The Use of Scenarios for Organisational Requirements Generation

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Abstract

When multi-user computer systems are implemented in an organisational context they can have widespread impact on users and other stakeholders. There are many forms in which new technology can be implemented and each has different implications. The scenarios discussed in this paper are socio-technical system scenarios created early in the development process to help users and stakeholders understand the implications of different options and to assist them in formulating their requirements for future systems. The paper presents the results of using scenarios in nine field studies and six empirical studies. A process of developing and evaluating scenarios is described which relies on three different perspectives: (1) of the social and political characteristics of the systems development process, (2) of socio-technical systems and the implications of new technical systems and (3) of the forms in which scenarios can be represented and participants can engage with them. The lessons and issues of developing and evaluating scenarios for these purposes are described, focusing upon the factors which affect the effectiveness with which participants can engage with the realisation of the scenario.

1. Why scenarios?

The use of scenario-based design discussed in this paper arises from a particular concern with the development of user requirements for systems. The goal is to develop systems which meet the needs of the organisation both functionally and in terms of the impact on individuals and groups. Work has been carried out with a number of organisations on the ways in which they might implement information technology to improve their ways of working, either by enabling them to do new things or to improve the effectiveness and efficiency of their existing processes.

Typically the developments have been multi-user systems to support an existing population of users organised into groups with different roles and responsibilities.

The early stages of work in cases such as these are characterised by the following:-

- the existence of many different possibilities for the form of technology which might be deployed, for the way the organisational processes might be changed and for the relationships between the technology and the organisational process.
- a high degree of uncertainty in the users and in other stakeholders about the business, human and organisational implications of the alternatives and a difficulty therefore in articulating and choosing between the different forms of the application.

In some cases, for example in a study of the introduction of a computer system to handle the consolidation of loads in a ‘freightforwarding’ company which organised the import and export of goods, [1], it has been possible to obtain an 'off the shelf' system and implement it in part of the organisation as a trial system. This process enabled a wide range of implications to be revealed very quickly and the user population was able to develop their understanding of the issues and formulate their requirements so that a usable and acceptable system could be planned and implemented.

Although trial systems offer considerable benefits, not least because they are concrete and in context, there are three major drawbacks to their use:

- there may not be an appropriate 'off the shelf' product that is available
- it is expensive in time, money and staff commitment and many organisations are not prepared to invest the resources required
- only one of a number of possible visions of the future is examined and there is no possibility of comparing other avenues that may be equally promising.
The use of scenarios as an alternative way to generate the user and organisational requirements offers a potentially fruitful method by which the implications of applications can be tested early in the development process without mounting a full scale trial. Scenarios can address technological developments which are not yet available, they are relatively much less expensive to implement and it is possible to generate a number of alternative visions of the future which take account of the different options available. There are several requirements capture methods by which stakeholders work with scenarios, eg JAD [2], and Search Conferences [3], but the form of the scenario or the process of engagement with it is not discussed. The intention of this programme of work is to address the role and form of scenarios in the requirements capture process and the procedures by which they might be used.

2. Objectives and methodological considerations

The work reported here aims to explore the role of scenarios as a mechanism enabling stakeholders in a user organisation to formulate their requirements for a system very early in the development process. There is an applied objective to develop effective methods for this purpose and a series of field studies has been carried out in which different forms of scenario-based design have been used in the requirements capture phase of systems development. There is also a research objective which is to understand the behavioural phenomena associated with the generation and evaluation of visions of the future rendered in the form of scenarios. This relates to the behaviour of the participants in the scenario-based exercises and the development of theories and concepts about the variables which influence effective behaviour in this context. Strong theoretical foundations are needed to enable generalisation of the methods over the range of circumstances in which they might be used.

