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Keywords

organisational, driven, case, activity, theory, change, analysis

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Abstract

The paper describes unexpected problems encountered in the automation of a scheduling process using an IT application already in use in other similar organisations. A grounded theory approach was used to collect and categorise data on the case. Activity Theory was then used to analyse the attempt by management to implement organisational change through the introduction of the system. The findings suggest that it is inadvisable to impose organisational change through the introduction of a complex IT system, particularly when this disrupts entrenched decision-making processes of the organisation.

Keywords

Organisational change, Activity Theory, Grounded Theory, Case Study

1. INTRODUCTION

Although the environment in which we live has always changed, in recent times the nature of change has frequently been revolutionary rather than evolutionary (Artigiani 1987) to the extent that change management is a major concern. Information systems can be variously seen as driving, enabling, constraining or inhibiting the rate and pervasiveness of change and there is much debate as to which of these roles is appropriate or advisable in an organisation undergoing either evolutionary or revolutionary change. While attempts at ICT driven organisational change are fraught with danger, there is little doubt that organisations must understand how to continually expand their capacity to learn, supported or enabled by information and communications technology (ICT) systems (Markus & Benjamin 1997).

A case involving an attempt at organisational change, driven by the introduction of a new IT scheduling system, was discovered by the authors and, through its ensuing and intriguing complications, a grounded theory approach has been adopted to data collection and analysis. In order to present some concepts of interest emerging from this case, an activity framework will be used to analyse and display the data, which will then be interpreted through the Cultural-Historical Activity Theory. Activity Theory provides a unifying approach to the study of what people purposefully do and is a meaningful unit of analysis of human doing, which is both situated and contextual incorporating culture and history. According to Kuutti (1996) Activity Theory is a philosophy and cross-disciplinary framework for studying different forms of human practices and offers a set of concepts, structures and terms that are eminently suited to research in areas related to information systems.

The paper begins with a brief description of Activity Theory and an explanation of its usefulness in the analysis of complex problems such as this case presents. A description of the case follows, together with results of the preliminary grounded theory categorisations, before presenting the Activity Theory interpretation. The paper concludes with a discussion of the findings related to problems encountered when organisational change is imposed by the introduction of a complex IT system, particularly when this usurps the power of the existing custodians of knowledge and disrupts entrenched complex decision-making process of the organisation.

2. ACTIVITY THEORY AND ITS RELEVANCE

Activity Theory is a social-psychological theory that has its roots in the work of the Russian psychologist Vygotsky during the first half of the 20th century. Vygotsky's important insight into the dynamics of consciousness was that it is essentially subjective and shaped by the history of each individual's social and cultural experience (Vygotsky 1978). In addition, Vygotsky saw human activity as quite distinct from that of non-human entities in that it is mediated by tools, the most significant of which is language. Vygotsky's work was continued by others, amongst them Leontiev who developed a conceptual framework for a complete theory of human activity (Leontiev 1981). According to Leontiev (1981), activity is a system that has structure, its own internal transitions and transformations, and its own development.

Kuutti and Virkkunen's research (1995) has used activity systems as a representation of the common object of organisational work which cannot be studied by reducing the scope to one or another element, but where a minimum meaningful system as a whole should be taken as the unit of analysis and intervention. Engeström (1987) gave a more concrete expression to this structure in the triangular representation, shown in Figure 1, which is commonly used to depict an activity. The core of an activity is a dialectic relationship between subject (human) and object (purpose) mediated by tools and community. This is a two-way concept of mediation where the capability and availability of tools mediates what is able to be done and tools, in turn, evolve to hold the historical knowledge of how the communities behaves and is organised. This is particularly powerful when the tools are computer-based (Kaptelinen 1996). The formal, or informal, rules and division of labour of the community, in which the activity occurs, also dynamically mediate the subject-object relationship.

