# Searching for a Systemic Perspective on Systems Integration

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## 1. Introduction

For many organisations, the focus of IT is on systems integration rather than systems development. Where organisations have a policy of procuring rather than developing systems, significant effort must be put into integrating a variety of procured applications into a coherent application portfolio. Furthermore, for many organisations, a variety of information systems have been accumulated over a period of years. These now pose significant integration problems. Individual systems may be incompatible; data may be duplicated; links between systems may be absent, resulting in the use of manual processes to copy data from one system to another. Islands of information develop where information contained in one department in not accessible to another department.

Health care organisations, in particular hospitals, have faced such major systems integration problems (Hasselbring, 1997; Hasselbring, 2000, Grimson et al, 2000). In any hospital, a variety of systems fulfil individual functions. While the core administrative activities are grouped round the patient administration system (PAS), a number of department systems may exist providing the results of procedures in pathology, radiology and biochemistry. Further standalone systems will support the operating theatres, and a number of managerial and information analysis systems such as case mix may be operational. In addition, various specialities and departments may run their own administration systems. For example, the magnetic resonance imaging unit may have its own administrative system which contains a core of standard data that duplicates PAS, in addition to very specialist data concerning MRI settings and scan results. In some cases connections between systems are created using extract files. In other cases, particularly in which specialty-based systems are involved, system runs independently, data and processes from main hospital systems are` duplicated and significant clinical data is kept hidden from the rest of the hospital systems. The disparate systems in the hospital may run on different platforms, even different operating systems; may be based on different data models; contain duplicate data, often not updated in parallel and may even use different individual codes for patients. Such integration problems may render it impossible to obtain a complete picture of events, procedures and test relating to a patient's stay in hospital.

Systems integration issues are not only a concern for organisations internally, but also an external concern. The prevalence and importance of e-commerce means that organisations must be able to link systems with other organisations in the supply chain. Such requirements will involve the systems integrators overcoming compatibility issues between the internal systems of participating organisations. However, even e-commerce systems integration requires the integration of internal systems to meet the challenge of new information coming in from other organisation's systems.

Whether the system integration involves internal systems, or intra-organisation systems, the focus of the IT activity is on crossing systems boundaries. In contrast to typical systems development as represented in, for example, Vidgen et al,(2002), the focus of systems integration is not on the internal modelling of processes and information involved in purposeful activity *inside* a system, but on exchanges and activity at the interfaces *between* systems.

From my experience in consultancy and in IT departments, the approach to systems integration, internally and externally, is predominantly technical. Either computer systems are joined together through interfaces or feeder programs which extract data from one system and reformat it to suit another system, or existing legacy systems are replaced by integrated enterprise resource systems which combine processes and functions from several systems into one organisation-wide system. Systems integration concerns may include joining processes together, but primarily concern the rationalisation of data and the creation of data interfaces.

However, the issues of greatest concern in system integration are the non-technical ones which really require a systems approach. Individual and disparate systems arise from their origin within separate business and social systems. Issues concerning power, culture, ownership, historical origin will influence the evolution of computer systems and give rise to islands of information and incompatible, non-integrated systems. When e-commerce system integration is being considered, data and process compatibility are only two of many factors which will influence system integration. Culture, power and control incompatibilities may be equally important.

The importance of systems integration and the need to find a systemic approach to studying system integration and to provide practical solutions was made clear in some public sector consultancy I carried out for a local education authority. While the main brief involved the review of the statistical methods of an information and statistics department (ISD) and the review of their IT systems, I suspected that a number of social and systemic issues would arise and decided to apply the Soft Systems approach practically to try to draw the issues out.

This article describes the case study and approach. While the approach was helpful in making the participants more aware of the nature of their work and the problems associated with it, I do not think the application of SSM was entirely helpful in trying to tease out the systems integration problems because these were primarily boundary problems. ISD was a system surrounded by systems, and, while SSM enabled learning and understanding to progress inside the ISD system it did not provide a rich representation of the system interface issues which were the predominating concerning in systems integration. So, having described the case study as it stands, this article will start to pursue systems approaches which might be effective in taking a systemic view of systems integration.

## 2. Information and Statistics Case Study

The information and statistics department (ISD) within the local education department was concerned with forecasting pupil numbers in order to enable the effective distribution of financial resources within the geographically bounded compulsory

education system. Schools provided yearly census data on pupil numbers, broken down into significant detail. This data was combined with demographic data, planning data about new housing, birth statistics from the local health authority and data about feeder schools and nurseries to generate short term forecasts for the next year and longer term forecasts about changes in pupil numbers. Such forecast were of great importance since they determined the budget that schools received for the following year. If the forecasts were too low, schools might be short of money. If they were too high, clawback of money would occur later in the year, causing problems for the school.

