Go Back

Soft System Structures

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Abstract.
In this paper we adapt the usual definitions on which soft system approaches are based in favour of those that allow us to unfold a 'closed' enterprise into an 'open', dimensioned, layered, class-based and valued system of influences derived from expressions of interest or concerns of stakeholders. The approach is formal but we present the structures informally using a simple, novel, unfolding technique; the method of our soft system approach is developed elsewhere. A fictional example, based on airport security, is used to illustrate the structures and an example system archetype is interpreted. The intention is to make soft system structures more mechanical and therefore perhaps more acceptable to wider system engineering audiences.

INTRODUCTION

Soft approaches to systems engineering based on General Systems Theory (Skyttner, 1996) led to the methods of (Checkland, 1981), (Hitchins, 1992) and (Senge, 1996). In effect, these methods interpret system stakeholder viewpoints and develop responses that lead to system improvements. The approaches are structured and semiformal. However, the procedures and structures are based on differing definitions of concepts such as boundary, environment, process, etc. These definitions led us to ask:

Is there a common structured approach for system development, a structured approach that integrates soft and hard methods and which facilitates wider acceptance of "soft" concepts and their application in Systems Engineering?

Our practice suggests a common structured approach exists; it is novel but readily apparent. The structures parallel and overlay supply chains in business. The approach formalises interventions using common, structured, simple questions. From captured stakeholder responses, 'valued' systems of influences over the supply chains are derived and interpreted. The same simple questions and structures develop stakeholder requirements and a structured method statement for their achievement. While we do not present the complete model, we only address the structures here, we hope to stimulate discussion and we present the formal relational model in the appendix. To support our development, we briefly highlight some essential concepts. Then, we present our alternatives and illustrate them using an example fictional case study from Airport-Security and an interpretation of a system archetype.

Our common structured approach is to be defined formally elsewhere. Here, we use a simple demonstration technique that "unfolds" our enterprise structures from stakeholders viewpoints. Without loss of generality, the technique "unfolds" multidimensional and multi-layered, supply chain structures. These structures are relations over literature-based classes of resources and their properties, processes and their characteristics. Directed and valued influences, on which representations of the state of real world enterprise are based, overlay the structures

ON SOFT SYSTEM STRUCTURES

We highlight aspects of soft system structure definitions that led us to feel that **there is something not quite right**. We have used the methods referred to and they have benefited our students, our clients and ourselves. However, definitions of system, environment, boundary, emergence, hierarchy, communication and control, etc., that support the methods, conflict with our experience and increase intervention costs and risk.

On system environment and boundary

In General System Theory, (Skyttner, 1996), system environment is separated from system. Indeed systems exist within an environment separated by a boundary.

"In order to define the system's environment its boundary must be defined. The boundary surrounds the system in such a way that the intensity of interactions across this line is less than that occurring within the system. ... boundaries possess a coding and decoding property ... As systems do not always exist boundary to boundary, the concept of interface is necessary to denote the area between the boundaries of systems."

For us these definitions raise at least two questions:

- How do we meaningfully explore a system boundary and why should we? If interactions at the system boundary are relatively low there may be little of interest there. Of greater interest are interactions across high traffic interfaces. But that raises the question.
- What is an interface? If an interface exists between boundaries of systems, according to the definition, it lies in the environment. Is an interface then another system of the environment? If so, how do systems communicate through such interface systems? There appears to be a regression of isolated systems.

On holons and emergence

(Checkland, 1981) characterises Soft System Methodology as an enquirer using a 'holon' in a system of 'holons'. Holon is an abstract term used to convey that a system *"has emergent properties, has a layered structure and processes of communication and control which in principle enable it to survive in a changing environment"*. The term 'holon' is said to be misused when intended to convey wholeness about a system rather than a system being conceived as a whole by an enquirer. To us the term 'holon' masks an essential duality of system, that of the relation between the system as a whole, as attributed by an observer, and relations among system's parts that integrate it with parts of surrounding systems.

On emergence, emergence is said to be *"the principle that whole entities exhibit properties which are meaningful only when attributed to the whole, not to its parts"*. In the examples given, properties, claimed to be emergent, are characteristics of human bodily processes. To desensitised individuals such objects do not have these properties.

