

The Mobile Scenario Presenter: Integrating Contextual Inquiry and Structured Walkthroughs

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Abstract

Rapid advances in the capabilities of mobile computing devices provide new opportunities to overcome limitations with existing desktop-based requirements engineering tools. In particular mobile tools allow analysts to take acquisition, analysis and modelling tools to the stakeholders in their workplace, with potential benefits for requirements completeness and correctness. In this paper we describe the Mobile Scenario Presenter, an extension to the ART-SCENE environment designed to undertake scenario walkthroughs in the workplace using mobile computing devices, report some lessons learned during the design of the tool, and discuss future research directions.

1. Introduction

Software tools that support or automate software engineering tasks are typically available on traditional desktop-based workstations. In requirements engineering, for example, many such tools are available for acquiring, communicating, modeling, and managing requirements throughout the lifecycle of a software product [6].

Mobile tools for requirements analysts offer considerable potential. Analysts might be able to acquire more complete and realistic requirements for a new system by combining the observation of stakeholders in their work environment with structured tools for asking questions, recording requirements, and augmenting these requirements with audio notes or drawings. In short, mobile devices offer a mechanism for linking the ethnographic and contextual traditions in requirements engineers [3] with more structured and interventionist approaches from software engineering.

This vision is rapidly nearing realization. Mobile computing is a maturing and growing field and appears to become a dominant computing paradigm [5]. In the last few years the capabilities of mobile devices such as Personal Digital Assistants (PDAs) have advanced considerably. Frequently advertised benefits of PDAs include: anytime/anywhere computing; connectivity/browser support, for example, through Wi-Fi network access; or different input modes such as audio recording, drawing, handwriting, and typing. These developments let us envi-

sion novel mobile tools for requirements engineers that will be sophisticated enough to be used in real-world projects.

Our first step has been to design new mobile requirements tools that complement our existing platforms and make some of the current tool capabilities available to mobile analysts and other stakeholders involved in requirements processes. Furthermore, we had to overcome existing PDA limitations such as screen size, performance, accumulator capacity, network bandwidth and storage capability.

This paper is organized as follows: Section 2 describes the existing web-enabled ART-SCENE environment for scenario-driven requirements engineering. In Section 3 we describe the result of new work – the Mobile Scenario Presenter (MSP) and how we are looking to evaluate it in trials and on real-world projects. Section 4 outlines some significant advantages of using mobile tools for scenario walkthroughs. Section 5 draws conclusions and discusses future research directions.

2. ART-SCENE

ART-SCENE (Analysing Requirements Trade-offs: Scenario Evaluations) is a scenario-driven technique for discovering, acquiring and analysing stakeholder requirements [4]. It integrates results from basic and applied research with software engineering best practice to deliver a complete approach that development teams can use to produce requirements specifications.

The kernel of ART-SCENE is an innovative software environment that delivers two important capabilities to requirements analysts. The first capability is automatic scenario generation. In simple terms, ART-SCENE automatically generates one or more scenarios with different normal course event orderings and alternative courses from a use case specification with different parameter value settings that are produced by an analyst. This enables analysts to overcome the scenario generation bottleneck, and to generate and revise the scenarios quickly.

The second capability is guided walkthroughs of these generated scenarios. The big idea that underpins these walkthroughs is very simple – that people are better at identifying errors of commission rather than omission [1].

