INFORMATION SOCIETY TECHNOLOGIES

(IST)

PROGRAMME

Contract for:

Shared–cost RTD

Annex 1 – "Description of Work"

Project acronym: ACCORD

Project full title: Administering Connected Co–Operative Residential Domains

Proposal/Contract no.: IST–2000–26364

Related to other Contract no.: n/a

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1. Project summary

Objectives

The main aim of the ACCORD project is to develop facilities to construct, administer and manage future interactive home environments. We see the arrangement of interactive devices as the principle means of controlling the complexity inherent in domestic environments. We wish to realise dynamic and adaptive methods, techniques and facilities to allow inhabitants to evolve their own Tangible Interactive Environment (TIE).

In particular, we wish to empower future household inhabitants by developing a Tangible Toolkit that they can use to meet their local demands. In order to realise this Tangible Toolkit we need to undertake fundamental research focusing on:

(i) *How inhabitants understand and alter their domestic environments.* What current and new forms of application are likely to emerge within the home and what activities need to be supported?

(ii) *How inhabitants might relate to future interactive environments*. How do we develop and refine for new uses of information and new forms of applications?

(iii) *What are the core elements needed to realise a Tangible Interactive Environment*? How do we identify the core elements with an environment and how do we characterise these so they are readily understood by users?

(iv) *How might inhabitants construct domestic interactive environments from set of components*? What mechanisms are needed to support the rapid construction of a TIE from a set of components?

Anticipated results

ACCORD will address these core research objectives by developing in cooperation with users and designers a toolkit consisting of three main elements:

- ***A collection of hardware and software components*** organised around a taxonomy of elements to help potential users understand these components.
- ***A supporting communication and event infrastructure*** that allows different components to be combined and a set of guidelines on how these components can be combined.
- ***A set of editing facilities to rapidly combine different components***. These editors will combine desktop oriented editing approaches and novel tangible interaction techniques.

These three elements will build upon existing software and hardware infrastructures and will be informed the results of on–going studies and the emerging results from on–going design exercises. The project will exploit the results to emerge from disappearing computing projects developing supporting infrastructures and from the results to emerge from design led projects. In particular, the project will work in cooperation with the MIME project that will be undertaking design led development within domestic environments.

Description of work

As more technologies populate the home environment, consideration of their practical management, control and integration as an ensemble in the environment becomes more important. ACCORD endeavours to examine this situation in depth and breadth. In depth by performing studies to discover the details of how people manage and function in such spaces already. Existing studies of the home have shown that the practical administration of technology is central to the way in which people organise their domestic lives together. Domestic technologies are used as resources to co–ordinate activities. For example people often use broadcast media (TV or radio) to order their daily routine. While the relationship between home activities and technology is a complex one, home life is nevertheless organised around the accomplishment of daily routines that delineate clear patterns of technology use. Having an in depth understanding of these domestic patterns of use will enable a foundation in a search for opportunities of innovation and design. In breadth we will study an array of different solutions and possibilities that no one market–producer can manage. The main work will then be the development of a toolkit to enable people to develop and administer their own environments where the computer has disappeared, by providing a series of exemplar devices exploiting novel sensing technologies, a supporting event–based infrastructure, and a set of configuration tools. This toolkit will aim to enable functionality to emerge from the combination of a number of devices in practice. ACCORD will support the integration of information and activity inherent in this problem by developing and demonstrating the concept of a Tangible Toolbox. This toolbox is a collection of interaction devices and a supporting software infrastructure that enables people to convert a physical environment into an active tangible environment where the computer has disappeared.

Milestones and expected results

M1 Month 6 Initial specification of the Tangible Toolbox and Dissemination and Use plans available. Results from initial studies available. Major development work on the Toolbox begins.

M2 Month 9 Workshop to inform realisation plans for the Toolkit from the conceptual work.

M3 Month 12 Workshop to relate development of the Toolbox to tangible environment development.

M4 Month 15 Final report on the conceptual Tangible Toolbox

M5 Month 18 An internal version of the Toolbox will be available. This will support initial versions of the concept demonstrators.

M6 Month 24 An external version of the Toolbox released, including documentation.

2. Project objective(s)

A significant moment of opportunity exists for the realisation of new forms of support for everyday activities in which the computer disappears. Essentially, much of the low level network infrastructure required to underpin interactive environments, in which the computer is less central and visible, is becoming well established. Within the next few years, initiatives such as *IP6*, *THIRD GENERATION CELLULAR PROTOCOLS* and wireless standards (such as *BLUETOOTH*) will ensure high–speed reliable wired and wireless connection to most environments. While we can be confident about the technology over the next five to ten years we do not know, however, the ways in which the promise of "*any information, anywhere, at any time"* will change everyday life and the ways in which we live together. Nor do we know how to structure and interact with the emerging "global information space" in ways that are tractable, manageable and evolve over time to enable the emergent functionality central to the support of human activity.

ACCORD aims to focus on the utility of a diverse set of devices working in combination by considering how their potential may be exploited in integrating them into everyday settings of human activity. In order to do this the project takes the standpoint of looking at the broad and long–term picture by focusing on a particular setting, namely, *the home*. We have chosen to focus on the home as the explosive growth and development of the Internet has opened up a host of new technological interests and possibilities. We shall consider this setting as it is currently organised by people in their everyday activities and seek to understand the core elements of the domestic environment: the daily work practices of inhabitants, their routines, and the use of technologies in their activities. We seek to identify implications and opportunities from this understanding in order to construct techniques and mechanisms based on tangible, portable, manipulatable technologies that work toward integration and flexibility, enabling functionality to emerge from the combination of devices in practice. We search for solutions that simultaneously (i) integrate across different devices and applications enabling interaction and interchange and (ii) disperse function across devices given no single device will provide the solution for all needs.