Each of the field studies contains a research element in that different variants of the scenario-based approach have been tried and in each case there is a systematic attempt to review the effectiveness of the approach in relation to the particular circumstances. There are always limits on the degree to which it is possible to engage in systematic investigation in field settings. The advantage of the field studies is that they test the methods with real stakeholders and real systems. In each case, however, the scenarios have been used in different ways and judgements of their effectiveness have to be grounded in the specific design context, particularly the role played by the users in each case. In order to establish generalisations about important properties of scenarios and the methods by which they may be used, empirical investigations of the ways in which the attributes of scenarios affect the responses which are obtained have been carried out in parallel. In the empirical studies there is more control over the variables of interest but the reality of the systems design context is much diminished, if it not lost altogether. The programme of work described here is based on a mix of the two approaches with a view to developing a conceptual structure that is both systematically developed and tested by reality.

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At present there are data from nine field studies, which are listed in Table 1, where a scenario-based approach has been used. One of these, Case 5, the benefit eligibility case, is presented in some detail in section 4. The data from the other cases will inform the review of the lessons learned in section 5. In addition to these cases six empirical studies have been undertaken to examine particular facets of the process of constructing and evaluating scenarios. For example, one study examined the degree to which people representing stakeholders differed in their assessment of a scenario from the views of the actual stakeholders. In another example scenarios were presented in different degrees of concreteness to examine the differences in the assessments made by evaluators. The lessons of these studies are also discussed in section 5.

3. A conceptual framework for socio-technical systems scenario-based design

In developing this approach to the use of scenarios for socio-technical systems design, three perspectives have been adopted which are based on three different theoretical frameworks. These perspectives contribute to scenario-based design as depicted in Figure 1.

3.1 Development perspective

The first perspective views development as a technical, social and political process. There are many models which depict development as a process involving stages such as feasibility, requirements specification, design, implementation etc. For the purposes of this paper, scenario-based design has been located as part of the requirements specification process. Development is a social process involving the interaction of a number of specialists and different user roles and there are some important distinctions between, for example, customers and providers. The work described here is set in the context of a user organisation commissioning the development and implementation of a system from technical specialists, either within their own organisation or from an organisation providing the service from outside. Within the user organisations there may be many other stakeholders who have an interest in the planned system such as users, managers, purchasers etc. The development process involves many stakeholders who will have different roles, power, responsibilities and contributions to make. The process of using a scenario-based design method as a requirements generating method has to recognise the social and political environment in which it takes place.

3.2 Socio-technical perspective

The second perspective focuses upon the form of the planned system. In the field examples described here, the interest lies in the socio-technical system [4], with the elements described in Figure 2. There is a planned technical system which will be used to support a business process within the user organisation eg the accounting process, the management of freight forwardering, the teaching of children etc. The business process is performed by a number of people occupying work roles within a social system. The people in the work roles use the technical system to undertake their tasks in the business process.
3.3 Stakeholder perspective

In the third perspective the concern is with how scenarios are used by stakeholders to help establish requirements for future systems. It is necessary to understand the psychological task that stakeholders are asked to undertake when they are presented with a scenario and asked to make an implications analysis. They are usually asked to do two things. First to use their knowledge of the relevant tasks, processes and organisational context to indicate the consequences that would emerge and in particular to identify changes that would occur. Second to use their particular stakeholding (or understanding of the actual stakeholders) to place positive or negative valuations on the consequences and changes.

One theoretical formulation of value in understanding these processes is the concept of knowledge being 'ready to hand' [6]. In other formulations it is said to be implicit knowledge. The people who evaluate scenarios are chosen because they have knowledge which is relevant to understanding the implications of the scenario but the knowledge may not be easy for them to verbalise because it is knowledge acquired through action, triggered and controlled within action programmes. It is not stored in consciously created 'mental models' and is not available for expression through verbal interrogation. An important area for investigation is the extent to which scenarios can create a context within which the knowledge gained through experience can be liberated to make a constructive contribution to the requirements generation process.

4. Applying the perspectives to an example of scenario-based requirements generation: eligibility to receive benefit (case study 5)

The example below is used to demonstrate how the different perspectives relate to the use of a scenario-based approach to generate requirements in one of the case studies listed in Table 1.

4.1 Background

A government agency had established a project to replace a computer system. Local offices of the agency referred cases requiring judgements about claims for benefit to specialist centres when there was uncertainty about eligibility. The staff in the specialist centres communicated with the local offices and with staff in other agencies and organisations in the private and public sector in order to collect information relevant to the claim. They also used published guidance and case law concerning the relevant regulations to aid the decision making. An existing office automation system was used to support case handling but was quite old and becoming unreliable. Changes in the operation of the business and the links with the other agencies were projected to occur within the timescale of the development, and the business process within the agency would be subject to review.

