Using SSM and Software Prototyping: an Emergent Methodology for an Ethical Information System

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Abstract

We examine one particular example of multi-paradigm methodology - the combination of Soft Systems Methodology and software prototyping - to identify its strengths and weaknesses when used in the analysis of an 'ethically sensitive' information system. A range of theories and concepts is used to explore the emergent methodology, and the issues of boundary setting and participation are addressed in the context of this case study. The methodology is found generally effective but the ethical issues are seen to be privileged at the expense of the organisational analysis.

Introduction

In this paper, we ask the question, "Can Soft Systems Methodology [1] and software prototyping be usefully combined in the analysis of an ethically sensitive information system?"

The problem situation was the Detention Management Unit (DMU) within the United Kingdom Immigration Service, and the client with whom the project proposal was developed was the Detention Co-ordinator (DC). One of the responsibilities of the DMU is to track those immigrants detained by the Immigration Service for all or part of the time that their requests for asylum are being processed. The then Detention Co-ordinator for the Detention Management Unit was interested in how technology might improve the operations of the unit.

The analysis of the problem situation took place in two parts:
- (major part) analysis by a final year undergraduate (Davis) for his project and dissertation (one third of his final year work)
- subsequent analysis by the supervisor (Bell).

To answer the question above, (loosely guided by the NIMSAD framework [2]), we discuss the problem situation, the methodology user and the methodology itself (i.e. the particular combination of methodologies used in the analysis). Our discussion of the methodology is broadly organised into four phases: the formation of the project; the first part of the student project; the second part of the student project; and analysis since the formal completion of the student project and dissertation.

Throughout these phases, the following means of recording knowledge and reflections were employed:

- regular meetings between supervisor and student
- meetings between client and student/supervisor
- shared electronic workspace for supervisor and student, containing plans, models and records of meetings and client sessions
- hand written notes
- formal documents (Project Proposal in October 1997 [3], Interim Report in January 1998 [4], Final Report in April 1998 [5], and this paper in first written in July 1998)

A previous potential supervisor had highlighted the ethical issues in this project and had been unhappy to countenance the use of software prototyping in advance of significant analysis. Davis was particularly keen to have a practical element to his project, and favoured the use of Lotus Notes for prototyping, particularly as an asset to his curriculum vitae.

The objectives of the project were identified as [3]:

- a better understanding of requirements of any computer-based detainee tracking system that is developed,
- an exploration of any ethical issues that may arise in tracking detainees and the identification of any questions that may need to be answered before development of a production system could proceed,
- an investigation of the use of one candidate technology in the implementation of a prototype detainee tracking system

Davis completed the project in April 1998, and presented his findings to an audience including the client and the supervisor (Bell), since when further analysis of the problem situation and the problem-solving process has taken place.

We use Midgley's notion of marginalisation to discuss the use of boundaries within the analysis and evaluate the emergent methodology in terms of its treatment the technical, organisational and personal perspectives [6], [7], discussing reasons for any perceived deficiencies.

Discussion of Methodology

No doubt influenced by his experience of Systems Analysis on his course so far, Davis considered using structured techniques [8] as well as other approaches.

"These could include Entity Relationship (or Object) Modelling, Data Flow Modelling and Requirements Cataloguing. In addition, problem-solving techniques such as Soft Systems Methodology (SSM) will be used. A challenge will be in fitting these two approaches together in a cohesive way." [3]

The rather off-hand reference to SSM (Soft Systems Methodology [1]) as a problem-solving *technique* confirms that the analyst was somewhat less enthusiastic at that stage about using SSM than was the supervisor, who had suggested the use of SSM as a way of promoting the social and organisational issues to balance the functional / logical view offered by prototyping.