ART-SCENE Scenario Presenter				Domain Name:	Use Case Name: Use Case 1: If I am driving information for travel purposes	Use Case 2	Scenario
Normal Course				Alternative Course for			
Event	Action Type	Link	Description (Natural Language)	Event 1			
1	Physical	Start	The passenger looks at the Countdown display	GEV1	What if this event does not occur in this scenario?		<input checked="" type="checkbox"/>
2	Physical	End	The passenger looks at the Countdown display	GEV2	What if this event occurs earlier in time than expected in the scenario?		<input checked="" type="checkbox"/>
Main Menu	Communication	Start	The Countdown display shows the bus information for the relevant route	GEV3	What if this event occurs later in time than expected in the scenario?		<input checked="" type="checkbox"/>
	Communication	End	The Countdown display shows the bus information for the relevant route	GEV4	What if this event occurs more than once in this scenario?		<input checked="" type="checkbox"/>
Comments	Communication	Start	The passenger reads the bus information from the Countdown display	GEV5	What if this event occurs less frequently than expected in the scenario?		<input checked="" type="checkbox"/>
	Communication	End	The passenger reads the bus information from the Countdown display	GEV6	What if this event occurs more than once in the scenario?		<input checked="" type="checkbox"/>
All Requirements	Communication	Start	The passenger reads the bus information from the Countdown display	GEV7	What if a different event occurs instead of this event in the scenario?		<input checked="" type="checkbox"/>
	Communication	End	The passenger reads the bus information from the Countdown display	GEV8	What if an unexpected intrusion occurs into the system during this event?		<input checked="" type="checkbox"/>
Normal Requirements	Communication	Start	The passenger reads the bus information from the Countdown display	PE1.2	What if passenger has some unusual physical characteristics that affect his/her behaviour during this action?		<input checked="" type="checkbox"/>
	Communication	End	The passenger reads the bus information from the Countdown display	PE1.2.1	What if passenger is physically unable to undertake this action?		<input checked="" type="checkbox"/>
Alternative Requirements	Cognitive	Start	The passenger recognises which route number(s) will take them closest to their destinations	PE1.2.2	What if passenger is unusually young or old?		<input checked="" type="checkbox"/>
	Cognitive	End	The passenger recognises which route number(s) will take them closest to their destinations	PE1.2.3	What if passenger gender is different to what is expected during this action?		<input checked="" type="checkbox"/>

Figure 2. ART-SCENE's main scenario walkthrough window, showing a simple scenario related to the London Bus Countdown system – a computerized system that provides passengers with information about buses at bus stops.

From this general trend in human cognition for recall to be weaker than recognition, ART-SCENE scenario walkthroughs offer stakeholders recognition cues in the form of generated alternative courses. If the alternative course is relevant to the system being specified but not yet handled in the specification, then a potential omission has been identified, and ART-SCENE guides the developers to acquire and document the relevant requirements.

On top of this capability we have developed layers of process guidance and support: additional software features; guidelines about who should attend a scenario workshops; design of a scenario workshop; workshop facilitation processes; and profiles to tailor the generated scenarios to the relevant attendees. The next section describes these layers in more detail.

2.1 The ART-SCENE Environment

ART-SCENE provides a four-layered environment for discovering requirements with scenarios. The four layers, and the relationships between them, are depicted graphically in Figure 1.

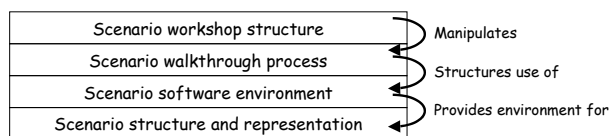


Figure 1. The four layers of the ART-SCENE approach, and the interactions between them

The lowest layer is how to represent and structure a scenario in ART-SCENE. ART-SCENE's scenario generation and walkthrough tools manipulate these scenario structures and representations. The features of the walkthrough tool are used during the scenario walkthrough process with stakeholders to discover, acquire and analyse their requirements. Scenario walkthroughs take place in structured workshops.

An ART-SCENE scenario is composed of two parts – the normal course event sequence for the scenario, and the alternative courses that have been generated for each normal course event. The normal course event sequence for a simple example scenario – describing how a bus passenger using an information system to catch the right bus at a bus stop – is shown in Figure 2. The ART-SCENE environment generates zero, one or many possible alternative courses for each normal course event. Example alternatives for 1 of the normal course start events – the passenger looks at the Countdown display – are also shown in Figure 2. Generated alternative courses include what if this event does not occur in the scenario (i.e. the passenger does not look at the display), what if this event occurs earlier in time than expected in the scenario (i.e. looking before the passenger gets to the bus stop), and what if the passenger is unusually young or old.

ART-SCENE scenarios are manipulated within the ART-SCENE software environment, which is composed of three basic components:

- *The use case specification component*, which enables analysts to write and specify use cases, then exports them to the use case database;
- *The scenario generation component*, which generates one or more scenarios from a use case specification in the use case database;
- *The scenario presenter component*, which presents the generated scenarios to stakeholders during a walkthrough in order to discover, acquire and describe requirements.

The use case specification and scenario generation components run on a Windows 2000 platform supporting an Access 2002 database that stores use cases and scenarios in the ART-SCENE environment, and MS-Word extended with tailored macros and supporting Visual Basic applications to edit use case specifications. The scenario presenter component has been developed to enable web-based access to the scenarios database via web-enabled tool developed using Microsoft Visual InterDev

supporting dynamic ASP pages on top of the Microsoft Access database, and running on IE 5.0 and above.

