COBRA2009

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The RICS COBRA Conference is held annually. The aim of COBRA is to provide a platform for the dissemination of original research and new developments within the specific disciplines, sub-disciplines or field of study of:

Management of the construction process

- Cost and value management
- Building technology
- Legal aspects of construction and procurement
- Public private partnerships
- Health and safety
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The built asset

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- Planning and property markets
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- Sustainability and environmental law
- Building performance

The property industry

- Information technology
- Innovation in education and training
- Human and organisational aspects of the industry
- Alternative dispute resolution and conflict management
- Professional education and training

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The Organising Committee for the RICS COBRA 2009 Conference consisted of:

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Kathy Michell	University of Cape Town
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The doctoral students' session was arranged and conducted by:

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The CIB W113 Law and dispute resolution session was aranged and conducted by Paul Chynoweth of the Univeristy of Salford, UK

Peer review process

All papers submitted to COBRA were subjected to a double-blind (peer review) refereeing process. Referees were drawn from an expert panel, representing respected academics from the construction and building research community. The conference organisers wish to extend their appreciation to the following members of the panel for their work, which is invaluable to the success of COBRA.

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In addition to this, the following specialist panel of peer-review experts assessed papers for the COBRA session arranged by CIB W113, Law and dispute resolution:

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A strategic perspective for managing socio-technical systems: the missing link

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Abstract

Most man-made systems around us are mainly socio-technical systems. As such it is imperative that to manage such systems effectively we need to understand their properties at both the micro and macro level and the holistic functioning of such systems. Such an approach is important in understanding the emergent properties that are exhibited by such system. We already have been delving into the micro level and the intricacies of the different subsystems without actually having the broader view of the whole system. This current approach came from the fact that reductionism is the '*mantra'* of our scientific nature and endeavours, and dictates how a problem is solved. In this paper a strategic approach is put forward, making use of the force field theory as a necessary missing component for designing and managing socio-technical systems. With this proposed strategic approach the true understanding of solving these emergent properties will be reinforced with what we already know and also help in solving some disorder exhibited in these systems, without creating more uncertainties. This paper sets out the framework and its usefulness to understanding the socio-technical systems around us.

Keywords: Emergent properties**,** Force field, Management**,** Socio-technical systems

1 Introduction

The built environment is made up of several man-made systems, divided into sectors such as, industrial, commercial and residential buildings. Added to that, you have the infrastructures such as roads, and civic parks, interacting with the people to create socio-economic systems (STS). Buildings, in particular under real estate umbrella, in this paper are one form of STS that is not fully appreciated in the wider literature as a STS. This is because existing literature have not fully appreciated that all the properties exhibited by these systems when in operation are within those defined as a STS. Most of the existing literature on socio-technical systems (STS) is mainly on the design of the system and an inadequate amount on the implementation of the system. Those literatures that are available on implementation do not go far enough in addressing the issues of operations, maintainability and support during the life of the STS systems. It is almost impossible to foresee all or understand all the emergent nature of the STS when in its full environment. As such, with all those emergent properties expected during it full operation, it would be naïve not to think that something new would also emerge. How do we plan for such scenarios? How do we optimize working STS that would not compromise any of the organisations or individuals that it is meant to assist?

The design of socio-technical systems have been around for quite a while. However, this paper concerns not the project delivery (i.e. feasibility, design, and construction) as amplified in most documents and literature within the STS, but rather on project operations, maintenance and support. This is where majority of the emergence properties that were not envisage during the design of the STS life are encountered and have to be dealt with. The is also the grey area where the full understanding of those STS emergent properties that were also envisage may exhibit properties that were not fully appreciated during the STS design. It is the long term view of what the STS will propagate in its environment that is more of a concern here, despite the fact that practitioners within the downstream ends would have been involved early in the development and creation of the system.

It is believed that there are currently three kinds of identifiable socio-technical systems. They

- Large technical systems (e.g. railway infrastructure)
- Sectoral systems (e.g. banking systems)
- Computer systems (e.g. aviation systems)

Some of these STS systems also fall within self-regulating systems (i.e. economic systems – stock exchange) that researchers have been studying by different methods for quite some time. In this paper STS systems like real estate are considered. The aim of the paper is therefore an attempt to develop a management support strategy for STS in its environment and future developments of its implementation. In this paper some theories are closely examined that are beneficial in understanding and developing better management approach to handling socio-technical systems in their dynamic environment. The other sections of this paper include: a methodology, a literature review, development of a management framework and discussion and conclusions.

