correcting when required (Johnson 1993). Moreover, codification entails not only the dissemination of knowledge, but in the process defining what knowledge is relevant and under what situations it is relevant (Schenkel 2002).

The paper begins by reviewing previous empirical work on second level effects and synthesizes this with Asplund (1979) and the Foucauldian[2] (1973; 1977a; 1977b, 1980)

[2] One of the challenges of using Foucault as a source of inspiration is that Foucault never intended to write a grand theory of second level effects of technology or a grand theory at all for that matter (Smart 1985). The use of Foucault therefore involves a bricolage to links his disparate works. The Foucauldian scholar would argue

concepts of discourse, epistemes and social practice in order to develop a conceptual framework for understanding second level effects. The site where the second level effects of ISO 9000 is explored is the contractor organization constructing a 5-mile long multi-billion dollar bridge connecting Sweden and Denmark. A major infrastructure project offers the context to study emergent situations (Wantanakorn and Askew 1999) in a recently formed project organization utilizing ISO 9000. After describing the site, research methods are discussed. Following this the case structured around the four principles of ISO 9000 is described and analyzed through the lens of the conceptual framework. The final section discusses conclusions and the wider implications of the findings based upon the framework.

SOCIAL EFFECTS: DISCOURSE, EPISTEMES AND PRACTICE

The body of literature addressing the second level effects of technology is limited, with the three of the main works in this area constituted by Barley (1986), Chandler (1977) and Sproul and Kiessler (1991). Through ethnographic and sociometric methods Barley (1986) found that new medical technology in the form of computer imaging devices impacted on work roles and as such skills, tasks and activities. Further, work roles were found to effect the role's relations and in turn these effected the organizational and occupational structure. Chandler, (1977) in his seminal work of modern capitalism found that high-volume production, a technical change, required new organizational structures and roles. This subsequently led to the wide spread use and further development of the hierarchy as well as the distribution of work, lines of authority and communication. While Sproul and Keissler (1991) studied the implementation of new communication technology and found that second level effects of

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that this paper has misinterpreted Foucault and missed the point since he argues that episteme and social practice are facets of discourse and are different sides of the same coin. However, this approach is problematic since if everything can be reduced to discourse, the question is what is not discourse. If this line of thought is applied in the context of this research, all second level effects of technology are discourse and this brings us no further then we are now. Further, this research is driven by an increased understanding of an empirical phenomenon in the field of management and does not make a claim to contribute to the fields of sociology or philosophy. Therefore this study chooses to disgregate the concept of discourse in order to obtain an improved understanding of an empirical phenomenon as well as concepts which are researchable.

communication technology took the form of: social interaction patterns as well as norms, roles, procedures, jobs and departments. Cumulatively, these findings focused on changes in social practice - a public good that develops and is disseminated through patterned interactions or structure. Social practice is strategic and plays an ordering role in organizations signaling and guiding what is important or unimportant and is reproduced through its own ontogenesis (Clegg 1989). To this extent social practice represents legitimatized collective social developments that are dissemination and reproduced.

However, changes in social practice do not occur in isolation (Asplund 1979). Asplund[3] (1979) suggests that social practice reflects and develops in conjunction with an underlying episteme and indirectly with discourse. Despite this observation, previous research on the second level effects of technology has been limited and one dimensional, concentrating on the second level effects that technology has in terms of social practice. There has been little or no examination of the related concepts of episteme and discourse as well as the relationship that they have to social practice as well as amongst themselves.

Episteme are taken for granted thought grids which individuals use to categorize, understand and recall things (Foucault 1973). It is through episteme that what is considered a valid or invalid interpretation of a particular situation is developed. At any one time there is only one episteme, which defines the possibility of interpretations allowed (Foucault 1973; Smart 1985). Foucault means that there is a plethora of possible interpretations, but some become dominant and others subordinate. To this extent episteme enables some interpretations and constrains others. The role of episteme is not limited to the present but it effects future interpretations since how current situations are understood is retained in the form of memory and retrieved to interpret new situations (Mezirow 1991). Episteme can therefore reinforce

[3] Asplund used the concept of conceptual thought figure. This study uses a related Foucauldian term of episteme

previous understandings, unless assumptions underlying the episteme are questioned. As Schein (1985), Mezirow (1991) and Argyris and Schön (1996) have pointed out, underlying assumption are often deeply ingrained and left largely unquestioned.

Discourse is the third facet of proposed second level effects and refers to the rule steered ways of communicating, which reflect socio-historical arrangements and circumstance (Cuff, Sharrock and Francis 1979). Foucault (1977a; 1977b) highlights the multiplex nature of discourse and how it regulates many aspects of our communication. In particular the role that discourse has on affecting: who and under what circumstances people can speak/write, what people can speak/write about, how people can speak/write, and reasons why people speak/write (Jackson and Carter 2000). The ability to communicate refers just as much to rules governing communication as well as to those, which regulate non-communication. Further, the ability to communicate impacts on knowledge as if a person can communicate in a given situation this suggests that he or she is knowledgeable. Conversely, non-communication implies that a person is less knowledgeable or this is not an appropriate situation for them to express themselves.