Thus, it is attribution by an observer that assigns properties from the human frame of reference onto remote objects. When we consider the partial viewpoints in stakeholder expressions, this explains the difficulty in attempts to construct emergent properties of systems from emergent properties of their parts.

On terminology and influences

(Hitchins, 1992) explores system interactions and potential interactions with newly introduced systems-of-interest. The N-Square chart of (Lano, 1979) is used to explore influences among system components. In using the chart we experience difficulties with inconsistent terminology in real systems. It is difficult to transfer experience from one investigation to another because of terminological inconsistency. Perhaps this is useful. It requires reconsideration of terminology. It can reduce the risk of erroneous transfer of concepts between applications. However, concepts derived from one intervention should be reusable and guidance on terminology should be provided.

On generic structures and system archetypes

In (Senge, 1996) '*Systems archetypes or generic structures embody the key to learning to see structures in our personal and organisational lives*'. The essential feature of archetypal systems is the influence concept; some aspect of a system influences, perhaps after a delay, some other aspect of a system. Influences cause some system properties to be reinforced and others to be eroded. Understanding relatively few generic influence structures can be a useful management learning technique.

For us, system archetypes suffer from a lack of regularity and inconsistent terminology. Archetypes are explained as influence processes operating over a mixture of entities, processes, properties, conditions, resources within a broader system. No consistent basis for archetypal structures is given.

On Thinking, Practice and Engineering

Summarising the above, we find that while soft systems structures are extremely useful, their conflicting, inconsistent terminology, their lack of regularity, reuse and repeatability across applications, and the difficulties of attribution, reduce their strengths and introduce weaknesses so that opportunities for integrated approaches are often seen more as threats to existing thinking, practice and engineering than as aids to competitive advantage.

A 'SOFT' VIEW OF SYSTEM ENGINEERING OR ENTERPRISE DEVELOPMENT

Stakeholders, Entropy and Enterprise Development

We start our definition of soft system structures with the stakeholders to an enterprise. This allows us to return to more mechanical definitions of structures. Instead of separating observers from enterprises under observation, we involve observers in order to reduce the effects of attribution. We set aside the definition of system, and discuss the issues of system engineering under the heading enterprise development. We offer the following.

- An enterprise is a name for some entity that is of benefit to stakeholders
- Stakeholders are themselves enterprises who benefit from a common enterprise

- Stakeholders have varying degrees of interest or concern in their common enterprise
- Enterprise development is the satisfaction of stakeholder interests or concerns in their common enterprise

These four statements suggest that enterprise development is guided by two overall aims:

1. elaboration of the common enterprise according to the needs of its stakeholders
2. elaboration of a means to develop the common enterprise to satisfy the needs of its stakeholders

We discuss the means for satisfying these aims elsewhere where we present our approach but both aims introduce the concept of an ‘open’ versus a ‘closed’ enterprise and allow us to discuss the structures of our approach. Thus:

- An enterprise is either ‘open’ or ‘closed’ according to viewpoints of its stakeholders, their level of abstraction and the level of disorder they are prepared to accept.

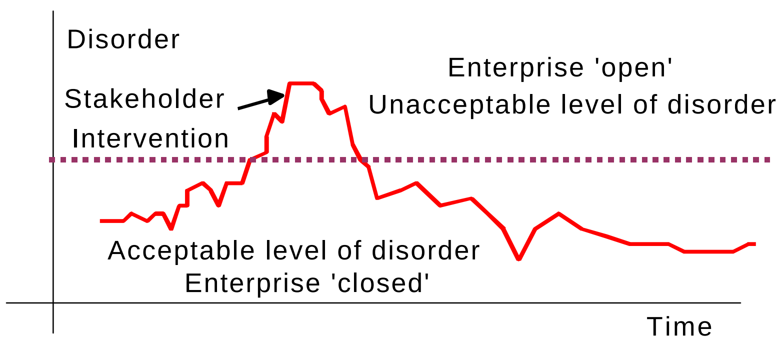

Figure 1: Entropic basis for Intervention

From this definition, an enterprise can be ‘closed’ with respect to stakeholders; see osed’, we mean stakeholders have no interests or concerns for the enterprise. As far as stakeholders are concerned, the goods and services provided by their common enterprise satisfy their needs.