The root definition of the ISD system was agreed as: a *system to accurately predict the number of pupils in individual local authority schools over the short term, such that accurate budgets can be allocated to schools resulting in a minimising of retrospective funding allocations or clawback. It is also a system to accurately predict the number of pupils in individual schools over the long term to enable both the school and the LEA plan its provision of educational resources for individual schools in the medium to long term. It is also a system to accurately predict the number of pupils in total across all schools within the authority, in order to determine the demand for educational resources over the short and long term.*

The consultancy focussed on reviewing statistical methods and as a secondary objective looked at the existing IT systems. However, it quickly became clear that both IT and organisational issues needed to be tackled to gain the most benefit from the exercise. There was a variety of IT systems within ISD. A lot of staff effort was involved in validating data which came into the department, particularly in cleaning up data from schools, and conducting various downloading exercises as well as manually entering the data into some systems.

A classical SSM process was adopted as part of the consultancy. Following the development of a root definition, a rich picture was developed to show the issues within ISD. It also had to address issues arising from various other organisations which influenced ISD's purposeful activity. A CATWOE analysis was carried out for the ISD, which raised a number of issues. In particular it was recognised that there were a number of different customers with quite different demands for statistical services, arising from different purposeful activity and different worldviews. The higher level organisational analysis was accompanied by an analysis of information flows and the development of an issues catalogue, an extract of which is shown below in Table 1, which recorded problems identified in different departments and organisations.

| Issue No. | Description | Source | Comments | Action |
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| Issue No. | Description | Source | Comments | Action |
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| 1 | Schools don't have a good understanding of 4+ rules and point of transfer of pupil to nursery. | Finance | Need for clearer advice to schools? Information sheet? (See 6). | I & S Team to liaise with Admissions to ensure schools fully understand the rules. |
| 2 | Live birth data contains addresses and postcodes. This may be a problem in terms of data protection. | Area Health Authority (AHA) | Note AHA could provide data in different format, and include other attributes such as mother's religion. | Consider alternatives to current arrangements before AHA remove the current supply of data on live births. |
| 3 | Forecast 95 will need substantial alteration to cope with PLASC which works at pupil level. | IT Services | Problem may not be so great. Need to understand exact needs of Forecast 95 from Form 7 and hence from PLASC. | IT Service perception that Forecast 95 will need changes may be incorrect since the PLASC data process will bypass Forecast 95. |
| 4 | Schools have difficulty with nursery school allocations because they have to be reconstructed in Form 7 and are not simple brought over from SIMS. | EDISS | Problem results in queries with both the I & S Team and Finance. The I & S Team end up checking individual pupil records on the Pupil Database. | Queries should come to one place e.g. the I & S Team? Clear Form 7 nursery guidelines should be prepared. |
| 5 | Development and Review have a clearly identified need for local and global forecasts, which are based on assumptions other than the most probable outcomes. | Dev & Rev | Examples are forecasts that provide for maximum (optimistic) and minimum (pessimistic) numbers. This is to identify the range of possible outcomes, which the LEA should consider. | Develop a role for someone to produce these forecasts for Dev & Rev based on their specific needs. |

Table 1. Extract from Issues Catalogue.

These problems arose from different systems. A conceptual model was developed for the ISD system. The report made various recommendations concerning revising statistical methods, rationalising the IT systems and reorganising ISD as a service function involving the development of service level agreements and the appointing of a statistical service manager.

From a systems point of view, it became clear that ISD was one system surrounded by many systems which were influencing, serving and making demands on each other. Conflicts and problems in one system would affect another. Any systems analysis needed to study all the interacting systems. Table 2 lists the various systems which interacted with ISD. Each system has its own worldview, own purposeful activities

and own set of processes, only part of which involved interaction with ISD. Developing a detailed SSM model for each system would be impractical and inappropriate. The focus therefore should be on the interface effects and the information and cultural aspects which flow across the interfaces.

