

ACTIVITY BASED GENERATION OF REQUIREMENTS FOR WEB-BASED INFORMATION SYSTEMS: THE SSM/ICDT APPROACH

Meldrum, Mary, Business Information Technology Group, Manchester Metropolitan
University Business School, Aytoun Building, Aytoun Street, Manchester M1 3GH,
England, m.c.r.meldrum@mmu.ac.uk

Rose, Jeremy, Department of Computer Science, Aalborg University, Fredrik Bajers Vej 7,
Aalborg 9220 Denmark, Jeremy@cs.auc.dk

Abstract

Web site development method is at an early stage in its evolution. Most existing methods are concerned with technical software issues and are poorly adapted to help developers think about fundamental changes to existing business models that Web-based environments make possible. In addition, traditional methods of requirements elicitation dependent on users are often impractical. The approach described in this paper combines the well-tested ability of Soft Systems Methodology (SSM) to deliver useful models of business process (human activity systems), with recent thinking about mature Internet business strategies from INSEAD. Mapping the four virtual spaces of the ICDT model (information, communication, distribution and transaction) onto business activity models via a simple matrix ensures a reasonably sophisticated view of Web site potential, and ties it firmly to fundamental business processes. The approach, which is simple to learn and a small overhead in terms of development effort, is illustrated with a case study.

Keywords: soft systems, systems development, requirements analysis, Intranet, Worldwide Web

1 INTRODUCTION

Web-based information systems can take a bewildering array of forms, from a personal textual homepage to an largely automated business to an online interactive computer game. Many of them share, as their principal function, the support of purposeful human activity or business processes. Examples of such systems are intranets, extranets and Ecommerce applications. It is clear that the rapid development of the internet has opened up many new possibilities, both for automating the old ways of doing things, but also for discovering new ways. Innovative uses of web-systems facilitate business process integration, new business models, supply chain mediation, disintermediation and re-engineering, as well as offering new services to new markets. The rise and fall of the dotcoms illustrates the many innovative possibilities, as well as the inherent dangers and difficulties.

Many commentators argue that web-development is different from pre-internet development, citing speed of development, the many 'green field' (without precedent) developments and the focus on the interface as important factors. Though some of the differences may simply be the result of immaturity in development practice, the elicitation of requirements for web-based systems can be problematic. To name only the most obvious difficulties, many requirements analysis strategies are predicated on consulting the future users of the systems; in many web-based developments these potential users are so diverse and geographically wide-spread that this is impractical. In addition, conventional requirements analysis is normally aimed at automating existing practice. Where there is no existing practice (for instance a dotcom start-up) this is impractical, and where there is, the effect may be to strangle innovation.

These considerations suggest that there is a need for an approach to requirements generation for web systems that combines the recognition of multiple user views of a complex human activity system with techniques to help creatively map existing and potential business functions to a Web-based environment. The approach needs to be accessible to developers who are not IT function experts. The approach described in this paper combines the well-tested ability of Soft Systems Methodology (SSM) to deliver useful models of business process (human activity systems), with recent thinking about mature Internet business strategies from INSEAD (Checkland and Scholes 1990, Angehrn 1997). Mapping the four virtual spaces of the ICDT model (information, communication, distribution and transaction) onto business activity models via a simple matrix ensures a reasonably sophisticated view of Web site potential, tied firmly to fundamental business processes. Alongside this an overview of the technical context of development is undertaken. The ideas generated by using the ICDT matrix are considered alongside the technical possibilities and constraints so that informed choices can be made about the scope of the system to be developed. SSM has been widely taught in business schools for a number of years and is accessible and known to many potential, non-IT function developers. The approach is simple to learn and offers the opportunity for creative thinking in the generation of requirements. A case study is used to illustrate the approach.

2 WEB SYSTEM DESIGN APPROACHES

Web development is often thought to exhibit different characteristics from earlier development projects. These can include time pressure, vague requirements, a prototyping orientation, frequent releases and evolutionary development, parallel development, and an emphasis on small teams of highly competent programmers coding their way out of problems (Ramesh et al 2002). Requirements may be at an very broad level, imprecise or based primarily on imagination. In addition they may change frequently and/or grow rapidly.

