Systems Thinking and its Influence on Operational Culture

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Abstract

This paper reviews a recent period of change in the traditional manufacturing environment of a large oil refinery, and the role of systems thinking techniques in this development process. The focus is on how the gradual adoption of these methods as part of normal working practices has contributed to changes in attitudes, behaviour and performance. Attention is directed to the way the methods are themselves proving to be a vehicle for cultural development, as well as being part of the toolkit used to analyse specific issues.

The paper describes the way several techniques have been introduced, applied and combined. There is a commentary on how these approaches have helped to induce a shift from a rather intimidating fire-fighting mentality to a widespread embrace of the quest for structural improvements. This shift and the adoption of the techniques are, of course, mutually reinforcing. What is of particular significance is the way the virtuous circle was initiated. It is concluded that the approach was successful largely because it was consistent with the broader requirements of change-management and compatible with fundamental aspects of the predominant organisational culture.

While this is an ongoing process of transformation, the paper introduces a framework to conceptualise the insights which have emerged so far. It is intended that this will facilitate their further application and hence support the broader learning process.

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INTRODUCTION

As has been widely reported, a variety of systems thinking concepts, methods and processes have taken root within the Royal Dutch/Shell Group of Companies in the past two decades. Indeed, Shell managers and planners have at times been at the forefront of developments. The Group has been particularly associated with Scenario Planning[11, 12], Mental Modelling[5] and, to a lesser extent, Soft Systems Methodology[4]. Prompted and encouraged by formal corporate planning processes, training and their use to facilitate dialogue on complex issues, these approaches are very familiar to at least senior management throughout the company. They form a deeply influential aspect of strategic learning within the Group, supporting, for example, decisions on major investments in long-lived assets under conditions of often considerable uncertainty.

In the highly capital-intensive industries in which Shell operates, it is a simple truism that our potential for success is founded on the quality of these decisions. Putting the assets in place, however, is only the beginning of the story. They also have to be operated effectively, and linked flexibly into their overall business environment. Without this, the benefits accrued through strategic learning will be squandered. There is always going to be some difficulty, however, in establishing effective learning processes in this operational area because of the large number of decisions, people and activities it encompasses.

As line managers, we have recently been involved in a variety of initiatives to enhance performance at the major Royal Dutch/Shell refinery at Pernis near Rotterdam. A cluster of systems thinking techniques have been employed. As will be described, these methods have not only brought the benefits expected from improved analysis, but also appear to have been associated with a general shift in attitudes, perspectives and behaviour in the part of the organisation into which they were introduced. The desired learning culture seems to be becoming established. Looking back, there are a number of valuable lessons we feel can be drawn from this process, and from comparing it with previous experiences at this site and elsewhere in the Manufacturing Function of the company. We believe these insights will be applicable to other change-management activities.

In this report we adopt a very broad view of what can fall under the general heading of "systems thinking". For reasons which will become apparent, we include all techniques that encourage or demand practitioners to take an integrated view of events. In other words, to balance a focus on the individual events themselves with an appreciation of the relevant pattern of relationships between them.

RECENT EXPERIENCE WITH INTRODUCING SYSTEMS THINKING TECHNIQUES IN AN OPERATIONAL ENVIRONMENT

In the past few years, a number of different steps have been taken at the Pernis site to institute continuous performance enhancement. These have included, for example, the ISO9000 certification of various parts of the business. It became clear, however, that one of the more formidable barriers to improvement came from the unavoidable fact that a large number of different functional or operational processes are involved in each of our business processes. With the aim of clarifying and eventually re-engineering such sequences of activities, the concepts and methods of Business Process Analysis have been promoted. Interestingly, the most immediately successful of the various pilot projects which were initiated was actually one of the more complex as it crossed several departmental interfaces in very different parts of the business. It involved the commercial and customer transactions of the Trading department, the operation of logistics facilities at the refinery

by the Oil Movements department, and the coordination and optimisation of these activities by the Economics and Scheduling department.