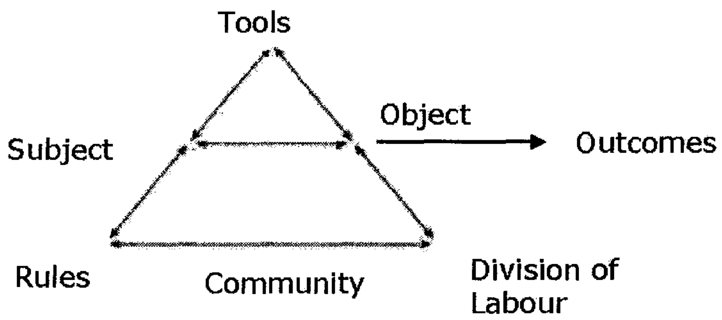

Figure 1: The subject-object relationship, which defines the activity, is mediated by tools and community through rules and division of labour. The subject may be individual or collective and outcomes of the activity are distinct from its object or purpose. (Engeström 1987)

Leontiev (1981) proposed that "activity" should be placed at the top of the hierarchy shown in Figure 2, associated with sustained human endeavour that has a long-term purpose and strong motives. This is a conceptual level above that at which most business analysis takes place, which is at the level of actions, undertaken towards specific, and often short-term, goals. Under certain conditions, conscious actions can be driven to a lower level of automation, often in computer systems, as they become standardised as operations. An activity is comprised of sets of actions (towards specific goals) and operations (routine and well known habitual cognitive or behavioural processes, now commonly the domain of IT systems). Where as an activity is defined by purpose and motive and is typically a long-term affair, actions are more planned with specific goals and a more limited time span. Actions are not meaningful in themselves unless they are part of an activity. For example it makes no sense to drive to work (an action) unless there is a work activity to go to.

There may be legitimate alternative sets of actions that can enable the successful performance of an activity, for example: it is common practice in IS development to assess the feasibility of different design solutions to an organisational problem and then choose one solution to implement based on a cost benefit analysis. However there may be instances where it is feasible to allow concurrent different solutions (i.e. different sets of actions) for an activity under different circumstances (eg in different countries where cultures vary or in different divisions of a company). It is important however to have a common understanding of the object (purpose) of the activity at the top of the hierarchy.

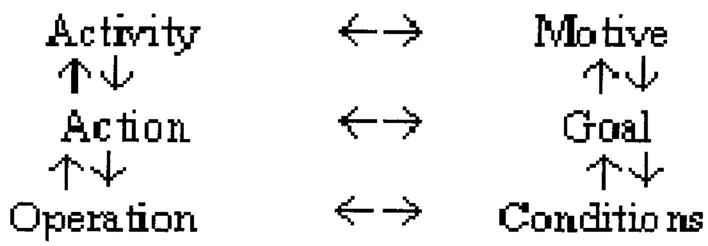

Figure 2: The definitive hierarchy of Leontiev (1981)

In addition to Engestrom's structure of activity (Figure 1) and Leontiev's hierarchy of activity, actions and operations, (Figure 2) there are several groups of researchers (Kuutti & Virkunnen 1995; Hasan & Gould 2001, Engeström 1999) who use frameworks of interrelated activities to represent complex organisational situations as shown in Figure 3. Taken together the three aspects of human activity will be used to analysis and present the case described in the following section of the paper.