Though early Web sites were written in HTML, there are now many software tools that automate the task of Web-site programming. IS researchers have addressed the shortage of design methods for Web sites and a variety of such methods have appeared, including the Relationship Management

Methodology (RMM) (Isakowitz et al. 1995) and Object Oriented Hypertext Design Method (OOHDM) (Schwabe and Rossi 1995). Takahashi and Liang (1998) note that these methods are useful in formally modelling kiosk-type applications that navigate users to their information goal in a systematic way. However if the goal involves a Web-based information system with “the need to process business data and communicate and collaborate with colleagues” then such methods do not provide help in linking to areas such as business goals and maintenance issues. Recent approaches such as Scharl’s Extended World Wide Web Design Technique (eW3DT) (Scharl 1999, Scharl 1998) have been more user-centric. All of these approaches share a software engineering focus on technical system construction. De Troyer et al (1998) note that the older methods including RMM and OOHDM were originally designed for hypertext or hypermedia applications and do not deal with Web-specific issues. They suggest that many are data driven in approach and concentrate on maintenance issues rather than usability. They propose a user centred design method (WSDM) that takes into account different user views of the system, but the concern here is with mapping site layout onto user views rather than taking a step back and looking at the underlying business processes and rethinking them. The Internet Commerce Design Method (ICDM) (Standing 2002) incorporates SWOT analysis, value chain analysis and Business Process Re-engineering into the design process, thus focusing more on business activities, but at the cost of a multi-stage analysis-heavy process. Vidgen extends the Multiview framework to Web-based information systems (Vidgen 2002, Vidgen et al 2002). This approach focuses on organisational analysis (using SSM), but no clear link is made from the SSM analysis to the identification of how existing and potential business functions can be mapped to a Web-based environment.

Many of these design approaches are primarily technical in focus, and take for granted the existence of a reliable set of requirements. In this they echo Checkland and Holwell’s (1998) complaint that information system development normally starts too far down the line focusing on data and data processing concerns, in a rather mechanistic and functionalist manner. Fundamental issues about the organisational activity that is supported are ignored. Like traditional methods, they do not address issues to do with understanding and defining organisational purpose, performance and operational requirements (Winter et al. 1995). Methods in this technical arena focus on software skills, ignoring other important design skills such as telecommunications skills, artistic (graphic) skills, business process design skills and change management skills (Lyytinen et al. 1998). Some more recent web design approaches do take the derivation of appropriate requirements more seriously, such as ICDM and the Vidgen approach. However the ICDM approach requires specialist business analysis skills not typically possessed by web designers, and the Vidgen method offers no way of progressing from organisation analysis to requirements. Both are rather analysis-heavy for the time constrained world of web development.

This analysis suggests a sensible approach to requirements analysis for web-based systems which support human activity systems should be quick, flexible, independent of users (they may contribute or they may not), activity or process focused and able to support both existing activities and help envision new ones.

3 SOFT SYSTEMS METHODOLOGY AND INFORMATION SYSTEMS DEVELOPMENT

The philosophical basis of Soft Systems Methodology is associated with interpretivism (Rose 1997, Checkland 1981, Checkland and Scholes 1990, Checkland and Holwell 1998, Jackson 1991). SSM is well established as a vehicle for thinking about Information System problems. Wilson developed a form of information analysis based on consensus primary task models and mapping of information categories onto a matrix, or ‘Maltese cross’ (Wilson 1984). Many attempts to link SSM products with traditional systems analysis techniques have been made (Prior 1992, Sawyer 1992, Gregory 1995, Lewis 1994). Further attempts have been made to link the methodology with various hard systems methodologies including SSADM and Jackson System Design. Two styles of doing this, grafting and

embedding, were distinguished by Miles (1992). Problems in achieving these links largely stem from the different ontological and epistemological positions involved (Doyle and Wood 1991). In addition there are ISD methodologies that:

- bolt in SSM tools (Multiview (Avison and Wood-Harper 1990)),
- are based upon SSM (FAOR: (Shafer 1988))
- are heavily informed by SSM(Client-Led Design (Stowell and West 1994))
- build SSM into scenario-based information management work (Galliers 1992).

