original | copy No:

A Report on a Procurement Exercise Employing Scenarios and a Requirements Pattern Language

PETER MERRICK peter.merrick@uea.ac.uk

School of Computer Science, University of East Anglia, Norwich, NR4 7TJ

tel: +44 (0)1603 592847

PATRICK BARROW pbmb@cmp.uea.ac.uk

School of Computer Science, University of East Anglia, Norwich, NR4 7TJ

September 28th. 2005

Abstract

This research reports on the efforts made at the Health and Safety Executive to procure a new COTS application for the management of research assignments. A novel approach to the production of tender documents is explored that employs requirements patterns which produce scenarios from use cases. This differs from other approaches in that it is claimed to be faster than other methods making it particularly well suited to procurement. Adopting this approach led to the articulation of scenarios that pre-defined the demonstrations suppliers were required to perform. The effect was to request supplier demonstrations that were directly comparable, thus allowing a measure of functional fit between requirements and product features. A procurement cycle is reported that was deemed inclusive from the perspective of the end-users, and which focussed on functional fit as a measure for supplier selection.

Keywords: scenarios, procurement, COTS

Introduction

The research reported here took place within the Health and Safety Executive (HSE) in the U.K. with the recognition that, over time, three separate applications had come into being for the management of research contracts, operated by different business units. None of the applications had been professionally built; they were all 'home-grown', having come into existence through the effort of the users themselves. This situation became unacceptable when a new IT maintenance company was asked to provide application support, and the complexities of doing so became apparent. The project's purpose was the recommendation of a replacement for the three existing applications. Although a bespoke solution was not ruled out, the likelihood that the replacement system would be a Commercial Off-the-Shelf (COTS) application was considered likely by management as the suspicion existed that the functionality that was required was generically referred to as 'contract management'.

The scope of this research was to determine whether the application of a requirements pattern language would result in a superior procurement cycle. Past procurement cycles of COTS solutions had suffered from a lack of 'know-how' that would allow the HSE to match its functional objectives against the pre-configured functionality offered by any one of many possible COTS applications that would result in a good fit, thereby minimising implementation risk and required expenditure.

The first task to the replacement of the existing applications was to seek user agreement that the tasks they performed were essentially identical, and therefore capable of being managed by a single replacement application. Achieving user support (internal stakeholder 'buy-in') is seldom a trivial matter. Representatives from different departments in the organisation had been discussing this issue for more than twelve months without marked progress; there was no single business case document in existence. It is at this point, and for the purpose of remedying the impasse, that the author became involved through an invitation of a project meeting attended by the interested parties from across the organisation. The author participated in the questioning of user representatives and captured the relevant responses.

The result of attending this user meeting was the capture of a natural language description of the workflow for the management of research assignments which is reported here.

The Requirement

Within its mandate, the HSE is responsible for identifying hazards in the work place and reporting on ways in which those hazards can be minimised or eliminated. To do so they have a research budget which is spent on research assignments that address pressing safety concerns. Research assignments are carried out by qualified specialist providers drawn from industry or academia. By way of example, a research concern might be ‘injuries sustained in falls from height’, and a specific assignment might be ‘the design of safety harnesses’. The HSE is sub-divided into the Chief Scientific Office (CSO), and the Nuclear Safety Inspectorate (NSI); both of whom hold their own budgets and are responsible for how money is spent.

In the general case, an assignment is proposed, and those individuals who have an interest pass comment on the strength of the argument for carrying out the research. When everyone who is qualified to comment and who wishes to do so has had their opinion canvassed, a decision can be made as to whether the research should be undertaken. If the research assignment is to be taken forward, a suitable research provider will be sought, and a contract to undertake the work agreed. The research then proceeds. Periodically reports may be submitted culminating in a final report. As work progresses payments may be made in stages, or against milestones, or simply when the work is completed. NSD function in the same fashion but with the additional complexity that they recharge the costs they incur back to the nuclear licensees (the companies that own and operate nuclear power stations).

Assignments that are considered small (in monetary terms) do not have to pass through a rigorous approval process. Large assignments require approval from the budget holder before suitably qualified providers may be sought and contracts agreed.

Once an assignment is completed, the results may be referred for peer review, and/or public material published to the internet. Eventually, the results become out of date and the material is archived.

Apart from the need to replace three systems, (no longer deemed capable of technical support) the project stakeholders were made aware of the advantages a new system could bring by allowing for budgetary reporting across the entire activity; a task that had previously been difficult to accomplish. In addition, it was agreed that it would be an improvement if the departments were able to perform budgetary forecasting with respect to the likely impact of their commitments whilst exploring different hypothetical research assignments.

Modelling the Problem

Generally, procurement exercises rely on a natural language description of the problem in-hand that is communicated to potential suppliers via an Invitation to Tender (ITT) (sometimes preceded by a Request for Information (RFI) and/or a Request for Proposals (RFP)) [1-3]. There are recognised problems with natural language descriptions, in that language of this sort is often ambiguous, seldom describes behaviour which is discrete, and tends to mix functional and non-functional behaviour together in a manner that is not helpful.

The objective of the modelling exercise, undertaken in this research, was to first arrive at a use case model that the business stakeholders could agree upon thereby soliciting their support in the procurement exercise. Secondly, the accepted models would then be employed to create user scenarios to populate the ITT to short-listed suppliers. Suppliers would then be expected to demonstrate the conformity of their products in the satisfaction of the user scenarios. In this way, it was hypothesized that the quality of the COTS presentations would be improved, by way of being more meaningful to the audience of user representatives.

