



## **Determining Stakeholder Needs in the Workplace: How Mobile Technologies Can Help**

*Neil Maiden, Norbert Seyff, Paul Grünbacher, Omo Otojare, and Karl Mitteregger*

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# Determining Stakeholder Needs in the Workplace:

## How Mobile Technologies Can Help

**Neil Maiden and Omo Otojare**, *City University, London*

**Norbert Seyff and Paul Grünbacher**, *Johannes Kepler University*

**Karl Mitteregger**, *Oberösterreich Tourismus*

Mobile RE tools help elicit stakeholder needs in the workplace. The authors discuss lessons learned that practitioners can adapt and use in their work.

**S**takeholders' needs often emerge from analyses of their working practices. Although this has been reflected in the increasing use of observation<sup>1</sup> and ethnographic techniques<sup>2</sup> in requirements processes, the literature reports little use of software tools when analyzing these work practices. Indeed, most tools supporting requirements acquisition and discovery reside on desktop computers, suggesting that stakeholders come to the tools rather than vice versa. This makes it difficult

to discover stakeholder needs that emerge in the workplace. In many situations, it's more effective to take the tools to the workplace, exploiting mobile computing technologies' increasing power and reliability.

In the last few years, mobile computing has advanced rapidly, with significant advances in processing speed, storage, connectivity, and usability. For example, mobile devices such as PDAs or smart phones and wireless technology such as Wi-Fi or the Universal Mobile Telecommunications System let people use software applications whenever and wherever they like. But what does this mean for requirements engineering? What challenges and opportunities does mobile computing hold for RE? Observation and ethnographic techniques, for example, have generally lacked software tool support, in part due to a lack of suitable technologies. Mobile technologies of-

fer exciting new opportunities to improve these important requirements processes by empowering analysts to understand stakeholder needs in their work context.

One option is to use general-purpose tools shipped with mobile devices to start documenting requirements and capturing multimedia content. Another is to use mobile Web logs (also called *Moblogs*), which use pictures annotated with basic text descriptions to share information. However, tools that support established RE methods can provide more specific support. We've developed two mobile RE tools to address conventional tools' limitations in acquiring requirements: ARENA-M, a requirements negotiation tool, and the Mobile Scenario Presenter, a scenario-based RE tool<sup>3</sup> (see the "Our Mobile Requirements Engineering Tools" sidebar for more information). In this article, we draw on different experiences

with both tools, although space restricts us to describing only the MSP in detail.

## The Mobile Scenario Presenter

The MSP supports both mobile analysts and future system users to acquire requirements systematically and in situ using structured scenarios. The MSP is based on ART-SCENE (Analyzing Requirements Trade-offs: Scenario Evaluations), a scenario-driven technique for discovering and documenting stakeholder requirements. ART-SCENE integrates results from basic and applied research with software engineering best practices to deliver a complete approach that analysts can use to produce requirements specifications.

ART-SCENE supports analysts and stakeholders when they walk through scenarios that are automatically generated from use-case specifications. The big idea underpinning these walkthroughs is simple—people are better at identifying errors of commission than omission. To address this general human cognitive trend (that is, that recall is weaker than recognition), ART-SCENE scenario walkthroughs give stakeholders recognition cues via automatically generated alternative courses. If the alternative course is relevant to the system being specified but the specification doesn't handle it yet, the analyst has identified a potential omission, and ART-SCENE guides the analysts to specify and document the relevant requirements.

Unlike the ART-SCENE ScenarioPresenter tool, the MSP runs on a PDA. Walking through scenarios lets analysts or future system end users elicit new requirements and comments (see figure 1). Using the MSP, analysts can observe current system behavior and stakeholder interactions simultaneously. The MSP's what-if capabilities let analysts consider questions about abnormal and unusual behavior in situ (such as, "What if this action does not complete?").