Alternatively, an enterprise can be ‘open’ with respect to stakeholders. By ‘open’, we mean stakeholders have interests or concerns. The goods and services provided do not satisfy stakeholder needs. Such definitions create a Principle of Normality and its opposite a Principle of Abnormality:

- ***A normal enterprise is a ‘closed’ enterprise***
- ***An abnormal enterprise is an ‘open’ enterprise***

Hence, enterprise development is itself an enterprise for returning some common enterprise in an abnormal, or relatively disordered state, to an enterprise in a normal, or relatively ordered state. Our structures are therefore ‘entropic’.

By the definition of abnormality, stakeholders only have interests or concerns in 'open' enterprises. Such enterprises indicate that, at least, there is ***'something not quite right'*** there is possibly even something quite wrong, and something needs to done. Alternatively, the '***something not quite right'*** might indicate an advantage to be gained by developing the enterprise; again something needs to be done. 'Open' or 'closed' states are not mutually exclusive states. The state of a enterprise is relative to its stakeholders, their levels of abstraction and their flexibility, their adaptability, in the face of disorder.

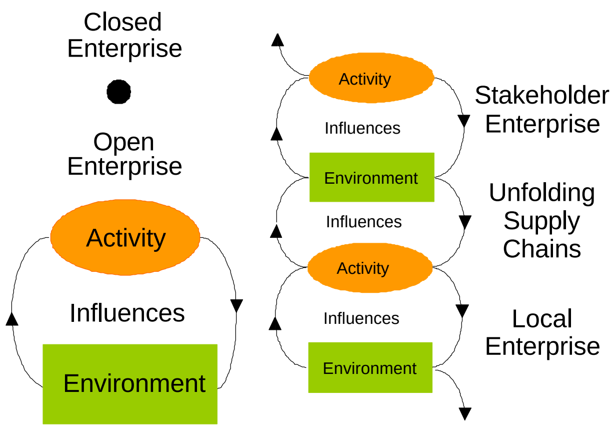

Figure 2: Unfolding an Enterprise

For example, provided airline passengers, as goods, arrive at the correct gate, in the correct numbers, of the correct type, with minimal variation in arrival time and of the correct class, the gate handling staff treat the service of preceding enterprises as closed enterprises, as normal enterprises. Such enterprises are processing passengers appropriately such that its outputs satisfy the interests or concerns, the needs, of gate handling staff. However, if gate handling is disturbed by the late or unannounced non-arrival of passengers, then the preceding enterprises, in the supply chain of passengers, become 'open' for analysis and subject to expressions of interest or concern; ***something is not quite right!***

Unfolding the 'something ...'

When enterprises are 'opened' to their stakeholders, an unfolding takes place. An enterprise is unfolded as a duality; differentiated into an 'environment' and an 'activity'. The unfolding defines enterprise environment and activity as:

- Environment comprises those resources which support enterprise activity
- Activity comprises those processes which support enterprise environment

In the passenger handling example, the environment comprises the resources needed to support the activity for processing passengers from the departure lounge onto a flight. The activity comprises the processes supporting the transformation of potential passengers into actual passengers.

In unfolding the closed enterprise, as well as revealing its partial structure, expressions of stakeholders reveal potential influences among resources and processes that are the possible causes of disorder and dissatisfaction; see Figure 2. Also, unfolding possible influences between the common enterprise and that of a stakeholder illuminates commercial supply chains and supply chain influences.

A definition of enterprise boundary is offered:

- The boundary of one enterprise with another is the collection of resources and processes the enterprises hold in common

By unfolding, rather than the environment of an enterprise being separated from its surroundings, as in the system view, the environment of an enterprise is integrated with stakeholder environments. Integration is a partial function of enterprise activity. Conversely, enterprise activity is integrated with stakeholder activity. Integration is a partial function of enterprise environment. Enterprises interact through resources and processes held in common. In effect, waves of activity sweep along supply chains supporting waves of change in the environment. Conversely, waves of change in the environment support further waves of enterprise activity. The issues for enterprise arise from the influences particular resources in an environment have on particular processes in an activity and vice versa. Such issues cause disturbance and disorder in the supply chains.

