

## The Disappearing Computer



Information Document, IST Call for proposals, February 2000.

### Mission Statement

To see how information technology can be diffused into everyday objects and settings, and to see how this can lead to new ways of supporting and enhancing people's lives that go above and beyond what is possible with the computer today.

Specifically, the initiative will look at how to make 'information artefacts' based on new software and hardware architectures that are integrated into everyday objects. It will look at how collections of artefacts can act together, so as to produce new behaviour and new functionality. It will investigate the new approaches for designing for collections of artefacts in everyday settings, and how to ensure that people's experience in these new environments is coherent and engaging.

### A vision of the future

A vision of the future is one in which our world of everyday objects and places becomes infused and augmented with information processing and exchange. In this vision, the technology providing these capabilities is unobtrusively merged with real world objects and places, so that in a sense it disappears into the background, taking on a role more similar to electricity - an invisible pervasive medium.

As a consequence, human-centred notions, such as real objects and everyday settings, can come into foreground, rather than the computer-centric ones which have determined the evolution of the computer-as-we-know it. It offers the opportunity of seeing how objects can become augmented with new properties and qualities and how these can be designed to enrich everyday living in completely different ways.

Artefacts will be able to adapt and change, not just in a random fashion but based on how people use and interact with them. Together, new functionalities and new forms of use will emerge that will enrich everyday life, resulting in an everyday world that is more 'alive' and 'deeply interconnected' than our current day understanding.



A vision of the future

## Moving towards the vision

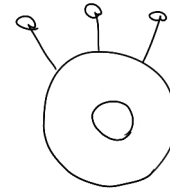
As much of the above represents un-charted territory, the aim of the disappearing computer will be to explore the underlying concepts and methods that will 'set the trends' for future development. In this spirit, the initiative will focus on three inter-linked objectives:

- 1) Create artefacts
- 2) Emerging functionality
- 3) People's experience

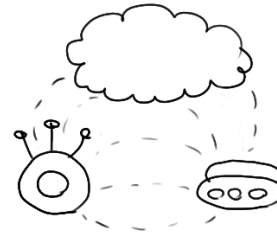
A detailed description of these objectives is given in Annex I.

The initiative will address these three objectives by launching a number of independent research projects that will be selected from the current call for proposals. Individually, projects will address specific topics; collectively they will address the three objectives as a whole. In addition, promising and complementary work that emerges from the various projects will be able to be integrated by new projects that can be created throughout the duration of the initiative. Annex II details how this will be done.

In order to maintain a sense of direction and coherence across all the projects, a number of support activities will be put into motion. A network made up of a representation of all project partners will run these activities. Details are given in Annex III.



Create artefacts



Emerging functionality

## ANNEX I

### Objective 1): Create artefacts.

In the vision of the 'disappearing computer', information artefacts are future forms of everyday objects that represent a merging of current everyday objects (tools, appliances, clothing, etc) with the capabilities of information processing and exchange (based on sensors, actuators, processors, microsystems, etc).

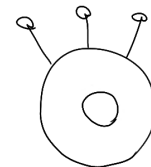
These artefacts have the capability of communicating with other artefacts based on local (typically wireless) networks, as well as accessing or exchanging information at a distance via global networks. In this way, these artefacts possess the capability of both local and global inter-working.

Individually, artefacts may have a small range of capabilities but together can exhibit a much broader range of behaviours. Alternatively, in certain cases, they may be designed to individually have a wider range of functions, but still working within an ensemble.

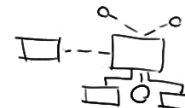
This objective focuses on how to create individual artefacts, particularly ones that will have the attributes of openness and connectivity, so that together they can form an open and adaptable system. How they can work together using this as a basis, is taken up in objective 2.