Ormerod provides case studies of this style of work in consultancy contexts (Ormerod 1995). Vidgen extends the Multiview framework to Web-based information systems (Vidgen 2002, Vidgen et al 2002).

Checkland’s account of how knowledge may be achieved underpins his understanding of how organisational actors select, capture and utilise the ‘information’ which is the focus of an information system (Checkland and Holwell 1998). However it may equally well be applied to the organisational processes concerned with developing information systems. In this interpretive context, it becomes rather difficult to accept the ‘requirements analysis’ of conventional systems analysis life-cycle models. Their assumption is that requirements are facts which have an objective existence of their own. Such facts are waiting to be discovered by the analyst employing the correct scientific techniques. An account more consistent with the interpretive philosophical basis of the Checkland model might suggest that requirements for information systems are socially constructed. They consist of sets of intentions negotiated from perceptions of events, which are married to expectations of technologies. What to build into an information system may be considered a kind of knowledge about organisational and user needs. It includes associated knowledge about how to build information systems. The term ‘requirements generation’ is preferred to the more usual ‘requirements analysis.’

Checkland’s underlying model of an information system may be characterised as organised information provision in support of purposeful activity. Meaningful information system development, according to Checkland, starts with analysis of the underlying organisational activity or business system. Most traditional methods start with analysis of the current information provision. ‘Whenever one system serves or supports another, it is a very basic principle of systems thinking that the necessary features of the system which serves can be worked out only on the basis of a *prior* account of the system served’ (Checkland and Holwell 1998). One well-established way of conducting that analysis is with Soft Systems Methodology.

4 THE ICDT MODEL

The ICDT model (Figure 1) (Angehrn 1997) (developed at INSEAD in France) identifies four potential virtual spaces for companies wanting to develop Internet business strategies:

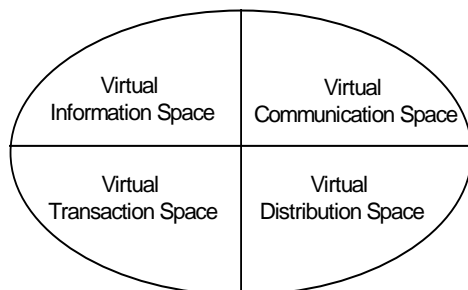


Figure 1 The ICDT model (Angehrn 1997)

- The *information* space allows agents to display information about themselves, (often in forms like catalogues and brochures) to customers or partners.
- The *communication* space offers traditional email communication, and a variety of virtual meeting

forums where ideas can be discussed. These constitute ‘new channels for the creation of virtual communities of interest whose members can communicate at high speed, low cost, and bypass traditional geographical constraints’

- The *distribution* space allows the distribution of products and services. Any product, which can be represented in a digital form (programs, books, articles, pictures, video, music) can be distributed via the Internet. Non-physical services such as text, voice or video-based training, consulting can also be distributed
- The *transaction* space facilitates traditional business activities such as orders, invoices and payments, and interactions of a contractual nature.

Angehrn comments that Internet development strategies are often narrowly uni-dimensional, focusing primarily on the virtual information space. As a result, ‘the World Wide Web has become rapidly crowded with multimedia presentations of product and service providers from practically every business sector’ (Angehrn 1997). The ICDT model allows developers to distinguish between four separate types of ‘business presence’ on the Internet. Developments may (Angehrn 1997):

1. increase the visibility and improve the perception of products or services (VIS presence)
2. increase the visibility and improve the perception of products or services by influencing how economic agents communicate about them (VCS presence)
3. reduce the cost, improve the quality or introduce new products or services by distributing them via the Internet (VDS presence)
4. exploit the Internet for product/service related transactions (VTS presence)

5 THE SSM/ICDT APPROACH

This approach for negotiating Web system requirements uses Soft Systems Methodology and the ICDT model. It is intended to serve as an initial enquiry approach preceding prototyping. The schema for the whole approach is given in Figure 2. The approach is an adaptation of Soft Systems Methodology. The underlying business activity for which the Web site is required is analysed in the normal way using rich pictures, and root definitions and conceptual models of relevant human activity systems. The comparison stage of SSM is replaced by requirements generation using the ICDT model. The model is targeted at the formulators of business strategy. Here it also provides a device for structuring the perceptions of users and developers of the possibilities available for creative, multi-dimensional uses of technology.