> ACCORD will develop a toolkit to enable people to develop and administer their own environments, where the computer has disappeared, by providing a series of exemplar devices exploiting novel sensing technologies, a supporting event–based infrastructure and a set of configuration tools. This toolkit will aim to enable functionality to emerge from the combination of a number of devices in practice. ACCORD will support the integration of information and activity inherent in this problem by developing and demonstrating the concept of a *Tangible Toolbox*.

The *Tangible Toolbox* is a collection of interaction devices and a supporting software infrastructure that enables people to convert a physical environment into an active tangible environment where the computer has disappeared. The goal of the tools is to find accord between the competing interests of home and work. Explicit aims of the toolkit will be to enable users to:

- Create active information artefacts from everyday objects (tools, paper, appliances, clothing, etc.).
- Support information exchange (based on sensors, actuators, processors, mircosystems, etc.).
- Enable communication with other artefacts based on local (typically wireless) networks.

ACCORD proposes to exploit the combination of available devices *in domestic practice* as a means of managing the daily affairs of the home environment, enabling the personal balancing of different needs and desires in an increasingly technological world. At this point we are not yet

certain of the exact scenarios and examples the toolbox will support and enable in the home. This is something that will become apparent from the studies that are undertaken at the start of the project. The kind of activities and scenarios we anticipate supporting include:

- Family co–ordination – a working couple with young children often has competing priorities and must inhabit an uncertain and unpredictable environment. Work and family activities must be juggled – medical treatment (e.g. doctor or dentist) for children must be fitted in with the working agenda, and parents and children need flexible ways of communicating and negotiating their activities in a flexible and dynamic manner. We also wish to consider monitoring activities, with parents being able to more easily be aware of where their children are and what they are doing. Here we look at a single home environment and inhabitants of this environment both at home and away from it.
- Social planning – targeting the age group 15–25, where friends often take holidays together and have an active social life together. How can we use tangible environments and the toolbox to enable this group of people to more easily co–ordinate their activity and keep in touch with each other. Here we consider homes connected together and not just activity in a single home.
- Extended family support – how can we support activities between different generations, for example providing elderly family members more contact with their children and grandchildren, as well as with friends of their own generation.

However, we must stress that the above scenarios are examples of the type of activity we wish to support, are not intended to be exhaustive, and are not descriptions of the actual activities the project will address. These activities will be informed both from our initial thoughts and the insights gained from our studies.

While the relationship between activities in the home and the technology used there is a complex one, home–life is obstinately organised around the practical administration and accomplishment of *daily routines* that delineate clear *patterns of technology use.* Identification of patterns of technology usage is central to ACCORD, providing a grounded base for the specification future scenarios that bring novel devices together and put them to use in the practical administration of everyday life *by* domestic residents.

Our exploration of the *Tangible Toolbox* as a means of combining the functionality of novel interactive devices is situated in the home environment to enable us to adopt a broad approach to functionality. By involving the inhabitants in the home we can extend the existing focus on the workplace to consider how information can be diffused into everyday artefacts and how we can realise a world that is more deeply connected. At the same time, and importantly, we can also consider IT as a supportive medium where the intent is to *enhance* and *enrich* everyday living rather than to improve information–processing productivity.

To realise the concept of a *Tangible Toolbox* that enables people to design and develop their own tangible environments Accord will address three core objectives:

Objective 1: To conceptualise the Tangible Toolbox in co–operation with inhabitants of the domestic environment. This will help refine our vision of the needs and nature of the toolbox.

Objective 2: To develop the elements of the Tangible Toolbox and a set of techniques and infrastructures to support their use. This will enable Tangible environments to be built in a consistent way from the Tangible Toolbox.

Objective 3: To use the Toolbox and collect the lessons learnt about how to develop tangible environment through a Tangible Toolbox handbook. This will also provide a vehicle for disseminating the results of the project and enable others to develop Tangible environments for themselves.

3. Participant list

List of Participants

Partic. Role*	Participant name	Participant short name	Country	Date enter project**	Date exit project**
C	Swedish Institute of Computer Science	SICS	S	Start of project	End of project
P	University of Nottingham	UNOTT	UK	Start of project	End of project
P	ACREO	ACREO	S	Start of project	End of project

4. Contribution to programme/key action objectives

ACCORD will build a Tangible Toolbox that permits information technology to be diffused into everyday artefacts and home–life situations in as unobtrusive manner as is possible. The Tangible Toolbox will be developed iteratively in co–operation with potential end–users through hands on prototyping activities, which enables us to *build on* people's experiences and to identify, explore, and elaborate needs and desires *in context*. We will study a broad spectrum of domestic activities, including social and leisure activities, and professional activities that happen in the home (as many activities actively cross the domains of private and professional space and time). Examples of such might be reading a newspaper at breakfast, watching television with the family, using the computer for leisure, and the more work–oriented activities such as reading and answering business email, preparing documents, and tele–conferencing. Consequently, ACCORD addresses following objectives:

1. Creating Artefacts: Based on patterns of current technology usage, ACCORD will integrate existing and novel technologies, such as paper–based computing and tagging technologies, to create the Tangible Toolbox. The toolbox will make it easy for people to create new artefacts or embed functionality into existing artefacts around the home. With the toolkit, the user can configure the ensemble of artefacts to support emergent functionalities of relevant use.

2. Emerging Functionality: ACCORD will explore the use of a Tangible Toolbox in the domestic environment. Everyday artefacts and existing devices with embedded functionality will be used to co–ordinate and administer activities in the home. We will study how different artefacts interact with one another in the course of their use and (thus) how new functionality emerges over time as a result of the knowledge gained from actual usage in the domestic environment.

3. Use Experience: ACCORD will present a coherent experience to users, using the home environment as an exemplar of how novel technologies can be integrated with real places and locations. Through a study of the demands and requirements of people in the home, particularly of their daily patterns of technology usage, associated behaviours, and related technical consequences, we will build up a collection of experiences of how interactive technologies are may be effectively combined and deployed within the home.