### New architectures

The creation of artefacts will require research on new software and hardware architectures, particularly ones that:

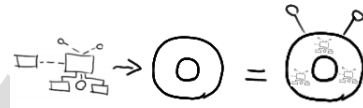


Create an artefact



A new architecture

- ?? Accommodate trade-offs between networking, computing, and power consumption.
- ?? Form part of an open system that allows for wireless communication with other artefacts, for example to connect with global networks.
- ?? Allow for adaptive behaviour, for example through the design of adaptive software architectures, or re-configurable hardware.
- ?? Allow for an awareness of their context, for example with a system of sensors.
- ?? Enable an artefact to be modular, either from the software or hardware points of view.



### Embedding into everyday objects

In order to make information artefacts, the IT components will have to fit them unobtrusively. This will require research into ways of merging information technology with objects and materials, including for example:

- ?? Methods and techniques for adding-on or embedding IT components.
- ?? Techniques for miniaturising components so as to allow easy embedding
- ?? Coating, or sticking components onto objects, or interweaving them with their constituent materials.

Research could also consider approaches that would make it easy for people to embed IT components into everyday objects themselves, for example, with 'do-it-yourself' toolkits.

Embed into an object



A DIY artefact toolkit

## Objective 2): Emerging functionality

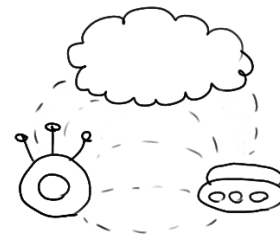
The functionality of an artefact corresponds to the range of functions it exhibits or the experience it provides. In reality we may expect a range of different kinds of artefacts, some general purpose and some quite specific. Even if an individual artefact has limited functionality, it can have more advanced behaviour when grouped with others. The aim is to look at how collections of artefacts can be made to work together, and in particular how they provide behaviour or functionality that exceeds the sum of their parts.

The basis for new functionality to emerge is due to the fact that artefacts have properties as described in the first objective, for instance:

- ?? They are Modular
- ?? They can Communicate with others
- ?? They can adapt and learn from previous events
- ?? They can be placed in various locations

These properties lay the basis for collections of artefacts to be able to behave as a complex interacting system. The main aim of this objective is to see how to *take advantage* of this inherent complexity so as to allow for the behaviours and functionalities of collections artefacts to be changeable and emergent.

Because artefacts can be re-configured, or recombined by people and because they can adapt and evolve, their collective behaviour is not static, and collections of artefacts can evolve to produce new behaviours. This is not just a random behaviour, but one that is guided by how artefacts are used or configured by people. As a



A cloud representing an emerging functionality

consequence, people are given 'things' with which to make 'new things', rather than only being supplying with fixed and un-changeable tools. This requires a 're-think' about the ways in which tools should be conceived of and designed, and this is taken up further in objective 3.

In order to lay the foundations for new functionality to emerge from collections of artefacts, this objective considers two main topics:

### Working together

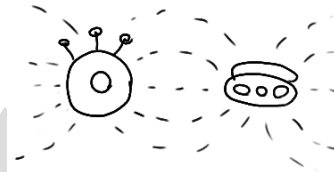
Artefacts will have to be able to work together in order to allow new 'collective' functions to emerge. As a basis for this, research will be needed into:

- ?? The ways in which artefacts communicate with other artefacts or other information sources (either globally or locally) and the protocols they should use.
- ?? The structuring of different kinds of artefacts into collections or 'families', each with a different role and level of influence.
- ?? The design of new forms of 'adaptive operating systems' that would provide a platform for more general software across a range of artefacts.