Social practice, epistemes and discourse are directly or indirectly related with each other as shown in Figure 1 with epistemes acting as the lynchpin between discourse and social practice. Thus a change in social practice effects episteme and indirectly discourse and at the same time episteme is a reflection of underlying practice and discourse. Applied in the context of second level effects of technology this means that the changes in social practice can be expected to result in, and reflect, changes in the underlying episteme and discourse. Similarly, changes in episteme or discourse effect and reflect changes in social practice. Thus the relationships between discourse and episteme as well as between episteme and social practice are dialectical to the extent that the effects go in both directions.

INSERT FIGURE 1 ABOUT HERE

METHODS

The data for this paper was collected over a nine month time period ending May 1999. The focus of this study was on the management of ISO 9000 deviations. What is a deviation? A deviation according to Sundlink's operation manual is defined as a reported situation in which articulated procedures or products do not comply with requirements. The international contractor consortium, Sundlink Contractors, which designed and constructed the Öresunds Bridge, a five-mile bridge connecting Denmark and Sweden provides the backdrop of this study. Sundlink Contractors utilized a formal quality system standard based upon ISO 9000. Organizationally Sundlink is divided functionally into two main groups: operational and support departments. The operational groups consisted of 9 departments responsible for the actual construction of the bridge and each department was divided into sections. The support departments included in this study were limited to those working with technical and quality issues. A description of the respective departments is shown in Table 1 and an organization chart of Sundlink is included in Appendix 1.

INSERT TABLE 1 ABOUT HERE

Multiple methods in the form of case studies, a questionnaire and secondary data were used to collect data. Secondary data took the form of two documents: Sundlink's General Procedure: Control of Non-Conformities and the Operation Manual. Cumulatively, these documents represent the four ISO principles: (1) formally defining customer targets or requirements, (2) planning and codifying requirements and control procedures, (3) control to confirm that procedures and requirements met and, (4) evaluation and correction. Specifically, the working methods as stipulated in the Operation manual act to define targets and the planning

of procedures to obtain these. While the control procedures, the second part of the Operation manual define the procedures which check to see that targets are obtained and that procedures followed. When deviations from targets and procedures are found these are evaluated and managed through the General procedure for the control of non-conformities (NC). Figure 2 displays the ISO activity and the corresponding Sundlink document.

INSERT FIGURE 2 ABOUT HERE

The purpose of the 9 case studies was to develop an in-depth understanding of the management of the over 2,000 reported ISO deviations or NCs during the 5-year period in which the bridge was constructed. The criteria for the selection of the case studies was: (1) to enhance accuracy reported deviations could not be over two weeks old and, (2) diversity in the form of the variety of individuals and formal organizational groups involved in the deviation was sought. In total, 28, 40-60 minute interviews were conducted and a list of interviewees was generated through a snow ball sampling. The interview protocols were structured around open and semi-structured questions with particular attention paid to: describing the incident as well as communication and interaction patterns. The interview data was analyzed using NU*DIST, a program for the thematic analysis of data.

The third source of data was a questionnaire administered to 137 people (87.6% response rate) during a nine-month period ending in May 1999. Respondents included the population of all people who had an email address at Sundlink and as such representatives from both operative as well support departments were included. Two particular types of questionnaire data were collected: communication/interaction patterns and sociometric data. This paper utilizes the responses to the survey question asking respondents to list the people that they sought advice from in the context of a deviation situation. Data from this question were analyzed using the UCINET network analysis software package (Borgatti et al., 1999) and

imported into Krackplot (Krackhardt et al., 1994), a program used for the graphical analysis of networks.

ANALYSES

To conduct analyses of the second level effects of ISO the secondary data is "unpacked" and repackaging with primary data to form two coherent descriptions based upon the principles of the ISO 9000. The first description describes the construction and working methods used to build the bridge and this can be viewed as corresponding to the targeting and planning stages of ISO. The second description focuses on control procedures and the Non-Conformity (NC) procedures which in ISO terms is equated with the control and evaluation. Thereafter each of these descriptions are analyzed based upon the inductively and deductively developed framework for understanding the second level effects of ISO 9000 (see Figure 1). The purposes of the analyses are to illustrate the usefulness of the framework for understanding second level effects of technology and to tease out some of the second level effects of a codified knowledge management systems and in particular ISO 9000.