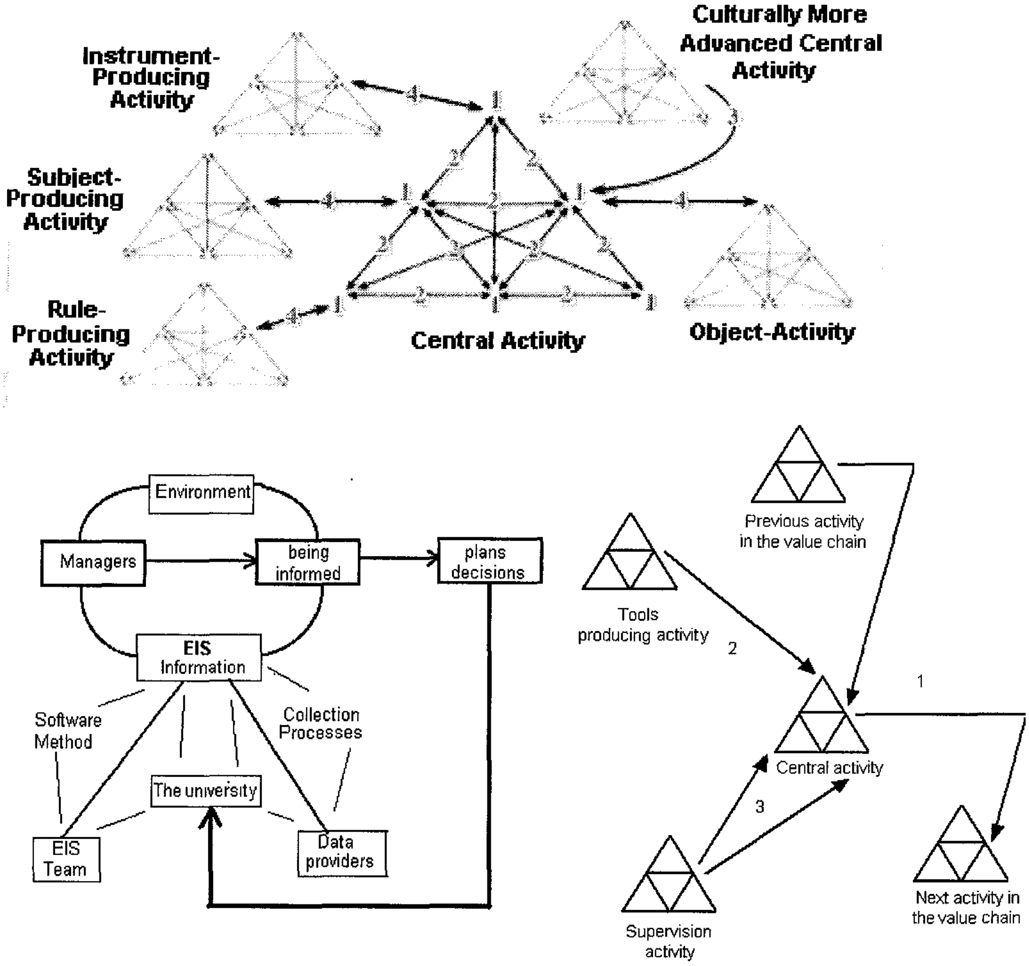

Figure 3: Sets of interrelated activities in the research of Engestrom (1999), Hasan & Gould (2001) and Kuutti & Virkunnen (1995)

3. AN ATTEMPT AT IT-DRIVEN ORGANISATIONAL CHANGE

One of the most complex and time-consuming tasks in a large educational institution, is scheduling the annual timetable of classes, particularly in the current environment where resources are stretched to the limit, course offerings are extremely varied and students numbers are uncertain often up until the day classes begin. The case chosen for this study concerns a decision to introduce a comprehensive, automated timetabling system into a university in order to transform the efficiency of use of both physical and human resources, for on-campus teaching. This decision was made by senior management and the registrar, on advice from an external consultant who had assisted with the introduction of the same technical system in other universities. The system purported to have the capability to automate all the logistical aspects of the teaching activities of the institution under every conceivable constraint, including the allocation of class space, time and teaching staff. From a management perspective the introduction of the new timetabling system would revolutionise the running of the teaching program. A significant change to greater efficiency in this area was therefore the principal motive of senior management in agreeing to the purchase of the system.

3.1 Research Method

This case was chosen for study because, predictably, the first session of full use of the system did not go well and it was clear that an analysis of the case had the potential to produce meaningful insights into the perils of IT-driven change. The research plan was to approach the field study with no preconceived research questions or hypotheses, to collect data through interviews and relevant documents and to use a grounded theory research approach to induce theoretical concepts and patterns. This approach was shown to be suitable for information system's research, which characterises the organisation's experiences in terms of process of incremental or radical change, in the award winning paper of Orlikowski (1993). It allows concepts to be suggested by the data rather than imposed from the outside and then organised by recurring themes into a set of stable and common categories which can then be combined with the insights from formal theory, in our case Activity Theory.