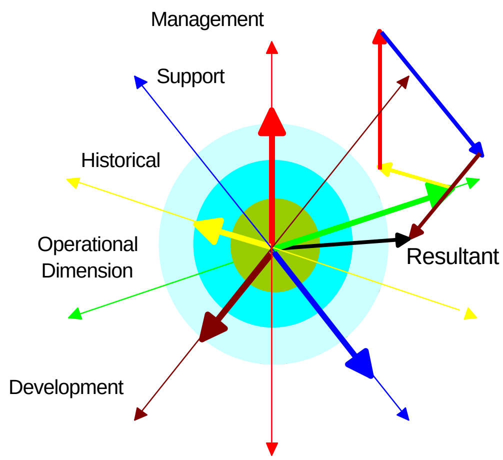

Figure 3: Layers, Dimensions and Johnston Vectors

Multiple Dimensioned and Layered Enterprises

Refining supply chains, we note that, without loss of generality, there are at least five supply chains interacting in and being integrated by any one enterprise and that each supply chain defines a dimension. We propose that the five dimensional supply chains are:

- **operational** dimension of material and money transformations as goods and services
- **management** dimension of strategic decisions and tactical responses
- **support** dimension of maintenance demands and service responses

- **development** dimension of requirement formulation and project management
- **historical** dimension of defining and auditing the state of the enterprise

Along each of these dimensions environment resources and activity processes mutually influence each other and therefore the state of disorder and disorganisation.

We used the term 'level of abstraction' with regard to stakeholders. By this we mean a stakeholder viewpoint is with respect to their relative position in a supply chain. Those stakeholders immediately involved in a local enterprise have an immediate level of abstraction, they are aware of immediate resource and process issues. Those stakeholders who benefit directly in external and sub level enterprises have a direct level of abstraction, they are aware of issues in relation to goods and services. Those stakeholders who are more remote in wider and base-level enterprises have indirect levels of abstraction; they only have a direct view of issues concerning their own direct stakeholders and can only infer issues for indirect stakeholders. Indirect stakeholders only view the enterprise through interactions with their own direct stakeholders. Levels of abstraction therefore provide a layered view of enterprise; our model is multi-layered and multidimensional; see Figure 3.

In our structures, influences derived from stakeholder views are directed parallel to supply chain dimensions and, according to the relative frequency and significance of those views, such influences have magnitude. (Johnston, 2000), found it beneficial to study the implication of such influence vectors in developing strategy for engineering departments. Figure 3 refers to these vectors and their resultant as Johnston vectors. Since the direction and magnitude of Johnston vectors are derived from stakeholder views, subject to review and audit, their attribution as emergent states of enterprise is meaningful.

Resource-Property and Process-Characteristics classes

Influences at work in a dimension as perceived by stakeholders are influences of resources over processes and processes over resources. More specifically, influences are due to the properties of resources and the characteristics of processes. Resources, properties, processes and characteristics have been classified loosely in the literature. Jenkins, (Checkland, 1981) defined systems as '*groupings of men and machines with an overall objective and characterised by an economic criterion which measures success*', provides us with three classifications; manpower, machines and money. To these we would add methods and materials. Enterprise environment comprises collections of resources in the classes

- **Manpower:** human resources needed to motivate the enterprise
- **Materials:** resources transformed by the enterprise into Money
- **Machines:** organisational and other devices used to aid the transformation of materials
- **Methods:** procedures, definitions and descriptions for the activity of the enterprise
- **Money:** resources transformed by the enterprise into Materials

The operations management discipline (Slack et al, 1998) discusses characteristics that distinguish operations. We reinterpret these characterisations for properties of resources. Thus we qualify resources by properties in classes:

- **Volume:** properties that quantify resources
- **Variety:** properties that classify resources
- **Variation:** properties that stabilise resources
- **Value:** properties that qualify resources
- **Venue:** properties that localise resources with respect to subject, place, etc.