Construction and working methods

The methods to construct the bridge were determined early on in the project in conjunction with the tender for the project. As part of each bid, the contractor(s) had to describe the construction method they would use to build the bridge. For Sundlink contractors, the proposed methods were contractually binding and consisted of the traditional and less traditional construction methods. Traditional methods meant that parts of the bridge were to be constructed out at sea. While less traditional methods entailed prefabricating several key components of the bridge on land and thereafter shipping them out to sea for final assembly. The methods not only differ in terms of where the actual construction takes place, but

moreover in the underlying tradition in which the method is grounded with traditional methods reflecting the craftsmen tradition in which each item is purposefully built and the the non-traditional methods reflecting the factory assembly line.

The multi-methods used for the construction of this bridge were chosen according to an interviewee because, "to build a bridge out at sea meant that we couldn't meet the (client's) time requirements. Building on land had the advantage that construction was shielded from weather and wind. Furthermore, there were not transport problems for people and material." Several respondents described the overall construction method of the bridge as similar to erecting a large "lego" set with the different land and sea based components representing different pieces of the set which when assembled form a bridge spanning from Denmark to Sweden. The development of the method was described by a senior engineer as follows, "it grew forward and it was clear from the beginning. The decision was self-evident. Everyone saw this was the way to work." The overall construction method was developed by the team of engineers from the respective companies, which formed the Sundlink consortium. It is interesting to note that this particular construction method was also used in the construction of a Storabaelt bridge in Denmark. The link between these two projects is that several of the companies which built the bridge in Denmark are also part of the Sundlink consortium.

The chosen construction method influenced the development of targets and the formal organization. One interviewee expressed the relationship between methods, targets and the formal organization as follows, "In deciding how to construct the bridge, targets and methods are determined." The construction method influenced the formal organizational structure as the different lego pieces corresponded to the various formal sections. Examples of the various "lego" pieces which for their part formed targets include: pylon, pier shaft and caisson – all sections in the formal organization at Sundlink. On a departmental level the onshore

department represented non-traditional construction methods and departments such as pylon and bridge line traditional construction methods.

Once Sundlink was awarded the contract they developed a 70 page Operation manual consisting of two parts: method statements and control procedures. Method statements are articulated procedures to obtain prescribed targets and can be viewed as an operationalisation of the construction method and correspond to the targets and planning parts and control procedures to the control part of ISO 9000. Specifically, method statements describe: how work should be carried out, divisions of labor and co-ordination between actors and departments, the number of people involved in activities, required resources in the form of equipment and materials as well as the time required to complete activities.

On an espoused level according to the operations manual the multiple working methods should have been constituted by the respective operational department "in close cooperation with the Technical department". However, this cooperation only applied to a limited set of working methods as the formulation of the all important concrete based working methods was the sole responsibility of the concrete technology section head, a member of the technical department. The exclusion of these working methods is of interest since concrete activities are the raison d'être of this steel and concrete bridge which uses over 310,000 m2 of concrete and 60,000 tons of steel reinforcement bars in its construction. Specifically, the concrete section head is responsible for the following activities: (1) "the preparation of work, trial and inspection procedures covering concrete", (2) producing of…calculations, (3) monitoring of concrete…works and (4) preparation of tests and test documentation." Simply put, the concrete section head is responsible for most aspects of concrete activities and this means most of the working methods involved in the construction of the bridge. One operational supervisor commented about the activities of the concrete section head as follows, "In the engineering department he is the one responsible for concrete curing and things like that. He

is the one making the curing plans and the repair handbook and things like that. So he is the engineering department's concrete expert."

While the exclusion of operative people from the constitution of the overall construction methods can be considered as part of "normal" practice, the constitution of working methods has traditionally been the domain of craftsmen. One operative person explained this change as follows, "Previously we were told what to do, but not how to do it." The change in who constituted working methods was not without consequences as it seemingly had the effect of invalidating previous work experience of operative personnel. Another operative supervisor expressed this in the following way, "Think if someone says that you have to cool concrete for 30 weeks because that is what the written guide says. I feel run over and violated in that what we have done in previous projects is not good enough. Our hands are tied."

Non conformity - control procedure

Prescribed working methods constitute a way of thinking about what is normal and at the same time they provide the basis for which all work is judged against. To ensure normality, that is to say the following of working methods and obtainment of prescribed requirements, there are control procedures -- the third part of ISO. These procedures involve a specific control mechanism in the form of checklists and actors to identify deviant products or procedures. Checklists in the form of explicit criteria of how things should be are enforced through both designated actors whose role is to confirm that criteria are met as well as actors who use checklists as the basis for completing their tasks. The QC is a prime example of an actor who enforces checklists through inspecting work after the activity has been conducted. However, there are also other actors who use checklists as the basis for conducting their work and in the process control becomes a natural extension of work. As one operative supervisor commented, "I am responsible for this caisson and all the concrete in it. So when we take off

the forms we do a visual check of how it is and discover damages. I do such a check and fill in what type of damage and then I leave it to the QC. He sends in the NCR."

