Designing Tomorrow's Smart Products – Experience with the *Smart-Its* Platform

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Abstract
Designers will increasingly be facing the challenge of creating context-aware or "smart" products – everyday objects that have embedded computation, sensing and communication capabilities. *Smart-Its* is a prototyping platform for creating such objects, that is being developed in a European Union research project. A Smart-It is a very small computer equipped with wireless communication and a set of sensors. We describe how we approached the design of future user experiences and interactions based on the Smart-Its platform. Using scenario-based methods to support collaboration within a multi-disciplinary working group, we developed innovative demonstrators of how "smart" objects support dynamic usage situations and new interactions in a restaurant setting. A group of designers were invited to provide feedback on design aspects of prototyping with Smart-Its. We found that our prototypes and design materials stimulated creative speculation about future interactive products.

Keywords
Concept Design, Product Design, Interaction Design, Ubiquitous Computing, Pervasive Computing

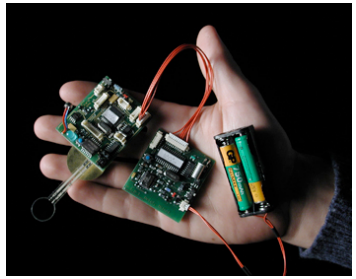
Industry/category
Consumer Products, Embedded Computing, Mobile Applications, Sensors

The Smart-Its platform
A *Smart-It* is a very small computer that can be attached to everyday objects. A Smart-It consists of a *communication board,* with a wireless transceiver to let the device communicate with other Smart-Its; and a *sensor board,* which gives the Smart-It data about its surroundings. More information: *www.smart-its.org*

The standard sensor board has five sensors:

- Light
- Sound
- Pressure
- Movement
- Temperature

For specific purposes, other sensors can be added, for instance a gas sensor, or even a camera for receiving images.



Project statement

By using sensors, computer-enabled artifacts can gather information about the environment and the actions of users – they become aware of their surroundings and may even act on their own behalf. Such "smart" everyday objects represent an entirely new product category. It might be a coffee cup that knows if it's full or empty, and the temperature of the liquid inside [2]; it might be a table that keeps track of the objects that you place on it [6]; or it might be a piece of flat-pack furniture that helps in the assembly process by monitoring the user's progress and giving appropriate instructions according to the situation [1]. To explore such "smart" products, researchers and designers create working prototypes that demonstrate possible functionalities and user experiences. However, developing this kind of applications requires a lot of initial work in hardware and software development.

Smart-Its is part of the European Union's *Disappearing Computer* initiative (www.disapperingcomputer.net)[1]. The project aims to create a platform that will lower the hurdle that currently makes it so difficult to create interactive user experiences in the physical domain. We do this by developing a small computer, a "Smart-It", that can sense information about its environment and communicate with other devices (see sidebar). While the project at this stage is still mostly aimed at researchers, ultimately we hope to provide a kind of toolkit that will make creating a "smart" product as easy as designing a webpage in a WYSIWYG editor.

[1] Smart-Its is funded by the Commission of the European Union under contract IST-2000-25428. Partners are ETH Zürich (Switzerland), Interactive Institute (Sweden), Lancaster University (UK), University of Karlsruhe (Germany), Viktoria Institute (Sweden) and VTT (Finland).

Project participants

The scenario process and application implementation was led by an interaction designer working with expert partners in communication software and perceptual computing, plus technical design students. The follow-up study was led by a Ph.D. student in informatics.

Project dates and duration

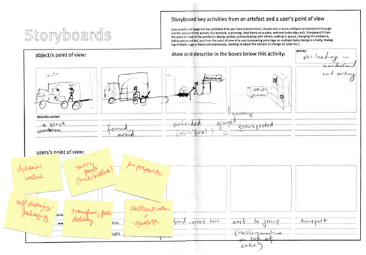
The Smart-Its project runs from January 2001 to June 2003. This portion ran June 2001 to December 2002.

Process

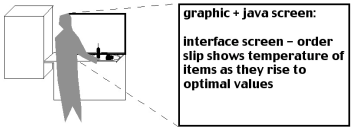
The consortium includes partners from five countries comprising a wide range of technical disciplines and perspectives. Hardware and software development occurred in parallel with application development and design. A major concern was to create a collaborative design space for diverse stakeholders and expertise, and to achieve a balanced approach to both technical innovation and user experience. To support this, we used *scenarios* as:

- *Ideation* for application definition in workshops with project partners
- *Guidelines* for design decisions and technical specifications in application development
- *Formats* for communicating the concepts and technology to stakeholders and the public

The scenarios were developed in workshop sessions using experiential design methods and materials [3, 4, 5]. Initially, we used scenarios as speculative sketches and paper mock-ups of potential behaviors and functions. Later, they were refined as storyboards through role-play and video scenario techniques, to guide specifications for sensor and application



ARE YOU BEING SERVED
trigger: items on tray



The design work culminated in an exhibition, where animated scenarios were triggered as visitors interacted with Smart-Its-augmented objects.

programming. Finally, scenarios accompanied working prototypes to convey the look and feel of the user experience and provide an accessible means of conveying the technical story to the public.