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| Education Centre | Provides support and training to schools running the software for generating yearly returns. Their purpose was to reduce the amount of calls made concerning errors arising from lack of training. |
| Central Government Department for Education and Employment | Requires the statistical returns to be delivered promptly. |
| Capita Services | Delivers educational administrative software to most educational authorities and had an interest in incorporating forecasting into its products. |
| Schools | Forecasting is only one part of the purposeful activity of schools. Heads of schools may do their own forecast. |
| Local Authority Finance Department | Uses ISD's forecasts and analyses retrospective funding problems. |
| Development and Review Department | Looks at long term development, housing needs and environmental changes. It is interested in long term forecasts. |
| Local Health Authority | Purposeful activity involves predicting healthcare needs. |

Table 2: Systems Interacting with ISD

## 3. The Nature of the Systems Interface

The interface between two computer systems poses a number of technical challenges. There may be different hardware, protocols and software associated with each system. With the increasing standardisation offered by open systems and by web-based computer systems, the interface problems at this level may be reduced or removed. At the application level, the systems integration task will probably be greater. Each computer system may run different application processes, with different timings and orderings of activities. The data items stored may be different. Formats of the same data item may vary. In addition data items may be unique to one system. Relationships between data items may differ. Also data with the same name may have different meanings. These differences are the basis of the technical challenge in systems integration. Getting two systems to talk to each other involves reconciliation

of processes and data. This may be achieved by the replacement of the two systems with a new system, a favoured Enterprise Resource Planning (ERP) approach. This requires the construction of migration approaches. Alternatively the existing systems may be left in place and joined by a feeder program which in batch or real time transmits data from one system to the other.

However, the technical approach leaves out many organisational and social issues which determine or influence the technical problems. It is these areas that the messy problems lay which SSM may address. The computer systems may be in different departments, influenced by different cultures, perspectives and power structures. Their actual presence may derive from social battles concerning the ownership of data, social identity of individuals and groups, and even issues of professional and occupational identity. Hence, the systems integration cannot be treated simply as a technical exercise the technical differences will have an organisational derivation.

Systems integration must involve an understanding of why disparate and non-integrated systems exist; an explanation of why data is manually transferred between systems; a discussion of historical reasons for particular configurations of systems and particular information flows and an understanding of interactions at the organisational level between the groups, departments and organisations that support the IT systems and carry out the purposeful activity. In viewing systems integration as a technical problem concerning data rationalisation and the imposing (almost) of an-organisation wide information system key organisational issues get over looked.

Hence we need a systemic approach to systems integration which draws out the organisational issues and provides solutions, perhaps in a form of a conceptual model which then influence or determine technical strategies and solutions. The systems approach must focus on the systems boundaries and the influences and information which cross the boundaries. A rich understanding of the boundaries should be achieved without having to probe the details of systems processes and models within each system.

In exploring the systems interfaces, the following may be considered:

Hotspots. What are key concerns or themes emerging between the systems? On what are those concerned with purposeful activities within each system focussed?

Points of contention. Where are the principle points of disagreement? What social and technical issues give rise to disagreements between the systems and hence resistance to integration.

Points of consensus. Conversely, where are the points of agreement? What might provide the seed for establishing integration and communication across the interface?

Conceptual gaps. Once the key concepts concerned with the interface have been identified, conceptual gaps concerning these may be explored with system participants. These gaps in perception or understanding may be the impetus for overcoming the systems integration problem.

Aligned and non-aligned interests. In order to have integration there must be organisational or individual interests which, when aligned (as may be suggested in actor network theory, see McBride, 1993), may produce integration. Where interests are not aligned, then social and managerial activities may be considered to translate these interests into aligned interests.

Attracting forces. Certain social, organisational and even personal factors may acts as attractors, drawing the systems together.

Repelling forces. Similarly, certain factors, right down to personal dislike and organisational mistrust may repel systems. These conflicts will have to be resolved in order to obtain some kind of holistic integration both at the IT technical level and the organisational level.

Cross-interface perception and interpretation of purposeful activity. The perception of what people do in the other system may influence integration. These perceptions and interpretations will need to be teased out and challenged.

Communication strategies. A key element of looking at the interface between two systems will be the understanding of how messages are transmitted and what the communication strategies are at a social, organisational and technical level. There may be differences in the use of difference channels as well as in different message structures and content. Examination of this communication is a systemic issue, not just a technical issue involving protocols and message standards.

Taking these issues into consideration, the next section considers how some systems approaches may support the activity of systems integration.

## 4. Systemic approaches

### 4.1 SSM

SSM studies have perhaps been limited to closely defined limited system within organisations (Office management, hotel management, for example) where the boundary is easily defined. Even NHS contracting has a fairly well defined, non-porous boundary. Such systems may be almost parochial. Perhaps we should consider the effect of dynamic or porous system boundaries, particularly resulting from globalisation. Such considerations may be important in assuring the relevance of SSM to global internet-mediated networks of systems.