Use cases are recognised as being a superior mechanism for the communication of user requirements. However use cases are not generally employed in the procurement cycle because they are constructed according to an iterative process that is deemed too time consuming to be acceptably quick in the typical procurement cycle.

To overcome the twin problems of ambiguous natural language description, and time-consuming use case creation, a requirements pattern language (Inflatable Pattern Language for Procurement (IFPLP)) was employed for the creation of an early lifecycle use case model that the author had previously shown to have merit [4, 5].

Identifying Actors

The application of the IPFLP first calls for the identification of the users of the proposed application and their inter-relationships.

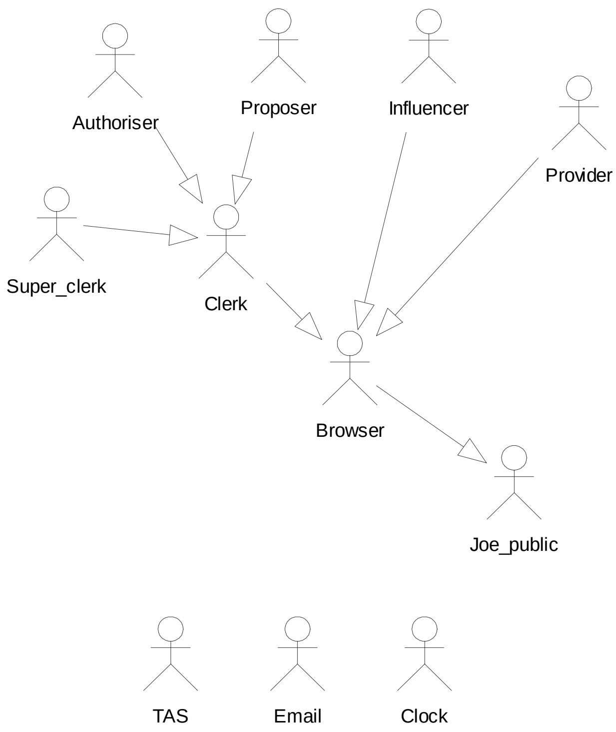

Figure 1. The actor set identified for the management of assignments represented in a hierarchical structure. Actors are related by inheritance. When actors are associated through inheritance it is not structure that is being inherited but permissions over defined functionality.

The actors represented in Figure 1, were identified through recourse to the *Usual Suspects* pattern (part of the IFPLP). The objective of this pattern is to allow for a rapid identification of roles, known in UML as *actors* [6, 7], who have a high likelihood of occurring in a business-oriented software application that offers a service to an end-user.

In Figure 1 the actors in the envisaged application are illustrated. The actor *Joe_public* has permissions to browse over public material and conduct relevant searches. All users come onto the system with this authority prior to logging-on. When a known user logs-on, their profile is found and an interface appropriate to their permissions is presented. A user can log-out manually, or is automatically logged out according to the business rules (e.g. on machine shut down).

A *Clerk* enters data with respect to the day-to-day management of an assignment. The *Clerk* can perform all mundane functionality, but does not take important decisions with respect to the management of an assignment or budgets. The *Clerk* also performs searches and runs reports.

The *Super_clerk* creates all new user profiles and performs modifications to user profiles. This actor is also responsible for managing concerns, and for the definition of *Providers* and *Licensees*. *Super_clerk* inherits the permissions of *Clerk*.

The *Proposer* has ownership of an assignment and its lifecycle of state changes. She decides when a prospective assignment should go to the *Authoriser* for approval and which *Provider* should be awarded an assignment. The *Proposer* searches over budgets and inherits the behaviour of *Clerk*.

The *Authoriser* manages all aspects of budgets and also decides whether a prospective (tentative) assignment becomes a pending (with authority to proceed) assignment. The *Authoriser* inherits the behaviour of *Clerk*. The *Influencer* receives email notification with respect to assignments that are of concern to them. The *Influencer* is able to attach comments to prospective assignments designed to persuade the *Proposer* as to value of a particular piece of research being undertaken. The *Influencer* inherits the behaviour of *Browser*.

The *Provider* is the actor that represents the role of the research organisation that undertakes the research assignments. The *Provider* can perform updates on the definition of progress being made on an assignment. *Provider* inherits from *Browser*.

The *Browser* is an actor that can view all information that is internal to the organisation in its dealing with third parties. It can be thought of as an 'extranet' user, an individual who can access data such as that regarding potential opportunities that have not yet been awarded.

The *Clock* is a non-human actor (as is the *Email* actor and *TAS*) that generates automatic reminders and reports. It is a type of trigger for automated behaviour. The *Email* actor is a simple interface to standard communications functionality. *TAS* is the existing accountancy system.

Considering Data

The next pattern in the IFPLP is *Minimal Data Representation*; useful in the rapid identification of the major data entities that must be supported. It is necessary to discover these data entities in order to uncover the essential behaviour and requirements that must be satisfied.

The discovery and representation of a database schema normally takes place later in the development lifecycle, and is the object of much effort designed to ensure the database is efficient. The purpose of this pattern is to act as a 'short-cut' in producing the smallest possible set of data entities that would be required in an application that could support the stated business requirement. Data is an important component of IT systems that can be usefully employed in gaining an appreciation of the size and nature of the eventual system that will emerge.