5. Innovation

We see a future home with a large number of small and relatively cheap devices distributed throughout the environment that provide its habitants with services when and where they wish to have them. We seek to develop a toolbox that is readily accessible to the general citizen and which enables them to decide how their environment is managed and controlled. Also, we seek to create a tangible technology that adapts, and can be configured, to suit people's varying contexts in the home environment, such as working, leisure, private time, dinner time, and so on. We define a tangible technology as a *distributed* interface that utilises both physical and spatial properties of the artefact. We envision that such tangible interfaces are non–intrusive in the sense that they can make good use of habits that are already developing in the computer–less society, such as putting computation into well established paper based usage.

This raises a number of questions:

- What are the different sensors that are best adapted to home situations? Cameras? RF–tags? Touch displays? How can these different sensors be used in practice and what sorts of guides can we provide to enable a resident to add these sensors to their homes.
- What are the different technologies to present information that best adapt to different levels of engagement? Large wall–size screens? Embedded displays? Physical manifestations? Electronic paper?
- How is it possible for residents of future homes to specify, monitor and control such complex behaviours and interactions? Would the home "operating system" be intelligent enough to remember patterns in people's habit and propose them some degree of automation? Is it possible to provide users with enough building bricks for such automations and let users "program" them themselves?
- How does the specific and idiosyncratic arrangement of devices in the home interact with the routine general and standardised set of services and portals available across the Internet of the future?
- How do we achieve systems that are non–intrusive and that seamlessly interleave with the everyday professional and leisure activities of the home and that can easily be controlled and turned off?

Researchers and companies are providing the core technologies to answer some of these questions through the development of:

- New interactive devices that exploit new sensing technology.
- New forms of middleware that enable different packaging of services
- New forms of agent based technologies to enable patterns of behaviour to be learned
- New forms of remote and unencumbered sensing
- New forms of paper–based computing technologies that enable users to print out disposable dynamic interaction devices on ordinary paper with ordinary printers.

6. Community added value and contribution to EU policies.

The ACCORD project aims to build a tangible ubiquitous interface toolbox that permits information technology to be diffused into, and combines the use of everyday artefacts in, domestic environments. A collection of interaction devices and a supporting software infrastructure enables people to convert a physical environment into an active tangible environment. The development of this toolbox brings together The Swedish Institute of Computer Science, University of Nottingham and Acreo AB.

- **SICS:** A Swedish research centre who have developed, distributed and supported a *distributed multi–user cooperative virtual environment* that exploits a novel set of spatial mechanisms to support the cooperative activity of users.
- **University of Nottingham**: A UK university with extensive experience in managing European projects and developing *novel architectures to support co–operative work* that are informed from ethnographic studies of work.
- **Acreo AB**: A Swedish research institute in electronics and optics, with competence spanning material and surface science and technology, production technology, electronic design, large area processing, optical communication and also imaging, and in particular are developing *printing techniques for production of electronics on flexible surfaces*.

The combination of these institutions affords significant community added value and contribution to EC policies.

7. Contribution to Community social objectives.

With the development of mobile communication facilities, on–line access from anywhere for everyone is seen as imminent and inevitable rather than a fanciful speculation. An ever more reliable and higher bandwidth digital infrastructure interconnects an increasingly heterogeneous collection of devices and services. The convergence of interactive digital systems, local and wide area networks and mobile communications has already started to transform the ways that people work, shop, converse, and entertain themselves. However, this access is more than merely "fetching" information – it reflects everyday activities and the everyday experiences of the European citizen.

Improving the Quality of Life of the future information citizen

A central motivation for the work of the project is a desire to improve the quality of life of these citizens. These improvements will take a number of forms.

The application innovations in domestic technology to emerge from the project will seek to allow people the ability to control and manage their relationship with the ever–growing amount of on–line information and digital media.

An increased flexibility of working life will be allowed by through the embedding of functionality in tangible everyday objects or artefacts. These will allow people to interact with their environment and other people more easily, allowing more flexible approaches to work.

Improved support for the life of the everyday citizen will be encouraged through the focus on everyday use and the development of future visions of experiences within a Tangible Interactive Environment and the development of tangible artefacts to embody the relationship between the citizen and the infrastructure.

8. Economic development and S&T prospects

A significant proportion of the effort during the lifetime of ACCORD will be directed towards ensuring that full advantage is taken of opportunities for effective development of project results. Three main mechanisms will be used to realise this:

- Co–operation with other Disappearing Computer projects
- Industrial liaison
- Active participation in the research and scientific communities

Each of these different mechanisms is considered below. Given the rapid development of the state of the art it is difficult to be very specific about the details of these events and it is potentially dangerous to be overly prescriptive. In contrast we intend to adopt a response mode targeting the project's limited resources towards activities that are considered to offer maximum benefits.

Co–operation with other Disappearing Computer (DC) projects

A significant motivation for the development of the tangible toolkit is the bringing together of a disparate range of resources to emerge from the information environment. As part of the need to consider heterogeneity ACCORD will make contact with other DC projects. In section 10 we identify other DC projects we envisage working most closely with, although this list is not a closed one. Close co-operation will be achieved by sharing project results through document exchange, joint workshops and shared seminars and meetings at regular intervals. It is difficult to foresee all of the potential links in advance and we envisage using common workshops and seminars hosted by the network of excellence associated with the DC programme as a mechanism to identify common links.

Industrial Liaison

The exact activities supporting this strategy include continuously making relevant material available over the World Wide Web. Other specific activities include targeting industrial events and groups. The broad area being addressed by this project is seeing an increasing number of conferences, exhibitions, trade shows and fairs aimed specifically at an industrial audience.

Participation in the Research Communities

The research nature of ACCORD and its broader objective are long term and sufficiently ambitious so that they cannot be fully realised in practical settings within the timescale or resources of the current proposal. Consequently, research communities themselves will be an important target for dissemination of project results. As well as traditional journal and conference outlets, some of the material placed on the World Wide Web will be aimed at this community. These will include reports of applied results alongside more experimental ideas and attempts to generalise our results, so providing opportunities for critical feedback on the work of the project as it progresses and input from the broader community.