	Problem Situation - Knowledge of / treatment of (*focus*)	Methodology User	Methodology
Before Jun - Sep '97	(Context Local to DMU) problem perceived with processing of information related to the management of detained immigrants. (Political Context) New (Labour) government in power.	(RD as analyst, FB as commentator) awareness of social/human issues strong focus on technical	• strands identified but planned process unclear • prototyping approach adopted
During Oct97- Jun98	Rich picture (secondary boundary) permits wider consideration of problem context (identifying stakeholders) - *Zooming Out* Initial conceptual model and prototype itself improve understanding of functioning of the DMU (primary boundary). - *Zooming in*	(RD as analyst, FB as commentator) • major concern at this time is the logical stream of analysis using SSM • prototype used to mediate discussion between DC and analyst • recognises stakeholders	• embedding approach to SSM [9], [10] • SSM's logical stream of analysis + exploratory prototyping
After – Conclusion of "Project" Feb 98- Apr 98	Area between primary and secondary boundaries is explored via root definitions of relevant systems. Better understanding gained of customer - supplier relationship between IND and Group 4 in detention of immigrants. - *Zoom to medium*	(RD as analyst, FB as commentator) • Cultural stream of analysis is major concern • Experience gained in use of SSM • range of tools, concepts, theories learned and used for ethical analysis • personal ethical position developed	• SSM found to be good for mapping out cultural stream of analysis., supplemented with ethical theories
After – Further analysis May 98-July 98	Existence of IND/Siemens Caseworking Project emerges and "asylum seeker" issue increasingly becomes subject of media and parliamentary debate. *Zooming out again*	(FB as analyst, RD as commentator) • Further analysis of problem situation • Critique of project methodology	Project methodology is evaluated here, using additional theories / concepts

Table 1 - Methodology summarised using NIMSAD framework, Jayaratna 1994

Davis says himself,

"... at the start of the project, the reason I was sceptical about using SSM was because I was of the (mistaken) belief that it was a toy for academics" [11]. The planning schedule included with the report reveals a little more about the analyst's intentions. SSM is included within "Produce Feasibility Document" and "Human/Legal Issues" two activities to be conducted in Weeks 8-11 of the 27-week project.

We have an included an overview of the methodology (see Table 1) influenced by the NIMSAD framework [2].

However as you will see, Davis became an enthusiastic exponent of SSM and used it alongside Software Prototyping to analyse the problem situation, an example of method integration [12]. His approach was influenced by the idea of 'embedding', whereby additional techniques or methodologies are introduced at an appropriate point but SSM still guides the intervention [9], [10]. This type of approach is elsewhere described as *methodological imperialism* [13] and *methodology enhancement* [14]. In fact, the process that emerged was fluid: at times the prototype predominated, and other techniques and concepts were drawn on as seemed appropriate at the time. For example, although SSM loosely structured the ethical analysis, the main support was from theories and ideas about ethical issues, not declared in advance. Additionally Wood-Harper et al's ethical analysis approach was used to post-rationalise the ethical analysis process [15].

SSM, Prototypes and Boundaries

We can use the notional boundaries identified to examine the role of methodology (including prototyping) in the analysis process. Initially when Davis envisaged the project, a boundary was drawn around the Detention Management Unit itself and the perspective was primarily technical.

When the first rich picture was drawn up (for the initial discussion with the client), the wider perspectives were evident in two ways:

- within the drawn boundary which represented the "scope" of the Detention Management Unit, other organisational and extra-organisational elements can be seen (e.g. Prison Governor, the hostels, etc.)
- outside of this drawn boundary we can see other organisational players (e.g. Immigration officers at the point of entry) and stakeholders (Parliament, Amnesty International, Local Authority, detainees' families, etc.) [1]

Davis' use of this boundary within the rich picture emphasises his perceived need to bound the project, for practical reasons of time and limited access to the organisation, and because he was required to do so by the project guidelines formally expressed in a student handbook.

Discussions with the client, based on this rich picture and use of the first prototype, enabled Davis to gain a much richer understanding of the management of the detainees. This management was from the perspective of the DMU and thus

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[1] It is interesting to note that the detainees figure mainly as arrows, only appearing as a person at the point of entry to the country.

was more concerned with their placement and tracking than their day to day supervision. Other issues which emerged were the need for detention centre governors to have improved information about the people in their care, and the treatment of any possible conflicts arising from the use of that information.

Observation of the second rich picture reveals that the increased understanding of the organisational context appears as increased detail *within* the DMU boundary and the pushing of some elements *beyond* this boundary. Detainees still appear as arrows flowing (like physical goods) across the boundary.

Midgley contends that when a boundary is set, it can be a grey area between the light of what we include in our system definition and the dark of what we exclude [6]. He uses this concept to discuss *marginalisation* where marginal elements are those lying between the primary and secondary boundaries set. In the rich pictures of Figures 1,2, we can see that Davis has specified a primary boundary (the scope of the DMU). The secondary boundary can be seen to include anything within the rich picture itself. Thus elements considered to be outside the scope of the DMU can be seen to be marginalised, some (e.g. Police, Courts, Prison, etc.) *becoming* marginalised in the development of the rich picture from version 1 to 2.