Similar to working methods, formal control procedures represented a change from traditional practices. In previous projects control was conducted through self-inspection of the product and process by employees or through a third party formal inspector. One operative department manager commented as follows, "This project is quite special but I think that it will be the future in the way that we have the duty to inspect our own work. Our quality system is based on self control and the actual client doesn't need to have any inspector." In this project there is an absence of both external inspectors and at the same time articulated procedures and standards for judging what work against.

The purpose of control is to confirm and ensure that products and procedures meet prescribed requirements. When deviations from procedures or products are identified the deviation needs to be corrected and prevented from reoccurring. To accomplish this there is a procedure called General procedure: Control of non-conformities. The first step is in this procedure is for the person who detected the deviation or what is called non-conformity (NC) to immediately notify their superior or the quality control engineer (QC). The QC is a specific actor who works with quality and they are responsible for completing a Non-Conformity report (NCR), a four-part standardized document composed of: (1) a description of NC, (2) explanation of its occurrence (3) proposed remedial action or action focused on remedying the situation on hand and (4) proposed corrective action or the action to prevent the deviation from reoccurring. Describing NCs and the taking of actions brought with it the development of a classification system with words such as "rats nest" and "honeycombs" used to describe and classify deviations. Rats nest for instance refers to situations in which the concrete did not reach all parts of the concrete form, while "honeycombs" describes a situation is which air got into the concrete and the result of this is a structure that resembles a

honeycomb. Even within these terms a formal sub-classifications system developed. As one operative supervisor commented, “There are two damages on the Eastern wall up there along the long wall. Honeycomb type 1, because it is not a visible wall…. If you had seen the reinforcement it would have been a damage 2. ”

At times the QC requires assistance in the management of NCs and filling out the NCR and in these cases the NC procedure stipulates that the QC is supposed to seek advice from the Technical department. Examples of situations in which the QC would need advice is if they are not aware of why the NC occurred, what actions should be taken to remedy the situation and to prevent the situation from reoccurring. As a newly appointed QC said, “I contacted the technical department’s expert. But, it was because of the discussion that I had with my section head and my predecessor. They recommended that we ask the technical department’s expert whether we could repair the deviation on the spot or wait [QC 2].” Once completed and approved by the respective operational manager, a paper copy of the NCR is sent to the Quality Assurance Department (QAD) for registration. The NC procedures states that only a paper based version of this report can be used and all other forms of communication are prohibited. As one QC said, “It is all stipulated how to do it so I have to use paper and I have to bring it around the system because the quality procedure in the NCR tells me to do so. There is no room for email or things like that. I can’t process an NCR over email. I have to hand over the paper.” Once the QAD registers the NCR it is sent to the Technical department whose responsibility according to the NC procedure is to “ verify that the proposed remedial action is acceptable from a technical and contractual point of view.” Once the NCR is approved by the technical department it is sent back to the QAD for approval. In this instance the role of the QAD is to confirm that contractual conditions regarding the NCR are respected and when necessary a copy of the NCR is sent to the client for approval. When all relevant approvals are received the operative department are notified that they can commence with the

respective remedial and corrective actions. Figure 3 shows the main activities of the NC procedure and the responsible department.

INSERT FIGURE 3 ABOUT HERE

The management of NCs suggests an interaction between operative departments and the technical department as well as between operative departments and Quality Assurance Department. As can be seen by the emergent advice network in the context of NC situations (Figure 4) the operational groups followed the prescribed procedures by seeking advice either from actors within their own operational department or from the Technical and QAD departments. Further, there are no direct contacts between operative departments.

INSERT FIGURE 4 ABOUT HERE

Analysis methods

The previous section described construction and working methods as well as their constitution through intertwining secondary and primary data. This section analyses the description of these two methods through the use of the framework as laid out in Figure 1.

The *discourse* surrounding the construction method to build the bridge is just as much about rules enabling some actors and groups as well as rules which constrain other groups. The double edged sword of discourse in this case enabled a set of engineers to constitute construction methods and excluded operative personnel. Operative personnel were not able to speak or write about construction methods as this was not the place or time for them to express themselves. The non-participation of operative groups and personnel is of interest since this is the group which carries out the "actual" construction of the bridge.