The team involved with this project began by developing a high-level overview of the logically necessary actions required to accomplish the chosen business goal. There were similarities, therefore, between this overview and the sort of conceptual models which result from applying Soft Systems Methodology[4] (SSM), the main differences being that no explicit worldview or root definition for the model were identified. Obviously, therefore, the potential value of investigating the implications of alternative worldviews or root definitions was not explored. The more general SSM process was introduced to the project group, but the relevance was not fully appreciated, and the focus remained on the overview or "Functional Activity Model" as it came to be known.

Each of the logical activities of the main overview was broken down into sub-activities and sub-models. It soon became clear, however, that an unmanageable proliferation of activities in ever greater levels of detail was going to emerge if this process was continued. To return focus to the most relevant issues, therefore, a previously prepared extensive list of points of concern was "projected" on to the activity model to highlight the areas where attention was most appropriate. Eventually three linked activities at the second level of model detail were selected for deeper analysis. Three teams performed detailed work-flow analysis in these areas, and then re-engineered, documented and implemented enhancements. Appropriate attention was paid to ensuring that quantitative feedback on the performance of the new processes was available and, to the satisfaction of all involved, improvements were quite evident.

In addition, considerable enthusiasm was generated for this process of combining functional activity models, points of concern and finally workflow re-engineering as a means of developing insights into problem areas and then translating these into concrete actions at the operational level. This approach has subsequently been applied in other projects.

At the same time, other methodologies were being introduced into the Economics and Scheduling department. From the world of Quality Management[7], statistical process control (SPC) runcharting was introduced to monitor deviations of actual plant, logistic and market operations from assumptions and instructions related to various time horizons. This was the first time such techniques had been used at the site to focus on coordination and planning rather than individual well-defined production processes. Statistical and probabilistic methods were also adopted to analyse data and relationships, with results used in simulations to support risk/reward analysis and decision-making. A functional activity model for the department was constructed, and developed into a Handbook detailing activities, responsibilities, information flows, business controls, document controls and interfaces with partners in other areas of the business. This specific functional activity model was then supplemented with more general conceptual models based on service provision and individual fulfillment perspectives. In other words, a more complete SSM approach was adopted. These conceptual models had a rich influence on self-perception within the department.
Causal-loop analysis and system dynamics concepts were also introduced. Initially application was confined to exploring physical interactions, but soon members of the department were including the impact of such variables as "anxiety" and "credibility" in their analyses, and taking these into account in their decisions and activities.

One of the most exciting facets of these developments was the way in which an initial lack of interest, scepticism, and even resistance were gradually replaced by enthusiasm, imaginative application and curiosity about other "exotic" techniques. This was also accompanied by a shift in the climate of attitudes and behaviour. A calmer and more systematic approach began to be adopted in routine activities, and there was a widespread embrace of the quest for structural enhancement. There was also an improved level of understanding of the mutual roles, responsibilities and interactions of management staff and operational staff, an area previously characterised by information blocks and excessive intervention. As an example of the progress, the

following is an extract from a presentation on the SPC philosophy prepared by members of the department and given to their counterparts in other departments.


"Management understanding" means "Better use of Management"

Employees: Duty to deliver information in understandable form.

Management: Duty to keep "hands off" if process understood and
                       demonstrably under control.

Besides anecdotal evidence related to specific examples as above, the change in climate was also apparent from the results of an anonymous questionnaire. The average responses to the questions most related to the subject of this paper are shown below. There is a clear appreciation that something has changed, and hopefully for the better!