The most developed conceptual models are those relating to the work of the Detention Management Unit, and specifically those elements seen to be amenable to support by information technology. Davis commented that

"SSM has proved to be a revelation in identifying logical activities required to perform tasks, stakeholders, and potential areas of disagreement. In fact, it was used much more extensively than the more traditional tools, and conceptual models were used in place of data flow diagrams for development of the second prototype" [4].

At this stage, other stakeholders and relevant systems were identified but not explored in great detail i.e. they remained in the grey area between the primary and secondary boundary. The competing demands of the prototype and the SSM study began to conflict at this point. A more traditional SSM study might have progressed the root definitions and conceptual modelling immediately. However, the client had responded enthusiastically to the first prototype and was keen to see his suggestions incorporated [3].

Such a use of prototyping is commonly called exploratory, where the prototype is used as "a learning medium between developer and user to help them converge on an adequate set of requirements", [8]. In commercial software product development, the prototype can become the finished product and the specification develops in tandem.

Schrage compares the reflexive relationship between specification and prototyping with that between theory and experiment in physics, where each takes a turn at driving the agenda [16].

Both schools of thought recognise that
1. prototypes can raise unrealistic expectations about functionality and resource efficiency, and
2. there is a tension for the analyst between maintaining user commitment and retaining some control over the analysis and development process.

The former was not a major issue in this project, since there was no expectation of a delivered system but the latter did apply. As this tension became evident within the project, Davis took action by suspending development work on the second prototype and concentrating on a wider analysis. Thus the effect was that the first half of the project was dominated by the logical stream of analysis and the second half by the cultural stream of analysis in SSM, and the prototype was influential at the *beginning* and the *end* of the project period.

The grey area between the primary and secondary boundaries set **first** began to be explored via root definitions of relevant systems relating to the wider set of stakeholders than the DMU itself. (See Table 2 for treatment of relevant systems, and Figure 1, Figure 2 for examples of root definitions of relevant systems)

Relevant System	Conceptual Models	CATWOE	Future Analysis
1. Immigration Service (Overview)	4	6	6
2. DMU	4	4	4
3. Welfare of Detainees	4	4	4
4. Stopping detention of non-criminals	6	4	6

Table 2 - Relevant System and Extent of Modelling

SSM proved to be very useful in identifying stakeholders and the transformations in which they were involved (as actors, clients, owners and/or elements of the environment). The sources were the rich pictures, the root definitions and CATWOE summary (Client, Actor, Transformation, Weltanschaunng (or Worldview), Owner, Environment) produced for each of the relevant systems, summarised in Table 3.

Davis also engaged in future analysis to explore the possible uses of technology, influenced by the use of the prototype. He found that SSM helped identify areas for investigation in the cultural stream of analysis.

Each relevant system can be considered to have its *own* primary and secondary boundary but we can regard modelling of relevant systems as shedding some light on the **initial** primary and secondary boundaries set. For example, the analysis did consider one group of those marginalised by the primary boundary, namely the detainees themselves. Consideration of their *welfare* (rather than aspirations) was consistent with the approach adopted and was also important to the Detention Co-ordinator himself for the rational reason that if the detainees were happy, then it was less likely that disturbances would break out.

A Government owned system operated by the Immigration Service to monitor the welfare of detainees, by means of Government resource, in order to ensure that detainees are treated humanely and given maximum access to relatives and legal representation.

C:	Detainees and their families
A:	DMU; Immigration Officers; Parliament; European Union
T:	Need to be 'looked after' $\Leftarrow$ That need met
W:	Detainees have in most cases not committed a crime (other than illegally entering the country or overstaying a visa) and deserve to be treated with consideration and humanity
O:	Parliament / Government
E:	Public opinion (British)

Figure 1 - Root Definition and CATWOE Analysis – A System to Monitor the Welfare of Detainees (Relevant System 3)

A system to prevent immigrants who have not committed a crime (other than illegally entering the country or overstaying a visa) from being imprisoned, by means of public support and pressure on the Government, in order to uphold the principles of natural justice.