Consequently, one would have expected that this group would be most knowledgeable about how to build a bridge or knowledgeable enough to play a key role in the constitution of construction methods. However, this was not the case at Sundlink. In part, the absence of operative personnel can be explained by existing construction practice of large infrastructure projects in which engineers design the project and craftsmen carry out the actual work. Thus the exclusion of operative personnel can be interpreted as a continuation, as well as a result of historical patterns of discourse. In this respect discourse takes on a dual role: constituting and constuitive and is illustrative of the two way relationship between discourse and technology. Further, the ability of certain groups to express themselves is not without related effects as the technical department was subsequently viewed as knowledgeable – "experts". At the same time, the ability to define construction methods also presupposed that the group defining the methods were knowledgeable. In addition to regulating actors, the type of media used was effected as construction methods were expressed in writing as part of the tender.

In contrast to the discourse surrounding construction methods which, appeared to be effected very little from ISO 9000, changes in discourse accompanying working methods utilizing principles of ISO 9000 were noted. On an espoused level according to the operations manual the ability to define working methods is the joint responsibility of the technical and operative departments. However, the constitution of the all important concrete methods, the most wide spread and important method used to construct this mainly concrete and steel structure, was the exclusive purview of a member from the Technical department with operative personnel – craftsmen – excluded from participating in the discourse. The role of operative personnel in this instance was to ostensibly follow the explicit working methods as articulated by the Technical department. However, unlike construction methods, the constitution of working methods, was traditionally the purview of operative personnel and embedded in their practice as opposed to manifested in a codified document. In this respect the constitution of working methods by the technical department represented a two-fold change both in terms of who is

articulating knowledge as well as where knowledge resides. Further, it is interesting to point out that working methods defined the actual production of products and this is in contrast to the traditional view of ISO which only defines the procedures which produce the goods (Johnson 1993). Thus the inclusion of actual working methods becomes indicative of what knowledge is relevant in an ISO based system.

Embedded in the construction method is an *episteme* of how a bridge of this nature should be constructed, targets to be achieved and what type of formal structures are appropriate. To the members involved in the constitution of construction methods the combination of traditional and non-traditional methods represented not only methods to construct a bridge but a way of thinking about its construction. The chosen construction method was very similar to the one used in the construction of a bridge in Denmark and can be viewed as a form of memory, a part of episteme. The choice of construction methods can be interpreted as providing the justification as well as a validation for previous construction methods and is an illustration of how construction methods are reproduced through their own ontongenesis. In this respect the relationship between epistemes and technology is two way to the extent that episteme effects technology. This reproduction can be explained by the unquestioning of assumptions underlying amongst others the construction methods as the choice of methods seemed obvious and self-evident to those involved in the process. There was only one clear alternative to choose amongst. Further, the choice of construction method brought with it a strong sense of what are appropriate targets to achieve as well as how the project should be organized. In this case targets, structures and methods were intertwined and one in the same. For example, the pylon department was a target, a department in the formal organization and also an integral part of traditional construction methods.

Working methods reflect an *episteme* or grids of thinking and understanding what is considered normal in terms of procedures and products and this is perhaps one of the most

pronounced second level effects that ISO has. Through defining working procedures two possible states of understanding are created, and come to dominate the sphere of understandings at Sundlink: normal and deviations. Normality is equated with the following of procedures and obtainment of articulated goals. While deviation denotes a situation in which either goals are not achieved or procedures are not followed. In this case, what is deviant is only judged in relation to what is normal and similarly what is normal can only be judge against what is deviant. Moreover, both of these states represent not only two distinct ways of thinking about work, but form a classification system, an episteme. Further, the choice of construction or working methods, targets and or structures all represent some dominant value as there is a plethora of alternatives available. For example, the project could have been organized according to different construction method or different functional activities. Thus unless assumptions are questioned values stay largely unchanged (Schein 1985) and in this case they were reproduced in the form of methods, targets and structures.

On the level of *practice*, the chosen construction method had a salient effect on the actual carrying out of the construction of the bridge as the chosen methods directly impacted on the overall work which is carried. In this case work took the form of the prefabrication of components on land, non-traditional methods as well as building other components on site, traditional methods. The reproduction of working methods also suggests how social practice effects technology. Working methods are an extension of construction methods and can be seen as effecting *practice* in a more precise manner. Specifically, working methods influenced what work was done, how work it is done as well as divisions of labor and coordination involved in the conduction of work. Thus working methods are perhaps the most salient aspect of practice and in this context they represent a change in how work is conducted – from largely practice determined rules which were often unarticulated to explicit procedures.