2.2 ART-SCENE's Scenario Presenter

Providing web-enabled scenario walkthrough capabilities offers several advantages to requirements processes. Stakeholders often work in distributed environments – web-enabled access to a central server that stores the generated scenarios in a single database can increase stakeholder access to the scenarios and communication between stakeholders. Likewise, bringing stakeholders together in the same place at the same time is both difficult and expensive – web-enabled access offers possibilities for distributed and asynchronous scenario walkthroughs.

The most important window during a walkthrough is the scenario window shown in Figure 2, which presents a scenario in four parts. The left-side menu provides different functions for viewing the scenario and the requirements generated for it. The top-line buttons offer walkthrough functions (e.g., next or previous event) and functions to add, edit or delete events, comments and requirements. The left-hand main section describes the normal course event sequence for the scenario. Each event describes the start or end of an action, thus enabling a scenario to describe concurrent actions in this text-list form. The right-hand main section describes generated alternative courses for each normal course event, presented in the form of 'what-if' questions. Different alternative courses are presented for different normal course events.

Some of the most important features are accessed using the top-line buttons. Each major feature is available either for the selected event in the normal course (accessible above the normal course event sequence) or the selected alternative course (accessible above the alternative course list). The most important features are the *add comment* [C] and *add requirement* [R] features shown in Figure 3. A user can enter a requirement or comment associated with any normal or alternative course event at any time during a walkthrough. To add a requirement, the Scenario Presenter allows the user to specify the type, description, rationale and source of the requirement. These attributes are a subset of the VOLERE requirements shell attributes [7] that are used to describe requirements in the RESCUE process [9]. We chose the type, description, rationale and source attributes to be completed during a walkthrough as each attribute can be specified during a walkthrough. Likewise, a user can add one or more comments to any event and define its level of importance and whether it requires a change to the scenario.

The left-side menu provides different functions for viewing the scenario and the requirements generated for it. The user can view all of the requirements generated

using the scenario, all requirements generated for the selected normal course or requirements generated for a selected alternative course event in list form. Alternatively the user can view the requirements inserted into the scenario normal course event sequence underneath the associated event. The user can also choose to restrict the amount of information presented on the scenario.

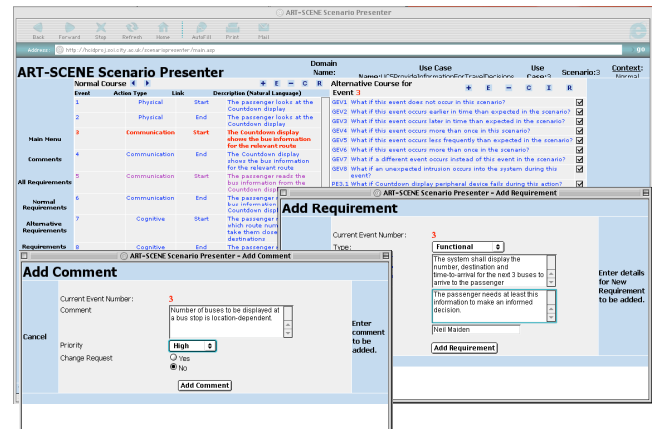


Figure 3. Adding requirements and comments in ART-SCENE

Systems engineers and air traffic controllers in France and the UK have successfully used this version of the Scenario Presenter to discover and document requirements for DMAN, the new departure management system for major European airports such as Heathrow and Charles de Gaulle. Twelve scenarios generated from DMAN use case specification were walked through in facilitated half-day walkthrough workshops. Results included over 300 new stakeholder requirements on the DMAN system as well as changes to domain assumptions and the scenarios themselves to reduce the extent of automated support for controllers that had been specified. The walkthroughs also revealed further requirements and opportunities for the Scenario Presenter, and a new version released in January 2004 is available at www.soi.city.ac.uk/artscene.