It is almost self-evident that there should be a connection between adopting systems thinking techniques and a shift towards a more systematic and structured view of the environment. It is not surprising that the change in behaviour goes hand in hand with the change in perspective, and that they are mutually reinforcing. A more complex issue to understand, however, is how this virtuous circle was able to be initiated in the first place. In a very similar department with a similar profile of employees at another Shell refinery, the very same line manager had attempted to initiate the same kind of change, but with relatively little impact. To really get to grips with our experience, therefore, at least the following questions need to be addressed.
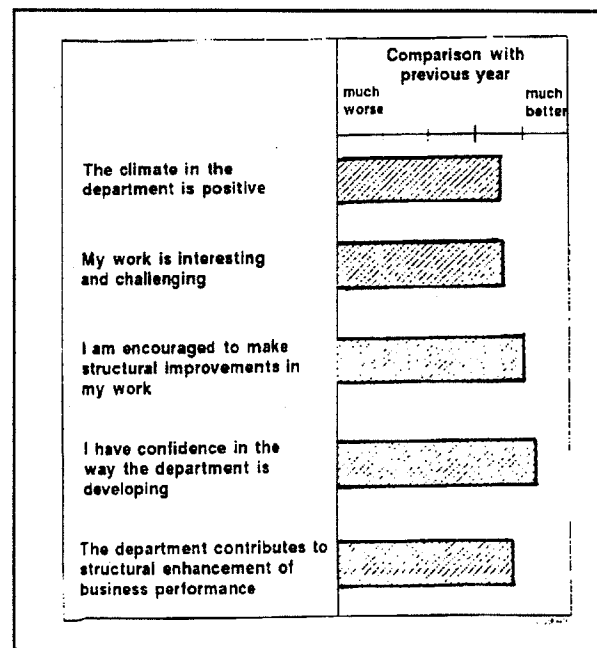
1. Why has the Economics and Scheduling department proved to be particularly receptive to these changes?
2. Why were the changes embraced at this site and not in a very similar situation elsewhere?
3. Which systems approaches were most enthusiastically adopted and why?
4. How did the factors build on each other, providing a path to accepting and embracing progressively more abstract and powerful perspectives?

In any kind of complex situation, a wide variety of alternative explanations is possible. Nevertheless, in what follows we have tried to encapsulate the quality of our own specific experience in a consistent way which draws heavily on frameworks derived from the literature.

THE DYNAMICS OF CULTURAL CHANGE

On the basis of his extensive work on the culture of organisations, Schein[9] describes the dynamics of change in terms of processes of "Unfreezing", "Cognitive Restructuring" and "Refreezing". To unfreeze the existing culture there must be sufficient gap between performance and expectations to produce anxiety or guilt. This disconfirming data establishes the need for new learning and a re-definition of core assumptions. If and when such changes lead to performance enhancement, their validity becomes accepted and they will gradually become elements in a new cultural pattern.

As Schein and others[1, 13] have pointed out, however, it is quite possible for members of an organisation to deny the relevance or validity of disconfirming data for very considerable periods, for example by a process of rationalisation which essentially reduces expectations. In addition, the anxiety generated by the performance gap can completely arrest the required learning process because people become too insecure to conduct the experiments needed to generate fresh insights. The treadmill of "doing more of the same" while rationalising unsatisfactory performance becomes, therefore, a substitute for learning and adaptation. Making use of the "Eroding Goals" system archetype described by Senge[10], the dynamics of this process are illustrated below.

For change to take place successfully, therefore, Schein[9] points out that there must be a climate of psychological security in which change can be contemplated without fear, as well as the undeniable connection of disconfirming data to important fixed goals and ideals. Finally, there must be concrete experimentation based on trial and error or the adoption of new role models.

To effectively support or promote change, therefore, management attention should be consciously directed into these three areas, as shown below.