We've used the MSP in different workplaces to acquire requirements. For example, at a conference, seven analysts used the MSP to walk through the scenario shown in figure 1 to discover their own requirements for a conference presentation support system. During conference presentations, analysts used the MSP to document the audience's requirements for the envisaged system. The scenario was composed of nine normal course events (see figure 1a) and three to 32 generated alternative courses (see figure 1b). Example alternative courses included

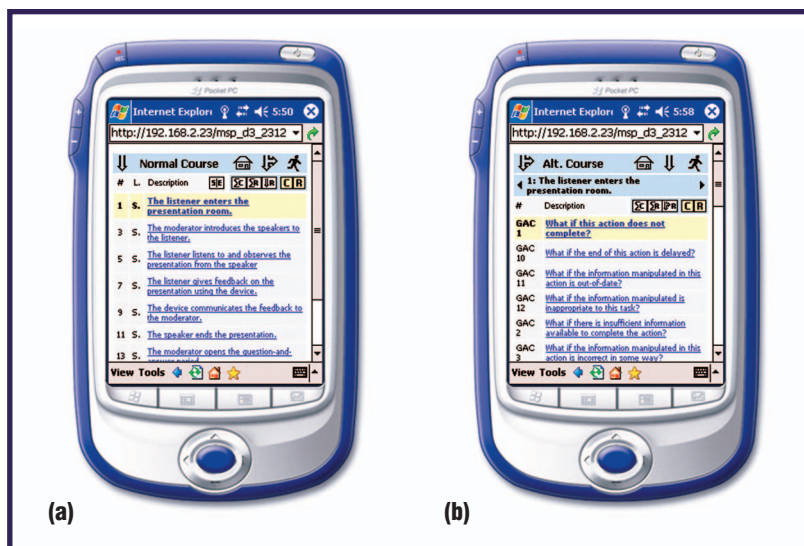
## Our Mobile Requirements Engineering Tools

ARENA-M (Anytime, Anywhere Requirements Negotiation Assistant—Mobile) supports negotiation-based requirements acquisition.<sup>1</sup> It helps mobile stakeholders and facilitators reach a consensus about requirements. Stakeholders can express their goals and expectations using an electronic brainstorming tool. They use electronic polling to prioritize requirements. Stakeholders can then identify arising issues and options for each unresolved issue. The team agrees on the requirements guided by the win-win negotiation model.

The Mobile Scenario Presenter is a Web-based tool for requirements discovery using scenarios. It works in tandem with the ART-SCENE Scenario Presenter, a Web-based tool that provides scenario-walkthrough capabilities.<sup>2</sup> We describe the MSP and underlying ART-SCENE technologies at length in the main article.

### References

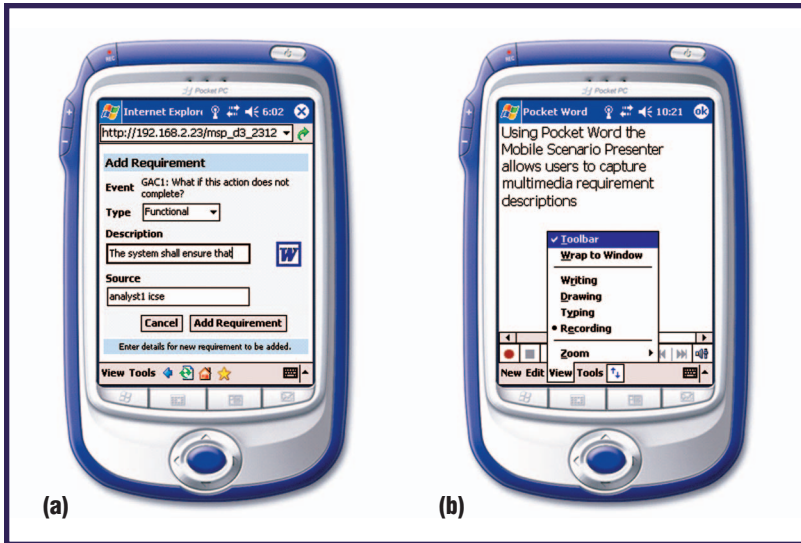
1. N. Seyff et al., "Enhancing GSS-based Requirements Negotiation with Distributed and Mobile Tools," *Proc. 14th IEEE Int'l Workshops Enabling Technologies: Infrastructures for Collaborative Enterprises (WETICE 05)*, IEEE CS Press, 2005, pp. 87–92.
2. N.A.M. Maiden, "Systematic Scenario Walkthroughs with ART-SCENE," *Scenarios, Stories, Use Cases*, I. Alexander and N.A.M. Maiden, eds., John Wiley & Sons, 2004.