It is now the case that a number of the major research conferences are drawing significant numbers of participants from industry, thus making them an increasingly attractive forum for dissemination of results beyond the research community. Events such as tutorials are especially popular with commercial attendees, so we will endeavour to produce tutorial material and demonstrations (actual and video recordings) for major international conferences (e.g. CHI, ECSCW) as the work within ACCORD becomes more mature. The aim will be to use a series of installations to demonstrate the role of design within these interactive systems communities.

ACCORD is well placed within the research communities since its partners have international reputations for both their research and their leadership roles in organising these communities through working groups, major conferences and the editorial boards of international journals.

Intellectual Property Strategy

The ACCORD project will focus on the production of material for public use and dissemination. To this end all deliverables will be considered public with electronic versions of the deliverables freely available. These public deliverables will be complemented by an internal report series where reports are available across the consortium and external access is managed via the originating partner.

The Project Management Committee, as part of the overall management of the project, will address any intellectual property issues or opportunities that arise. All IPR agreements will be subject to the following guiding principles.

- Rights to ownership of background information brought to the project by project partners remain with the partner.
- The ownership of all intellectual property (including copyright, software and know–how) resides with the originating party.
- The ownership of intellectual property for all jointly produced systems will be shared between those involved in its production.

Exploitation by third parties of results emerging from ACCORD will be subject to the establishment of suitable licensing agreements directly with the originating partners. There will be a preference for any such licensing agreements to be non–exclusive to maximise opportunities for exploitation. It should be noted that the use of paper based displays is covered by a non-disclosure agreement (NDA) with Acreo AB, details of which can be found in Appendix C.

9. Workplan

9.1. General description

The core aim of the ACCORD project is the realisation of a Tangible Toolkit that allows users to administer and manage the complexity inherent in activities within the home environment. The Tangible Toolkit will bring together dynamic and adaptive methods, techniques and facilities to enable the inhabitants of future environments to administer, manage *and* evolve their own environment.

The current trend in the development of technologies to support tangible interactive environments is seeing a proliferation of devices and technologies. We currently see a plethora of different wireless communication techniques, sensing approaches and communications infrastructures. The Tangible toolbox seeks to make sense of these currently disparate technologies by adopting an extensible component approach that will allow components essential to the development of tangible devices to be readily understood and used in practice.

9.1.1. The Tangible Toolbox

Given the central nature of the Tangible Toolbox to the ACCORD project it is worth elaborating the nature of the toolbox we envisage being realised within the project. Essentially, a tangible toolbox will need to provide three key elements

- A component model for interactive environments.
- An infrastructure to allow these components to talk to each other
- A set of facilities to allow the rapid composition of environments from a set of components.

Each of these different components needs to be informed by an understanding of current and potential use and will be realised both as a technological demonstrator and supporting concepts and theories. Given the emergent nature of this area and the continual development of technologies it is equally important that the toolbox is extensible. The core of the flexibility lies with the development of the supporting concepts and theories.

The Component model

The core of the toolkit is the development of a readily understood component model. This model needs to consist of two main elements:

- A taxonomy of components for interactive tangible environments
- A composition model for combining components

The component taxonomy will provide an abstraction over existing technologies allowing new and emerging technologies to be easily added into the toolbox. The composition model will focus on how these different components can be combined and the properties of different arrangements. To illustrate these different elements further it is worth elaborating the way in which we would foresee these different parts of the component model developing during the project.

The component taxonomy

The taxonomy provides a set of structuring principles to underpin how components should be understood and used. The component model provides a functional decomposition of technologies

and a conceptual architecture for relating these. We would currently envisage the following sets of components:

Information components. These provide an abstraction over abstract information sources and would range from database elements to on–line web based information.

Awareness and event components. These provide access to ephemeral activity information and would include the context models developed as part of MIME.

Communication components. These would provide access to different communication infrastructures including both wired and wireless communication.

Sensor and Input components. These would provide access to both traditional components (e.g. keyboard), unencumbered interaction (e.g. video tracking, speech) and novel sensors (e.g. passive IR, heat etc…).

Display and Output components. These would enclude large and small graphical displays, audio devices and physical manipulators.

Tokenisation and Tangible components would provide support for the physical manipulation of different artefacts and classify the forms of output they would provide.

Augmentation components allow existing physical artefacts to be supplemented in order to allow these to form part of an interactive community of tangible devices.

These different components provide an abstraction that allows existing technologies and new and emerging technologies to be used together. Inherent in the taxonomy is an arrangement of these devices. It is worth stressing that this initial classification provides the starting point for the development of the toolkit and we would see a key part of the research being the identification of a useful taxonomy.

The composition model

Closely related to the taxonomy is a model of how these devices are put together. Existing composition models focus on object oriented approaches (e.g. JavaBean, COM etc…). However, these models focus on a function oriented view of the world and it is not clear that the dynamic and emergent properties of interactive environments fit readily into these models. Consequently, we will seek to develop an extension of these models that focuses on the needs of interactive environments. This may explore aspect-oriented architectures and pattern based models as a means of composing these components.

The Component Infrastructure

The supporting infrastructure will need to allow existing components to readily communicate and interact with other components. A number of competing models are currently under development including the JINI vision from Java and Universal Plug and play from Microsoft. It is not clear that any single infrastructure will dominate and the toolkit will seek to provide an abstraction over these. This element of the toolkit will rely heavily on the infrastructure development work undertaking within other DC projects. Initially, the work will extend the multicast models used within DIVE and provide an abstraction of JINI and Javaspaces.

The Configuration Facilities.

One of the most novel aspects of the toolkit is that it seeks to directly involve users in the development of environments. This will require the development of a series of component based editors to support the rapid configuration of facilities. Three main classes of configuration editors are envisages.

Component centred editors will present the composition model and component taxonomy to the user and exploit 2D visual programming techniques to combine components. This approach is analogous to the Bean Box methods suggested by the Java Bean framework.