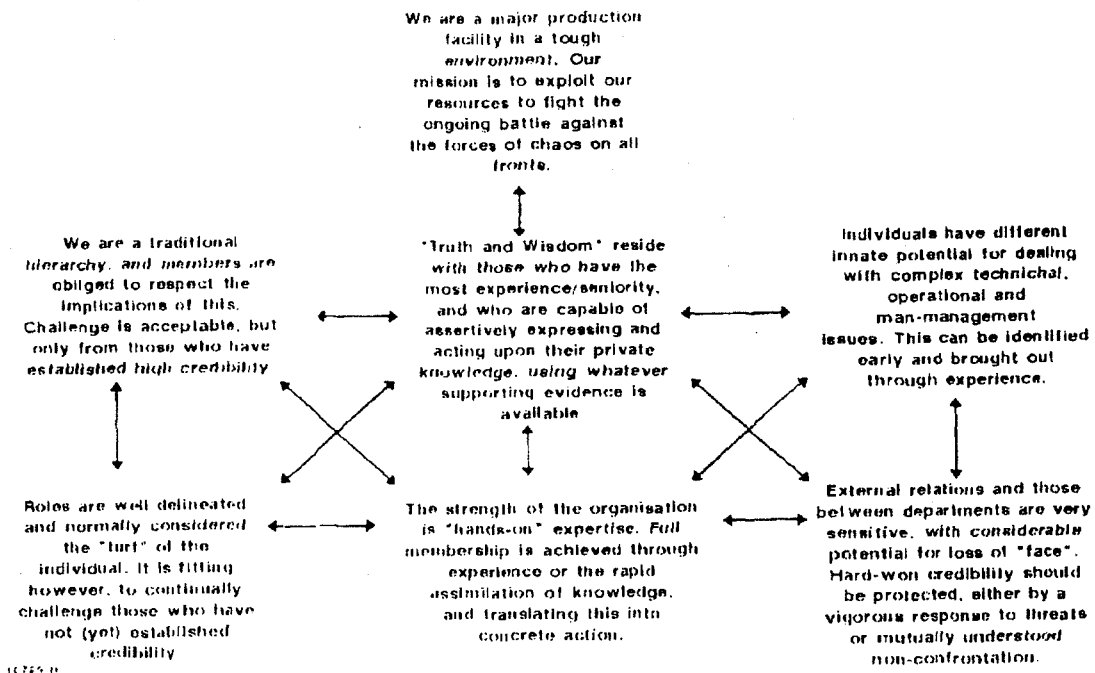**"Eroding Goals" structure in Change Processes**
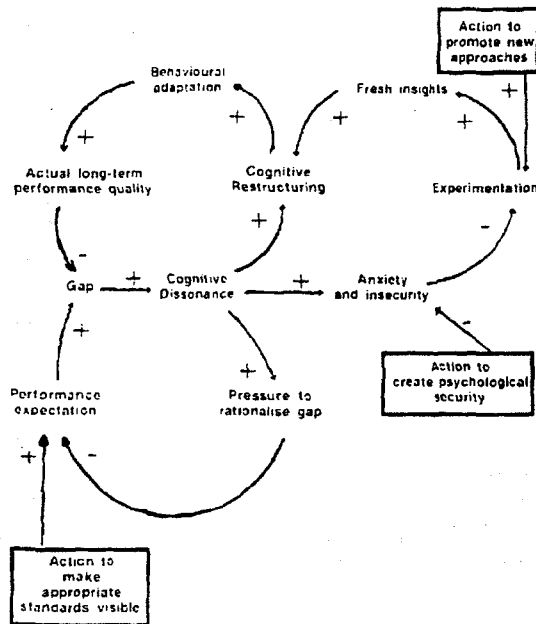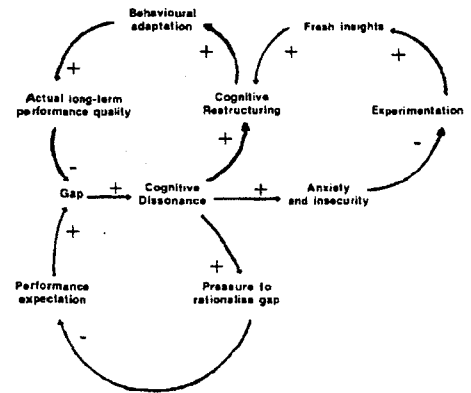
One of the reasons for the relatively disappointing response to attempts to initiate similar changes at another site can be identified from this structure. A long period of business difficulties and general recession had resulted in a degree of anxiety and suspicion which undermined psychological security and, therefore, the forces for change. In contrast, the situation at Pernis was less extreme and there was considerable management action to promote a climate of trust.

TOWARDS THE LEARNING CULTURE

To get to grips with the changes we believe are taking place, we first need to develop a description of the original situation. In this, we again follow the lead of Schein[9] in characterising organisational culture according to a number of key dimensions, summarised in a self-consistent and reinforcing pattern of underlying assumptions. Bentham[2] has given a detailed account of applying this type of analysis to describe the assumptions prevalent in the Central Office of the Manufacturing Function in the 1980's. Not surprisingly given the degree of personnel exchange, the pattern which emerges for Pernis shows many similarities with that developed for the central manufacturing function. The most relevant differences are the heightened emphasis on concrete experience as the fundamental source of individual credibility, and the focus of attention on immediately current events.