**Figure 1. Two MSP screens showing (a) a scenario normal course and (b) generated alternatives for the selected normal course event.**

"What if this event does not occur?" and "What if the action does not complete?"<sup>4</sup>

In another study, we used the MSP to discover requirements for a London bus stop information system. Countdown is an electronic information display system that provides bus arrival times in real time. An analyst used the MSP at the bus stop to walk through the scenario by observing the domain and its stakeholders while walking through the normal course events. The analyst entered requirements discovered for selected events from observations and an acquisition dialogue with an end user or



**Figure 2. Using  
(a) the MSP to enter a  
text-based requirement  
description and  
(b) Pocket Word to  
annotate multimedia  
content.**

browsed the automatically generated alternative courses for this event.<sup>4</sup>

The MSP has several features that enable it to acquire requirements in the workplace. Figure 2a shows the dialogue for adding new requirements. The lack of a scribe and traditional keyboard when using the MSP means that analysts must capture requirements and comments differently. We introduced new features for audio recording requirements and comments using PDA technology and applications. The MSP supports two different options for working with multimedia content. The first is to use Microsoft's Pocket Word to add audio recordings and sketches (shown in figure 2b). The second option is a plug-in offering a seamlessly integrated and customizable approach. We developed simple, easy-to-use plug-ins for recording audio and drawing sketches. Both solutions support synchronizing requirements with desktop systems.<sup>5</sup> After a mobile scenario walk-through, users can synchronize the PDA with the desktop ART-SCENE server to further elaborate the recorded requirements and comments.

Because research into mobile RE tools is new, we undertook a range of studies to explore whether requirements analysts could use the MSP and ARENA-M tools during requirements discovery, documentation, and negotiation tasks and whether the tools were useful for these tasks. We initially studied the ARENA-M tool<sup>6</sup> in the domain of mobile information systems. We investigated the effect of prototype MSPs on requirements discovery in a range of settings, including analysts using the MSP to document their own or an end user's

requirements, as well as analysts using the MSP when moving or not moving around the domain. Detailed results from these studies are reported at length elsewhere.<sup>4,7</sup>

## Lessons learned

Our experiences with mobile RE tools reveal six lessons that can help requirements practitioners establish stakeholder needs with mobile technologies and better use mobile technologies in their requirements processes.

### Consider mobile tools where stakeholder needs emerge

The most obvious use of a mobile device is to capture requirements where they emerge—that is, in the future system users' workplace. While analysts are observing the work environment, the mobile device guides them to interact with future end users to better understand their needs and to gather more relevant requirements. Our results suggest that scenarios that analysts viewed in the MSP provide a script for asking questions to stakeholders in the workplace.<sup>4</sup> In its simplest form, the scenario was a memory aid for the analyst (much as an agenda guides a structured interview), freeing some of the analyst's cognitive resources to observe and interact with people in the workplace. The scenario's structure was largely sequential—a list of events that might happen in the domain—and this influenced which questions were asked. This reveals our first lesson learned:

*Lesson 1: You can use mobile technologies in the workplace to discover requirements that precisely reflect the future end users' needs.*

Current mobile applications can deliver some but not all possible benefits, such as using the workplace context (for example, who is being observed, where she is, and what she's doing). Imagine a mobile requirements application that can generate context-sensitive questions that are informed by the analyst's location and proximity to people or places. This isn't as farfetched as it sounds. We're exploring the use of RFID in a workplace to tag stakeholders, objects, and locations. These tags reference agents and objects modeled in MSP-generated scenarios. Therefore, when the analyst is in a location or near an object or agent, the MSP scenario prioritizes questions about that location, object, or agent. Furthermore, if we extend these scenarios with

simple models of the properties of these locations, objects, and agents, the scenario can generate tailored questions for the analyst. Although we currently restrict the context to physical location and proximity, we hope to report the perceived effectiveness of such context-sensitive questioning. The underlying technologies are available now, and we encourage you to experiment with them to deliver informed requirements questions.

