Chapter XXII
Modelling and Simulation of Mobile Mixed Systems

Emmanuel Dubois
University of Toulouse III, France

Wafaa Abou Moussa
University of Toulouse III, France

Cédric Bach
University of Toulouse III, France

Nelly de Bonnefoy
University of Toulouse III, France

ABSTRACT

Interactive systems are no longer expected to be used in confined and predefined places. By increasingly taking advantage of the physical environment, interactive systems are becoming mixed, that is, merging physical and digital worlds. Moreover, they support user’s mobility and thus can be referred to as “mobile mixed systems.” To overcome technology-driven development processes and to take into account their physical nature and mobile dimensions, specific design approaches are required. From this perspective, we present the interweaving of an existing design model (ASUR) for mixed systems, and a 3-D environment (SIMBA) for simulating modelled mobile mixed system. The aims are to support the investigation of mobile mixed system design through the dedicated modelling approach, and to better understand the limit of the modelled solutions through their simulation. This constitutes a first step toward an iterative method of design for mobile mixed systems, based on “midfidelity” prototyping.
**INTRODUCTION**

Interacting with a computer system through keyboard, mouse, screen, and speaker in a fixed and predefined working environment is no longer the only available solution. Although such static interactive situations are useful for individual and acontextual applications, mobile interactive systems are tightly interwoven with the existing user’s activity, physical artefacts, and application domain resources (Rodden, 1998). They provide a good support to information dissemination, opportunistic share or collection of information, intuitive manipulation, and so forth. Simple examples include the Wii console interaction device, museum guide overlaying exhibits with digital information, and so forth.

Recent advances in the technological, software, and communication infrastructure domains facilitate the implementation of different forms of mobile interactive systems (Renevier, 2004):

- Nomadic systems are carried by a mobile user. Wireless, light, and small devices are required.
- Ubiquitous systems offer services in any places, thus supporting the user’s mobility, but remains invisible. It relies on the understanding of the use and manipulation of physical artefacts.
- Context-sensitive systems are influenced by physical properties of the user. User’s location and orientation are the two main characteristics of importance.

In this chapter we particularly focus on the two last categories, and use the term “mobile mixed systems” to refer to them. The MARA prototype constitutes a good example of such systems (Kähäri & Murphy, 2006). In this denomination, the “mobile” dimension covers the third form listed (context-sensitive) and “mixed systems” depicts interactive systems that combine the use of physical and digital entities (Dubois, Nigay, Troccaz, Chavanon, & Carrat, 1999) and covers the second case (ubiquitous). Mixed systems include interaction paradigms such as tangible interfaces, augmented and mixed reality, and so forth.

The design of mobile mixed systems introduces many new aspects such as physical artefacts and properties description, links between physical and digital entities, identification of the multiple interaction facets, and so forth. However, traditional HCI approaches leave out most of these specific aspects. Therefore, most contributions in this domain consist of the development of empirical and ad hoc systems. Other contributions have recently introduced models and approaches supporting early design phases: physical objects and interaction description, context models, spatial organisation, and so forth.

The work presented in this chapter aims to take advantage of both kinds of approaches, empirical developments and modelling approaches, to support the design of mobile mixed systems. By coupling these approaches, the goal is twofold:

- To add some rationale in the currently ad hoc solutions in order to justify and document design choices, and to better support the reusability of technical implementation parts;
- To settle direct links between early design and development phases, in order to anchor the reasoning about interactive technique design and its software implementation.

To do so, we have chosen to adopt an iterative HCI design process: participatory design. As presented in Mackay et al. (Mackay, Ratzer, & Janecek, 2000), this iterative process is based on four steps, each of them instrumented with different methods:

- **Analysing:** It refers to the requirements analysis and problems identification. This step relies on user’s observations in situ with probes, or in vitro within labs.
- **Designing:** It consists of generating ideas to solve aspects of the interaction techniques being designed. This second step can be based on a combination of informal techniques (brainstorming, focus group, interviews, etc.) and formal techniques (models, notation, diagrams, etc.), respectively used to generate ideas and then describe the solutions.