Action learners, quality gurus, etc., define enterprise activity using process sequences. In (Deming, 1986) for example, the Shewhart cycle is given for transformation processes which we abbreviate to Observe, Study, Analyse and Act; other authors attribute the terms differently. We reinterpret this cycle to highlight the difference between preparing an understanding of what we want to act on(our first aim) and preparing to act (our second aim). We also recognise that in an arbitrary enterprise, individual processes are concurrent. Therefore enterprise activity comprises collections of processes in classes:

- **Observing:** capturing and recording data on the enterprise environment and activity
- **Modelling:** assessing observed data and creating information in support of the decision process
- **Defining:** deciding the resources and processes needed to sustain the enterprise as a closed enterprise
- **Organising:** planning, scheduling resource availability and process initiation
- **Interpreting:** acting out the organised plans for the enterprise environment and activity

Again in (Slack et al, 1998) performance objectives are discussed. We use such objectives to characterise processes. Thus, we define five characteristic classes for processes:

- **Quality:** characteristics for the qualification of processes
- **Speed:** characteristics for the quantification of processes
- **Dependability:** characteristics for the availability of processes
- **Flexibility:** characteristics for the adaptability of processes
- **Productivity:** characteristics for the capability of processes

In (Slack et al, 1998) the fifth performance objective, is Cost. We have deliberately adopted the term Productivity to eliminate an ambiguity. Cost is a property attributable to a resource; a Volume property attributed to a Money resource. Money resources are exchanged between stakeholders for Materials with appropriate properties. Cost therefore indicates a direct relation between stakeholders, whereas we want to express the immediate relationship between input and output resources, the transformation of Materials and Money, and the capability of transforming processes; Productivity.

Using our definitions we define:

- enterprise activity as:

- The interpretation by manpower and machines of methods for observing, modelling, defining, organising and acting in the enterprise environment, to support the transformation of materials into money and money into materials

- enterprise environment as:
  - The manpower, machine and method resources that support processes in the enterprise activity for observing, modelling, defining, organising and acting to transform materials into money and money into materials
- enterprise as:
  - environment resources integrated with activity processes communicating with stakeholder enterprises through changes in the properties of common resources and changes in the characteristics of common processes.

Influences at work in an enterprise that cause stakeholders to express interests or concerns are relations between instances of resource classes and properties classes and instances of process classes and characteristic classes, the instances being rooted in terminology of real-world enterprise.

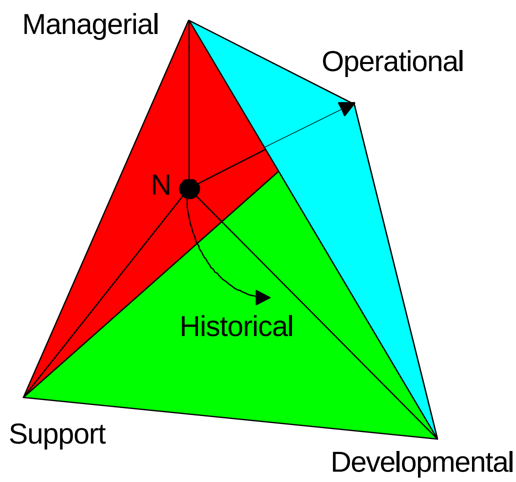

Figure 4: Tetrahedral View of Enterprise

Finally, in our structure definitions, management and marketing use the technique of SWOT (**Strengths**, **Weaknesses**, **Opportunities** and **Threats**) analysis for assessing business. We classify our influences according to SWOT values. Strengths and weaknesses are immediate, positive and negative influences. Opportunities and Threats are direct and indirect, positive and negative influences. Using SWOT values and our definitions, we have a relational model for real-world enterprise that is structured and ordered according to dimensioned, layered, class based, directed and valued influences.

In general our valued influences have the structure:

- dimension, layer, resource, property, influence, dimension, layer, process, characteristic
- dimension, layer, process, characteristic, influence, dimension, layer, resource, property

Using relative frequencies and levels of significance of stakeholder viewpoints, the relational model, see appendix, allows a classified form of N-Square Chart to be used to capture enterprise state. From this chart, representations of enterprise state can be displayed. Figure 4 illustrates dimensional state and can be adapted to include layered states. Ideally, a closed enterprise N is positioned instantaneously and historically at the equilibrium point, equidistant from the four vertices. Figure 5 is a SWOT matrix setting immediate against direct and indirect influences for a given supply chain dimension. Ideally, the Centre of Value is at the origin so that the ideal enterprise has no superfluous strengths, all weaknesses have been addressed, there are no unsatisfied opportunities and no unmitigated threats. If the Centre of Value is at the origin for each of the five dimensions, the stakeholders have no interests or concerns for their common enterprise and it is effectively closed. However, some residual strength, some residual opportunity, is beneficial in allowing the enterprise to weather transient weaknesses and threats.