Analysis - control and evaluation

This section analyses control procedures as well as the procedures for the management of NCs for second level effects. Checklists, one of the main mechanisms of control in ISO 9000 effects *discourse* in through the media in which checklists were expressed which in this case were codified as well who can define the checklists. In this case the checklists were a function of the working methods and therefore defined by the Technical department. In terms of NCs, the actual NC procedure effectively regulates who can communicate, what they can communicate about and how they can communicate. For example in the context of NCs the QC can write the actual NCR and comment about causes of the NC as well as stipulate what actions are required. Additionally, the Technical department can formulate working methods, approve NCRs and provide advice in NC situation. Conversely, discourse regulates who cannot comment about NCRs and in this case other operative departments did formally comment about each department's NCRs or were not formally encouraged to. Secondly, the actual choice of communication media is influenced by ISO procedures which in this case required that only paper-based NCRs could be used. All other type of media such as e-mail were prohibited. Thirdly, the actual layout of the NCR structured and governed which information was relevant in a NC situation as well as how this information should be presented. To this extent the relevance of information is regulated by the format of the report and information which is not considered relevant is either excluded or slotted into the existing headings.

In the context of control and NC procedures ISO 9000, effected the episteme in several ways. Firstly, the use of the NC procedure strengthened and reinforced the concept of deviations. Through checklists people started to think about there work in a special way and the actual NC report assisted in the institutionalization of the concept of deviation. In conjunction deviations a sub- *episteme* developed as words such as "rats nest" and "honeycombs"

entering the vernacular to describe and classify different types of deviations. Further, the Technical department's advice giving role as suggested by the emergent advice network became embedded in the organization's memory as this was the department which operative departments sought advice from. Their knowledge was apparently highly valued by operative departments.

In terms of practice the use of formalized checklists and NC procedures represented a change in *practice* in terms of roles and tasks. The use of QCs and the Quality Assurance Department were new roles whose purpose was to ensure that requirements were enforced and obtained through the use of checklists. When stipulated criteria were not met, QCs were responsible for filling in NCRs. Additionally, checklists were used by operational personnel to conduct and judge their work against. Further, NC procedures can be seen as effecting interaction patterns as the emergent advice network closely resembles the prescribed network. When people required advice they followed procedures and contacted the technical department for assistance. As pointed out the Technical department was central in the network and there was little inter-departmental communication. The absence of contacts between operative departments is surprising because these departments were encountering similar problems according to an interviewee and could have shared experiences with each other. The following of prescribed interaction procedures is not self evident since NC situations are not necessarily "better" managed through the prescribed communication network. As numerous scholars (Kanter 1983; 1989; Kotter 1982, 1985; Ibarra 1992) have suggested informal networks are more effective than the formal networks in the achievement of organizational outcomes and the regularity of activities.

In sum, the two main analyses examined the second level effects of ISO 9000, a technology, through the use of the conceptual framework as presented in Figure 1. Data were unpacked and thereafter repacked into two descriptions. The first description concentrated on methods

and the second one on control as well as deviations. Through unpacking data this paper was able to illustrate how technology, ISO 9000, effects discourse, epistemes and social practice and at the same time how these second level effects effect ISO 9000. Clearly, the effects of technology are not limited to just social practice and nor are they in one direction. The overall findings are summed up and presented in Table 2.

Methods and control and evaluation are not unrelated in terms of second level effects. The construction methods constituted an episteme of how a bridge should be built and in this case it was through the use of two different and previously used construction methods. Further, working methods act as an extension as well as an operationalization of construction methods and in turn constituted an episteme of normality. Through defining what is normal in terms of methods, procedures and outcomes, what is deviant is also defined. Control in ISO is used to ensure normality and to identify deviations. In the case of deviations there is a specific procedure for their management. The control and NC procedures can be seen as an extension and a way to reinforce and constitute the episteme around what is normal and what is deviant. At the same time how normality was thought about reflected a corresponding change in practice in terms of conducting and checking work. Similarly, how work was though about had a salient effect on the discourse surrounding work. It effected practice in terms of what work was carried out, who it was conducted by as well as the very knowledge base which practice relied upon. Discourse was effected by epistemes in that how normality and deviation were thought about were reflected in how and who defined working methods, the media used to define methods as well as effecting the nexus of knowledge. Thus, how a bridge is conceived of and discussed in the tender (discourse) is connected to how it is thought about (epsiteme) and this in turn influences the actual construction method to build the bridge (practice).

INSERT TABLE 2 ABOUT HERE

DISCUSSION AND CONCLUSIONS

This research has broadened the conceptualization of second level effects of technology as well as the interrelationship of different types of effects. This was done through drawing on and reframing previous studies and linking these with the works of Foucault and Asplund through the use of abduction. In this paper second level effects were conceptualized in terms of discourse, episteme and practice. Thereafter this study illustrated some of the second level effects that ISO 9000 as well as the relationship between second level effects and technology and through doing this the overall value of the framework was illustrated. ISO 9000 was found to effect the very way which in which we communicate (discourse), think (episteme) and work (social practice) in a large complex project. Further, these effects are not independent of each other and instead as this paper has shown these effects are interrelated with epsisteme acting as the linchpin between discourse and practice and at the same time a reflection of it. In addition, to technology leading to second level effects, second level effects effect effected technology. This was most clearly illustrated in the adoption and use of previous construction methods from a project in Denmark.