2 Methodology

Research and its methods can be seen as instruments for provoking a response from the world. The nature of the response depends on both the world and the instrument (Mingers, 2001). There are different approaches in studying and researching into different phenomena. Currently researchers focus either on using the quantitative method or qualitative method, although recent researchers are beginning to use a hybrid of both. Within these methods you have different approaches to use. Qualitative research focuses on the process that is occurring as well as the product or outcome. Researchers in the qualitative field are particularly interested in understanding how things occur (Fraenkel & Wallen, 1990, Merrain, 1988; Minger, 2001). Moreover meanings and interpretations are negotiated with human data sources because it is the subjects' realities that the researcher attempts to reconstruct.

In this study it is advantageous that interpretive approach be adopted. The reasons are that the study is used in understanding most of the literature, frameworks, tools and techniques that are in current usage in managing STS systems. Any meaningful understanding is sought from both the literature and empirical materials (although few) that are available and accessible to the researcher. Furthermore in the proposed study the research problem needs to be explored because not much information is known on the topic. There is no known universally accepted robust theoretical base to guide the study because those available are inadequate, incomplete, or simply missing aspects that are may be relevant to the present study.

The interpretive approach is a method that is informed by a concern to understand the world as it is. It seeks explanation within the realm of individual consciousness and subjectivity, within the frame of reference of the participant as opposed to the observer. It sees the world as an emergent social process, which is created by the individuals. Interpretive philosophers and sociologist seek to understand the very basis and source of such social reality. They often enquire in the depth of human consciousness and subjectivity in the quest for the fundamental meanings, which underlie social life. Therefore on the basis of an extensive review of literature within this study, the proposed research is considered exploratory in nature. This therefore also leads in inevitably to the interpretive paradigm as the most appropriate approach within which to develop an appropriate research methodology.

3 Understanding the Available Literature

In this study the working definition of a system is (Sommerville, 2003):

'*A system is a purposeful collection of inter-related components that work together to achieve some objective*'.

Hence a STS system is made up of socio-technical constituencies. Socio-technical constituencies are dynamic ensembles of technical constituents (for example, machines, instruments) and social constituents (for example, organizations, interests groups) which interact and shape each other in the course of the creation, production and innovation of specific technologies (Molina, 1999, Nicoll, 2000).

Essential Characteristics of socio-technical systems are (Checkland, 1998):

- They have emergent properties that are properties of the system as a whole rather than associated with individual parts of the system. Emergent properties depend on both the system components and the relationships between them.

- They are often non-deterministic. This means that it cannot be guaranteed that, when presented with specific input, they will always produce the same output. The system's behavior depends on the human operators and people do not always react in the same way. Furthermore, use of the system may create new relationships between the system components and hence change its emergent behaviour.

- The extent to which the system supports organizational objectives does not depend on the system itself. It also depends on the stability of these objectives, the relationships and conflicts between organizational objectives and how people in the organisation interpret these objectives. New management may reinterpret the organizational objectives that a system is designed to support and a 'successful' system may then become a 'failure'.

There are two types of emergent properties (Checkland, 1998; Sommerville, 2003):

- Functional properties that appear when all the parts of a system work together to achieve some objective.

- Non-functional emergent properties that relate to the behaviour of the system in its operational environment. Examples of non-functional properties are reliability, performance, safety, usability, and security. The success or failure of a system is often dependent on these emergent properties.

The social constituencies of the systems involve human elements. Human organizational factors such as organizational structure, management and politics have a significant effect on the operation of socio-technical systems. These human, social and organizational factors are often critical in determining whether or not a system successfully meets its objectives. Unfortunately, predicting their effects on systems is very difficult for engineers who have little experience of social studies. To help understand the effects on system on organisations, various methodologies have developed such as Mumford's socio-technics (Mumford, 1989) and Check land's Soft Systems methodology (Checkland and Scholes, 1990, Checkland, 1981). There have also been extensive sociological studies of the effects of computer-based systems on work (Ackroyd, Harper, Hughes and Shapiro, 1992). However, must of these studies are focused on the design and implementation stages of the STS not so much on the operational environment of the systems.