In order for this pattern to be employed, a natural language specification, (normally the document known as the *business case requirement* or similar) must be consulted in the identification of entities. An entity is defined as an identified concept, having an independent existence thought to naturally exist in our minds [8, 9]. Entities are one of the phenomena Jackson describes as being present in the problem domain [10]. A useful way of identifying entities is to identify nouns through the technique of noun analysis [9] However not all nouns represent entities, and not all entities will initially need to be modelled. Exceptions to the mechanistic approach of accepting all nouns in the problem statement as candidates to the minimal data representation are presented in [5]

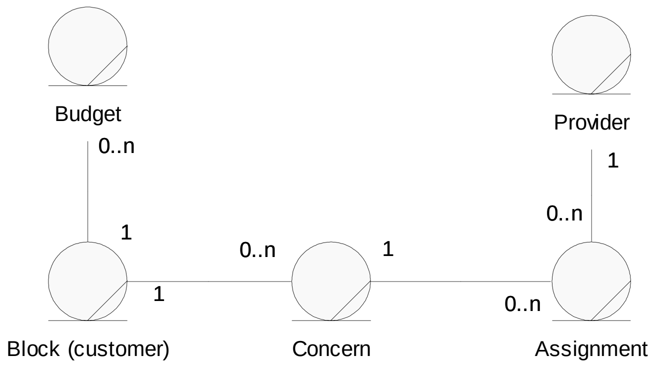

Figure 2. The minimal data representation is a logical model required for the management of assignments. It is created through the application of the *Minimal Data Representation* pattern.

In Figure 2, the main entities are represented along with their notional cardinality. Cardinality is not necessary to express, but it is useful in articulating and testing business rules and assumptions. In exploring cardinality it becomes clear that a *customer* has many *concerns*, and each *concern* may have many *assignments*. Equally each *customer* (department or *block*) may have many *budgets*. A *provider* may undertake many *assignments*, whereas an *assignment* only ever has one associated *provider*.

From the diagram of the minimal data model in Figure 2, it is possible to identify the 'key class'. The key class is the entity that undergoes the greatest degree of state change. Articulating the state change of the key class is a prerequisite of deriving the use cases that will inform the user stories (scenarios) that will, in turn, provide the basis of the ITT [11].

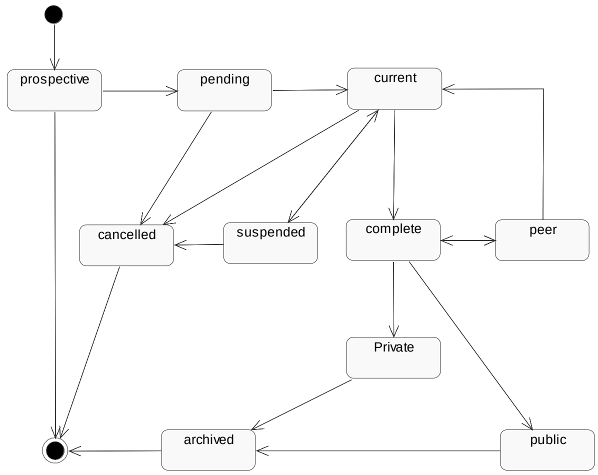

Figure 3. State diagram of an *assignment* illustrating the lifecycle of this key class from creation to the end state.

Figure 3 introduces the states an *assignment* may be in. An *assignment* begins in the *prospective* state, and if it is accepted moves into the *pending* state. When a provider is found and associated with an assignment, it moves into the *current* state. It is possible that an *assignment* may be *suspended*, or even *cancelled*, though normally it will continue until it is *complete*. A *complete* assignment may go to *peer review* from which some revision may be undertaken, or it may immediately be made *public*, published for *private* consumption, or directly *archived*. Eventually the results of an assignment become out of date and are *withdrawn*. Such is the lifecycle of an *assignment* in the HSE.

Use Case Modelling

To produce an early lifecycle use case model, the New, Search, Modify (*NSM*) pattern was applied. Use cases can be represented at different levels of abstraction. It is imperative that models are 'levelled', whereby they do not mix use cases at different levels of goal abstraction [12-14]. Use case models are normally constructed only once a supplier has been chosen, however in this situation a way is sought where use cases can be defined during the procurement phase. Use case modelling is generally time consuming; instead a method is required that allows use cases to be identified quickly. It is not mandatory that every candidate entity identified by *Minimal Data Representation* should be subject to *NSM*. Entities that change very rarely (that are more akin to *constants*) are unlikely to benefit from *NSM*. One test as to whether *NSM* is applicable is whether an actor interface is required to manage the entity. Applied indiscriminately, this pattern generates three use cases for each data entity; *New* <<entity>>, *Search* <<entities>> and *Modify* <<entity>>. Formal analysis of the candidate use cases is necessary to derive a more appropriate set based on business rules and state changes. In this example, and for the benefit of conserving space the tag *Manage* is employed to represent New, Search and Modify, following Cockburn [13].

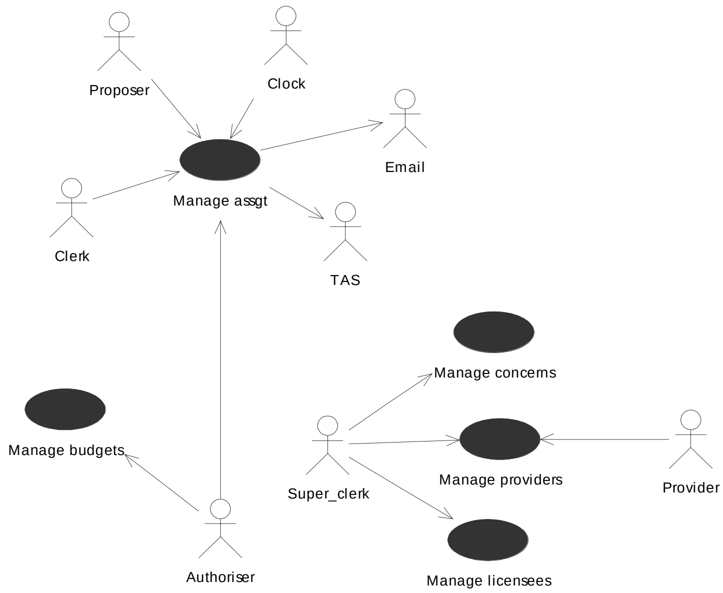

Figure 4: A high level business use case model that includes the main actors identified in Figure 1. These use cases are abstract, in that they are represented at a high level in the hierarchy of user goal abstraction. They have a graphical representation, but no textual components. The audience for these use cases is senior management. In addition, they are a convenient way to introduce wider functionality that is later introduced through more detailed use cases.