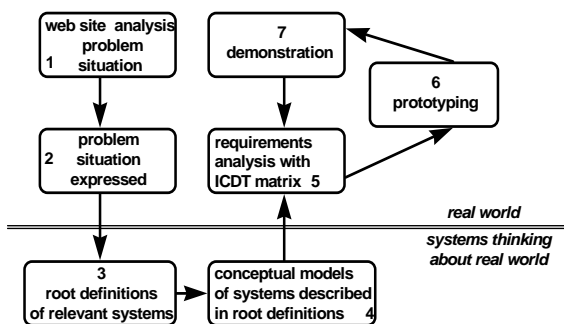


Figure 2 Web-site development using SSM, the ICDT model and prototyping

Requirements generation using the ICDT model can be accomplished starting with a matrix (Figure 3). Activities from the SSM conceptual models are mapped onto the left-hand column of the grid. Each activity is then analysed using the question ‘How could a Web site support the *information /communication /distribution /transaction* potential for the activity? The answers can be mapped onto

the matrix resulting in a creative set of potential ideas. These can then be prioritised (in terms of feasibility and desirability) in discussion with users to arrive at an agreed set of requirements. This is followed by a prototyping development strategy.

Experience to date shows that analysts may initially have some difficulties with deciding what should go in each column. It is more important to record the ideas than to get them in the 'correct' column. Simplicity of use is one of the matrix's strengths. Each of the matrix entries can be annotated at a later stage with an indicator of priority (e.g. high/medium/low) or optionality (mandatory/optional). However the matrix (rather like brainstorming) generates ideas for functionality, without necessarily offering the form and structure necessary for a coherent requirements specification. Further thinking is required to shape the ideas that have been generated.

requirements analysis matrix

activity	information	communication	transaction	distribution
1				
2				
3				

Figure 3 Requirements generation matrix using ICDT model

A ranking operation is carried out by considering the business and technical constraints. Sometimes technical constraints or internal politics will rule out ideas that have been prioritised quite highly. Some ideas may be grouped as packages of inter-dependent requirements. Business constraints should be evident from the SSM analysis, particularly if analysis of the cultural and political situation and analysis of the intervention itself have been carried out. This may also throw up some of the technical constraints. The technical constraints may need further investigation so that the analyst understands what is feasible on the IT platform that is currently available (or likely to be available). The IT support available to build and maintain the system and the technical skill base of the potential end-users of the system also need to be investigated. When the requirements have been generated using the SSM/ICDT approach then a variety of appropriate methods are available to continue the development process. Choice of additional methods will depend on the application type; for instance a project may result in requirements for a mix of structural Web pages, databases and pages front-ending these databases. Appropriate design methods need to be selected for each.

The SSM/ICDT approach largely follows the theoretical precepts set out by Checkland. Techniques familiar from SSM are used for organisational analysis to help form an account of underlying human activity. This precedes any formulation of what the information system should look like, or consideration of technical computing issues. The SSM models are not representational or normative (Rose 1997), but part of the discourse which structures our understanding of events - 'relevant to debate' (Checkland and Scholes 1990). The ICDT model is employed to focus the process upon the potential offered by a Web site to support the underlying activities. Technical issues are taken into account when selecting a scenario to prototype. Although organisational analysis takes precedence, the approach is basically iterative, as SSM action research usually is (Baskerville and Wood-Harper 1998). It should not be confused with the rigid linear process embodied in many structured methods. The importance of the various analysis tools lies in the discussion and rethinking that the models produce; the models are not normative design specifications. For these reasons, the term 'approach' is favoured over the more usual 'method.'

6 REQUIREMENTS GENERATION FOR A WEB-BASED UNIVERSITY PROJECT

To illustrate the approach, the following section reports parts of an action research project commissioned by a neighbouring Higher Education institution in the UK. The Department of Education wished to develop a Management Information System with a Web-based front-end and the resulting study was carried out by one of the authors. Much of the detail is omitted from the case study to provide a clear exposition of the approach.