These should not be surprising characteristics for an "Operational" culture!

<u>The pattern of cultural assumptions in the Pernis Operational Environment</u>

We are a major production facility in a tough environment. Our mission is to exploit our resources to fight the ongoing battle against the forces of chaos on all fronts.

We are a traditional hierarchy, and members are obliged to respect the implications of this. Challenge is acceptable, but only from those who have established high credibility

"Truth and Wisdom" reside with those who have the most experience/seniority, and who are capable of assertively expressing and acting upon their private knowledge, using whatever supporting evidence is available

Individuals have different innate potential for dealing with complex technical, operational and man-management issues. This can be identified early and brought out through experience.

Roles are well delineated and normally considered the "turf" of the individual. It is fitting however, to continually challenge those who have not (yet) established credibility

The strength of the organisation is "hands-on" expertise. Full membership is achieved through experience or the rapid assimilation of knowledge, and translating this into concrete action.

External relations and those between departments are very sensitive, with considerable potential for loss of "face". Hard-won credibility should be protected, either by a vigorous response to threats or mutually understood non-confrontation.

It is valuable to compare these characteristics with those of a "Learning Culture" as described by Schein[9]. The dimensions where there appear to be significant differences are summarised in the table below.

DEVIATION BETWEEN CHARACTERISTICS OF "LEARNING CULTURE" (●), AND "REFINERY OPERATIONAL CULTURE" (X)

Nature of Human Nature

Humans basically evil		Humans basically good
	X	●

Human nature fixed		Human nature mutable
X		●

Nature of Human Relationships

Groupism		Individualism
	●	X

Authoritative/paternalistic		Collegial/participative
X	●	

Nature of Time

Past oriented	Present oriented	Near-future oriented
X		●

Short time units	Medium time units	Long time units
X	●	

Information and Communication

Low level of connectivity		Fully connected
	X	●

Subcultural Uniformity Versus Diversity

High uniformity		High diversity
	X	●

Task Versus Relationship Orientation

Primarily task oriented	Task and relationship oriented	Primarily relationship oriented
X	●	

Linear Versus Systemic Field Logic

Linear thinking		Systemic thinking
X		●

To simplify matters, we distil these relevant characteristics into two summary dimensions.

The first of these distinguishes fragmentation from integration, and thus echoes something of the flavour of the work of Bohm[3]. The second makes a distinction between a natural tendency to interpret events from a mechanistic or objective perspective as opposed to a humanistic or subjective worldview. Based on the information summarised above, and particularly given the monochronic view on the nature of time and the emphasis on the present moment and short time-scales, we would describe the underlying refinery perspective as "fragmented". There is also a clear tendency towards the "mechanistic" orientation.

In contrast, the learning culture is relatively integrated on one dimension and more balanced between the poles on the other. The desired and, to some extent, experienced shift in cultural orientation can, therefore, be summarised via the illustration below.

Desired shift in Underlying Orientation
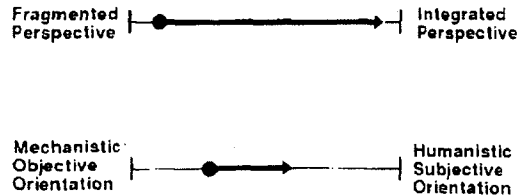
These dimensions are intended to summarise the general culture of a group as it is related to organisational learning. It is also of interest to note, however, a degree of consistency with descriptive frameworks applied to characterise individual personality, preference and learning style. Lewis and Margerison[8] have analysed the strong correlation between the factors used to describe Jungian archetypes and the Kolb/Plovnick learning style model. We hypothesise that our fragmented/integrated dimension is related to the concrete/abstract and sensing/intuition axes of these frameworks, and that our mechanistic/humanistic axis is related to the thinking/feeling and active/reflective dimensions. Given a relationship between cultural assumptions and individual style, it would seem likely therefore that a fragmented/mechanistic culture would tend to be associated with individuals having sensing/concrete and active/thinking orientations. Using standard questionnaires to assess individual style and preferences, we have indeed observed this tendency in our admittedly limited experience. In addition, these inventories give an indication of diversity and balance within a group, which are also considered to be important factors in organisational learning. We will certainly consider using this approach in future to assist in cultural analyses.