The field study lasted over a year, covering three main stages:

1. The period from mid-2002, when faculty and school timetabling officers were required to collect, and enter, details of classes to run in 2003,
2. the first half of 2003, using the timetable and dealing with requests for changes,
3. the period in mid-2003 when details for 2004 classes were being entered.

Interviews were held with key stakeholders: a senior manager, the registrar, the external consultant, the university's timetabling manager, faculty and school timetabling officers, IT systems support staff, academic teaching staff and students. Relevant documentation was collected included systems documentation, user manuals, training manuals, some instructions to staff and evaluations of the utilisation of space before and after the introduction of the new system.

3.2 Research Results

The initial findings of the grounded research comprise the following set of concepts identified, as potentially significant, from an interpretive analysis of the data in the interviews and documents.

- From the perspective of the managerial stakeholders, the new timetabling system held the golden promise of IT in that, once it was set up, it would automate all timetabling decision-making, providing the most efficient allocation of resources with least amount of effort with most satisfied stakeholders. It appeared to do everything, storing all "knowledge" of physical and human resources, teacher and student requirements, while being flexible and responsive yet comprehensive.
- The lack of understanding of local cultural and contextual factors in systems implementation was apparent in the problems encountered. The timetabling system was already well established in other universities and there was an active user group, with lots of experience and knowledge of these previous implementations. The system was highly regarded in user group, which was composed mainly of the IT support staff and university administrators. Missing were key stakeholders in the system, those involved directly in the teaching activities.
- Despite the plan to follow an acceptable implementation procedure of conducting a limited initial trial of the system, no-one seemed to anticipate the impact that the sudden full use of the system would cause. The trial used experienced and cooperative timetabling officers in two small faculties. Little formal evaluation was done of the trial outcomes with no real feedback from those responsible for whole timetabling and teaching process.
- Most stakeholders in the faculties and schools were ill-prepared for the subsequent full and complete adoption of the system, which caused chaos and widespread angst. These direct and indirect users of the timetable were suddenly faced with problems of getting the new system to work rather than being presented with a workable timetable that they could use for their classes.
- Much critical knowledge was not in the system. One simple example of this was the varied reasons for repeat lectures. The system was programmed on the assumption that lectures were repeated because the class was too large for any available room whereas often the repeat lecture catered for different groups of students such as part-time working students or to fit in with off-campus classes. This one false assumption alone produced an unworkable timetable for some of the teaching staff. It was however only one of many such items that were mainly held as tacit knowledge by various groups or individuals. While each item in itself was quite small, the quantity, interaction and changeability of these items were indicative of the inherent complexity of the timetabling process that could never be accurately and timely captured in the system.
- Key stakeholders in the timetabling process were school and faculty officers who had varying levels of computer literacy and timetabling experience. Some had just been appointed, unwillingly, to do timetabling and they were completely lost. Others, who had done the job for years, had accumulated vast knowledge on timetabling issues. They were worried that the system would make them redundant.
- The university timetabling manager and the external consultant were experts who failed to appreciate the problems that casual users would have entering data through the complex system interface.

- In the first year of full operation much of the "automation" of the system was circumvented or not implemented for end-users in the schools and faculties as had been originally envisaged. This resulted in a huge workload for the university's timetabling manager who ended up re-entering data and rescheduling classes manually.
- Together with the external consultant, a simplified set of data entry screens was built for the routine entry of required course details and is being used for entry of the 2004 details. It amazed us that the need for this add-on was not known through the system's user-group as other universities, already using the system, must have encountered the same problem.
- Lack of coordination of the timetabling unit with others in the university administration meant that several major systems changes occurred at the same time – right at the beginning of the teaching session for 2003. This included a major redesign of the university's website, upgrades to the student management system and a server migration of the undergraduate student email system. As users made more hits finding their way, the whole university system was severely overloaded just as the timetabling system needed to respond to sudden changes in class sizes due last minute enrolments.
- Initial evaluation has shown that there is no significant improvement in resource utilisation in the first year of operation of the new timetabling system.