Furthermore, we are currently extending the Scenario Presenter to handle multi-media scenarios. Multi-media authoring guidelines linked to the ART-SCENE scenario structure guide the elicitation of text, graphic, audio and video material that is associated with a whole scenario or individual scenario events to enhance the communication of a scenario to stakeholders and support requirements acquisition and discovery. However, reliance on traditional devices (e.g. PCs & laptops) restricts when and where these interactive ART-SCENE scenario walkthroughs can take place. Multi-media scenarios can depict an environment or work context and the human actors in it, but requirements analysts using ART-SCENE cannot interact directly with these depicted actors. Instead, desk-bound scenario walkthroughs require stakeholders to take time out of their work environments

to participate in formal acquisition sessions. As well as restricting access to stakeholders who might not have the time to participate in these sessions, requirements acquisition sessions take place out of the work context, thus diminishing the effectiveness of acquisition techniques.

To overcome these limitations, we investigated the use of PDAs to undertake ART-SCENE scenario walkthroughs in the workplace, and developed a prototype called the Mobile Scenario Presenter (MSP) to implement such walkthroughs. The next two sections discuss the advantages and disadvantages of PDA-based requirements tools explored in this project, and the MSP tool that was developed as a result.

3. The Mobile Scenario Presenter (MSP)

The MSP [8] is a PDA-based ASP.NET web application that uses a mobile browser and wireless access to the server-side ART-SCENE scenario and requirements databases. The tool is currently optimized for Microsoft's Pocket Internet Explorer included with Microsoft's Pocket PC 2003 OS.

The MSP is designed to support analysts who are using structured scenarios to acquire requirements systematically and in the workplace. As such, the analyst can undertake future scenario walkthroughs and observe current system behaviour at the same time. Furthermore, the MSP's what-if capabilities – generating candidate alternative courses for each event – enable the analysts to follow up and ask questions about abnormal and unusual behaviour in different work contexts, thus leading to more complete and correct requirements. Figure 4 shows a walkthrough of one scenario using MSP. The analyst can view scenarios and add requirements and comments events described in the scenario using PDA audio recording capabilities.

The MSP has several features that distinguish it from the desktop Scenario Presenter. Most of them are specific to PDAs. The first is its use of the limited screen real estate available on PDAs. The desktop Scenario Presenter presents the normal and alternative course events side-by-side and highlights the current event being walked through, thus providing stakeholders with the wider context of that event at any time. In the MSP it is essential to maintain the current event's context when most of the scenario cannot be shown on the screen. The MSP displays the normal and alternative courses on separate pages as shown in Figure 5, but also provides contextual information (e.g., the current normal course event) in the horizontal bar at the top of each page, and separate functions for walking through the normal course whilst viewing generated alternative courses. Scroll bars and linked text items enable the analyst to access hidden information and features on other MSP pages. The concept of horizontal versus vertical navigation of events within the MSP tool is implemented at the scenario and event levels, and is

reflected in the design of the MSP icons.

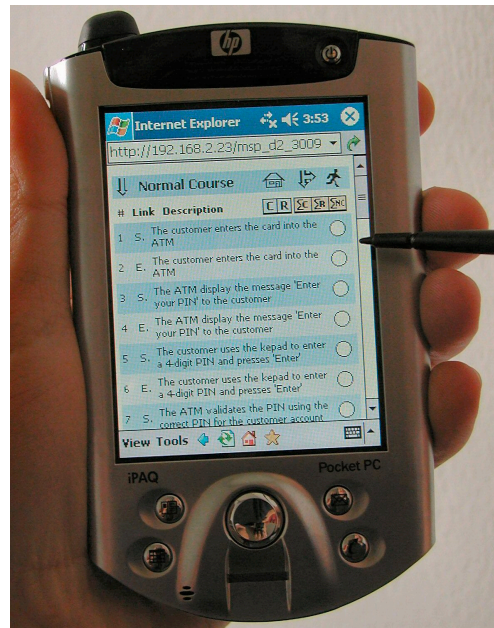


Figure 4: An analyst using the Mobile Scenario Presenter during a scenario walkthrough

Another feature of the MSP was the development of icons that replace larger scenario view functions in the Scenario Presenter but maintain its original look-and-feel. MSP icons are shown in at the top right of the MSP in Figure 5, and enable the analyst to step through a normal course event sequence, see alternatives for current normal course event, add a requirement or a comment for that event, view all recorded comments and requirements for the scenario or the event, return to the list of all available scenarios, and logout. Not all original Scenario Presenter functions were implemented in the MSP – only those pertinent to a scenario walkthrough in a work context. All scenario management and report functions remain with the desktop Scenario Presenter tool.