Environment centred editors will exploit the spatial layout and arrangement of devices. This will use both 2D and 3D screen editors to combine components.

Tangible editors will exploit tangible interaction as a means of combining components. This will involve the placement of devices within physical spaces and the use of specialised physical devices to represent different abstract components.

We would envisage these different forms of editors being explored in tandem with a particular focus on tangible editing techniques to combine these components. This will make use of simple electronic token technologies (e.g. RF tags, Java I buttons etc.) and simple environment sensors (e.g. video and scanning technologies.)

9.1.2. The Technological baseline

The development of a Tangible Toolkit represents an adventurous challenge for the project. One reason why we can tackle this problem is that we have already established a significant technological baseline for the project. In this section we will briefly review the candidate technologies that may be incorporated into the Tangible Toolbox.

We would envisage that very first realization of the Toolbox and an early demonstrator will be built on technology that the ACCORD partners currently have experience of. Today there exist a number of embedded systems that would be suitable for the toolbox. TINI and uCSimm are two that both have Ethernet connectivity and thus can directly connect to the Internet. UCsimm (http://www.uclinux.com/) uses a micro version of the well-known Linux operating system called UCLinux from Lineo (http://www.lineo.com/) and RT-Control (http://www.rt-control.com/). On the other hand the TINI from Dallas Semiconductors, http://www.ibutton.com/TINI/ uses its own operating system that implements a Java virtual machine that gives the TINI a lot of benefits. Both of these systems can connect some sensors, but to achieve more flexibility the BasicStamp from Parallax Inc, http://www.parallaxinc.com/, can be used that has a large number of input and output options. Also a readily available wireless RF module exists for the BasicStamp, which would make it easy to simulate Bluetooth services. The simplest kind of sensors we are thinking of, such as switches, temperature, light and humidity, are available at most electronic shops. Dallas semiconductors (http://www.dalsemi.com) also have their 1-wire product line, which implements several simple sensors and also a range of control and identification devices. Some of these devices are also packaged in the iButton (http://www.ibutton.com). Other identification technologies we forsee in the toolbox are RFIDTags (Radio Frequency Identification Tags). RFIDTag readers from ADC-Systems (http://www.adc-systems.se/) have already been used in projects like KidStory and eScape. A more sophisticated sensory and identification technique is camera vision that also has successfully been used in projects like KidStory and eRena.

The component infrastructure will require significant capabilities for creating and merging user-generated events (dependent or independent, as the case may be) and will be addressed in the software itself through modular programming, just as JINI handles plug-and-play hardware devices. Object oriented code, along with code reflection methods, enable software components to be integrated and inter–connected. Reflection defines the concept of summoning code on demand and availability, making relevant objects active automatically if their presence is detected. The system as a whole is expandable and not limited to any set of modules, other than inheritable ones. The object oriented code parallels, in a sense, the higher–level user programming for which the toolbox is intended for; connecting ready-available components and providing simple methods

for creating new ones on demand. Software modularity was introduced recently in the eScape project, allowing new features to be seamlessly integrated into the basic platform. Such a configuration allows us to effectively introduce and test new features and programming solutions, for e.g. rapid–prototyping and reducing code re–write.

We believe that one important issue, when having the home as the focus area, is that most people can't afford and don't want to have cables all over their house. Therefore wireless connectivity is an important issue, but among the available techniques Bluetooth is the only one that seems to be adequate. The problem with Bluetooth is it is a relatively new standard and few ready solutions exist today. Until Bluetooth is available, the same functionality can be achieved with different technologies like serial transceivers. Several companies produce these, e.g. RF Monolithics (http://www.rfm.com/), RF Micro Devices (http://www.rfmd.com/), Abacom Technologies (http://www.abacom-tech.com/) and Nordic VLSI (http://www.nvlsi.no/). Though the most promising is from Gran-Jansen AS http://www.granjansen.com/gjpp400-design-kit-product.htm as it directly supports multipoint networks

9.1.3 The research approach

The development of the Tangible Toolkit requires a user-oriented approach to the representation and use of components. We need to move from the current technological dominated focus to consider components that make sense to the user. To achieve this we exploit a unique combination of activities:

- *Ethnographic field studies* to identify the daily activities, routines and patterns of technology use within current home settings.
- *Technical assessment and component identification* for understanding the current technologies offered and envisioned and the construction of a set of components that embody the most significant technologies.
- *Opportunity identification of scenarios* that combine patterns of use identified in the field and identified components.
- The *construction of a Tangible Toolbox* demonstrator that instantiates selected components using existing candidate technologies and provides an infrastructure and configuration facilities.
- The *development of demonstrators* that combine future use scenarios with an understanding of the setting to illustrate the utility of a *Tangible Toolbox*.
- The *study of the toolbox in use by end–users* to understand, assess, elaborate, and refine the usability of the tools under development.

To ensure that future needs are met, the project adopts a strongly iterative human–centred approach, driven by formative validation and evaluation with end–users. ACCORD will use a combination of studies of work and future design envisionments based on co–operative design exercises. This approach to the development of the Tangible Toolbox arises from the combination of expertise within the ACCORD consortium and will enable the project to be driven by the envisionment of possible futures while being grounded in the realities of the present (See Figure 9.1).