When analyzed through this conceptual model, several other related conclusions centered around the concepts of power and knowledge can be drawn. Firstly, the second level effects highlighted in this paper can be interpreted as something more pervasive and more specifically they are expressions of power. At any one time there are competing forms of discourse, epistemes and practice and power effects which of these second level effects become dominant (Foucault 1977). Similarly, power effects which second level effects are subordinate. Thus discourse, episteme and practice are not only second level effects but rather becomes effective encompassing consititutions of power influencing the possibilities of what is done and experienced (practice), interpretations of situations and meanings attached to them (epistemes) as well as our communications (discourse). As some discourses, epistemes

and social practices become dominant through the use of ISO 9000, this strongly suggests that ISO is neither value neutral or nor without effects.

Secondly, in this study ISO acted as a constraint for operative personnel who were not able to participate in defining the discourse – working methods. Instead, operative personnel became subjects of ISO 9000. Their experiences were viewed as less legitimate and this can be traced to the knowledge base which ISO relies upon. Working methods can be understood as a manifestation of professional knowledge or knowledge which is theoretical and learned passively (Schön 1983). This type of knowledge is in contrast to gestalted knowledge or knowledge which is formed and reflected in doing (Molander 1996). Traditionally, gestalted knowledge has been the base of the construction industry with working methods largely decided by the craftsmen practice (ibid.). In this respect ISO is not only brings about second level effects, but it reflects the knowledge bases in which they are based upon.

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FIGURE 1
Conceptual Model: Second Level Effects