Figure 4 is not detailed enough to capture enough information from which the use cases that will be transformed into scenarios for inclusion in the ITT. They need to be further de-composed. For example, the use case tag *Manage Assignment* was combined with the state diagram of an assignment in Figure 3, to produce the more specific use case model featured in Figure 5.

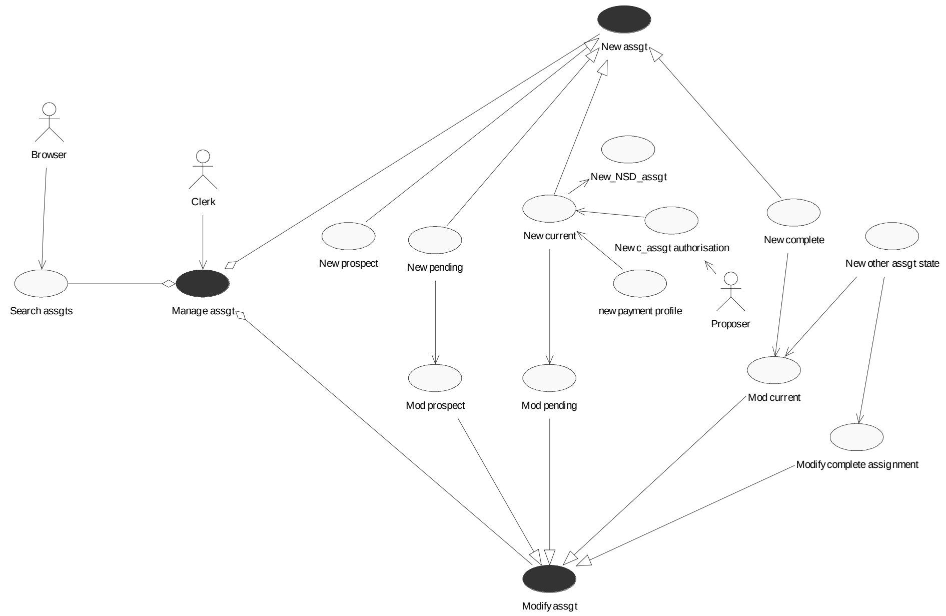

Figure 5: A representation of the decomposition of *Manage Assignment*. Aggregation has been used alongside the standard UML <<include>> association to allow high level (abstract) use cases to be decomposed and represented in a hierarchical structure [15].

From Figure 5 it is possible to identify individual use cases that must specify a use case textual component as opposed to simply offering a named oval like those depicted in Figure 4. Once the use case has been identified its textual component can be written. It is a simple process to move from use case text (abstract) to a user scenario based on the underlying use case (concrete language). Scenarios can be verified with users for correctness, in that they correctly represent the function that is typically performed. This is the process followed in the experiment by which the correctness of the model was tested and the output of the pattern language shown to be a true reflection of the behavior required by the users in the execution of their job to manage the lifecycle of research assignments.

Following this process it was possible to identify a representative candidate set of scenarios that would be included in the ITT and thus form the basis of the supplier demonstrations.

The Procurement Process

Increasingly customers are choosing to satisfy their IT requirements by buying Commercial Off-the-shelf (COTS) applications rather than contracting for the supply of a bespoke application. There are many reasons for this, but chief amongst them is the perception that the COTS route carries with it less project risk; being more likely to be delivered to time and to budget. However going down the COTS 'road' carries with it significant challenges that are different from those contained in a bespoke development [16-21]. Primarily, the challenge in COTS procurement is being able to match the user requirements with the features available in the various COTS applications. In this respect, the challenge is being able to choose from a wide variety of possibilities capable of satisfying the functional requirements, and then balancing the functional fit with the non-functional architecture and the commercial imperatives (cost, commercial terms, size of company etc.).

The procurement process followed at HSE included the identification of a 'long list' of potential suppliers from internet based research. Once a long list had been established, the vendors on that list were sent a RFI (Request for Information) questionnaire. Responses to the RFI allowed the long-list to be reduced to an 'intermediate list', from which a 'short-list' of candidate suppliers would be selected. Suppliers on the short list would then be invited to give a demonstration of their product's 'goodness of fit' in satisfying the users in the audience based on showing their products in action fulfilling the requirements of each of the pre-defined scenarios with which they had been supplied.

The long list contained ten potential suppliers. Seven suppliers responded to the RFI. Of the seven responses, one was eliminated due to a poor 'fit' with the HSE hardware architecture. This left six responses in contention on the intermediate list. Of these six, three suppliers were chosen to proceed onto the 'short-list' based on the quality of the responses they made to the RFI with respect to prospective functional fit and considerations of commercial expediency. Suppliers who emerged onto the short-list were invited to give demonstrations of their products. A summary of the supplier demonstrations follows that focuses on the effect of pre-defined scenarios in tailoring demonstrations to user expectations.