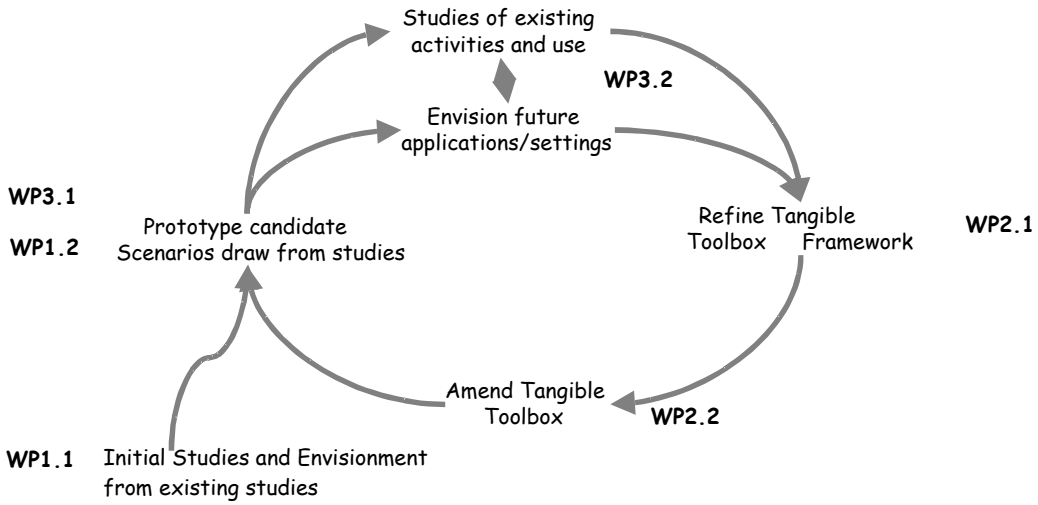

Figure 9.1 the overall project approach

Project objectives will be reviewed at each project phase during the overall iterative approach of the project. In all, three main generations are anticipated.

Generation I: *Conceptualisation of the Tangible Toolbox* will outline the common concepts and methods underpinning the Tangible Toolbox, providing input and gaining feedback from the realisation of the Toolbox. This will outline the taxonomoy of components and suggest some initial configuration facilities.

Generation II: *Realisation of the Tangible Toolbox* will develop the elements and associated infrastructure that make up the Tangible Toolbox. Initial scenarios (future tangible environments) will inform on the structure of the Toolbox. This will result in an *internal release* of the Tangible Toolbox.

Generation III: *Refinement of the Tangible Toolbox* will consider the Toolbox in wider scenarios, learning from patterns of use and changing the Toolbox accordingly. This will result in an *external release* of the Tangible Toolbox.

The release of each generation represents significant milestones for the project and corresponds with the production of deliverables and external project review. The milestones are summarised in table 1

Milestone	Date	Deliverables	Description
M1	Month 6	D2.1, D5.1, D1.1, D4.1, D1.2	Project information, initial specification of the Tangible Toolbox, and Dissemination and Use plans available. Results from initial studies available. Major development work on the Toolbox begins.
M2	Month 9	D1.3, D2.2	Workshop to inform realisation plans for the toolkit from the conceptual work.
M3	Month 12	D3.1/D2.3	Workshop to relate development of the Toolbox to tangible environment development.
M4	Month 15	D2.4	Final report on the conceptual Tangible Toolbox
M5	Month 18	D3.2, D2.5	An internal version of the Toolbox will be available. This will support initial versions of the concept demonstrators.
M6	Month 24	D3.3, D3.4, D2.6	An external version of the Toolbox released, including documentation.

Table 9.1 ACCORD project Milestones

9.2. Workpackage list

B1. Workpackage list

Work–package No[1]	Workpackage title	Lead contractor[2]	Person–months[3]	Start month[4]	End month[5]	Phase [6]	Deliv–erable No[7]
WP0	Inter–project collaboration	SICS		0	24		
WP1.1	Understanding current and future use within tangible interactive environments.	UNOTT	6	0	6		D1.1, D1.3
WP1.2	Implications and opportunities in study	UNOTT	12	5	12		D1.2, D1.3
WP2.1	Conceptualising the Tangible Toolbox	SICS	16	0	15		D2.1, D2.2, D2.3, D2.4
WP2.2	Realising the Tangible Toolbox	SICS	26	6	18		D2.5
WP2.3	Finalisation of the Tangible Toolbox	SICS	14	15	24		D2.6
WP3.1	Understanding and using the Tangible Toolbox	UNOTT	27.3	6	18		D3.1, D3.2
WP3.2	Reflecting on the use of the Tangible Toolbox	UNOTT	9	12	24		D3.3
WP3.3	Development of the Toolbox Guidebook	UNOTT	6	18	24		D3.4
WP4	Dissemination and Implementation	SICS	3	0	6		D4.1
WP5	Management	SICS	16	0	24		D5.1
	TOTAL		135.3				

[1] Workpackage number: WP 1 – WP n.

[2] The contractor leading the work in this workpackage.

[3] The total number of person–months allocated to each workpackage.

[4] Relative start date for the work in the specific workpackages, month 0 marking the start of the project, and all other start dates being relative to this start date.

[5] Relative end date, month 0 marking the start of the project, and all end dates being relative to this start date.

[6] Only for combined research and demonstration projects: Please indicate R for research and D for demonstration.

[7] Deliverable number: Number for the deliverable(s)/result(s) mentioned in the workpackage: D1 – Dn.

9.3. Workpackage descriptions

WP 0: Inter–project collaboration

Workpackage description	
Workpackage number :	WP 0: Inter–project collaboration
Start date or starting event:	0

Objectives:

Overall this work package aims to develop an internationally recognised community of researchers around the DC theme that builds on the broad range of expertise of the component projects. The WP will support a number of major activities with the clear purpose of encouraging cross project collaboration and to challenge project boundaries. The WP will emphasise the importance of competitive European research and develop synergies between projects.

1. Establish a responsive management structure for the inter-project collaboration to include a steering-group (SG) to administer the pooled monies and an inter-project activities manager.
2. Put in place simple and responsive mechanisms for applications and management.
3. Set up a series of "*disappearing days*" on topics relevant to projects. For example on privacy, evaluation, narrative, and sensor fusion.
4. Set up cross project *themed ateliers* and *troubadours*.
5. Establish *rapid response teams* to provide additional competencies or resources at points in time not available in the project, as is, e.g. specific design or technical expertise.
6. To run a yearly major event (a *jamboree*) to coalesce the community.
7. Report to Commission on a regular basis on inter-project activities.
8. Establish connections between the existing i3 network and the DC projects.
9. Foster and encourage excellence in research.
10. Provide a focal point for the DC community.