4.2 The development process

The development team (perspective 1) was in the early stages of planning the project. The activity was led by a central business team who operated the existing computer system and who are the clients for the new system. This team had commissioned an internal information systems group to specify the system which was to be provided by an external IT partner. The business group were also considering the possible business and organisational changes affecting the administration of the benefit and the relationships these could have to the technical system to be supplied. The majority of the end users were located in offices distributed throughout the United Kingdom, organised by region. The agency had a tradition of involving users in the discussions about new systems from early in the process.

4.3 Socio-technical futures

Initial discussions about feasible replacement systems within the business and IT groups revealed a number of options which were more or less radical (in terms of technical facilities and organisational change) and which had varying timescales for implementation. The task for the user-centred design team was to assist with the specification of the system, taking account of both current and future tasks, business processes and organisational structures. A scenario based approach was adopted to assist with this and, as a result, four socio-technical systems
were modelled using scenarios. These may be summarised as:

- a direct replacement of current functionality retaining the current business process and organisation,
- a replacement system with additional processing facilities but the same business process and organisation,
- the additional facilities plus networked links with other systems and internal changes in the organisation of the office and
- the networked system accompanied by major changes in the business process and organisation.

4.4 Scenario realisation and stakeholder evaluation

The scenarios were realised as business flow diagrams with pictorial illustrations accompanied by a textual description of available facilities. To construct the scenarios the user-centred design team visited eligibility offices to study the current work and worked with the business process and IT development team to understand the technical and business options being considered. The scenarios to be examined were then constructed and discussed with the business process and IT development team to ensure they covered the critical issues that needed to be addressed.

Each scenario included a representation of (a) the activity flow and the responsibilities that have to be met at each stage, (b) the current holders of the responsibilities and (c) the links to external agencies which are involved in the process but beyond the remit of the systems change under consideration. A summary version of this basic representation is provided in Figure 3. For each scenario the proposed technical facilities were overlaid on the work flow diagram such that the relationship with each responsibility was depicted. In the scenario which included networked links to other systems, for example, the representation showed that, when a case was transferred from a local office all the case data was transferred electronically. This was not true of the system currently in place.

The scenarios were evaluated in a one day workshop to which representatives of all the different stakeholders were invited. Those attending included users from all grades of staff in the local offices and from all regions in the country. Each of the scenarios was presented from the least to the most radical and stakeholders were invited to explore the organisational ramifications of each.

In other scenario workshops it has been possible to assign representatives to the work roles, for example, the clerk, the assessor and the court officer, and to take example cases and work through the process discussing the envisaged role of the new computer system at each stage. This process enables the stakeholder to closely examine the implications for the fulfilment of specific responsibilities and to ‘live the future role’ see, for example, Eason and Olphert, [7] for a description of how this process worked in Case Study 6, a mobile communications system for service electricians). It is through this process that stakeholders are helped to articulate implicit knowledge and apply it to the scenario in question.

In the benefit eligibility case the time restriction meant that the process had to be completed in one day and respondents were invited to view each scenario from the perspective of one of the work roles and identify issues and requirements associated with that role. To assist them they were given a checklist identifying different types of implications. The first and most direct level was the technical facility available to support each task. As an example, some of the local office staff asked whether they would be able to access notes for several cases simultaneously as it was not uncommon for them to be working on one case and to receive a telephone query about another. The checklist worked outwards through implications for the work role as a whole, to relations with colleagues and with external agencies. In this study the stakeholders raised questions about the future workload and even the continued existence of the role of the clerk. In the current system the clerk creates the case record but in some of the future scenarios most of the information would be received electronically, reducing this activity considerably. There were also perceived second order implications in relation to other agencies, for example, if there were network connections to systems used in other

![Figure 3](attachment:image-url)
agencies what protection would there be to stop the staff in these agencies accessing the highly confidential material contained in the benefit eligibility system?