The Scenario Presenter also allows recording new requirements during the walkthrough and linking them to the triggering scenario normal and alternative course events for traceability purposes. During a walkthrough session a scribe uses a traditional keyboard to type the requirements and comments in windows visible to all stakeholders, as shown in Figure 3. Obviously the lack of a scribe and traditional keyboard when using the MSP means that requirements and comments needed to be captured differently. Hence we introduced a new feature – audio recording requirements and comments – using current PDA technology and applications.

An analyst adding audio recordings or drawings uses Microsoft's Pocket Word, which is also shipped with the Pocket PC OS. The analyst can add a pocket word document to each new requirement generated in the MSP. The

analyst activates the "add word file" button and the web-server downloads an empty word document with a special ID, traceable within the requirement, to the mobile client. The PDA then opens Pocket Word and the user is able to use all the functions that Pocket Word provides – include audio recording data through the PDA's built-in microphone or Pocket Word's drawing features.



Figure 5. Two MSP screen shots showing a scenario normal course (left) and alternatives for the selected normal course event (right)

Once recorded, the pocket word document is stored locally on the PDA and the unique ID of the document is uploaded to the webserver. As soon as the scenario walkthrough is over, the analyst returns to the desk-bound ART-SCENE environment, synchronizes the PDA with the desktop PC to view the word document, then transcribes each recorded requirement and comment using existing Scenario Presenter functions on its desktop version. This simple but elegant solution avoids introducing more complex technologies and exploits the relative strengths of the Scenario Presenter and MSP tools.

The next sections describe how we use the MSP to integrate structured scenario walkthroughs with contextual inquiry techniques from participatory design [2] to generate new requirements processes that become possible using the MSP.

4. Bringing ART-SCENE Scenario Walkthroughs into Contextual Inquiries

Contextual inquiry is the first part of contextual design – a customer-centered process that supports finding out how people work, so that the optimal redesign of work practice can be discovered [2]. It adopts techniques that keep analysts focused on the data, in order to discover design implications for redesigning work practice and structure the new system so that it supports work redesign. Its purpose is to help analysts to understand the customer and their needs, desires and approach to work. The analyst interviews the customer one-on-one in the work-

place whilst they work. The project team then undertakes interpretation sessions in which different stakeholders bring their particular views and perspectives to bear on the data. This data provides the foundation for subsequent work modeling and work redesign in the contextual design process. Therefore asking the right questions and recording relevant data is critical in contextual inquiry, and there is potential for tool support to aid contextual inquiry if it does not interfere with interacting with the customer.

Contextual inquiry is based on four principles that define different aspects of interaction with the customer – context, partnership, interpretation and focus [2]. *Context* is all about being in the workplace and seeing work undertaken, using the context to discover tacit knowledge. *Partnership* involves the analyst developing expertise in seeing the work structure and asking about it through conversation – alternating watching and probing – rather than more formal question-and-answer sessions. *Interpretation* is the chain of reasoning that turns captured facts into an action relevant to design intent and underlying facts. *Focus* defines the analyst's point of view when studying the work. It provides a mechanism for structuring the inquiry without controlling it and stopping a partnership arise.

So how can the MSP support contextual inquiry? We believe that it has the potential to support the application of three of the four principles. Its use of mobile computing means that the tool can be taken into the workplace, and the increasingly ubiquitous nature of PDAs suggests that using a PDA is unlikely to distract stakeholder attention from their work. MSP scenarios provide the analyst with the work structure and simple-to-use probes, thus freeing up cognitive resources to observe stakeholder work practices. Finally ART-SCENE's scenario generation parameters, which determine the depth and content of generated alternative courses and scenario contexts that the MSP presents, enable the analyst to adopt a focus and probe stakeholders with relevant questions. Of course, using the PDA can also disrupt contextual inquiry and undermine its principles, however we believe that the potential benefits, once realized, outweigh the drawbacks and bring bespoke requirements tools into contextual design for the first time.

Adopting the MSP tool within contextual inquiry changes the structure of the acquisition process and the processes themselves as well as tool's capabilities, as shown in Figure 6. Predefined workshops are replaced by a two-stage process – one-on-one interviews in the workplace using MSP followed by project-wide interpretation sessions using the desktop Scenario Presenter tool at a later date. The scenario walkthrough process changes from facilitated consideration of normal then alternative courses in turn to more flexible and responsive use of probes (e.g., generated candidate what-if alternatives) related to the current work equivalent to normal course

events in the scenario. These environment and process changes have impacted on the design of the MSP tool, as described in the next section.