Supplier Demonstrations

As an initial requirements model had already been undertaken and use cases identified (with text components written) it was straightforward to transform use cases to scenarios that could form the basis of demonstrations. The scenarios were intended to present user recognisable representative behaviour. It was intended the scenarios should be indicative without being overly proscriptive so that demonstrations could be created within the timescale imposed and the investment each supplier could be expected to make as no payments were envisaged as being required to be made. Each prospective supplier would need to view the demonstration as part of the *cost of sale*. Therefore the demonstration scenarios were a sub-set of the functionality that was envisaged, yet it was indicative of the general lifecycle foreseen in the management of a typical research assignment. The scenarios included in the instructions to suppliers with respect to the demonstrations that were expected were made up of the following: *New concern-budget, New provider, New Current Assignment* and *View concern-budget.*

The following table outlines the format of a typical scenario as presented to the short-listed suppliers from which each was expected to construct their demonstrations.

Table 1: A scenario presented in the style of a use case template.

Use Case ID:	CA 1-0		
Use Case Name:	Manage assignment		
Created By:	PJM	Last Updated By:	PJM
Date Created:		Date Last Updated:	1.9.2004

Actors:	
Description:	Create a new current assignment from an existing pending assignment.
Preconditions:	A pending assignment exists that has been approved and for which budget is available.
Postconditions:	A current assignment exists.
Normal Course:	The clerk discovers that an assignment has been accepted to go forward as a provider has been chosen. The clerk finds the assignment, and updates it with details of the correct provider, plus other information such as the start/end date and assignment value. The clerk defines the payment profile to trigger payment when the work is completed. The clerk saves her work. The system notifies the proposer that an assignment is ready to go forward and be worked on. The proposer checks the clerk’s work and accepts the new information. The system changes the status of the assignment and informs the provider the assignment is now loaded on the system.
Business Rules:	The concern must have adequate money in the budget to cover the projected cost of the assignment.

The other identified scenarios were likewise represented as illustrated in Table 1. The focus of the research turns to the performance of the suppliers on the short-list in the delivery of their product demonstrations.

Supplier 1

The representative of the first supplier began his presentation by complimenting the requirements team, when he said the requirements amounted to the most detailed specification he had ever received (a good way to start from the author's perspective).

The representative said that he had taken three days to configure the presentation. He demonstrated a good understanding of the business domain, and the user language.

According to the representative, the demonstration application *(system 1)* was described as being 'entirely configurable', requiring no customisation (changes to programming code). It was a toolbox, from which 'any' database driven application could be built. This product represents a rapid application development (RAD), where construction is defined as being a collaborative process between the user and the implementer. The demonstration can be described as being accessible in which there was a lot of user involvement.

Of particular note was *supplier 1's* ease and familiarity with the product, which meant he could demonstrate the ability to make changes 'on the fly'. This is always a risky thing to do in a live presentation, but there were no problems showing the audience the ease with which *system 1* could be configured.

The users were very positive about the demonstration and gave it a high approval rating. Still, some disquiet surrounded the amount of configuration that was necessary to deliver a working application. Concern was expressed that *supplier 1* was a small company, and although capable, some members of the procurement team were sceptical about doing business with a company of such small size. *Supplier 1* was able to demonstrate conformance with every defined scenario.

Supplier 2

The representatives of the second supplier gave their presentation on the following day. They fielded a large team of personnel, however no work seemed to have been undertaken to customise the presentation to the pre-defined scenarios. Nor was their evidence that they were familiar with the requirement except in the most cursory way. In fact, they did not seem to understand the business requirement. They failed to communicate with the audience using the language of the business. When it became clear that the audience were expecting to be shown conformance with scenarios, an attempt was made to comply, however they were largely unable to demonstrate any aspect of 'workflow'.

The *supplier 2* team disregarded the defined user scenarios which made their presentation unconvincing and at times uncomfortable. *Supplier 2* acknowledged their presentation was inadequate when they proposed a 'proof of concept' exercise be undertaken whereby their product would be configured to demonstrate the HSE user scenarios. Were this to be done, it would be a 'paid for' exercise, and as such was not an appealing argument, especially in light of the previous day's presentation where all scenarios had been demonstrated, and where no payment was demanded or contemplated. In conversation after the demonstration, the *supplier 2* presentation was deemed to be disappointing.

Supplier 3

The *supplier 3 system* was clearly intended for contract management; contract management was at the heart of the application as opposed to being a more universal tool as could be described *system 1*. The 'goodness of fit' of this product would therefore depend on how closely the management of a research assignment was analogous to the management of a generic contract. Although the HSE specific scenarios were not specifically demonstrated, the presentation made reference to them throughout. The application had not been configured in any way to be representative of the specific language or workflow of the management of research assignments. Instead, the presenter talked about the satisfaction of a particular scenario while demonstrating the configuration of the existing product. This gave the impression the *supplier 3* application offered a lot of functionality 'out of the box', although a significant degree of configuration would be necessary.

In post-demonstration conversation, the product appeared to offer a straightforward implementation route. *Supplier 3* appeared to be confident about the amount of time an implementation would take, which had the effect of making their bid look less risk laden and liable to be realistic.

Results

Before the procurement process could be undertaken, internal stakeholder 'buy-in' had to be secured. This had been an elusive prerequisite for the preceding twelve months. When the use case modeling was presented to the stakeholders in a meeting, they were well received. The meeting lasted 4 hours, after which a questionnaire was distributed asking the attendees to rate their satisfaction with the experience and their confidence that what they had seen was an accurate representation of the system they would like to procure. 83% of the attendees were 'comfortable' or 'very comfortable' with the user model presented, from an audience of six attendees (5 out of 6 – one attendee was uncomfortable with graphical representations of user requirements.)