You can also embed mobile technologies in established requirements methods, making them more available to a wider requirements audience. One such method is Contextual Inquiry, which is based on four customer-interaction principles:<sup>8</sup>

- *Context* is 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 between watching and probing—rather than more formal question and answer session.
- *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, providing a mechanism for structuring the inquiry without controlling it and stopping a developing partnership.

So, how can tools support Contextual Inquiry? The MSP can support the application of at least two of the four principles.<sup>7</sup> The MSP's use of mobile computing means that you can take the tool into the workplace *context*, and the increasingly ubiquitous nature of PDAs suggests that using them won't distract stakeholders from their work. Furthermore, ART-SCENE's scenario generation parameters, which determine the depth and content of the MSP's generated alternative courses and scenario contexts, let the analyst adopt a *focus* and probe stakeholders with relevant questions.

Finally, another emerging direction for mobile tools is a requirements trainer. In our studies, one analyst claimed that, over time, she learned the scenario events and eventually asked probes without referring to the MSP. Although we didn't anticipate the emergence of the mobile tool as a possible training tool, it

raises the possibility of extending mobile requirements tools to train requirements analysts before a session. The mobility is critical to this learning. Analysts will often have to travel to the workplace, and they can use the mobile tool to learn, before arrival, important domain concepts and questions to ask. Therefore, not only can analysts use mobile tools where stakeholders' needs emerge, but mobile tools can train analysts to observe and acquire these needs where and when they emerge.

### **Use RE-specific tools instead of general-purpose tools**

Today, mobile devices are designed as general-purpose tools to support the needs of as many customers as possible. Although this has led to a wide range of application types on mobile devices (for example, for capturing text, audio, and video), there's a lack of highly specialized applications for specific domains such as RE. In principle, a mobile analyst can use applications such as Pocket Word to support RE activities. These off-the-shelf solutions initially appear effective for taking notes about future system users' requirements. However, real value comes from integrating a PDA's capabilities into an application that supports specialized RE tools for mobile requirements discovery.

Using structured RE techniques in the field with mobile devices benefits from support for specific RE methods and the tight integration of mobile device capabilities to allow their seamless use. For example, during requirements negotiation, a stakeholder could use messaging or email tools available on a mobile device. However, our experiences suggest that such an approach won't work for most stakeholders owing to the difficulties of tracking and structuring such negotiations. Analysts could use Pocket Word to represent scenarios and manage their walkthroughs. However, users would miss RE-specific features such as automatically generated what-if questions or wizards for entering requirements. Furthermore, Pocket Word lacks multiuser support and automated synchronization of the captured results with a desktop scenario tool—features that are important in desktop uses of scenario walkthrough tools.

*Lesson 2: To achieve real benefits, we need a range of bespoke mobile requirements tools.*

In addition to seamlessly integrating a collection of functions specific to RE activities,

**Real value comes from integrating a PDA's capabilities into an application that supports specialized RE tools for mobile requirements discovery.**



## Using a mobile device in the workplace for observing users and discovering requirements is challenging.

bespoke mobile RE tools offer additional functions, such as lists of questions to ask stakeholders. Although the MSP exploited the ordering of events in a scenario, you can apply other frameworks to generate requirements questions that are delivered through mobile tools. You can apply the Non-Functional Requirements framework,<sup>9</sup> Planguage,<sup>10</sup> and quality models<sup>11</sup> to generate questions about different qualities (performance, reliability, and availability) associated with a stated requirement or observed task. For example, Planguage decomposes a usability requirement into requirements about entry-level experience, training, handling ability, likeability, and demonstrability. Why not tailor these decomposed requirements types to ask questions specific to the actors and objects being observed, such as “What is the minimum level of experience needed to use the system?” and “What levels of training are needed?” Being able to interrogate these actors directly in the workplace can lead to more accurate answers and, hence, requirements.

### Know your mobile tool’s target users

The participation of both analysts and future system users is highly desirable in RE, but the ways they use mobile tools can differ. When developing RE capabilities for mobile devices, you must be clear about your target users. Our studies show that analysts seek more features, explicit support for RE processes, and a large degree of control over the tool’s behavior, while future system users prefer much simpler tools.<sup>4</sup> The studies also showed that evaluations of the MSP’s usability revealed a lack of guidance for difficult tasks and meaningful feedback for different types of users as two major issues. The PDAs’ nature and usability extenuated this problem.