Using this framework, it is now possible to offer an explanation for the particular receptiveness of the Economics and Scheduling department to change. The cultural pattern illustrated previously describes the general orientation of the refinery, but within this there are a variety of nuances distinguishing different sub-cultures. The nature of coordination and planning activities, for example, promotes a more polychronic appreciation of the flow of time, a greater focus on the near future and a greater emphasis on relationships as well as tasks. Being closely involved with the very different worlds of refinery operations and trading, the members of the department also have a deep awareness of the very different perspectives which can be brought to bear on the same events and activities. In other words, the sub-culture found in this type of department is already one small step closer to the learning orientation than the bulk of the organisation and is therefore more likely to be responsive to the changes introduced.

THE CONTRIBUTION OF SYSTEMS THINKING TECHNIQUES

As indicated previously, the re-structuring of assumptions which forms part of the change process is driven by fresh insights. Systems methods can obviously play a role in this. In circumstances where the underlying perspective is predominantly fragmented, experimenting with these methods can lead to a new appreciation of relationships between events previously treated in isolation, placing them in a context of causal loops and meaningful patterns developing over time. In terms of the framework which has been developed, this will tend to promote a shift of underlying assumptions in the direction of a more integrated perspective. Mental mapping and soft systems

methodology also focus attention on the influence of perspective on interpretation and action, and can encourage a shift towards a more balanced position in an organisation with a predominantly mechanistic/objective orientation.
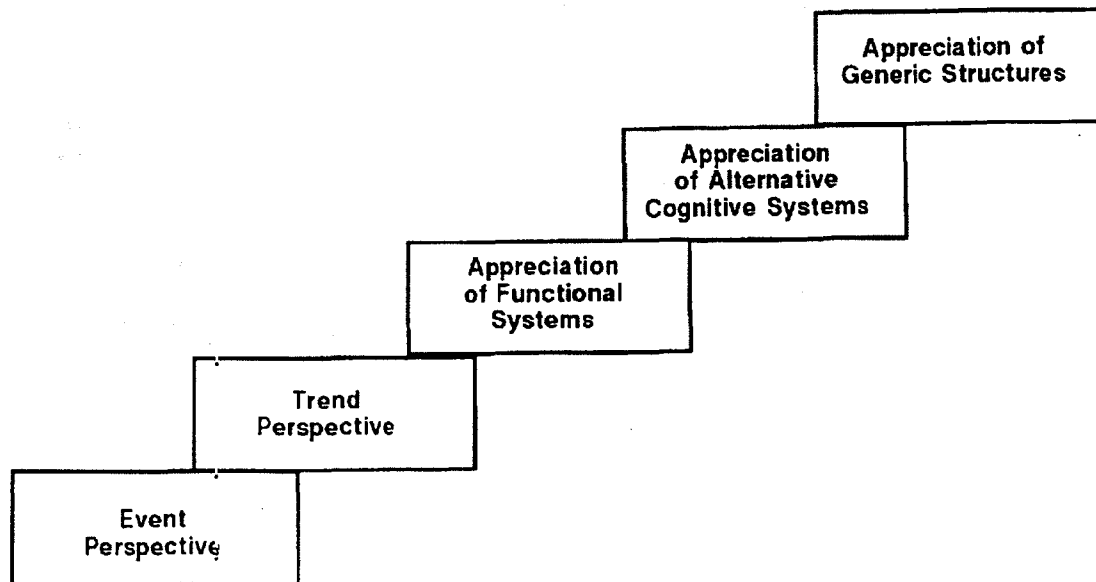