Work package description:

The **philosophy** of the WP is to encourage and build a cohesive DC community that is research focused, reactive, creative and challenging. The WP presents a focal point for enabling this community. Moreover, the WP will act as a conduit for communication between the i3 and DC communities.

The **management** will be based around an elected steering group (SG), initially four DC representatives. A commission representative will be entitled to be present and have a right of veto on steering group decisions. The SG will be selected annually by election with each DC project having one vote; the SG will then elect a chair. An initial SG will be set-up pending an open election to the DC community before month 1. The SG will have the ability to change the size of the group in response to changing circumstances. The first thing the elected SG will undertake is to produce a charter for operations.

An **administrative** organisation will be selected. The administrative organisation will hire an inter-project activities manager (AM), within a given budget, to administer on a day-to-day basis the collaboration under the guidance of the steering group. The AM will provide central services and resources to the DC community (web site, information repository, newsletter, etc.) and will facilitate and administer (financial and administrative) the activities of this work package. The AM will carry out the decisions of the SG. In order to streamline processes, the AM will be given some limited flexibility, defined by the SG, to react immediately to circumstances and applications. This

AM would be given a budget with which to promote specific inter-project activities. They will report to the SG on a regular basis.

The **mechanism** by which the pooled monies will be managed will be defined and agreed by the EC by month 0. For this purpose, the 50 K allowance per project has been allocated. Each project will either place 50k euros under "sub-contracting" costs or delegate to another project to do this on their behalf. Initially 20k will be paid to the administrative organisation by the project, or its designate, after the project has received its advance payment. The SG will detail the subsequent payment schedule in consultation with the commission.

The WP will support a number of major activities with the clear purpose of encouraging cross project collaboration and off challenging project boundaries. These will be reactive activities – feeding off the evolving DC projects. The framework to enable this will be:

Disappearing days: Facilitated 1-day workshops that identify themes of broad interest to community. Examples could be: Evaluation, privacy, narrative, architecture and ICT, or sensor fusion. These should be the *breeding ground* for troubadour grants and ateliers. To ensure monies are spread over the 18-month period, these will be based on lightweight applications open every 3 months with 2-week response.

Research ateliers: The DC projects as a whole could be enhanced by allowing people to work together in one location on specific tasks for short periods of time. 'Research ateliers' will be designed to allow researchers to come together for periods of time (a week or a month) to work on a specific topic. In such ateliers, people from a range of projects could construct and experiment with technologies together, thus laying the foundation for integrating components into more coherent systems. Projects would be able to apply for funding for ateliers from the network, either individually or on a cross-project basis. To ensure monies are spread over the 18-month period, these will be based on lightweight applications open every 3 months with 2-week response.

Troubadour grants: These enhanced travelling grants will enable a researcher or researchers to travel between a number of sites. For instance, being able to support the use of one projects deliverables within other project(s) platforms (assuming appropriate IPR arrangements). Examples could be: a peer review activity, encouraging excellence in PhD student research, a Postdoctoral pool, or I3 integration activities to exchange skills. To ensure monies are spread over the 18 month period, these will be based on lightweight applications open every 3 months with 2 week response.

Rapid response teams: Within any project, or group of projects, unexpected or out of scope challenges will occur which the project team do not have the skills, funds or time to address. This activity will provide short (≈ 1 week), focused responses to these challenges. A team will be assembled and "parachuted" in to help solve these problems. This action will be reactive and continuously "open" to proposals. The SG will ensure that the funds are dispersed evenly throughout the 18 month period.

Jamborees: As a focus for the DC community, two major conference-like events will be organised where projects will be able to present and demonstrate their work. The first of these will be organised in collaboration with the I3 jamboree in September 2001.Dates for the second Jamboree will be decided by the SG.

Tasks:

1. Establish management structure.
2. Collate a comprehensive and annotated list of shareable public deliverables from all projects.
3. IPR resolution. Establish a modus operandi for inter-project collaboration that is lightweight and unobtrusive as possible. Based on each consortium agreeing the onus is on them to protect their

own IPR.

4. Perform six types of interaction: (i) Disappearing days, (ii), Research ateliers (iii) troubadour, (iv) Rapid response teams, (v) Jamborees and (vi) I3Net collaboration.
5. Establish broad agreements on technology standards to encourage transferable results, e.g. agreement on preferred communications technologies. Indicative domains are (i) data communications, (ii) data structures, (iii) power supplies, (iv) sensors, (v) evaluation etc.
6. Establish an information dissemination point for DC community and focal point for commission communication with community. Perform activities such as setup web presence, quarterly reports, yearly newsletter, DC book, and maintenance of information repositories. Where appropriate we will utilize the skills of I3, for instance collaborating on their well-established magazine to provide a DC/I3 magazine.

Deliverables:

1. Agree charter for operation and management of network.
2. Disappearing days: Six intensive themed 1 day workshops.
3. Research ateliers: Small focused and themed projects that cross consortia boundaries and which have benefit to the DC community as a whole. Suggested topics include: Evaluation, privacy, narrative, competition, or incubators.
4. Troubadour grants to encourage skills transfer. Will include themed visits across sites, postdoctoral exchanges, and PhD excellence through groupings, and interaction across DC projects and I3 projects.
5. Rapid response teams. A minimum of 4 such projects.
6. Research Jamborees: 2 larger showcase events: at least 1 collocated i3Net.

Milestones:

Facilitated kick-off meeting of all DC projects(month 0)

Jamboree (September 2001 and TBD)

Deadlines/results of atelier/troubadour/disappearing days “proposals”: (every 3 months)

Milestones and expected result

Major milestones correspond to above deliverable.

Expected results are:

- Report detailing plans for dissemination of results.

Cost model:

We assume 16 projects, providing an income of: 16 x 50k euro = 800k

Each project will provide to administration organisation 35 k in year 1 and 15 k in year 2 giving a dispersion over the 3 years of:

Year 1	Year 2	Year 3
560	240	0

Below is an *indicative* division of the funds.