When looking at the links between a number of systems, both rich pictures and conceptual models may become too generalised to be of value. Some development and enhancing of those aspects of SSM which could be appropriate to an interface is needed. CATWOE as a basic modelling approach in SMM (Bergvall-Kareborn et al, 2004) may provide a descriptive tool for exploring the interface between two systems as a precursor to systems integration. Table 3 identifies the issues, primarily boundary issues that were surfaced by the application of CATWOE in the ISD. It also highlights boundary issues that might be addressed.

| CATWOE Element | ISD system | Interface Concepts |
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| Customers | Local Authority Finance Section<br>Development and Review Section<br>Schools<br>Local Authority Treasurer's Department<br>DfEE | Different customers for each system.<br>Competing goals and needs<br>Customer may be present in the opposite system |
| Actors | Local Authority Finance Section<br>Development and Review Section<br>Schools<br>Local Authority Treasurer's Department<br>DfEE | Customers in service provision, carrying out part of the transformation.<br>Lack of clarity about roles and responsibilities may occur at the interface. |
| Transformations | Raw statistics transformed into forecasts using statistical expertise and tacit understanding. | Transformations across the interfaces. Two way transformations. Interface transformations may be different from the systems transformations which may themselves conflict. |
| Worldviews | Forecasting seen as a financial system | Different worldview for different systems<br>Clash of worldviews likely at the interface. |
| Owners | Chief education officer<br>Schools<br>Parents<br>Tax payers | Joint ownership across interfaces.<br>Problems of ownership of data /systems within a systems integration exercise. Levels of ownership. |
| Environment | Public sector<br>Constantly changing government demands for information.<br>At the time PLASC replacing Form 7<br>Demographics<br>Changing organisational structures | Volatility of the interface<br>Openness to environmental effect. Each system represents an environmental effect on the other system.<br>Environmental effects important as system interface. |

Table 3, CATWOE at the Interface.

The use of CATWOE at the system boundaries may enable us to look at each system and contrast the two systems. It may enable problems likely to cause conflicts and issues concerning systems integration to be surfaced. The problems here is that, since SSM focuses on purposeful action within each system, the individual systems maybe probed at level which is unnecessary for the system integration task. However, one approach would be to view the system integration process itself as the system understudy, to take the viewpoint of the systems integrator and reflect relevant models for representing the system process.
Another alternative may be to treat the interface itself as a system, producing transformations of information between two feeder systems. In the same way as Checkland viewed contracting as a purposeful activity and a focus of activity (see Checkland and Holwell, 1998), the business purpose of the interface between two systems could be treated as the focus for purposeful activity. A business-to-business e-commerce interface could be considered as a system to exchange transaction data and control stock levels, for example. However, Internet based systems where there is a proliferation of interfaces may need a different interpretive approach.

## 4.2 VSM

In contrast the SSM, the Viable System Method (VSM) offers a more interface-oriented perspective. It recognises multiple recursive systems in an organisation and focuses on the cybernetics of control, feedback and regulation of these systems through interactions between them. In using the concept of requisite variety it concentrates on matching variety within a system with variety within another system or an environment at the interface. While many practitioners may be put off by the apparent complexity of VSM, at its heart is a cybernetic approach to modelling relationships. Seen as a simple modelling of relationships, it may fulfil a role in systems integration, where the integration of two systems is dependent on the context and content of the relationship between them at many levels. It should not be necessary to go inside the black boxes of individual systems in order to understand how they function and the interactions between them at the systems boundary.

In a systems integration project it may be appropriate to consider activity at the interface as represented in the different interfaces. System 2 control artefacts will be important in regulating activity at the system interface. System 3 operational activities may be defined or mapped at the interface. System 3* quality measures should be defined for the interface and forward planning and strategic planning considered when reviewing an interface. An understanding of the processes needed for what might be called a viable interface may further be classified under the headings of co-ordination, cohesion, monitoring, intelligence and policy (Table 4).

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| Co-ordination | Standards, protocols and timing schedules. Synchronisation of activities at the interface. Consensual processes for crossing the interface. |
| Cohesion | Effective division of resources at the systems integration interface. Well-communicated performance measures and targets for the interface. Creation of holistic representation of interface |

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| | activities which encompasses the whole range of transactions and interactions. |
| Monitoring | Exchange of timely and accurate performance, availability and activity data which supports the development of mutual trust in the robustness and reliability of the systems interface. This involved targeted, relevant and manageable data subjected to an agreed interpretation. |
| Intelligence | Development of activities (jointly by both systems) which, using forward planning, marketing, forecasting and technical development, which assure the continued development of the interface to the mutual benefit of participating systems. |
| Policy | Development of a policy for the use and evolution of the system interface. Agreed security policy. |

Table 4. Organisational Processes for a Viable Interface.