To promote these changes, however, requires that the approaches are applied widely and regularly over a reasonable period. They need, therefore, to be accepted by the majority of individuals as relevant working techniques which justify the time and effort involved in learning how to use them. Half-hearted application is unlikely to be successful. The reaction of an organisation to unfamiliar methods and ideas is often, however, analagous to the reaction of the immune system to unfamiliar bacteria. Our experience has taught us that preventing premature rejection requires careful matching of the initial approach with the existing culture. In an operational environment with a strong orientation towards mechanistic and fragmented perspectives, for example, the value of mental mapping and soft system methodologies is not likely to be immediately recognised. This was certainly our experience in trying to introduce systems thinking via such methods at both sites. In contrast, however, if people perceive the relevance of an approach, they are more likely to apply it willingly and it is more likely to have a positive impact. In turn, this builds confidence and unfreezes perspectives, enabling further approaches to be introduced, and so on. This dynamic is, therefore, an engine of change contributing to the generation of fresh insights and the reduction of anxiety levels, as illustrated below.
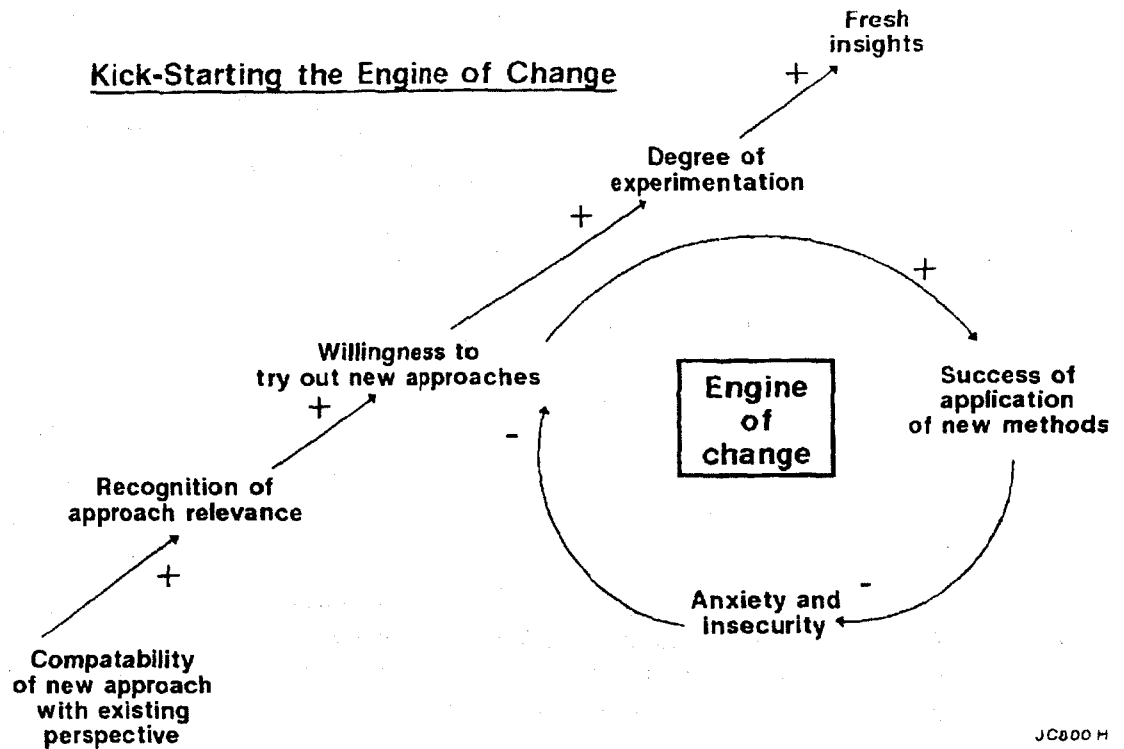
Although not normally considered a systems thinking methodology, the introduction of statistical process control methods provided the required "kick-start" for the Economics and Scheduling department at Pernis. The accent on measured, concrete data was compatible with the mechanistic/fragmented operational culture, while it encouraged the first steps towards an integrated perspective by highlighting trends, patterns and other systems properties. There was the further advantage that the style of data presentation was familiar to those working in a process industry. In addition, SPC made disconfirming data on performance highly visible in a non-threatening manner, emphasising the performance gap without undermining psychological security. Similarly, the construction of a functional activity model was directly appealing within this environment.