At the end of the presentation the users were asked to take the models and supporting documentation away and report any issues they had within two weeks. In the event, the only issues that were reported were around the permissions that each actor would have and the nature of inheritance between actors presented in Figure 1. The users were able to come to a unanimous agreement that the model presented was a fair and accurate reflection of the business process they undertook and that the various user communities were now convinced that, in essence, they performed the same activities.

HSE reported a higher proportion of responses to their RFI competition then they had ever achieved before, where 10 invitations had resulted in 7 responses, in the past no more than 3 responses had been received. This meant that in the past, all those who responded had been invited to give demonstrations, whereas employing the described route, the HSE was able to be more selective.

The user community was involved over three full days of presentations. The amount of time allocated to each presentation was more than had been allocated in the past. Each demonstration was allowed up to 6 hours. When asked to comment on their experience of the demonstrations, the generally expressed views of the user attendees was that they had found it easier to concentrate on the demonstrations (the word 'boring' was used to describe past experiences of attending supplier demonstrations). Users felt able to comment on the application demonstrations they witnessed, because they knew what they were expecting to see, and the presentations were set against a pre-defined 'script' as contained in the scenarios with which the users were all familiar.

After each presentation the representatives of the user community were invited to score each product against a set of questions that were derived from the scenarios. The users found it hard to score, because the scoring mechanism was not well defined. However, even with this limitation, at the end of the three presentations the users were able to rank the three presentations in order of preference without difficulty. One system was eliminated from the competition (*supplier 2*) by unanimous decision, largely because they had failed to incorporate any conformity to scenarios into their presentations. Of the remaining two competitors, *supplier 3* was preferred, because it was felt that the management of research assignments was much like generic contract management. Because *supplier 3* had a product that was solely designed for contract management, this option was selected as the most desirable.

The decision of the user representatives was not the only opinion that was to be canvassed in making the final selection. The preference for *supplier 3* was based on functional fit and the perception of low risk by users. Other IT professionals (project managers, architects) were also present at the demonstrations. Although functional fit is not the sole measure on which a procurement decision is made, it is an important measure (arguably the most important measure). In the past, price has been an important determinant of selection, whereas in this process it was relegated to a secondary consideration.

When asked at the end of the process how they had found the experience, the users were unanimous in finding it a worthwhile and felt pleased that they had been able to contribute in a way that had felt inclusive and beneficial. The opinion was expressed that, historically, IT demonstrations and procurement had been profoundly technical, but in this case the presentations had been pitched at a level that gave users confidence in being able to usefully participate.

Lessons Learned

Aspects of the scenario-based approach to procurement were highlighted as requiring more attention. Greater care is needed in designing the scoring system by which users rate suppliers after each demonstration with respect to their ability to show various aspects of each scenario. Weightings as to the importance of a requirements satisfaction were shown to be problematic. It is not clear how the satisfaction of one requirement over another can be reliably weighted. In addition, problems can occur where the failure to demonstrate a function may have the knock-on effect of failing to demonstrate a range of further functions that have the first function as a prerequisite.

It is tempting to suggest that it would be preferable to rate the demonstration on the basis of how convincingly each scenario was presented. Even this approach presents problems. Consider that although *System 1* was configured to give an excellent presentation that demonstrated the actual scenarios and *System 3* was not configured at all. However the overall impression given by *System 3* was that it was able to suggest how the scenarios would be accomplished with confidence. These presentations cannot be directly compared with the same ranking mechanism.

Overall, the process by which the demonstration was defined, with UML based scenarios was successful. None of the suppliers had any objections to the way in which the requirements were communicated, and indeed two suppliers were openly complimentary. One of the suppliers was based in North America, and when directly questioned as to the prevalence of UML based requirements specifications estimated that they accounted for around 50% of the specifications they received. It seems safe to conclude that there is no barrier to the communication of user requirements from the perspective COTS suppliers.

A purchase decision will be a consequence of a judgment concerning the ‘goodness of fit’ of the supplier in functional, non-functional, and commercial domains. In the opinion of this researcher the weightings between these three domains should never allow the weakest competitor in the functional arena to triumph because they are the strongest in the non-functional and commercial domains. That would imply the purchase of a system that appears to be commercially advantageous, and that is based on a preferred architecture, but which has not been shown to be fit for the purpose of satisfying user needs. Such an outcome would tend to make a mockery of user involvement in the procurement process. The choice of a system that was a good non-functional and commercial fit but a poor function fit would equate to a project that had a higher risk of failing, because it is hard to imagine how a product that cannot be reliably demonstrated to deliver functional requirements can be reliably priced (price over-runs and time over-runs being explicit factors in software project ‘failure’ [22]

Research Contribution

There are other ways of creating user models [23-25], and specific ways of creating use case based models [12, 26], some of which have been applied to the improvement of procurement [19]. This paper explores a specific approach to creating UML based models for procurement that employs a requirements pattern language. It is suggested that, good as the other approaches are, they are constrained by requiring an iterative approach that is time consuming. The advantage of the requirements pattern language based approach is that it produces an accurate model rapidly enough to inform procurement consistently. Previous work had suggested that the Inflatable Pattern Language for Procurement (IFPLP) offers promise in creating early lifecycle models available in a timely manner to inform the procurement cycle. The work reported here provides further evidence to suggest the pattern language is effective in this role. In the earlier paper [4], the IFPLP was reported to be useful in the articulation of requirements in the domain of educational courses, in this example it is shown to be adequate in the domain of research assignments, and in subsequent applications (not yet reported) it has proven useful in the realms of human resources management and' just-in-time' delivery systems. The hypothesis is that the IFPLP is a useful tool in the articulation of all database driven transactionally-oriented applications and this paper provides further evidence as to that assertion.