A VSM approach may highlight the control and monitoring aspects of the systems interface. However, alternative approaches may be needed to capture the socio-political aspects of the interface. VSM may not highlight the soft issues which as so significant in successful systems integration. VSM will focus attention on the viability of the systems interface, its match with both the feeder systems and the environment, and its adaptability (i.e. its ability to match its variety with environmental variety). The viability of the interface will be influenced by a set of factors including the mutual dependence of the systems, the sustainability and volume of the information flow, the economic viability of the interface and the social commitment to its use.

### 4.3 Sociotechnical Approach

Sociotechnical approaches such as ETHICS (Mumford, 1995; Adman and Warren, 2000) focus on the individual tasks and the needs of the employees. Such approaches may be used to focus on boundary issues. As with SSM, the use of ETHICS may work better if the interface is treated as a system and as the focus of systemic analysis. The prime elements of ETHICS are the mission identification, identification of key tasks, identification of efficiency and effectiveness issues and job satisfaction issues (Adman and Warren, 2000). All these elements are of importance (Table 5). However, their analysis will require looking at both systems and analysing these elements for each system. To constrain the scope of information gathering, it may be appropriate to focus only on those points of contact with the interface.

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| Identify the mission | Delineating mission and purpose of |

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| | interface or point of integration of systems may help in understanding social and technical elements of interface. |
| Identify key tasks | Key administrative tasks will change as a result of the interface. |
| Investigate efficiency and effectiveness | Systems integration must improve efficiency and effectiveness... These will be investigated as part of the justification for integration. |
| Investigate job satisfaction | Elimination and changing nature of the jobs of people who work at or near the systems interface need to be established. |

Table 5: Principle information gathering tasks in ETHICS.

Sociotechnical approaches highlight the importance of individual involvement and individual tasks. A focus on cross-over tasks will benefit the system integration process. Which tasks require information to cross the systems boundary? What information leaves one system for another? How is that information perceived and hence used by the receiving system? Does that usage match the expectations of the sending system? Does the information crossing the boundary align with the tasks of the recipient? System integration will at least change the physical frequency, information transformation activities and the storage of the information. There may be a radical effect on the internal processes of each system, resulting in changes in tasks. These changes in task should lead to increased efficiency and effectiveness. Hence, any systemic approach should involve considering cross-over tasks as a source of information for integration and as a target for change resulting from integration. Studying the tasks currently generated at the interface will help in understanding how those tasks will change – for better or worse – once the systems are integrated or, for example, an e-commerce link is created.

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## 5. Conclusions

System boundaries need to be an important focus of systems thinking. Since many information systems are now Internet-based, the number of boundaries involved will increase. Increasingly, organisations are working with global systems which involve many interfaces, raising cultural and political issues as well as technical issues. Systems thinking must be able to accommodate the demands of global, multi-interface systems. System boundaries are areas of friction where conflict results from political, cultural and attitudinal differences.

The boundaries provide the entry point for environmental influences since they are permeable such that information, energy and resources can cross over. Furthermore, the organisation of any system of systems comes from the way in which material of whatever kind crossing the boundaries provides the glue of interdependence without challenging autonomy. The success of systems integration depends on the way binding forces between systems are exploited and issues causing friction are overcome. This is clearly a systems issue.

The three systems approaches discussed above tackle system boundary issues in different ways. Of the three, SSM may have the least fit. The difficult of using SSM in systems integration may be a significant shortcoming particularly in dealing with global systems. In carrying out the Local Education Authority study, SSM provided a good way of sensitising ISD staff to the problems they were experiencing and looking for a variety of systems solutions. However, it was less useful in tackling interface problems. It seems to me that a combination of concepts from all three approaches is required. This is where further work needs to be done.

## 6. Discussion Questions

How can we use systems thinking to explore system integration issues?
What is the most appropriate systems approach for drawing out social and technical factors influence systems at the point where they interact?
To what extent do we have to look inside every interacting system? Do we have to do root definitions, CATWOEs and conceptual models for each system? Can we infer the nature of these systems just be studying them at their boundaries?
Can we treat the interface between two systems as a system in its own right?

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