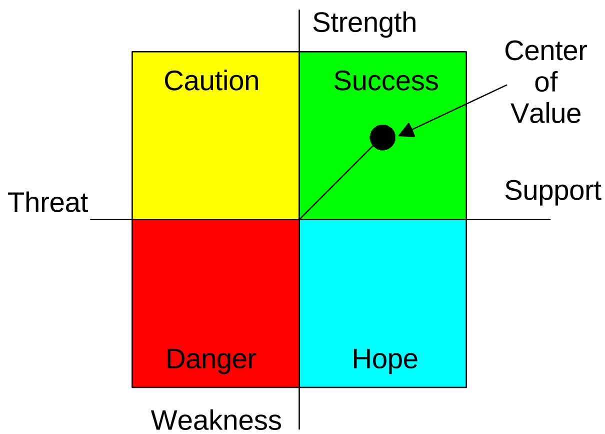

Figure 5: SWOT Matrix representation of influences

THE AIRPORT SECURITY EXAMPLE

We outline an example enterprise, illustrative of those on which our model is based. The example is airport passenger security and only illustrates structural definitions.

Passengers, on arrival at an airport, check in at an airline desk and proceed to the departure lounge via airport security. At this point, passengers form orderly queues and proceed one at a time to deposit hand luggage on the X-ray scanner conveyor and their personal metal items in a visible tray. Passengers proceed through archway scanners and their hand luggage is X-rayed. If alarms trip, randomly, according to passenger profiling, or because suspicious material is detected, passengers or their luggage undergo detailed scrutiny. Secure passengers proceed to the departure lounge, insecure passengers are detained. Uncleared passengers form a common resource for check-in lounge and security check. Secure passengers are a common resource for security check and departure lounge. Insecure passengers are a common resource for security check and police services. The operational supply chain boundary for the security check enterprise is therefore well-defined.

Non-exclusively, resources for this localised enterprise include:

- **Manpower:** operations staff, management staff, maintenance staff
- **Material:** passengers, electrical power, luggage
- **Machine:** archway-scanners, X-ray scanners, hand-scanners, conveyors
- **Method:** security procedures, equipment operations procedures, standing orders, search techniques
- **Money:** departure-lounge space, slots in the check-in queue for security, security incidents

Properties of such resources include:

- **Volume:** passenger numbers, staff numbers
- **Variety:** passenger types, airport security state
- **Variation:** passenger size, queue size, passenger density, emotional state, (e.g. staff fatigue)
- **Value:** contributions to airport security, airport use
- **Venue:** ground side, air side locations

Airport security environment is a mix of such resources and properties.

The activity processes for this localised enterprise include:

- **Observing** passenger shapes and sizes, luggage contents, tray contents
- **Modelling** displayed shapes, sizes and colours against prohibited items
- **Defining** real and potential security breeches
- **Organising** and allocating staff
- **Interpreting** procedures and conducting searches

Characteristics of these processes include:

- **Quality:** securing the correct passengers and securing them correctly
- **Speed:** rate at which passengers are processed
- **Dependability:** availability of the airport security service, their effectiveness in detecting security breeches
- **Flexibility:** ability to react to incidents
- **Productivity:** number of passengers processed in unit time, the number of incidents

Airport security activity is a mix of such processes and their characteristics.