To the author's knowledge, this paper introduces for the first time the approach of employing scenarios based on use cases that define the demonstration required by suppliers. The anecdotal evidence of this research suggests this is a superior approach from the perspective of the users' satisfaction with their involvement in the procurement decision process. It is suggested that the scenario-driven approach to procurement offers an approach that de-emphasises price in the list of decision making factors and builds a sense of confidence in the ability of the proposed supplier to deliver on the promises they are eager to make in the heat of the sales process.

Threats to Validity

The work reported here could be considered to be of interest in the solution of small or 'toy' problems, but inadequate in addressing the modeling of medium sized or large applications. Although this could be a legitimate concern, there is no evidence to suggest that solutions to 'toy' problems do not provide helpful guidance to the solution of larger problems, in fact, Jackson states the contrary position, extolling researchers to embrace solutions to toy problems as a means of stripping away incidental complexity [10]. Additionally, it is instructive to consider what is meant by a 'toy' problem, and to whom it is a toy. Several dozen individuals are employed at the HSE in the management of research assignments, who control a budget in excess of ten million pounds. The application under investigation for purchase may have cost less than 100 thousand pounds, but this does not include configuration and ancillary costs. Therefore the suggestion that the application of the IFPLP is adequate only to the solution of 'toy' problems must be treated with care; as the study of toys can be instructive, and one individual's identification may differ from another's depending on their point of view.

The methodology by which this research has been undertaken could have been more qualitatively based. The work could be improved by collating starting metrics with respect to measuring more thoroughly past procurement exercises, and their degree of success, against which this work could more reliably be measured. This work does not follow a recognised qualitative approach [27] The best that can be said for the method applied in this research is to brand it an example of action research. The term 'action research' implies some tension as 'action' and' research' seem like separate activities that are not easily reconciled. The method dictates an intervention in the functioning of the real world and a close examination of the effects of such intervention. In some quarters, action research has been seen as a necessary corrective to the failure of official bodies to implement traditional research findings.

Action research is 'situational'; being concerned with diagnosing a problem in a specific context and attempting to solve it in that context. Usually it is collaborative and participatory whereby all stakeholders take part directly or indirectly. The ultimate objective of action research is to improve *practice*, and as the objective of this research is to improve the practice of procurement, action research is a compelling methodological approach [28]. This project was conducted by transforming disparate opinions regarding requirements into a unified whole and then seeking agreement that this *whole* was representative. It then took the single representation and produced scenarios that informed demonstrations. Those scenarios were then used as the basis of evaluation of COTS presentations. This paper can be said to suggest the IFPLP is capable of producing models quickly. There is the suggestion (so far untested) that the language produces those models more quickly then an iterative approach. This paper suggests that scenario based demonstration definitions are superior to vendor inspired demonstrations because they allow users to play a more integrated role in the solution selection. In addition, scenario based demonstrations appear to de-emphasise price as a decision making factor in supplier selection.

The internal stakeholders working on this project believed that the models produced were a good representation of the business process they wish to manage. As a consequence, the internal stakeholders were supportive of the effort to find a replacement system, and appear to have confidence in the team tasked with doing so. However, not all of the individuals involved have first hand experience of being on a project team tasked with procuring a new IT solution, and so may have little to judge it against. Having said that, the ones with experience of undertaking this sort of activity, report that the approach reported here is an improvement because they feel more able to comment as the language of discourse is within their frame of technical competence.

Future Work

On the subject of COTS procurement, this experiment was universally agreed to have been a positive experience for the users involved. It would be useful to conduct further iterations of this experiment and to more rigorously canvass the views of the user participants as the process proceeded, simply to build a more statistically compelling argument. It would be interesting to demonstrate a link between satisfactory user involvement and ultimate project success.

The reaction of suppliers to receiving a specification based on scenarios has only been superficially investigated. There is some justification to looking more closely at the role of UML requirements specifications in reducing ambiguity and supplier assumptions and how that affects the validity of project pricing.

It is intriguing to contemplate the inclusion of UML models in commercial negotiations, and in making them intrinsic to the commercial contract which result. Looking further ahead, there is reason to believe that the work invested in this 'up-front' requirements gathering [29] may be useful in reporting project progress, managing requirements change, and defining the basis of acceptance testing.

There is growing evidence that the requirements pattern language on which the original requirements specification was based is acceptably accurate; certainly that it is less ambiguous than a standard natural language description [4, 30]. All the work that has been done to date is empirical, and it remains to continue to apply the method in an attempt to provide quantifiable evidence both in the same business domains and in different domains. Certain domains are recognised as being more inherently complex than others, such as banking, and it is here that an application of the method would be instructive. As research continues into this approach to applying the IFPLP and deriving scenario-based demonstrations it will become realistic to move from an action research based methodology to a more strict qualitative methodology. This ambition remains elusive due to the paucity of reliable metrics data and the difficulty in persuading host organisations that the investment in time to allow their collection will be amply repaid.