C:	Society; Immigrants
A:	Amnesty International; Government; Lobby groups
T:	Need to stop detaining non-criminals (that need met
W:	Immigrants who have not committed a crime (other than illegally entering the country) should not be detained.
O:	Government
E:	Perception of economic difficulties (unemployment); perception of political difficulties (racial tensions)

Figure 2 - Root Definition and CATWOE Analysis – An Alternative View (Relevant System 4)

Stakeholder	Relevant System 2	Relevant System 3	Relevant System 4
Detention Co-ordinator / DMU	Actor	Actor	
Immigration Service	Client	Actor	
Detention Centre Staff			
Group 4 Security	Actor		
Her Majesty's Prisons			
Police	Actor		
Detainees and their families	Client	Client	Client
Local Authorities			
Parliament	Environment	Actor, Owner	Actor, Owner
Home Office	Owner		
EU	Environment	Actor	
Pressure Groups (e.g. Amnesty International)	Environment		Actor
British Public		Environment	Client, Environment

Table 3 - Stakeholders and their role in relevant systems modelled

Ethical Analysis

An ethical analysis was always planned for this project but the process was not initially clear. From the use of SSM, relevant systems and stakeholders concerns with ethical implications were highlighted but this did not constitute a satisfactory analysis of the ethical issues (see summary in Table 4)

Principal Stakeholder(s)	Transformation	Worldview
Immigration Service / Parliament	Need for immigration control met	Immigration control is necessary
Detention Management Unit	Need for detention management met	Immigration detention is necessary in certain circumstances
Detainees / Detention Co-ordinator	Need for detainees to be looked after met	Immigrants deserve to be treated fairly
Amnesty International	Need to prevent immigration detention met	Non-criminals should not be detained

Table 4 - Summary of Ethical Perspectives

To supplement SSM's cultural stream of analysis, Davis studied the work of various authors in the field of Information Systems Ethics [19], [20], [7], and [23]. His application of his study to this particular problem situation enabled him to:
- develop a personal ethical position
- identify the moral agent(s)
- identify the alternative courses of action and discuss their likely results
- explore further the stakeholders and their concerns.

He also used the Wood-Harper et al's ethical analysis process model to organise the models and relevant systems already identified, and to progress his analysis [15].

Davis states his personal ethical position (arrived at as an outcome of the ethical analysis) as follows:

"My own position on this issue is that in this country the law comes from the people (through the election of parliamentarians). Those working in the Detention Management Unit are officers of the law and therefore any involvement with them in developing a new system would be morally acceptable in principle. However, the law can be used to suppress minorities and blind conformance may not be ethical."

The first and second sentences are not surprising since an analyst with deep reservations about the need for immigration control would have been unlikely to take on this particular project. Davis found that Mumford's suggestion of an "ideal" solution was untenable [21]:

"In this case none exists, since there are two polar arguments: one which holds that immigration detention is a fundamental and unacceptable breach of human rights; and another (dominant) view that it is necessary to maintain political and economic stability." [5].

Most of the ethical analysis is concerned with the final sentence in Davis' personal ethical statement. Davis' use of theories to explore the current and possible future problem situation was effective. His vision of the future was helped by his dialogue with the Detention Co-ordinator (sometimes mediated by the use of the prototype) and his study of Amnesty International publications.

He identified a feature of modern information technology systems (such as Lotus Notes) that, in enabling end-users to develop functions themselves, we give them the capability to use the technology to support what we may regard as ethically unsound decisions.

"The current Detention Co-ordinator is keen to ensure that the system is an ethical one and that detainees obtain maximum benefit from it, but there is no guarantee that the next incumbent will be so detainee-oriented." [5].

Thus, he distinguishes between ethical analysis and ethical operation or action, and stresses the role of the Detention Co-ordinator as moral agent, in addition to his own (the analyst), [22].

Further Analysis

The student project concluded with a formal presentation attended by the client, the supervisor and other assessors of the student's work. After the meeting, the client, supervisor and student held a meeting to progress reflection on the area of action and the methodology used for the project. A chance remark by the client revealed that currently under development for the Immigration and Nationality Directorate (IND) was a substantial Information Technology project (called the IND Caseworking Programme) to support the process of deciding on immigrants' claims for asylum and/or nationality. This revelation provoked a new phase of analysis, this time with the supervisor Bell playing the role of analyst, and Davis playing the role of commentator.

The further analysis has uncovered some interesting facts and raised even more interesting questions about the progress (or lack of it) of the IND Caseworking Project but these are beyond the scope of this paper. Were the DMUIS analysis to be progressed, it would need to be extended to take account of this parallel development for the following reasons:

- both projects shared a need to know personal details and the whereabouts of detainees
- the delay in processing of immigrants' cases adds to the pressure on places in detention centres and may affect Immigration Officers' decisions on where (or even if) to place detain an immigrant
- (to our knowledge) no analysis associated with the IND Caseworking Project has involved participation by officers in the DMU.