Using the defined influence forms:

- dimension, layer, resource, property, influence, dimension, layer, process, characteristic
- dimension, layer, process, characteristic, influence, dimension, layer, resource, property

We interpret possible stakeholder comments:

- staff fatigue influences passengers processed per hour
    - operational, local, manpower, variation, weakens, operational, local, defining, productivity

- passengers per hour influences departure-lounge-queue size
  - operational, local, defining, productivity, strengthens operational, local, money, variation
- large departure-gate-queue sizes influence security decision accuracy
  - operational, local, money, variation, weakens, operational, local, defining, dependability
- ...
- reduced numbers of passengers to be security checked influences security decision accuracy
  - operational, local, material, volumes, strengthens, operational, local, defining, quality
- improved security decision accuracy influences security staff fatigue
  - operational, local, defining, quality, strengthens operational, local, manpower, variation
- reduced staff fatigue influences the number of passenger processed per hour
  - operational, local, manpower, variation, strengthens, operational, local, interpreting, productivity

We note that, while the example draws only from the operational dimension, similar examples apply in other dimensions. The example illustrates:

- Resources, properties etc., drawn from general classes
- Transitive influences: influences form chains and loops
- Symmetric influences: resources influence processes and the same processes can influence the same resources
- Anti-reflexive influences: resources do not immediately influence resources, processes do not immediately influence processes
- Influences as instances of a general class of statements in a language with a formal structure

We note that this example illustrates a supply chain that conveys passengers from airport portals to seats on aircraft. It involves operational, managerial and support aspects which affect the airport at different layers. Airport security is the subject of development according to current national security requirements and has a history that has contributed to and influenced its development. Further,

- Operational stakeholders include check-in enterprises and departure lounge enterprises
- Managerial stakeholders include operations, strategic and corporate management of airport security and management of staffing schedules and availability tactics
- Support stakeholders include equipment maintenance, human resource, financial resource planning, airline security, police co-ordination, etc. and preventative maintenance, financial accounting and staffing, power supplies and distribution, health and safety, etc.
- Developmental stakeholders include passenger representation groups, airlines, planning groups and equipment suppliers, human factors engineering, power distribution, etc.

- Historical stakeholders include all those agencies that having served and been served by airport security and all those passengers, equipment suppliers, previous staff, have created the preconditions for its current state.

ON SYSTEM ARCHETYPES

We give one example, the Fixes that Backfire System Archetype, in the form of our soft system structures. In (Senge et al, 1996), the archetype is described as representing the situation in which '*whoever makes the most noise gets the most attention'* regardless of real need. A diagram of a similar archetype is given in Figure 6. Interpreting the diagram, using influence statements, we have:

- Problem Symptom influences Process Fix;
- Process Fix influences Problem Symptom
- Process Fix influences Side Effects;
- Side Effects influences Problem Symptom

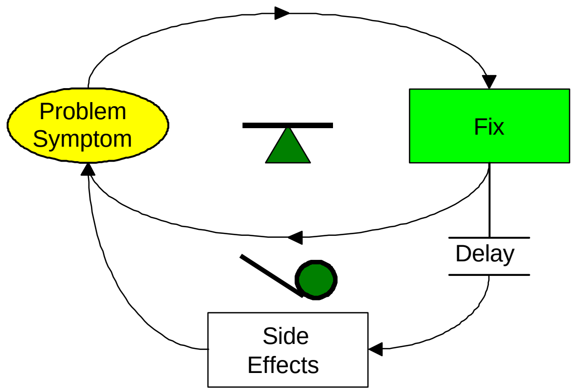

Figure 6: Fixes that Backfire

However, there is no information to distinguish what Problem Symptom, Fix or Side Effects are. We therefore make the following definitions. A Problem Symptom is a resource property. Some resource is exhibiting a problem. A Fix is a process characteristic. By adjusting characteristics of processes we seek to solve problem symptoms; to return the resource exhibiting this property to a normal state. Side effects are unintentional consequences of changing the characteristics of processes. Side effects are therefore either characteristics of processes that arise immediately or they involve chains of resources and processes that deliver the unintended consequences later. We therefore interpret the archetype in the form of Figure 7, where the side effect sequences can be of arbitrary length.

- Resource Properties influence Process Characteristics
- Process Characteristics influence Resource Properties
- Process Characteristics influence Side Effect Resource Properties
- Side Effect Resource properties influence Side Effect Process Characteristics
- Side Effect Process Characteristics influence Resource Properties

We note that delay is represented by cumulative process execution times. Generalising, and interpreting Problem Symptom and Process Fix as an Enterprise, such interpretations lead us to ask, before any change is undertaken:

- What will my Enterprise be?
- Who will my Enterprise benefit? Who are its stakeholders?
- What will my Enterprise do? Both intentional and unintentional
- What will my Enterprise use? What resources and their properties will be affected?
- How will my Enterprise be transformed?
- How will the intentionally and unintentionally transformed Enterprise influence other Enterprises?