The concepts, listed above and drawn from the case data, are deemed to fall into at least the following categories:

- The inherent complexity of the timetabling task
- Communications breakdowns between stakeholders
- Missing information particularly that associated with tacit knowledge
- Local contextual effects on technology transfer
- Systems usability problems due to the design of the interface

The concepts in each of these categories contributed to the adverse organisational impact of the initial use of the new timetabling system. The following analysis from Activity Theory attempts to reveal some of the underlying mechanisms of the case.

4. AN ACTIVITY THEORY ANALYSIS OF THE CASE

4.1 Stakeholder Activities

It is apparent that the mix of interacting stakeholder activities, emerging from the case, needs to be analysed and better understood. Such an analysis begins with identification, from the case data, of the contributing activities, defined by the relationship between subject and object, i.e. who is doing what. A summary of the expected activities of the main stakeholders is shown in Table 1. This does not reflect the extra activities that the introduction of the new timetabling system caused in the work of all stakeholders.

Subject	Object	Desired Outcomes	Mediating Tools	Context
Senior Manager	Resource utilisation	Lower teaching costs, no problems	Administrative staff and procedures	Pressure from above
Registrar	Running of Teaching Program	Contented managers, teaching staff and students	Unit staff and procedures	Pressure from the senior manager, dealing with problems of staff and students
External Consultant	Implementation of the system	Working system	Timetable system documentation, University requirements	Limited to interest in the system
University Timetable Manager	University Timetable of class space and time	Smooth, trouble-free timetabling process	The system, management demands	Responsible for smooth running of Timetable.

Subject	Object	Desired Outcomes	Mediating Tools	Context
Faculty/School Timetable Officers	Communicate between teaching staff and administration	Satisfactory timetable with ability to update as needed	Faculty/school procedures, the Timetable system	Variety of responsibilities in own faculty/school, conflicting needs of staff and students
Teaching Staff	Teaching courses	Good educational outcomes	The timetable and other systems	Changing educational environment
Students	Education	Good grades, learning	The timetable and other systems	Pressure to succeed

Table 1: A Summary of Expected Stakeholder Activities

4.2 Relationships between Activities

Figure 4 depicts the expected relationship between the normal activities of teaching and learning recognising that education, alongside research, is a dominant purpose of a university. These activities should take centre stage in what takes place within the faculties and schools of the university while the timetable, and the other work of the registrar's unit, occupy a lesser, supporting role. In this activity–based representation the registrar undertakes a sideline activity of providing a supportive environment for the main players, the teaching staff and students and timetabling is only a purposeful activity for the university timetabling manager with the timetable as the outcome.