In the technical constituencies of the STS we are dealing with a pre-existing system, complete with elements, relations and environment. Altered conditions on the level of the system can only be caused by changes on the level of the elements and relations, the internal system structure. This means that either the arrangement of the elements has changed, or the characteristics of at least one element have changed. But changes in the structure dimension are not sufficient to change the function of this structure; another qualitative jump is missing here (Fleissner, 1996). Additionally, a change in the system state is not enough to change the action of the system or its relationship to the environment; a jump in quality must also be assumed.

Hence the dynamics in STS systems involve a dynamic process of mutual adaptations and feedbacks between technology and user environment. A focus on STS may form a bridge between separate bodies of literature (Geels, 2004). Technical possibilities and scientific laws constrain the degree to which interpretations can be made.

Human actors are not entirely free to act as they want. Their perceptions and activities are coordinated (but not determined) by institutions and rules. Technologies have a certain 'hardness' or obduracy, which has to do with their material nature, but also economic aspects (e.g. sunk costs).

Actors and organisations are embedded in interdependent networks and mutual dependencies. People adapt their lifestyles to artifacts (e.g. mobile phones), new infrastructures are created, industrial supply chains emerge, making it part of the economic system dependent on the artifact. Thus technological momentum emerges (Geels, 2004).

To understand transition from one system *state* to another the notions of tensions and misalignment are useful. The different regimes have internal dynamics, which generate fluctuations and variations. These fluctuations are usually dampened by linkages with other regimes, thus providing coordination. At times, however, the fluctuations may results in mal-adjustments, lack of synchronicities and tensions (Freeman and Louca, 2001, Nicoll, 2000). This means that both stability and change of STS systems are the result of the actions and interactions between multiple social groups as well as technological subsystems. This constant change and uncertainties makes it rather difficult to manage an STS that is considered so dynamic. Given this present scenario, what can we do? In the entire proposition, the key elements about STS are the underlying human issues. These underlying human issues are variables that are difficult to determine, or predict precisely, due to the underlying variability, in the humans, the organizations and the environment in which they exist. Are the human issues, social only? If they are, there are so many theories within sociology that we can draw from to help in bringing some semblance to the STS. However, if the human elements are more than social, then we need to widen our understanding to other literature involving human aspects.

4 Towards a Strategic Management Framework for STS

In summary, a STS is made up of two distinct subsystems (i.e. social and technical) that will have to be managed, collectively but optimally. However, the approach in managing such a system should take into effect broader issues of the subsystems as discussed above. One is natural, the other is man-made. Using this premise, there are theories out there that have been tried and tested in the two domains. One is the field theory as defined in Lewin's work and another is the fifth discipline. The fifth discipline developed by Peter Senge can also be used in understanding, learning and managing collectively the two systems. The force field theory will be summarized in the next section.

4.1 Field Theory

The study of psychology is a science centred on understanding and predicting human behaviour. Throughout its history, distinct individuals have come along and dramatically impacted our understanding and perception of this science with their thoughts, theories, and research, shaping psychology into what it is today. One such person is Kurt Lewin. One of Lewin's work is *field theory*. Lewin research is directly purposed at understanding and generating practical applications and solutions to real world problems (Reber & Reber, 2003). Field theory stems out of the idea in order to explain human behaviour one must look at all pieces of the puzzle, all dynamic interactions influence outcomes. In his theory Lewin defines the field as the totality of coexisting facts which are conceived of as mutually interdependent (Lewin, 1951). The field represents the complete environment of the individual. Behaviour, Lewin believed, resulted from the tensions between individuals self-perceptions and environment encountered (Smith, 2001). Ones 'life spaces', or total environment of the individual all significant others, had to be understood and researched in order to understand behaviour. Lewin then concluded that as individuals participated in many life spaces such as family, church, work, or school, behaviour was represented as movements through life spaces that carry both positive and negative influences and are driven by ones perceptions based off their underlying psychological needs (Daniels, 2003). This theory has been in existence for the past fifty years.