The stakeholders came from many levels in the organisation and there was limited time to collect their responses to the scenarios. To overcome any issues of power and status and give everyone an equal opportunity to contribute, the scenarios were displayed on the wall and after each was presented the stakeholders were invited to ‘post’ their comments against the relevant responsibility or role holder etc. After working with each scenario the participants inspected the collective comments and considered the major implications in a group discussion.

4.5 Outcomes

Having considered the options and the feedback from the Scenario workshops, the development team decided to proceed with a hybrid solution in which a networked system would be developed and delivered as Phase 1 and, in parallel, an enhanced version of the system would be developed as the organisational changes imposed by the other agencies became clearer, this version to be implemented as Phase 2. It is important to stress that the feedback from the scenarios did not lead to a choice between them, but rather that the strengths and weaknesses of each were used to inform the requirements developed for the project as a whole. It is also worth noting that the development team identified a need to continue the use of scenarios as development progressed in order to assess the implications for more detailed aspects of requirements.

5. Lessons and issues in scenario-based design

As has already been indicated the use of scenarios in each of the field based case studies had unique characteristics, not simply because of the differences in the domains but in terms of the design context and scope for engagement. However it is possible, through analysis of each of the case studies, to identify a common set of issues which has to be addressed when using a scenario-based approach to specify user and organisational requirements. Coupled with the results of the empirical investigations this information is being used to develop a systematic basis for deciding on the procedure to be used in a new design context. The nature of the emerging procedure and the issues that have to be addressed are summarised in Figure 4. The procedure involves seven activities each of which gives rise to questions about the effectiveness of alternative ways of dealing with scenarios. For the purposes of this paper discussion is restricted to consideration of the Socio-technical Futures and the Scenario Evaluation perspectives. The broad development issues are treated as contextual issues in the results described below.

![Figure 4](image-url)

**Figure 4** Issues in the use of scenarios for requirements generation

Each of the issues listed in Figure 4 will now be discussed with the intention of isolating some of the critical factors and reporting the conclusions that have been gathered from the data at this point.

5.1 Generating alternative futures

An almost limitless array of alternative futures can be generated. There are different variants of the technology, different ways of adopting the technology within the organisation, different ways of changing the organisation, different timescales, different levels of description of the scenario, and the scope may encompass more or less of the organisation. The choices made about what to use in the scenarios which are created are essentially pragmatic, and usually driven by those factors that will address the most significant questions about solutions to the design problem or the questions that will clarify the risks associated with the design problem. However, each scenario that is generated needs to be clear about its boundary and the future that it seeks to represent.

Given the purposes for which these scenarios are being used it will be apparent that there is much less emphasis on the extent to which they replicate current practice than is the case for other types of scenario usage. The most important questions may be about what the implications will be of doing things differently. One outcome may be to clarify which aspects of existing practice are likely to be enduring and therefore form part of the requirements, and which aspects of existing practice may no longer need to be taken into account. For example, in examining the implications of new systems for the exchange of accounting information, (Case Study 7), it was evident that a scenario where accounts would be available for the world to see in real time, would be neither acceptable nor practically achievable given the enduring nature of the
5.2 Modelling socio-technical systems

The identification of the alternative futures to be incorporated into scenarios may often be governed by pragmatic considerations but there is a requirement to model these futures in a systematic way which expresses the elements of the socio-technical system and the relationships between them clearly and unambiguously. The development of modelling languages to accomplish this has been, and continues to be, a significant area of independent research because of its centrality to the problem of the formal specification of requirements. The work reported in this paper uses the ORBIT Modelling approach [9] as the basis for most of the case studies. In particular the ORBIT approach stresses the nature of the structural relationships between the social and technical components of the system and places emphasis on the roles and responsibilities of the human agents, which is particularly valuable in elaborating what people will be doing in practice in the future which is being envisaged. However, the choice of a particular form of modelling language is less important than its capacity to provide a systematic framework within which to express the alternatives.