Scenarios proved a valuable means of supporting communication, decision-making, and collaboration in the project. They refocused discussions that might otherwise have been dominated by technological concerns to the motivations, activities, and interactions of potential users. They surfaced new opportunities and solutions for ad-hoc networking, interaction techniques, and information display. We found that use of scenarios to explore future visions of technology provided an essential experiential and human perspective on applications involving emerging intelligence and distributed sensing in a networked world.

Final scenarios focused on the dynamic restaurant environment, which offers a challenging context where there are diverse artifacts, multiple actors and agendas, and many practical and logistic issues. Three scenarios were chosen to implement using Smart-Its:

- *Oyster Auction*: sensor-enhanced packaging enables oysters to determine their level of freshness and communicate through a dynamic "best-before" label
- *Dynamic Menu*: wine bottles monitor their treatment and negotiate values amongst themselves to update a dynamically updated menu
- *Ready to be Served*: items in an order monitor their state and signal the waiter when they are ready

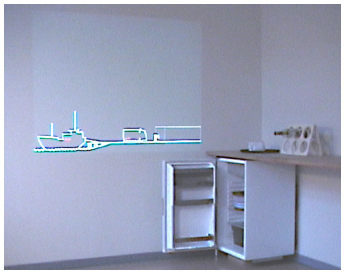
These scenarios demonstrated how Smart-Its technology could enable new user experiences by taking advantage of collective awareness among multiple, networked, context-aware objects. Prototypes were implemented with scenarios in an interactive installation, as part of a larger exhibition for the EU Disappearing Computer initiative[2]. Visitors to our installation were invited to manipulate a variety of "smart" objects to trigger video sequences.

For instance, in "Ready to be Served", visitors interact with objects that might be part of preparing a typical customer order (a piece of cheese, a bottle of wine, a refrigerator, and a serving tray). Each is equipped with a Smart-It for sensing and communication. When items are assembled and moved together on the tray, they are grouped together as an order (through Smart-Its accelerometer perception) and they update their status in relation to whether they are ready to be served. Conditions for this include checking the quality of items – for instance that the wine had not been roughly handled and that the cheese is at its appropriate serving temperature, which can be determined by the thermometer and accelerometer on the Smart-Its. Once all conditions have been met, the items signal the waiter that they are ready to be served.

Research details

The current Smart-Its platform was created primarily as a *vehicle for exploration,* and many choices and compromises were made to support this specific goal. After finishing the practical design work described above, we wanted to explore how designers not directly involved in the project would view the Smart-Its platform, and how well our final scenarios communicated properties of future "smart" products. We invited a total of 16 professional designers and

[2] *Disappearing Computer Jamboree,* Sept. 30, Göteborg, Sweden



The designers in the study were concerned with the size and appearance of the Smart-Its technology and the interactive prototypes.

design students to an evaluation session, divided in 5 groups. We explained the concept of Smart-Its, demonstrated the three scenarios mentioned above, and also showed an application example where Smart-Its provide instructions during furniture assembly [1]. In this way we tried to illustrate important concepts embodied in the demonstrations, such as *augmentation of everyday objects, context awareness,* and *networking between objects.*

After the demonstrations, we engaged participants in a workshop session where we tried to encourage a discussion about the Smart-Its technology in general. To encourage this, participants were given a sheet of paper with a few phrases. The phrases were: "Aware of its own status", "Aware of its environment", "Can talk to each other" and "Can collaborate". We discovered that it was difficult for the designers in the study to imagine how they would augment existing objects with Smart-Its. They had difficulties thinking beyond matters such as size, which researchers usually consider to be temporary issues that will be solved in the "next version". We also had trouble communicating that Smart-Its is a general platform for prototyping "smart" products. Several participants even remarked that it was unnecessary to have so many sensors in the same device, and suggested that we make devices that were more specialized and smaller.

We found it particularly difficult to convey the idea of collections of "smart" objects that communicate and share information between each other. In the final workshop we therefore encouraged the participants to use Post-It® notes to show how they imagined that they could stick Smart-Its onto different objects, and this clearly stimulated the discussion. The participants in this group were much more inclined to discuss concrete ideas using Smart-Its, and came up with some of the most interesting suggestions for "smart" products. This group also tended to focus less on size and other constraints of the current technology, leaving much more room for exploration of the conceptual side.

In conclusion, through the combination of scenario development, prototyping, and feedback from designers, our experience with the Smart-Its platform has uncovered both problems and potentials when designing "smart" products. The platform will continue to be refined based on this experience.

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