Daniels pinpoints three important summary points to Lewin's theory. First that behaviour is derived from the totality of all existing facts. Second that these coexisting facts make up the dynamic field, and that in the dynamic field every part is dependent on every other part. And thirdly that behaviour depends on the field, not on past or future encounters. Group dynamics resulted out of Lewin's work with field theory. Group dynamics are the collective interactions that take place within a group. For further reading of field theory the reference material are supplied in the references.

According to Kurt Lewin (1951), the behavior of a person is a function of the person and its environment. This can be put in a mathematical expression as:

$b = f(P, E)$

Where b is the behavior of the person, P is the person and E is the environment. The person is actually a sub-system in a STS. Also STS is a system, made up of other sub systems, some human and others technological. An emergent property can actually be considered as the behavior of a system as such; the same as formulated by Lewin, may be extrapolated to an STS system, when the behaviours of the human elements are contributing to the STS in operation. This theoretical framework has been used in different areas not including STS system – such as environmental psychology (Moore, 2003). It has been used in understanding organisations as well as environmental designs of housing for dementia patients for the past forty years. However, the behavior of our STS system, I prefer to call it the *availability* of the STS system. How the STS performance will be judged due to such emergent properties, in its everyday environment.

There will be different states of availability of the system, depending on its reaction to the changing external environment. However, holding the external environment constant, changes to its availability will come from the internal subsystems reactions. These are the force fields that produce the motion of change. The force field theoretical framework can be applied to an *individual,* a *group* and also to an entire organisation, as long as the unit of analysis is consistent to the environment and the person(s) in that environment. Appreciating the dynamics of the complex force field theory and learning how to apply it in practice to our STS system is paramount. This is shown in Figure 1 and 2. In Figure 1, the different properties of the person, such as the physical state of the person, the psychological makeup and the person social interaction will give different state of mind, as an individual also when in a social setting. The different environmental conditions interacting with the technology will also pose different range of properties impacting on the socio-technological properties, which exhibits itself as emergent properties.