5.3 The realisation of the scenario

It is in the realisation of scenarios that the scope for more empirical work seems to offer most opportunities. For example a study of a student information system [10] demonstrated that the level of specificity of text based scenarios did indeed affect the underlying character of the responses obtained. A variety of forms of representation is available, including text, diagrams, pictures, video, drama and role play. Within any of these there are a variety of options for the degree to which they are detailed and the extent to which they appear complete and “polished”. Experience [11] indicates that it is the capacity to make things seem concrete which enables respondents to relate to the scenario and to respond on the basis of their experience and knowledge. However, it is possible that if the scenario is extremely concrete judgement may be based on the particular attributes of the scenario rather than the general characteristics which may be under investigation. Nevertheless, experience with the mobile communication system case (Case Study 6) has demonstrated that the availability of a video involving existing role holders carrying out their day to day activities provides a powerful additional source of information making the diagrammatic and text based sources of information more meaningful [7].

There is considerable scope for developing understanding of the effects of different types of rendering on the kind of information which can be generated. This in turn will be useful in determining the benefits of moving beyond what has been the dominant format in most of the current field studies, ie text supplemented with simple diagrams.

5.4 Who participates in the evaluation of the scenarios?

The purpose of this work with scenarios is to help stakeholders generate the requirements they have for a future system. The obvious way to accomplish this is to ask the stakeholders themselves to engage directly with each scenario adopting the perspective of their work role to evaluate the implications of the scenario. This process enables them to use their knowledge of the work role to provide an informed commentary on the implications of each scenario and to use their stake in the future to evaluate the advantages and disadvantages. There are many occasions when it is not possible to engage the stakeholders themselves. It may be that, in a “green field” development for example, it is not possible to gain access to existing stakeholders. Within existing user organisations the power structure which directs the project may limit the possibilities of direct engagement. It is common to find that the managers who commission a development do not want to engage with other stakeholders at an early stage. especially if they want to examine scenarios which are unlikely to be implemented and which may either have negative consequences for some stakeholders or create unfulfilled aspirations. The principle of ‘why worry them unnecessarily’ is often advanced as the reason.

In these circumstances it is necessary to use substitutes for the real stakeholders in the evaluation of scenarios and it is important to understand the implications of such a process. It has been possible to experiment with the use of different kinds of substitutes in different studies. It might be expected that the closer the substitute to the actual stakeholder the better would be the outcome and this appears to be the case. The substitutes need to understand both the work role and the motivations of the people they represent and they are more likely to have that knowledge if they are part of the user organisation. However, substitutes from within a user organisation have their own roles and motivations and can easily slip out of the role they should be considering and into their own perspective. In the mail delivery case (Case Study 3) the substitutes were junior managers who tended to respond with the
management line rather than that of the work role holder. This effect was compounded by the fact that there was very little time to present each scenario and a detailed description of the work roles in the scenario was not provided on the assumption that this was common knowledge to the scenario evaluators. (In retrospect this assumption should have been investigated more closely before the scenarios were presented). The same scenarios were evaluated by students who knew nothing of the work processes and work roles and they were provided with a full role description. Their evaluations were much richer than those of the actual staff. The students found it relatively easy to identify the direct effects but more difficult to detect second order implications or to evaluate the likely reactions of the staff concerned (see Section 5.6 below).

The conclusion drawn is that if the role structure and work responsibilities are described as part of the scenario, the structural implications for the role can be detected by most participants. Where these are not part of the scenario, participants will revert to their own perspectives. Second order implications and evaluations depend on knowledge of local conditions and are difficult for people not in the know to identify with any confidence. This reinforces the view that participation of real users is necessary if all the implications are to be understood.

5.5 What is the process of engaging with the scenarios?

Just as there are many ways a stakeholder can engage with a prototype, from passive viewing to actively engaging in a task, there are many ways of engaging with a scenario. The demonstration mode is to ask a user to listen to or read a scenario and then offer a structured response. A more active role play mode consists of presenting the scenario with examples of the tasks and concerns of the role holder and asking the stakeholder to imagine undertaking the tasks in the scenario. An even more active dramatic mode is to write fictional scripts describing what happens in particular episodes of a scenario and perhaps to ask stakeholders to act out the part of the role holders in the scripts. In the telemedicine case a range of modes has been used, short of asking participants to act out the roles, and it does appear that the more active the engagement the more effectively people are able to stay in role and offer specific evaluations [12]. A danger however, rather like the issue of rendering the representation concrete, is that stakeholders respond to the specific details of the scripted episode rather than to the general properties of the socio-technical option.