Analysis of Perspectives

We can critique Davis' analysis using the technical, organisational (or societal) and personal perspectives [7].

Technical Perspective

The use of the prototype to mediate discussion between himself and the client helped to build requirements for the possible future use of information and communications technology (ICT) provided a useful technical perspective. Not only was discussion of the current situation and future requirements facilitated but also raised were the ethical issues raised by the use of ICT, e.g. searching of demographic data and security across different locations.

Personal Perspective

Interviewing and use of the prototype with only one user (the Detention Co-ordinator) certainly promoted his personal perspective over those of other potential users within the Detention Centres. As these users were more junior and/ or from a different organisation, it is likely that they had quite different personal perspectives. The perspective of the "immigrant" was addressed (e.g. their *welfare* was considered) but this was a less personal perspective. Immigrants themselves had no direct voice in the analysis: the Detention Co-ordinator (directly) and Amnesty International (indirectly via their publications) spoke for them. The analyst also addressed his own perspective in the analysis: in identifying himself as a stakeholder at the outset (e.g. his desire to learn Lotus Notes), and in his development of a personal ethical statement. The supervisor likewise has become a stakeholder, as she publishes this research into the process.

Organisational Perspective

The organisational perspective did not fare so well. Although aspects of work process are evident in the rich pictures and in some of the conceptual models, geographical distribution of work between the DMU and Detention Centres, and organisational distribution of work between the Immigration Service and the Contractors (Group 4 and Wackenhut) are not clear in Davis' analysis.

To what can we attribute this perceived lack of organisational analysis?

1. Checkland and Holwell [23] point to the "conventional wisdom" learned by students which tends to generalise, and to trivialise the need to understand each organisation as essentially different. Certainly, on Davis' course, there was relatively little study of the organisational context.
2. His supervisor could have insisted on a more robust analysis of the organisation. In reviewing the process of the project, we can see that the first half was dominated by the wider view (e.g. the rich picture) and the personal view provided by the Detention Co-ordinator. The response to the perceived technical dominance of the prototype was to concentrate on the ethical analysis (a priority). Had the ethical implications been less present, perhaps the organisational analysis would have assumed importance earlier than it did. If we compare Tables 3 and 4, we can see that the "principal stakeholders" identified in Table 4 are privileged at the expense of others e.g. Group 4 and Detention Centre Staff to the detriment of the organisational perspective.

Conclusions

We can look at the methodology from the analyst's perspective and examine the relationship between the quality of the analysis and the methodology adopted.

SSM was of benefit in three ways:

- the use of rich pictures and modelling of relevant systems (combined with stakeholder analysis) helped to surface ethical issues
- the use of conceptual modelling to help understand the logical dependencies of activities, some of which were further explored using the prototypes
- the methodology was used as a template for analysis (consistent with the findings of Fitzgerald [24],[25] for developers who have had educational exposure to methodologies).

The software prototype was effective in the understanding of functional requirements and the surfacing of ethical issues associated with the introduction of ICT.

We have found that some personal perspectives were "missing". In exploring why this should be so, we find that possible reasons include the narrow scope of the project definition and the very limited range of participation. In this respect, the methodology is not the guilty party but rather we can look at the circumstances surrounding the project. Indeed, were this project to continue, these omissions could be rectified with no contradiction to the chosen multi-methodology.

The reasons for the perceived lack of organisational analysis include developer-embodied factors [24], the initiation of the project, time constraints and the distraction posed by the pre-eminence of "ethical issues".

The major outcomes of this project were learning by those involved - student, client and supervisor: learning about the problem situation, the methodology used and about themselves, participating as actors in human activity systems. In answer to the question posed in the first paragraph of this paper, we believe that SSM can be usefully combined with prototyping in the analysis of an ethically sensitive information system, provided that the technical perspective offered by the prototype does not eclipse the organisational perspective. A significant realisation was that, although it is important to consider

the ethical implications when introducing technology, the technology itself is no guarantor of a particular ethical behaviour - that is bound up between the technology and the human actor who uses it.

A pertinent question to ask is why we identified in advance this information system as "ethically sensitive". What information system is not ethically sensitive? In doing so, we may have privileged glaring ethical issues (associated with immigration and detention) over other organisational issues (e.g. sharing of work managed by the DMU between the Immigration Service and contractors) which are important and have their own ethical implications.

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