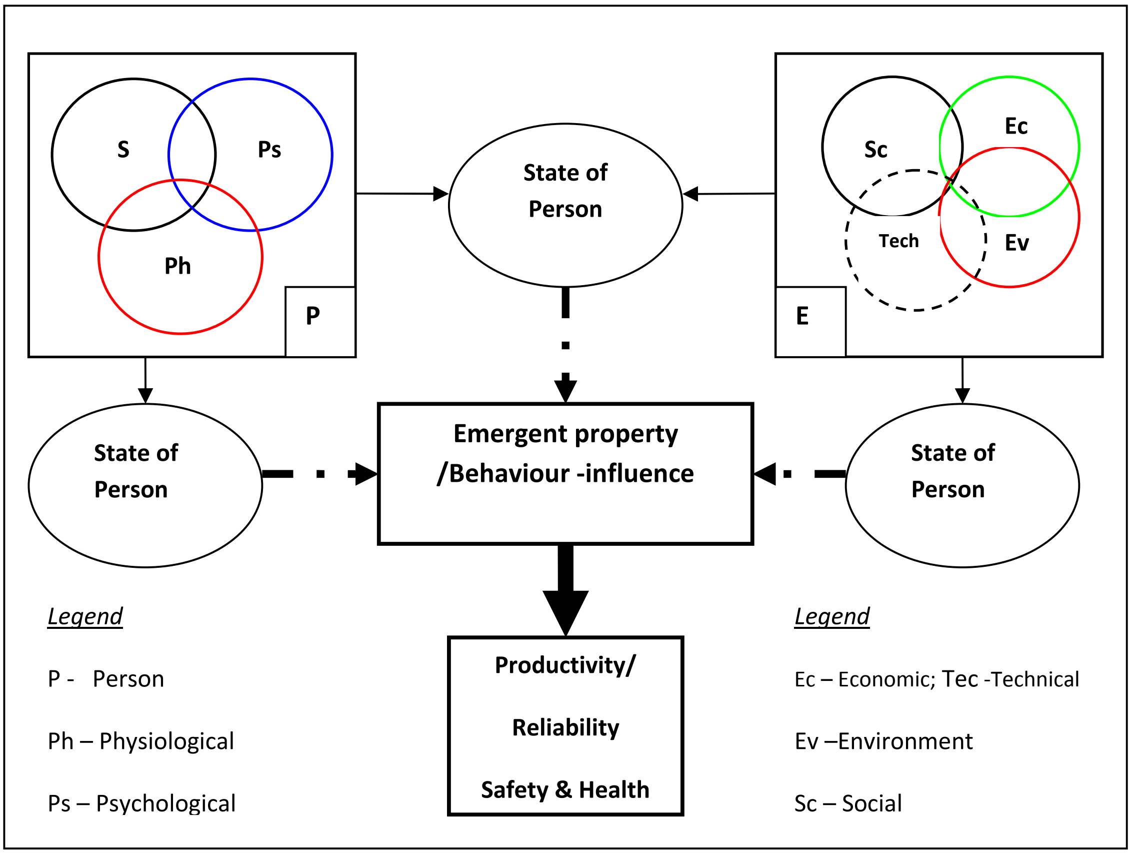

Figure 1: The relationship between the Person (P) and the Environment (E) –*field theory expounded*

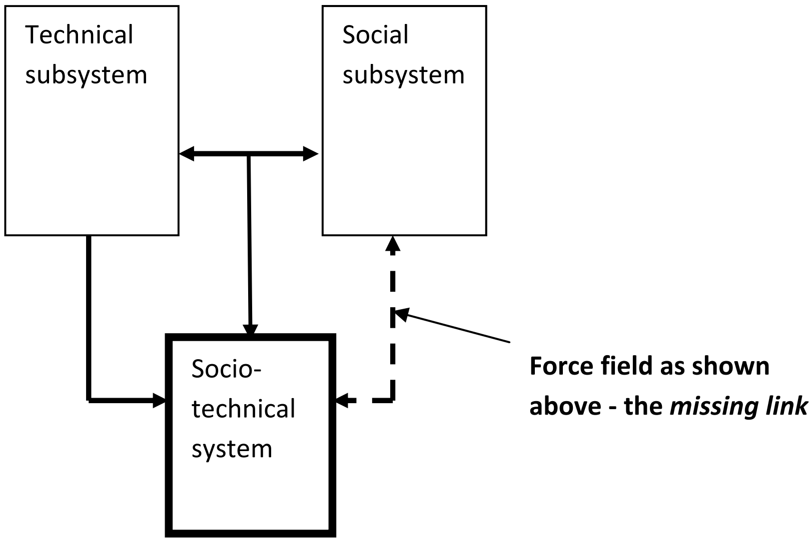

Figure 2: Conceptual application of the force field to STS systems

5 Discussion and Conclusions

The brief discussion above shows how some key tenets from the force field theory can inform and encourage us to rethink the way we manage STS systems. What we see here is just one example of how one emergent property of an STS emergent can be managed through its whole life cycle. This same type of procedure can be applied to other kinds of emergent properties that are exhibited by the STS should be understood and project managed effectively.

For example, in real estate such as social housing, as STS systems, a lot of thought process after their designs and implementation lacks the coordinated efforts of the designers, the operators and those social groups that are living in the STS systems. Most of the time what has been designed usually is the effort of the designers, the councils and so-called clients' representatives from users. In a short while due to in lack of understanding of the dynamics in the social undertone in the operating communities, the housing quickly becomes an eye-saw. Rather, when such projects are in operation, there is a constant dynamics going on between the social and the technical as well as those elements within each subsystem. This constant change in behaviours in the social groups as well as the environments needs to be fully appreciated by those managing the system.

We will never be certain of all the consequences of a particular decision taken when we design the STS because we never know what the future is going to require. Socio-technical factors that can exert a major influence on decisions are the nature of the environment that will contain the new system. As such, a successful design and management of the STS when in full operation requires tools and techniques that would embrace all the stages of its life cycle. Such can be found in using strategic methods that can be successfully applied in the field, such as found in force field theory. The application of the principles of force fields requires research in the STS natural environment – which is the continued area of future research domain. The essence of choosing the right unit of analysis for the research is paramount in ensuring better research outcomes in this area.

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