The project was originally presented as a replacement for an existing student administration system built on technology that was coming to the end of its life. As the requirements gathering exercise developed it became evident that, because of changes in the context within which staff were working, there was a need to consider something more radical that might involve new ways of doing things. It also became clear that an Intranet solution would be required to meet the full range of activities.

6.1 The problem situation expressed

A rich picture is a technique used in SSM to help express a shared concept of the problem situation. Its importance is in helping to abstract important issues from the problem situation. The rich picture in Figure 4 shows the context of development.

Within the University a variety of developments are taking place in response to changes such as the increase in student numbers, quality assessment procedures, league tables, research assessment, obtaining and managing external funding etc. Academics are being required to change their skill base to cope with the changes. Information technology developments are occurring in an ad hoc, end-user development approach to try and meet some of the pressures on staff. The focus of the system was the Department of Education, which was part of a faculty within the university. It had been subject to the usual quality assurance procedures followed throughout the University but also had additional requirements for information from the Department for Education and Employment, OFSTED and the Teacher Training Agency.

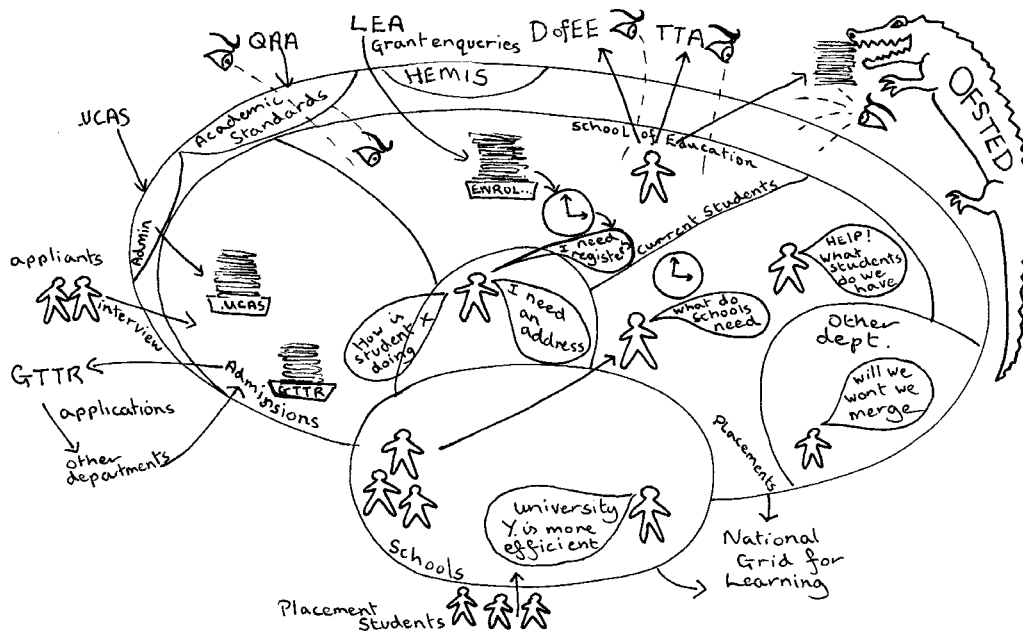


Figure 4 Rich picture of Department of Education administration

The University had merged with a local HE institution that also offered teacher training. The funding and quality assurance bodies looked for one return from the institution but this was difficult since both parts were being run independently. There were moves to rationalise the provision of the two departments but clear structures were yet to emerge. The issue of partnership with schools was also significant. Government policy had determined that schools took a much more active part in training of teachers and this involved transfer of funds and information between the Department of Education and partner schools. There was also a considerable involvement in training of school based mentors. The matching of students with schools was quite complex, particularly at secondary level, and often involved very short timescales. Students in the Department were all required to have a substantial IT component in their studies and it was realised that academic staff IT skills would need to be developed so that staff maintained credibility with their students. Administrative staff had well developed IT skills. The university had a central student administration system (HEMIS) that was in the process of being implemented. This system was being set-up to handle admissions and student progression but was not intended to handle the mid-year recording of assignment marks etc. The prime purpose of this system was to produce reports for the funding and quality assurance bodies. Any proposed local MIS needed to work with this system since otherwise duplication of data entry and resulting problems with data integrity would result.