Another issue concerns the social dynamics of engaging with a scenario. Is it better carried out as a workshop debate, group work or individual confidential analysis? How do status differences, different modes people are comfortable with, and the development of shared understanding and statements of requirements affect the nature of the responses obtained? As yet there is not sufficient data available to offer considered answers to these questions.

5.6 What data is gathered about the participants reactions to the scenarios?

Assessing the implications of a socio-technical scenario means examining the effects it would have on jobs and work organisation. People do not assess these implications in a systematic way unless they are given support. The computer impact literature [13] has identified the many kinds of impact there can be and this work has been used to provide a classification structure for evaluators to use. The evaluation begins at a direct or micro level with the impact of information technology on the information processing tasks of the staff in the relevant work process. It then works outwards through the impact on the whole job to the relations between job holders in the work process to broader organisational consequences (including job losses) to inter-organisational issues. Typically the direct effects (on the task and job) will follow immediately from the implementation of the scenario but the less direct second order implications (on the organisational context) may be experienced later and may be the result of further action, eg by management, to exploit the new productivity that is now possible.

In the naval manning scenario (Case Study 4) the participants found it relatively straightforward to provide rich commentaries on the direct effects of providing new technology to support particular work roles. When asked immediately to examine the second order implications on group work, manning structures and career issues they reverted to a general debate that was not specific to the scenario. More work was needed to develop the outputs from the first analysis into new scenarios for the socio-technical futures that might emerge and impact on such aspects of naval manning.

5.7 From implications analysis to user requirements

Elicitation of stakeholder responses to alternative scenarios for socio-technical futures does not, of course, automatically translate into an agreed set of requirements. Different stakeholders are “winners” and “losers” in different scenarios. The way forward is not necessarily to select one of the scenarios but to bring together those elements from each which together offer a way forward to meet the requirements of the different stakeholders. Ideally the aim is to find a ‘win-win outcome’ [14]. In several of the scenario-based cases, for example mobile communications, eligibility for benefit, freightforwarding and telemedicine, the system under consideration after the scenario evaluation was a new variant of the scenarios examined.

The strength of scenarios lies in their value in revealing where the gains and losses are and in making the consequences explicit. While the basic process does not in itself resolve inherent conflicts, some of the mechanisms used to evaluate the scenarios which involve groups of stakeholders working together can also serve a function in building consensus and identifying ways of optimising...
outcomes for all concerned. The mediation of these versions by translating them into more formal models of the socio-technical future also offers advantage to the overall specification of requirements.

Ultimately the determination of priorities is vested in the organisational, social and economic dynamics of the design context and therefore is linked back into the overall context of development as represented in perspective 1. A full discussion of the implications of participation in scenario based design processes for the empowerment of stakeholders with respect to design is beyond the scope of this paper, but one observation arising from these studies is that users benefit from the increase in their knowledge and understanding of the issues.

6. Conclusions

This paper has sought to describe some of the major features characterising the use of scenarios for the purpose of generating the requirements of stakeholders. As a result of the experience of working with scenarios in a series of field studies, the authors are convinced that this method can play a major role in the requirements capture phase of development. When it works effectively the stakeholders who participate emerge much better informed of the implications for their future. It has been possible to define a process for undertaking scenario-based design for these purposes but the detailed form it takes is dependent upon the systems development context in which it takes place (perspective 1).

There are many issues that need to be addressed systematically if a mature process is to be created which can be used effectively in the requirements capture phase of development. Some of these issues relate to the selection and development of appropriate socio-technical systems scenarios (perspective 2) and refining this process will need to be undertaken in field settings. However, the ability of participants to work with scenarios depends upon the realisation of the scenario and the process by which they engage with it (perspective 3). These issues can be addressed systematically outside of the field setting and it is to issues such as the concreteness and specificity of the scenario and the degree of role play engagement of participants that attention needs to be given if this use of scenario-based design is to be effective.

References