Bibliography

[1.] staff, *OGC Draft Procurement Project Guidelines*, 2001, Office of Government Commerce (OGC), London servicedesk@ogc.gov.uk
[2.] staff, *Getting Value for Money from Procurement - How Auditors Can Help*, 2001, National Audit Office (NAO), London http://www.nao.gov.uk/guidance/vfmprocurementguide.pdf
[3.] staff, *Value for Money Evaluation in Complex Procurements*, 2002, Office of Government Commerce (OGC), Norwich
[4.] Merrick, P. and Barrow, P., *Testing the Predictive Ability of a Requirements Pattern Language.* Requirements Engineering, (2004): p. (Online edition at time of writing), Springer Verlag http://springerlink.metapress.com/app/home/journal.asp?wasp=h07c7574wj2wnmf95ye0&referrer=parent&backto=linkingpublicationresults,1:102830,1
[5.] Merrick, P., *A Requirements Pattern Based Approach to Improvements in Government I.T. Procurement*, 2005, Ph.D., University of East Anglia, Norwich
[6.] Jacobson, I., Jonsson, P., Christerson, M., and Overgaard, G., *Object-Oriented Software Engineering - A Use Case Driven Approach*, ACM Press. (1992), Upper Saddle River, N.J., Addison Wesley Longman
[7.] Fowler, M. and Scott, K., *UML Distilled - A Brief Guide to the Standard Object Modeling Language*. (1999), Upper Saddle River, N.J., Addison Wesley Longman
[8.] Chen, P., *The Entity-Relationship Model - Toward a Unified View of Data.* ACM transactions on Database Systems, (1976). **1**(1): p. 9-36, Amercian Computing Machinery (ACM)
[9.] Abbott, R.J., *Program design by informal English descriptions.* Communications of the ACM, (1983). **26**(11): p. 882-894, ACM Press
[10.] Jackson, M., *Problem frames*, ACM Press. (2001), Harlow, Pearson Education Ltd., Addison Wesley
[11.] Sutcliffe, A., *The Domain Theory - Patterns of Knowledge and Software Reuse*. (2002), London, Lawrence Erlbaum Associates
[12.] Kulak, D. and Guiney, E., *Use Cases - Requirements in Context*. (2000), Upper Saddle River, N.J., Addison Wesley Longman
[13.] Cockburn, A., *Writing Effective Use Cases*. (2001), Upper Saddle River, N.J., Addison Wesley Longman
[14.] Merrick, P. and Barrow, P.: *Towards a Requirements Formalism in Procurement*. in *8th Annual Conference of United Kingdom Academy of Information Systems*. (2003), Warwick, England
[15.] Merrick, P. and Barrow, D.P., *The Rationale for OO Associations in Use Case Modelling.* Journal of Object Technology, (2005). **accepted for: November/December 2005** Chair of Software Engineering, Swiss Federal Institute of Technology
[16.] Maiden, N. and Sutcliffe, A.: *Requirements Engineering by Example*. in *IEEE International Symposium on Requirements Engineering*. (1992), p. 104 - 111, Annapolis, MD: IEEE Computer Society
[17.] Ncube, C. and Dean, J.: *The Limitations of Current Decision-Making Techniques in the Procurement of COTS Software Components*. in *First International Conference on COTS-Based Software Systems*. (2002), 176-187: Springer
[18.] Ncube, C. and Maiden, N., *PORE: Procurement-Oriented Requirements Engineering Method for the Component-Based Systems Engineering Development Paradigm.* (1999) Software Engineering Institute http://www.sei.cmu.edu/cbs/icse99/papers/11/11.pdf http://www.sei.cmu.edu/cbs/icse99/papers/11/11.htm
[19.] Lauesen, S.: *COTS Tenders and Integration Requirements*. in *10th Anniversary International Workshop on Requirements Engineering Foundation for Software Quality (REFSQ'04)*. (2004), Riga, Latvia: IEEE Computer Society http://ieeexplore.ieee.org
[20.] Konito, J.: *A Case Study in Applying a Systematic Method for COTS Selection*. in *18th International Conference on Software Engineering*. (1996), 201--209: Springer
[21.] Kunda, D. and Brooks, L., *Identifying and Classifying Processes (traditional and soft factors) that Support COTS Component Selection: A Case Study.* Journal of Information Systems, (2000). **9**(4): p. 226-234,
[22.] staff, *The Chaos Report*, 1994, The Standish Group, West Yarmouth, MA http://www.standishgroup.com/sample_research/chaos_1994_1.php
[23.] Checkland, P. and Scholes, J., *Soft Systems Methodology in Action*. (1990), New York, New York, Wiley Publishing
[24.] Lubars, M., Potts, C., and Richter, C.: *A Review of the State of the Practice in Requirements Modeling*. in *Symposium on Requirements Engineering*. (1992), 2-14, San Diego, California: IEEE Computer Society www.cs.ucl.ac.uk/research/renoir/TBRC_RR01.pdf

[25.] Robertson, S. and Robertson, J., *Mastering the Requirements Process*. (1999), Harlow, Essex, UK, Addison Wesley
[26.] Gottesdiener, E., *Requirements By Collaboration*. (2002), Boston, MA, Addison Wesley
[27.] Flick, U., *Introduction to Qualitative Research*. (2002), Thousand Oaks, CA, Sage Publications
[28.] Cohen, L. and Manion, L., *Research Methods in Education*. (1994), London, Routledge
[29.] Kwan, I. and Berry, D.: *Specify First or Build First? Empirical Studies of Requirements Engineering Activities: A Survey*. (2004),
[30.] Merrick, P. and Barrow, P.: *Testing a Requirements Pattern Language Through Reverse Modelling*. in *INCOSE 2004*. (2004), Toulouse, France: International Council of Software Engineers