6.2 Root definitions of underlying systems

Having provided a better understanding of the problem situation using the rich picture, SSM develops models of relevant systems. The word ‘system’ here means, of course ‘an organised way of working’ and does not refer to the technological system that may be the end product. Relevant systems for the education department project include the following:

A system to:

- monitor student progress
- maintain contact with mentors in schools
- maintain accurate and adequate records of current student numbers
- allow students read only access to their own performance records
-

These are later expressed as root definitions - short textual expositions of potential systems, which follow simple structural principles. In this study root definitions reflected the underlying organisation processes, a sample is shown in Table 1. These root definitions vary because of different stakeholder viewpoints of the problem situation. Though derived through the researcher’s perceptions of the situation, they were widely tested. Tensions identified through this analysis include: with partner schools the need for students and academic staff to have timely information on student performance; the University’s need for summarised data for external quality audit and funding body purposes; the need for good communications. Questions are also raised about the roles of academic and administrative staff.

Root Definition	Weltanschauung (world view)	Owner (i.e. whose viewpoint)
A system to provide academic managers with timely information on student performance, by means of providing information, in order to identify problems quickly.	Continual performance monitoring leads to a better quality course	Academic staff
A system to provide evidence of student assessment	The belief that maintaining	External

grades, by means of providing an audit trail, in order to ensure that satisfactory academic standards are being met.	an audit trail shows evidence of quality	examiners, auditors
--	--	---------------------

Table 1 Root definitions of some underlying systems

Thinking round a problem area in this way helps define requirements generation as a creative process where different ways of looking at the underlying human activity are considered.

6.3 Conceptual models

Activity models are associated with root definitions. One of the models that were used in the study was based on the root definition:

A system to provide academic managers with timely information on student performance, by means of providing easy access to information, in order to identify problems quickly.

The Activity Model is given below in figure 5.

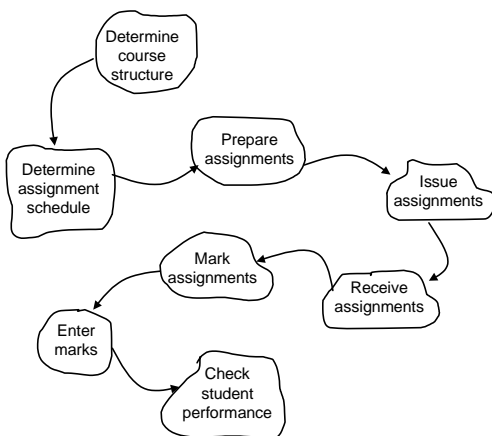


Figure 5 Activity model for student performance system

6.4 Ideas generation with the ICDT Matrix

The analysis to this point is targeted at gaining a rich appreciation of the underlying human activity. Now that analysis is redirected to the serving information system, to explore the possibilities for supporting underlying activity with a Web site. Each activity from the conceptual models can be mapped onto the ICDT matrix; the potential for Web site support for the activity is investigated in terms of information, communication, distribution and transaction, resulting in a list of potential requirements for the proposed site. A sample matrix, relating to the conceptual models in the previous figures, is shown in Table 2. The activities from the models are posted in the left-hand column, the remaining columns are used to tease out possible support for the activities that the Web-site may offer. The matrix generates a plethora of ideas for system requirements. This can be the starting point for a set of negotiations about relative desirability, technical feasibility, cost, associated changes in procedures and staged implementation. Some ‘must-have’ requirements are also easy and cheap to implement, and these naturally become the springboard for later developments.