*Lesson 3: Consider the needs of different users of mobile RE tools, such as analysts and future system users.*

We’ve been experimenting with features of mobile RE tools for different types of users. Our first MSP prototype supported field analysts with features for scenario walkthroughs. It gave analysts multimedia capturing through loose integration with Pocket Word. When developing a new release of the MSP, we aimed to improve support for future system users. This led to a plug-in architecture that let users seamlessly integrate multimedia capabilities for arbitrary media types.<sup>5</sup> Future system users also requested

more guidance and feedback for using the MSP, so we developed a wizard for entering new requirements and improved feedback to users about the status of important tasks. The MSP now also supports a role concept with defined features for each role and customization features to personalize the tool’s behavior.

### Ensure the usability of your requirements application

Researchers have put little emphasis on making requirements tools usable. On desktop computers, usability problems are often less critical for modeling or analysis tasks because analysts can easily find workarounds. This isn’t the case, however, with requirements applications on mobile computing devices because additional usability challenges emerge. Using a mobile device in the workplace for observing users and discovering requirements is challenging, and usability problems can detract significantly from undertaking these tasks successfully. Our studies with the MSP<sup>4</sup> revealed that even relatively minor usability problems led to difficulties. For example, in an early version of the MSP, users could accidentally log out of the system by hitting the “back” button in Mobile Internet Explorer.

We discovered the usability issues also by undertaking a heuristic usability evaluation with six experienced usability analysts—researchers, doctoral students, and postgraduate students at City University’s Centre for HCI Design. Five analysts rated the MSP as *excellent* or *good* for *supporting user recognition rather than recall*. Given the scenario walkthroughs’ purpose—aiding users to discover requirements by recognizing scenario events—the results suggest that the MSP accomplishes its main purpose. Five analysts rated the MSP as *good* or *good but can be improved* for *consistency and standards in its interaction design*. However, half of the analysts rated both the support to *recognize, diagnose, and recover from errors* and *documentation and help* as *very poor*. Likewise, no analyst ranked *arc of action* (that is, reviewing past and current activities) as *good*. These usability problems were diagnosed as reasons for poor analyst performance during our MSP.

*Lesson 4: Usability is essential for mobile requirements tools.*

How can we address this factor? Requirements analysts and researchers must understand

in more detail how they do their own requirements tasks, and researchers must practice what they preach, study and model requirements tasks, and evaluate prototypes that are designed to change and improve these tasks. Another implication is that we must value usability of requirements methods and tools—that is, the ability to learn and use these methods and tools without error, quickly and frequently.

### Provide a sound technical infrastructure

Mentioning a technical infrastructure might appear dull compared with the more exciting goal of discovering high-quality requirements. However, the tendency to focus on new technologies can lead people to underestimate the importance of infrastructure. In mobile computing, problems can arise from low battery power, short battery lifetime, intermittent network connections, or software problems. Requirements analysts usually test mobile RE tools on the newest mobile devices in a development environment with stable, high-bandwidth network connections. Out in the field, these operational settings can change dramatically, which could result in bad response times or even cause the tool to cease functioning.

When using mobile tools, it's essential to know the technical and physical environment in which you can use them. Reasonable performance and sufficient storage capabilities are the minimum requirements for your mobile device in all environments. The specific RE task at hand determines what else is important. For example, battery lifetime becomes an issue if you plan long walkthrough sessions. Although audio recording requirements makes sense in a low-noise office environment, it's of practically no value at a noisy London bus stop.

*Lesson 5: Carefully plan your use of mobile RE tools in advance to ensure a sound technical infrastructure or to lessen your dependence on the infrastructure in the first place.*

In some studies, we had to use the MSP in places with no Wi-Fi connections. Even hotspot locations in central London didn't offer reliable network connections. This required some extra work to provide a mobile server. Ultimately, these experiences led us to develop a version that offers a detached mode for offline operations that are resynchronized once back at the desktop. This prototype supports only basic scenario walkthroughs. Users can select normal and alter-

native course events and add requirements and comments without an Internet connection. After the walkthroughs, they can automatically synchronize requirements and comments with databases on the ART-SCENE server.