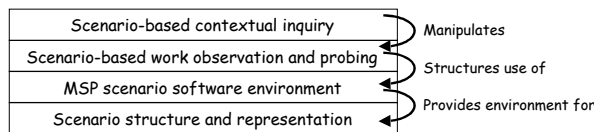


Figure 6. The revised ART-SCENE approach for using the MSP during contextual inquiry

5. Lessons Learned and Future Research

PDA's also offer some important challenges that requirements researchers will need to overcome. For example, the small *screen size* poses challenges for user interface design and *performance* is still an issue despite more powerful processors. Accumulator capacity, network bandwidth, and limited memory and storage also pose new challenges for requirements tool design.

Our experiences so far with the MSP tool, although limited, have provided us with some lessons that apply more widely to designing tools for mobile requirements analysts:

- *Focus on simplicity*: Features that are made available to mobile users should be carefully selected. The existing ART-SCENE Scenario Presenter already provides a precise definition of user groups and permissions which allowed us picking just the features useful for mobile analysts using the MSP;
- *Understand usage of mobile device*: Not all features that are useful on a desktop computer will make sense on a mobile device and vice versa. For example, audio recording, navigation, drawing is well-supported on mobile devices. Modelling and detailed documentation of requirements works better on desktop-based computers;
- *Integrate desktop tools and mobile tools*: The previous lesson already indicates that mobile requirements tools are only useful if they complement existing tools and environments. Integration is critical and mobile users as well as desktop users should have access to the same workspace. Furthermore, as ART-SCENE reveals most requirements tools need both acquisition and management capabilities best supported by mobile and desktop versions of the tools respectively;
- *Usability is a primary issue*: Designing the user interface and optimizing navigation and representation of information requires a lot of effort e.g., due to the limited screen size or different style of human computer interaction. Usability is also affected as sophisticated user interface concepts can often not be realized because the technology is still immature. While basic browser features are supported well there are still problems with more specific aspects such as scripting support, frames,

or scalability.

As part of ongoing research and knowledge transfer with Eurocontrol, we expect to evaluate the MSP with scenario walkthroughs on landside scenario walkthroughs for new airport systems in Europe. In parallel, the availability of such mobile devices is encouraging us to think more about the integration of contextual inquiry techniques into structured scenario and requirements methods. Indeed, mobile tools offer the potential to unite different requirements traditions that, until now, have been treated as separate. Whilst requirements documentation and analysis has borrowed from the structured analysis and systems engineering traditions, approaches from softer sciences such contextual inquiry are increasingly important for acquiring requirements. Mobile devices offer the potential to bring structured techniques, for the first time, unobtrusively into the workplace.

Acknowledgements

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References

- [1] Baddeley, A.D., *Human Memory: Theory and practice*. 1990: Lawrence Erlbaum Associates.
- [2] Beyer, H., and Holtblatt, K., *Contextual Design: Defining Consumer-Centered Systems*. 1998: Morgan-Kaufman.
- [3] Jirotko, M., and Goguen, J., *Requirements Engineering: Social and Technical Issues*. Computer and People Series. 1994, London: Academic Press.
- [4] Maiden, N.A.M., *Systematic Scenario Walkthroughs with ART-SCENE*, In, *Scenarios in Practice*, Alexander, I. and Maiden, N.A.M., Editors. 2004, to be published by John Wiley.
- [5] Myers, B.A., and Beigl, M., *Handheld Computing*. *IEEE Computer*, 2003: pp. 27-29.
- [6] Nuseibeh, B., and Easterbrook, S. *Requirements Engineering: A Roadmap*. In, *The Future of Software Engineering, Special Issue 22nd International Conference on Software Engineering*. 2000: ACM-IEEE.
- [7] Robertson, S., and Robertson, J., *Mastering the Requirements Process*. 1999: Addison-Wesley.
- [8] Seyff, N., Grünbacher, P., Maiden, N.A.M., and Tosar, A. *Requirements Engineering Tools Go Mobile*. In, *to appear Proceedings of the 26th IEEE International Conference on Software Engineering (Tool Demonstration Paper)*. 2004: IEEE Computer Society Press.
- [9] Maiden N.A.M., Jones S.V., Manning S., Greenwood J. &Renou L., 2004, *Model-Driven Requirements Engineering: Synchronising Models in an Air Traffic Management Case Study*, to appear in *Proceedings CaiSE'2004*, Springer-Verlag.