Finally, we note that these questions are the basis of structured and ordered enterprise developments.

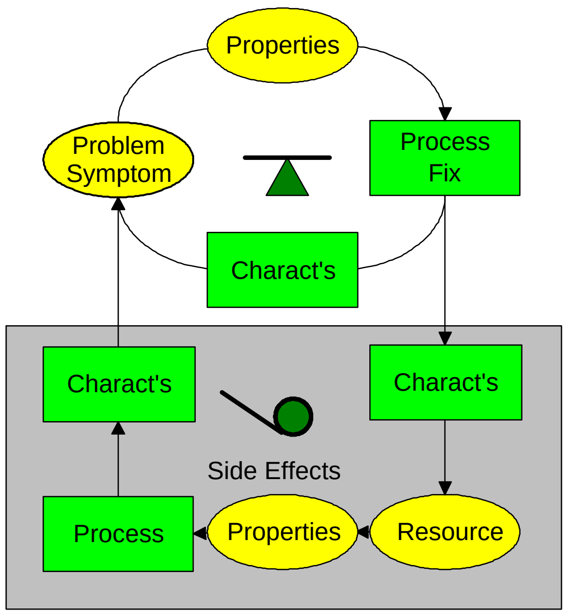

Figure 7: Structured System Archetype

CONCLUSIONS

Our approach to soft system structures started with the feeling that there is something not quite right with the definitions and examples underlying system thinking, system practice and system engineering. We sought and, we believe, found a rational and more formal basis for interventions in enterprise development. Our concerns led us to a soft system structure that helps overcome issues of conflicting, inconsistent terminology, lack of regularity, reuse and repeatability across applications, and difficulties raised by attribution. In consequence, in our own soft system practice, enterprise development, we have increased our strengths and reduced our weaknesses so that our soft system approach offers more opportunities for enterprise integration, is seen less as a threat to existing thinking, practice and engineering and as a greater aid to competitive advantage, risk reduction and cost reduction.

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APPENDIX: A RELATIONAL ENTERPRISE MODEL

Defined bottom-up:

Resources R = {Manpower, Materials, Machines, Methods, Money}
Properties V = {Volume, Variety, Variation, Value, Venue}
Environment $E_\bullet = R \% V$
Processes P = {Observing, Modelling, Defining, Organising, Interpreting}
Characteristics C = {Quality, Speed, Dependability, Flexibility, Productivity}
Activity $A_\bullet = P \% C$
Layers Z = {Wider, External, Local, Sub, Base}
Layered Environment $Z_{E\bullet} = Z \% (R \% V)$
Layered Activity $Z_{A\bullet} = Z \% (P \% C)$
Dimensions X = {Operational, Managerial, Support, Developmental, Historical}
Dimensioned, Layered, Environment $X_{E\bullet} = X \% Z_{E\bullet}$
Dimensioned, Layered, Activity $X_{A\bullet} = X \% Z_{A\bullet}$
Influences I = {Threaten, Weaken, Normal, Strengthen, Support}
Resource Influenced, Dimensioned, Layered, Activity

$K_{E\bullet A} = (I \% (X_{E\bullet} \% X_{A\bullet}))$

Process Influenced, Dimensioned, Layered, Environment

$K_{A\bullet E} = (I \% (X_{A\bullet} \% X_{E\bullet}))$

Enterprise N = Union ($K_{E\bullet A}$, $K_{A\bullet E}$)

BIOGRAPHY

John Boarder is an independent consultant. A BCS Chartered Engineer and member of the IEE, John contributes, to many system engineering events. Operating a research based consultancy, he lectures and supervises research in Computer Science, System Engineering and Operations Management. Material presented here is derived from practice and CMS, DMS, MBA courses. A co-author of the IEE Draft Guide to the Practice of Systems Engineering, John is a member of INCOSE UK.

END NOTE

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