These first steps paved the way towards experimentation with a sequence of increasingly conceptually complex and abstract methods which would have been considered alien and irrelevant in the original climate.

Conceptual Steps in Responding to Complex Situations

Appreciation of
Generic Structures

Appreciation
of Alternative
Cognitive Systems

Appreciation
of Functional
Systems

Trend
Perspective

Event
Perspective

A similar progression from integrative simplicity to integrative complexity is described in theories of cognitive style related to the development of individual personality[6]. In this case we have observed development from a description of the world in terms of individual events through to an appreciation of system archetypes[10] and generic structured metaphors[2].

CONCLUSIONS

We summarise the lessons from our experiences by means of the following recommended process for introducing systems thinking techniques as catalysts for behavioural change in an organisation. This emphasises the broader context of change-management previously described and the need to match the initial approach with existing characteristics and perspectives. We have found that the framework of cultural analysis briefly outlined in the text can be usefully applied to achieve this. When introduced appropriately in this way,

we believe a wide spectrum of systems thinking methodologies can contribute to the desired process of organisational development.
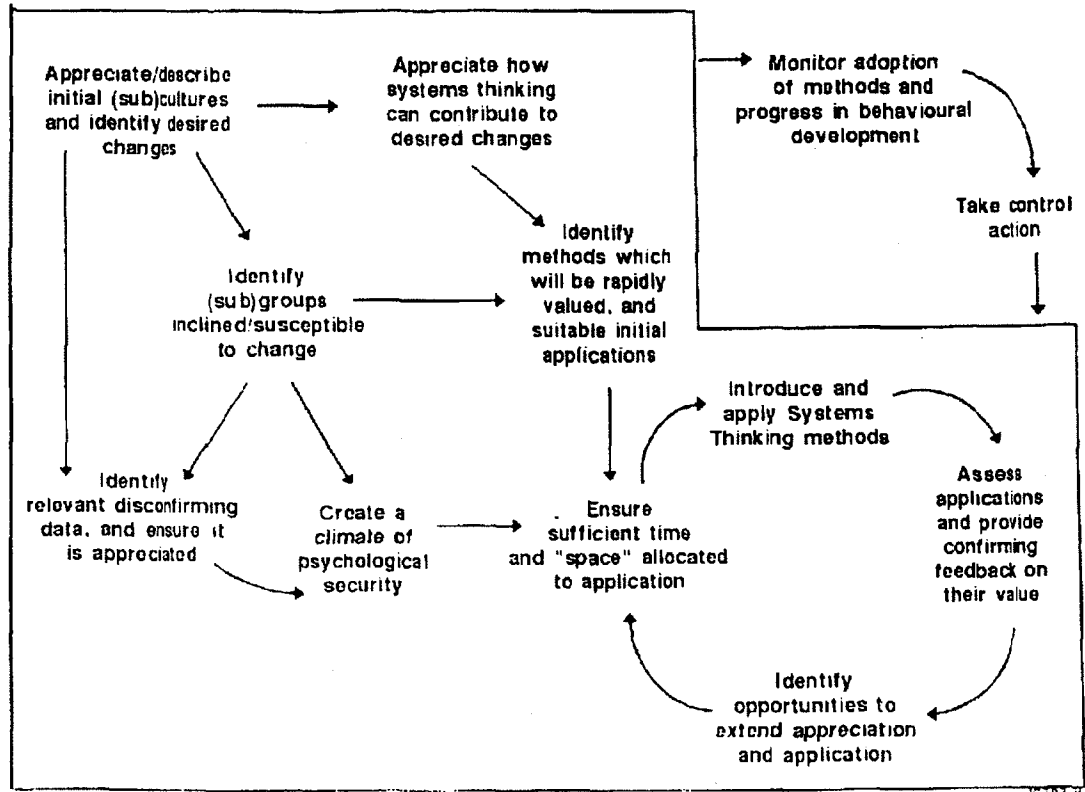
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