Activity	Information	Transaction	Communication	Distribution
1. <i>Determine course structure</i>	Display course structure from course definitive document (H) (HEMIS)	Record/update/delete course structure(H) (HEMIS)		
2. <i>Determine assignment schedule</i>	Display assignment schedule (M)	Record/update assignment schedule (M)	Email academic/admin staff with draft schedule for return with comments (L)	Distribute assignment schedule electronically to staff/students/schools (L)
3. <i>Prepare/modify assignment</i>		Prepare/modify assignment (L)	Email module team with draft assignment (L)	
4. <i>Issue assignment</i>	Display full assignment specification. (M) Display submission details (M)			Distribute assignment electronically(M)
5. <i>Receive/record assignment</i>	Display password protected individual submission details (M)	Record assignment received with date. (M) Record extension details. (M) Electronic submission of assignments (L)	Email academic staff notification of cohort assignment receipt. (L) Email notification of cohort late assignment receipt to staff. (L) Automatically notify student of receipt/non-submission (letter/email) (L)	Word.dot template for assignment. (L) On-line multiple-choice test. (L) Distribute assignments to module team (L)

Table 2. Part of the ICDT matrix for Dept. of Education MIS Web-site

6.5 Developing the requirements portfolio

The ideas generated in the ICDT matrix were ranked taking into account business and technical constraints. The chief business constraints were to find ways of moving forward that would not be compromised by the ongoing merger between two departments with different underlying cultures and procedures. The main technical constraints were threefold. Firstly the University network was divided into three separate areas for academics, administrative staff and students. The division caused problems in sharing data across these groups and it was essential to find a solution that worked within these constraints. Secondly the existing MIS system in the department was based on old technology and there was very limited technical support available for it so the business processes it supported had to be given high priority in new developments. Thirdly, the University's central student administration system was found to provide much of the functionality needed for many of the requirements generated but it could not meet all the needs of the department. It was therefore essential to look at how this University system could be used by the department as the core of its system with the additional facilities required built around it.

A system of high/medium/low priority rankings was found the best way to rationalise the list of ideas in the ICDT Matrix into a Requirements List. High was for functionality that was required urgently to replace the existing MIS or because of current operational problems; Medium was for functionality that was not considered critical in the short term but that would considerably add to the benefits of the system; Low was for ideas that might be added in the longer term but were not currently considered essential. Functions provided by the University system (HEMIS) were also annotated so that the developers had a clear view of what that system would provide.

It is important to note that the original ranking of ideas is not fixed. In line with the iterative nature of this approach further ideas can be added over time and re-ranking can take place. In this instance a set of ideas relating to business activities concerned with managing school placements was initially given a medium ranking but the department decided that this area should be given high priority.

7 CONCLUSIONS

This paper elaborates a set of concerns about current approaches to requirements analysis in Web site development. We find the methods available to be at an early stage in evolution, to focus too heavily on technical concerns at the expense of rapidly changing business needs, and to focus on the software skill set at the expense of wider skills needs. Requirements generation for web systems supporting human activities need to be quick, flexible, independent of users and not bound to existing business processes. An approach using SSM and the ICDT model is described and illustrated. Experience in using it shows that it is relatively easy to grasp (especially for anyone who is already familiar with SSM) and successful both at developing a rich appreciation of the situation which is studied, and at generating more creative expectations of Web-site possibilities. Modelling encompasses more of the social, cultural, and political diversity of organisational life. The SSM/ICDT approach concentrates more on organisational analysis and less on data manipulation systems. Technical issues are always important and will always help shape a requirements portfolio, however this approach does not attempt to cover specific technical design issues. These, it is assumed, will be considered later. Less functionalist system development approaches are long overdue, and tend to reflect better what systems developers actually do, rather than what the methodology inventors prescribe they *should* do.

In this paper, the case study functions more as an explanation than a validation, and more research is necessary to find out if the approach offers practical benefits. Matrix analysis can become repetitive and mechanistic; future research may try to develop conceptual modelling which already incorporates ICDT concerns. In addition, the ICDT model ignores a very important feature of Web sites, their ability to provide an integrative platform for the launch of other, already existing information systems. This may be a major component of future requirements generation exercises.