### Emerging Functionality

Given that artefacts can communicate, adapt and are modular, the specific ways in which functionality can be designed for collections of artefacts have to be researched. This should consider the ways in which functionality can be constructed and the specific ways or conditions for new functionality to emerge. Some indications are outlined below:

- ?? Because artefacts are modular means that parts of them (either from the software, hardware or physical aspects) can be constructed, deconstructed or mixed, or added on to other artefacts. These kinds of changes would in turn create a new hybrid artefact with a new functionality. Combinations or various artefacts would lead to new functionality that would go beyond what individual artefacts could do.
- ?? The fact that artefacts can communicate and can be aware of other artefacts,



Artefacts working together



Combining artefacts to get new functionalities

means that under certain conditions, artefacts could 'synergize' to produce new properties and behaviour that they otherwise they would not exhibit. For example, the proximity of a group of artefacts could trigger an interaction between them and a new functionality would become possible. This principle 'non-linear addition' or synergy could also be applied to certain groups of artefacts interacting over a distance.

- ?? The fact that an artefact can learn or adapt from a history of past events, means that this knowledge can trigger new functionality that for example, emerges with time. An individually adaptive artefact may also communicate with other adaptive artefacts so that a group would produce a more complex behaviour.

### Objective 3): People's experience

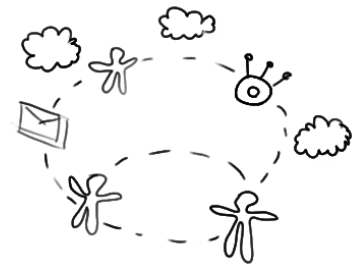
As described in the previous two objectives, collections of artefacts will represent a 'radical distribution' of computing and information processing that can inter-work to deliver new functionality and lead to new patterns of behaviour. It is the integration of these concepts with *real-world settings* and with *real objects*, that offers opportunities for new ways of supporting people's everyday activities - ways that go above and beyond what the pc can offer today. In this respect, one can imagine groupings of artefacts could substitute some of the functions that the personal computer (pc) can perform today, however in a more distributed fashion and based a more natural form of interaction. In other cases, one can imagine groupings of artefacts designed to take advantage of the new context and support people's activities in a completely different ways.

It is therefore necessary to address ways in which people's activities can be supported or enhanced in such new environments. The basis for this is to consider how to design artefacts or how to design for collections of them. Furthermore it is important to see how they can lead to coherent experience in real world settings and how people can participate in them.

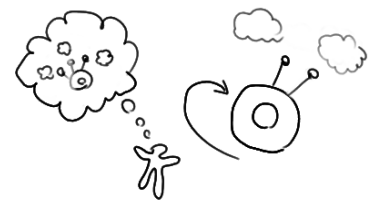
#### Designing and prototyping artefacts

The nature of information artefacts, as described in objectives 1 and 2, pose a number of challenges as regards how artefacts should be designed. This includes for example:

- ?? How to design an individual artefact, and how to integrate utility design with software/hardware constraints.
- ?? The design of the functionality of an individual artefact and how this can be combined with that of others.
- ?? Research on how to design for collections of interacting artefacts and how to



People's experience



Iterative design of an artefact and its functionality

- design in the context of a collective and emerging functionality.
- ?? The use of iterative prototyping and new evaluation methods.

#### Coherence

A world full of interacting artefacts could easily confuse people. Research will be needed in order to make sure that environments will be coherent and understandable. This could include for example:

- ?? Ways to integrate artefacts with real places and locations.
- ?? The use of metaphors, cognitive or semantic models, to guide the design of environments.
- ?? Approaches that ensure 'seamless interaction', for example, for an activity that takes place across different locations and different stages in time.



Coherence in space and time

#### Engagement

In contrast to concentrated engagement in one location (as with a pc), the distributed nature of a collection of artefacts in real locations leads to a range of research issues on how to support people's activities in this context, for example:

- ?? The ways in which both individuals and groups of people can participate in such environments.
- ?? The design of engagement that is appropriate to an activity. This includes active engagement that requires concentration, through to relaxed participation that is 'laid-back', enjoyable or fun.
- ?? The ways in which sequences of interaction and experience can be structured. For example, the use of 'interactive narratives', that can guide or engage people in space and time, and the ways in which such narratives can encompass pre-scripted elements as well as emergent, or unexpected events.



Interactive narratives