### Capture cues rather than fully specified requirements

Regardless of the chosen representation when capturing requirements (text, graphical, or audio), the competing demands of observing, asking, and recording mean that they're sketched rather than specified in full using a mobile device. This isn't as unusual as it sounds. It's a truism that as analysts write requirements, they won't get them right the first time, even in more traditional requirements processes.<sup>12</sup> Rather, the analyst first sketches the requirement and returns to it later to produce the more complete specification. Therefore, the sketch must be sufficiently semantically rich to help the analyst accurately and consistently recall the requirements and the associated rationale and arguments.

*Lesson 6: Capture just enough information about a requirement to enable its complete specification at a later time.*

Multimedia capabilities are helpful for capturing such cues, and tool support for organizing and structuring the captured cues is important. Ideally, a tool lets analysts link the cues to specific requirements in a requirements repository,<sup>5</sup> making it easier for them to produce more complete specifications.

Fortunately, solutions are available. If you're documenting requirements in text form, exploit existing mobile-phone technologies such as autocompletion. We've already used such techniques in requirements specification. Our Web-enabled UCARE requirements tool exploits glossary terms with their tagged senses from the online WordNet lexicon to give analysts autocompletion capabilities.<sup>13</sup>

A less technical approach is to employ a simple, codified requirements language that requires less documentation but still conveys sufficient meaning. Although a project can develop its own shorthand, existing requirements techniques such as Planguage<sup>10</sup> also offer simple-to-use templates that are quick and easy to fill in with qualifier terms and quantifiers. We've also added wizards to the MSP that expedite requirements entering by offering a reusable



## About the Authors



**Neil Maiden** is a professor of systems engineering at City University, London. His research interests include requirements engineering and scenario-driven approaches to software development. He received his PhD in computer science from City University, London. He's a member of the British Computer Society and *IEEE Software's* editorial board. Contact him at the Centre for HCI Design, City Univ., Northampton Square, London EC1V 0HB, UK; n.a.m.maiden@city.ac.uk.

**Norbert Seyff** is a research assistant at Johannes Kepler University Linz. Within the scope of his ongoing PhD research, he's developing and evaluating innovative methods and tools supporting mobile stakeholders and analysts in acquiring and negotiating requirements. He received his master's (Dipl.-Ing) in computer science from Johannes Kepler University Linz. Contact him at Johannes Kepler Univ., Systems Eng. & Automation, 4040 Linz, Austria; nseyff@sea.uni-linz.ac.at.



**Paul Grünbacher** is an associate professor at Johannes Kepler University Linz and a senior researcher in the university's Christian Doppler Laboratory for Automated Software Engineering. His research interests include automated software engineering and collaboration in software development. He received his PhD in business informatics from Johannes Kepler University. Contact him at Johannes Kepler Univ., 4040 Linz, Austria; paul.gruenbacher@jku.at.

**Omo Otojare** is an ICT project manager with the National Health Service in England. Her research interests include requirements engineering and systems analysis. She received her master's in business systems analysis and design from City University, London. Contact her at City Univ. London, Centre for HCI Design, London EC1V 0HB, UK; omo.otojare@nhs.net.




**Karl Mitteregger** is an IT project manager at Oberösterreich Tourismus, the Upper Austria tourism agency. His research interests include requirements engineering and IT project management. He received his master's degree in business informatics from Johannes Kepler University, Linz. Contact him at Oberösterreich Tourismus, 4041 Linz, Austria; karl.mitteregger@ib-stelle.at.

vocabulary of objects, actors, and keywords on buttons.<sup>5</sup>

**M**obile technologies offer exciting new opportunities to improve important requirements processes. However, providing usable, useful mobile RE tools is challenging due to mobile devices' limitations and limited knowledge on successfully using mobile RE tools in the field. You can use the reported lessons learned as an initial guide to develop and use mobile RE tools successfully. We believe that mobile RE tools will complement rather than replace traditional approaches, and the combination of context-aware and conventional elicita-

tion and negotiation approaches has the potential to improve the quality of requirements.

Evaluation studies also revealed several issues,<sup>4</sup> including biases arising from the limited information available on mobile devices; integrated training, process guidance, and tool support for analysts; and guidance for end users to discover and document their own requirements. Further work in the mobile RE field is needed to address these issues. 

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