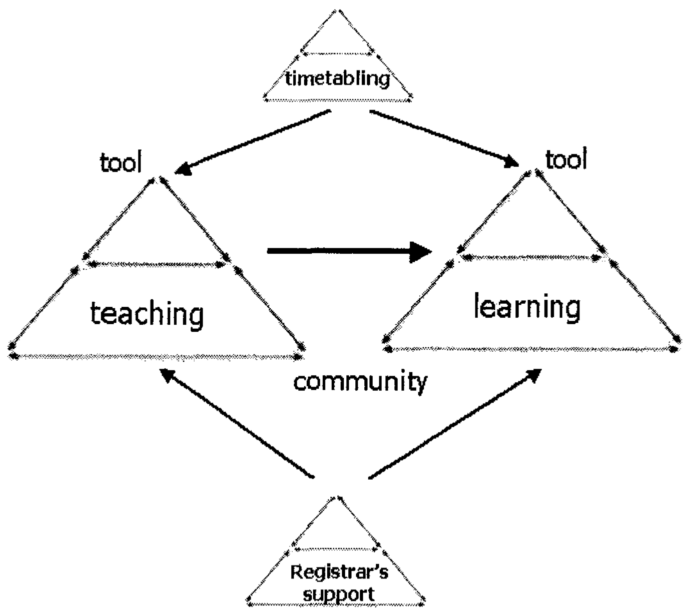

Figure 4 The ideal relationship between the dominant educational activities

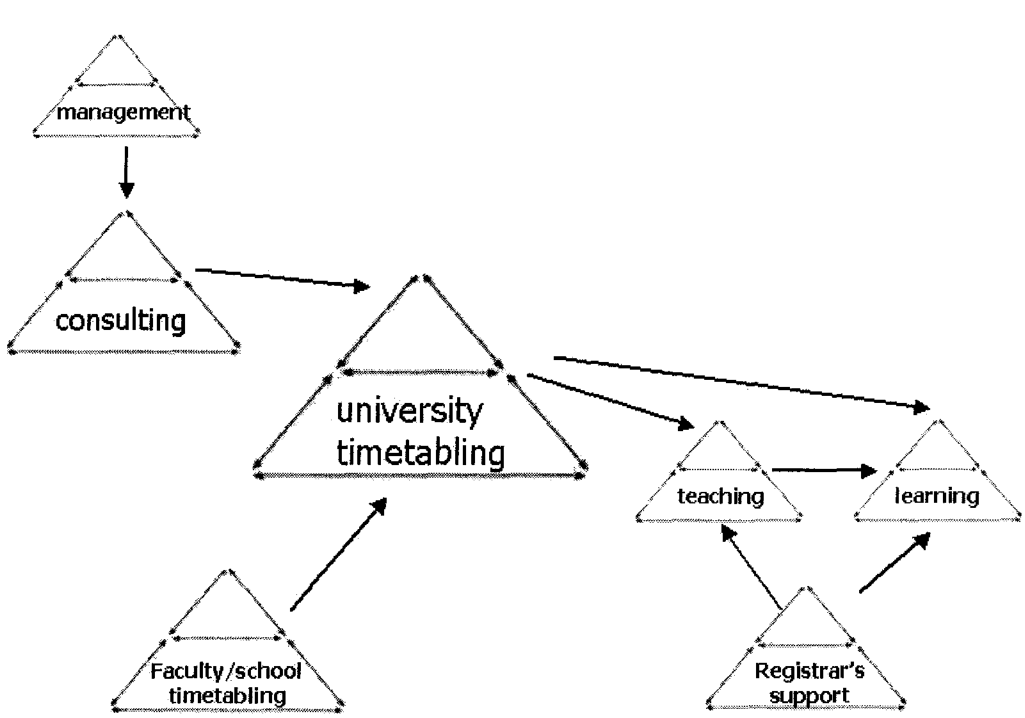

Figure 5 The distorted relationships between actual activities of stakeholder during the introduction of the new timetabling system.

What appears to have happened with the poorly planned introduction of the new timetabling system, was that the timetabling activity took centre stage and dominated the attention of most of the stakeholders as shown in Figure 5. The supposedly dominant activities of teaching and learning were pushed to one side as everyone made an effort to get data into the new system and then get it to produce an acceptable timetable. The activity of the consultant, engaged by senior management to advise the timetabling manager, was far removed from the end users and he was unaware of most of their specific problems. The senior managers and the consultant seemed to have one view and that was to automate an efficient timetabling system that would change the organisation from its previously, somewhat chaotic, state into a well-oiled machine. They saw a need to even out the popular times for classes, when resources were at a premium, and other times, when there were plenty of free classrooms. They also hoped to reduce the constant requests for changes to room allocations.

With the introduction of the new system, everyone was adversely affected either by the difficulties of getting data into the system or by the time consuming effort of checking for anomalies in the unworkable timetables it created. The former problem was due mainly to the poor usability and other shortcomings of the system and by the long time between the training of end-users and their use of the system. The latter problem was mainly due to the extreme difficulty of making sure all data and constraints were captured in the system. Several runs of this timetabling process were made before even a remotely feasible timetable was created causing great concern to the faculty and teaching staff.