References

- Angehrn, A. (1997). Designing Mature Internet Business Strategies: The ICDT model, *European Management Journal*, 15, 361-369.
- Avison, D. E. and Wood-Harper, A. T. (1990) *Multiview: An Exploration in Information Systems Development*, ed., McGraw-Hill, Maidenhead.
- Baskerville, R. and Wood-Harper, A. T. (1998). Diversity in Information Systems Action Research Methods, *European Journal of Information Systems*, 7, 90-107.
- Checkland, P. (1981) *Systems Thinking, Systems Practice*, ed., Wiley, Chichester.
- Checkland, P. and Holwell, S. (1998) *Information, Systems and Information Systems*, ed., Wiley, Chichester.
- Checkland, P. and Scholes, J. (1990) *Soft Systems Methodology in Action*, ed., Wiley, Chichester.
- De Troyer, O. M. F. and Leune, C. J. (1998) *WSDM: A User Centred Design Method for Web Sites*, Seventh International World Wide Web Conference, Brisbane, Australia,

- Doyle, K. and Wood, R. (1991). Systems thinking, systems practice: dangerous liaisons, *Systemist*, 13, 28-30.
- Galliers, R. (1992). Soft Systems, Scenarios, and the Planning and Development of Information Systems, *Systemist*, 14, 146-159.
- Gregory, F. H. (1995). Soft Systems Models for Knowledge Elicitation and Representation, *Journal of the OR Society*, 46, 562-578.
- Isakowitz, T., Stohr, E. and Balasubramanian, P. (1995). RMM: A methodology for Structured Hypermedia Design, *Communications of the ACM*, 38, 34-44.
- Jackson, M. (1991) *Systems Methodology for the Management Sciences*, ed., Plenum, New York.
- Lewis, P. (1994) *Information Systems Development Methods*, ed., Pitman, London.
- Lyytinen, K., Rose, G. and Welke, R. (1998). The Brave new World of development in the Internetwork Computing Architecture (InterNCA): or how distributed computing platforms will change systems development., *Information Systems Journal*, 8, 241-253.
- Miles, R. (1992). Combining Hard and Soft Systems Practice; Grafting and Embedding Revisited, *Systemist*, 14, 62-66.
- Ormerod, R. (1995). The Role of Methodologies in Systems Strategy Development: Reflections on Experience, In *Information Systems Provision: the contribution of SSM* (Ed, Stowell, F. A.) McGraw-Hill, Maidenhead.
- Prior, R. (1992). Linking SSM and IS Development, *Systemist*, 14, 199-201.
- Ramesh, B., J. Pries-Heje, and R.L. Baskerville. (2002). Internet software engineering: A different class of processes. *Annals of Software Engineering* 14: 169-195.
- Rose, J. (1997). Soft Systems Methodology as a Social Science Research Tool, *Systems Research and Behavioural Science*, 14, 249-258.
- Sawyer, K. (1992). A Contribution to the Debate on Linking SSM to IS, *Systemist*, 14, 199-201.
- Scharl, A. (1998) *Reference modelling of Commercial Web Information systems Using the Extended World Wide Web Design Technique (eW3DT)*, Thirty-first Hawaii International Conference on System Sciences (HICSS-31), Los Alamitos, IEEE Computer Society press,
- Scharl, A. (1999) *A Conceptual, User-Centric Approach to Modeling Web Information Systems*, Fifth Australian World Wide Web Conference, Lismore, Southern Cross University,
- Schwabe, D. and Rossi, G. (1995). The object-oriented hypermedia design model, *Communications of the ACM*, 38, 45-46.
- Shafer, G. (1988) *Functional Analysis of Office Requirements*, Wiley, Chichester.
- Standing, C. 2002. Methodologies for developing web applications. *Information and Software Technology*, 44: 151-159.
- Stowell, F. A. and West, D. (1994) *Client-Led Design: A Systemic Approach to Information Systems Definition*, ed., McGraw-Hill, Maidenhead.
- Takahashi, K. and Liang, E. (1998) *Analysis and design of Web-based information Systems*, 6th international World Wide Web Conference (WWW6), Santa Clara.
- Vidgen, R. (2002) *Constructing a web information system development methodology*, *Information Systems Journal*, 12, 247-261
- Vidgen, R., D. Avison, R. Wood, and T Wood-Harper. (2002). *Developing web information systems*. Oxford: Butterworth-Heinemann.
- Wilson, B. (1984) *Systems: Concepts, Methodologies and Applications*, ed., Wiley, Chichester.
- Winter, M. C., Brown, D. H. and Checkland, P. B. (1995). A role for soft systems methodology in information system development, *European Journal of Information Systems*, 4, 130-142.