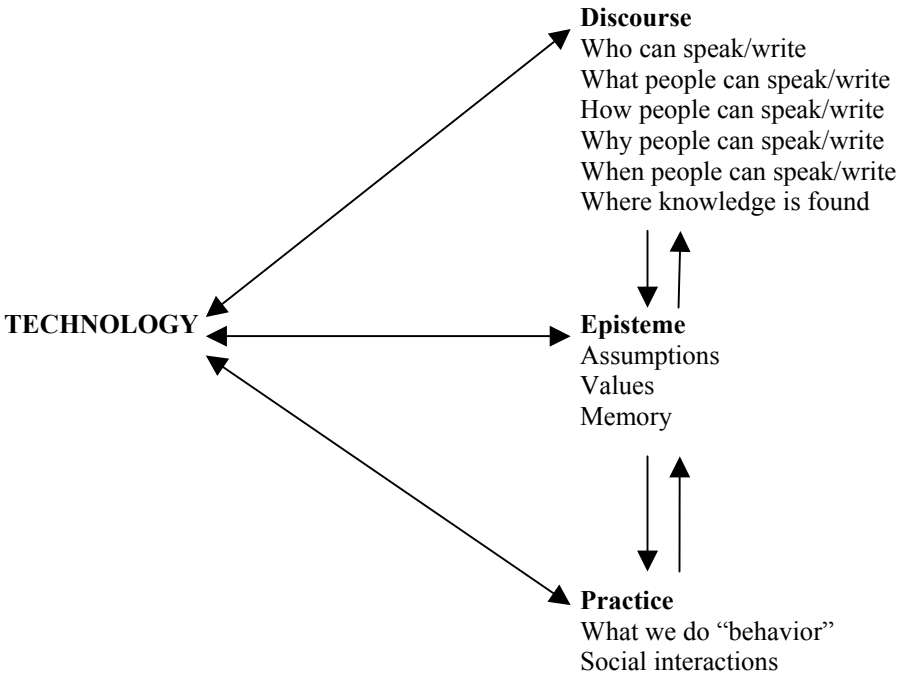

FIGURE 2
Relationship Between Secondary Data and ISO

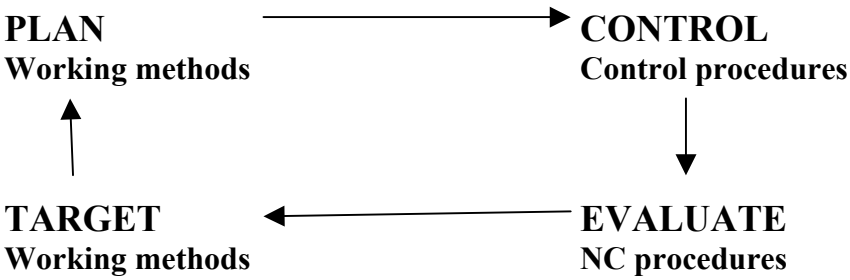

FIGURE 3
Non-Conformity Procedure

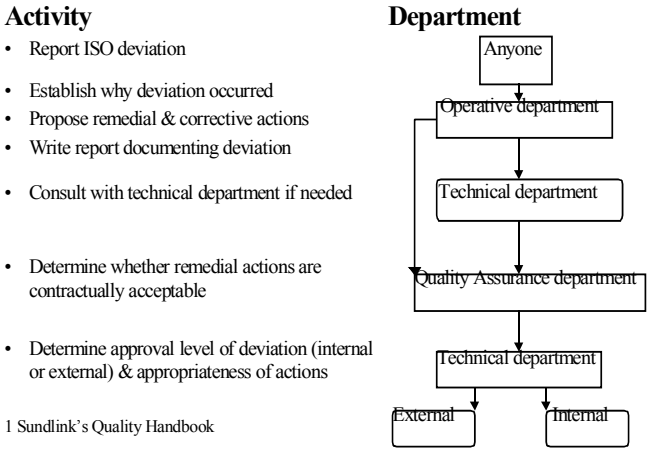

FIGURE 4
Department Contact Network

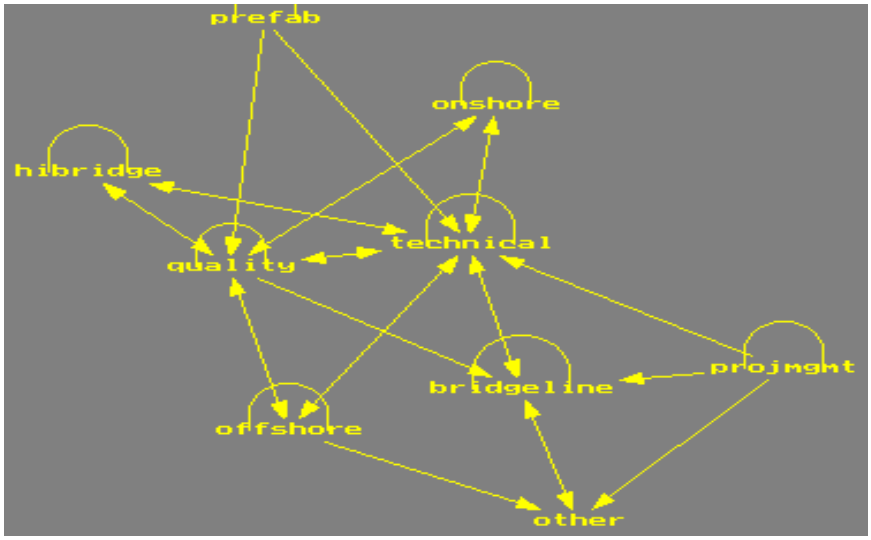

TABLE 1
Description of Operations and Support Departments

Department	Activity	Size of structure	Location
Offshore, Onshore	Constructed prefabricated concrete structures called caissons and piershafts	800 to 4700 tons 10 to 51 meters tall	Malmö, Sweden
High Bridge	Built concrete bridge pylons	Over 200 meters tall 4355 m3 of concrete 800 tons of reinforcement concrete	Malmö, Sweden
Bridge Line	Constructed viaduct using steel and concrete	560 meters long	Malmö, Sweden
Prefab Approach Bridge	Constructed steel and concrete girders	2000 to 6300 tons 120 meters long	Cadiz, Spain
Technical department	Provide technical support and advice		Malmö, Sweden
Quality Assurance and Development	Provide support and advice around quality issues as well as monitoring and enforcing quality system		Malmö, Sweden

TABLE 2
Summary of Second Level Effects of ISO

Activity	Discourse	Episteme	Practice
Construction	Technical people can talk about the construction methods and operative cannot Construction methods expressed in writing as part of the tender	Assumption: How do you construct a bridge "prefabrication vs traditional" Memory in terms of previous experience and how to design a bridge Value prefabrication – quicker than on site	Traditional and non-traditional means of construction
Working method	Who can express working methods "technical" & who cannot: operative personnel What people can discuss: Technical people can discuss concrete methods How they are expressed "written" Why: Technical can discuss because they are knowledgeable When: can discuss in the fomulating of methods.	Constitution of what is normal and what is deviant Who is able to define working methods – technical as opposed to operative Influences who or what is knowledgeable (technical department as well as explicit knowledge in methods) Expresses values in the form of preferences Assumption about how work is carried out and who it is done by Value the knowledge of the technical department	Methods effect practice in terms of: what work is carried out, who it is carried out
Control procedure	What media people use to check work against Who can define this media	A way for people to start to think about how to do their job	Checking work is a type of action taken Specified actors for checking work
NC procedure	Who can report NC Who can discuss them Who can come with suggestions and approve Media used to express NCR – paper	Reinforced concept of normality and deviation Sub-classification system developed Organizational memory of contacting technical department and at the same time their advice was valued	Filling in reports Contacting the technical department for assistance