5. DISCUSSION

The production of the annual class timetable had previously been an activity of the university timetable manager with input from the faculty, and school, timetabling officers. The Activity Theory analysis revealed that what was planned to be an operation, i.e. the automation of the timetabling processes, had become an activity of implementing a new IT systems and occupied the attention of administration and teaching staff alike. This was not only very disruptive to the normal activities of the university, teaching and learning, but also distorted the relationships between administrative and educational activities. This demonstrates that the object of an activity has a contextual, subjective component in that it is inevitably socially constructed. What people do in organisations is rarely defined by their official job description, but rather is socially negotiated and constrained by circumstance.

IT applications such as the timetabling system are designed to automate processes on the assumption that everything about the processes is knowable. The senior manager, the external consultant and perhaps to some extent the registrar, hoped and even believed that the system would streamline the timetabling and the teaching process. They intended that the implementation would drive change to essentially improve efficiencies through automation. They failed to realise, on the one hand, that the process was inherently too complicated, complex and unstable to be so completely automated, and hence relegated to the realm of operations, and on the other, that the outcome of any such automation would have a profound effect on academic culture, reducing the flexibility and agility of the teaching activities. Rather than professionals, teaching staff would be seen as tradespersons whose work can be automatically controlled and structured.

Similar findings have come from research into the introduction of Enterprise Resource Planning (ERP) systems into large organisations. What the creators of ERP strive to do is combine all possible functions that every company requires to do its job and integrate them all together in one software package that can be implemented in any organisation. Company managers invest millions in acquiring ERP systems in the hope of increasing productivity and efficiency, particularly for global operations. However, research (Pan et al 2001) has identified that knowledge integration is a key problem in ERP implementation and that this is a contextual issue that does not happen automatically. The degree of complexity, together with the uniqueness of each organisation confounds the hopes of managers that an ERP will drive organisational change to a more productive, efficient operation.

In the case of the university timetabling system, management proceeded under the assumption that, although the timetable was large and complicated, all relevant data needed to determine the time, place and staff for classes, could be known and hence put into the system which could then perform the scheduling function. The many inappropriate versions of the timetable that were generated and discarded, based on the initial round of data entry, are evidence that what was thought to be a complicated but rationally manageable system was really a complex and emergent one.

The realm of management decision-making is normally based on the assumptions of rationality and order, which are at odds with processes that are essentially complex and emergent The sense-making Cynefin framework (Kurtz and Snowden 2003) distinguishes four domains which set the context for collective decision-making in organisations. These include two domains of order, the known and the knowable, the domain of complexity and the domain of chaos. In IT implementations, such as the case of the university timetabling system, there is often the assumption that it operates in the knowable domain where all relevant data is available and can captured, and processed, in the system. Moreover, by doing so, the implementation of the system will drive significant changes to improved productivity and efficiency. In a complex world, reality changes too often for a system, such as the timetabling system, to stabilise its data set. An IT system may have the functionality to support work processes but cannot do everything or provide complete knowledge of the situation. In the complex domain, of the Cynefin model, it is acknowledged that not everything can be known and that people can work effectively with partial and emergent knowledge, which defies complete categorisation or definitive analytic techniques. Emergent patterns can be perceived but not predicted leading to the notion of retrospective coherence.

Trying to follow a path assuming that all is knowable, results in much dated information being crystallised in the system and in important information not being captured because it has never been made explicit. Alternatively if the decision-making path is assumed to be in the complex Cynefin domain, the limits of the system are recognised and it is expected that the automatically generated timetable will only be a guide, which will have to be adjusted with intelligent human input from existing custodians of knowledge. This requires a minimalist design of the system. Most systems tend to be over-designed in an attempt to do and know everything, which is just not possible in complex situations. Resultant change will occur, but will emerge through negotiated changes to work patterns rather than be driven by the constraints of the system.

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