100k for an activities manager for 18 months (including overheads)	160
5k per DC project for ad-hoc travelling and idea building.	80
Disappearing days	50
2 x jamboree	80
Research ateliers	240
Troubadour grants (min 8)	80
Rapid response teams	80
Travel for steering group	30
Total	800

WP1: Understanding the domain and developing driving scenarios for the Tangible Toolbox

This workpackage is essentially user study based. It has a number of broad aims:

- To inform the identification of components making up the core of the Tangible Toolkit
- To inform the development of the configuration tools used to present the Tangible Toolkit to users
- To assess the utility of the toolkit in practice
- To elaborate methods to underpin the design of future tangible environments.

The methods and techniques resulting from this workpackage will support users of the Tangible Toolkit in a number of ways. In particular, the lessons from this workpackage will allow users:

- To understand, in depth, the domain of the home environment with identification of particular sets of uses.
- To use that understanding to identify the implications and opportunities present in current practice.
- To envisage the implementation of new tools that will enable the management of the home environment.

Workpackage description

Workpackage number :	WP 1.1: Understanding current and future use within tangible interactive environments.		
Start date or starting event:	0		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	2	4	0

Objectives

To understand, in depth, the domain of the home environment with identification of particular sets of users. This will aim to

- inform the construction of the components within the Tangible Toolkit
- inform the construction of component configuration facilities

Description of work

This workpackage will focus on the identification and outlining of new and future scenarios of use. This work will consider the domestic environments from a series of ethnographic studies building upon existing studies. These will be complemented by a series of co-operative design session involving ethnographers, technologists, designers and future users.

The development of new forms of domestic information technology that support the social and domestic aspects of everyday life is seldom addressed by existing digital technologies that currently merely migrate the concepts from the office to the home. One reason for this is that the appropriate concepts have yet to be uncovered for the home. This project will build upon a set of existing ethnographic studies of home life undertaken by Lancaster University to explore new aesthetics and new functionality in support of a wider range of personal and social values. The project will use a combination of ethnography and design as a primary approach to investigation. Design techniques centred on evoking the imagination of designers as well as partners and users throughout the development process will be complemented by the results of ongoing studies of domestic environments and the assessment of devices in these environments.

Deliverables

Month 5 – Internal report **D1.1** of *Initial fieldwork and technical study report* to be incorporated into **D1.3**

Milestones and expected result

Major milestones correspond to above deliverables. Expected results are:

- Identification of a set of environments and target-users for study.
- Detailed social study of practice the existing environments.
- Detailed technical study of existing and future devices, infrastructures, etc.
- Understanding and presentation of results of study to inform the identification of the initial components in the toolkit.

Workpackage description

Workpackage number :	WP 1.2: Implications and opportunities in study		
Start date or starting event:	5		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	4	4	4

Objectives

To use understanding from WP1.1 to identify the implications and opportunities present in current practice and to envisage the implementation of new tools that will enable the management of the home–office environment.

Description of work

This workpackage will focus on the identification and outlining of new and future scenarios of use. This work will consider the domestic environments from a series of ethnographic studies building upon existing studies. These will be complemented by a series of co-operative design sessions involving ethnographers, technologists, designers and future users.

This work will focus in particular on the development of activities based on supporting interpersonal, family and cross–generational relationships. This might focus on the issue of "family management" – managing the increasingly complex relationships between home and work life where family activities have to be interleaved with work activities or where, in the case of working from home, work and domestic activities have to co-exist within a single physical environment. Other foci might include co-ordinating social activities among teenagers or supporting communication across generations, for example between grandchildren and grandparents.

This work will seek to explore the identification of the core deliverables and the means by which these may be developed and amended. The aim will be to explicitly identify in relation with existing and ongoing initiatives the core components central to the development of tangible environments and how these may be configured together.

Deliverables

Month 6 – Internal report **D1.2** of *Implications and opportunities from co–operative design sessions*.

Month 9 – **D1.3** *Presentation of use and development scenarios for the Tangible Toolbox*.

Milestones and expected result

Major milestones correspond to above deliverables. Expected results are:

- Identification of implications and opportunities in the study.
- Identification of prominent and promising existing infrastructure and products available for the studied domain.
- A detailed set of scenarios built from implications and opportunities found in the study.
- A worked out description of possible prototypes with resource assessment.
- A selection of feasible prototypes to be carried through into following year.

WP2: Developing the Tangible Toolbox

This workpackage focus on the development of the Tangible Toolbox; its underlying infrastructure, the actual devices and the concepts concerning the Toolbox. These were elaborated in some depth in the introduction of the work plan. The work plan reflects the structure of the Tangible Toolbox we envisage and has three dominant activities.

1. The outlining and development of toolkit components and a composition model for these components.
2. The development of an infrastructure to support the components
3. The outlining and development of configuration facilities to allow users to rapidly construct Tangible Environments from the toolbox.

These activities will take place in close partnership and will run for the majority of this workpackage before we focus on the packaging and presentation of the final public Tangible Toolbox. This workpackage provides the primary focus and main point of integration for the project. It seeks the development of the concepts behind the Tangible Toolbox to realise a Tangible Interactive Environment, and the actual infrastructure to provide supporting services for the Tangible Toolbox. We would envisage the workpackages outlined here provide:

- An initial set of seed components needed to realise a Tangible Toolbox to form a sustainable Tangible Interactive Environment;
- A Toolbox Infrastructure and associated awareness and mobility services to provide a dynamic and responsive Tangible Interactive Environment.
- Supporting services and software provided as part of the Tangible Toolbox that enables users access to the underlying components, e.g. physical icons for configuring the tangible environment;
- Configuration facilities for the Tangible Toolbox that promote flexibility and enable a Tangible Interactive Environment to adapt to local demands, e.g. enabling someone to create an alarm messaging service for their summer house;

Workpackage description

Workpackage number :	WP 2.1 Conceptualising the Tangible Toolbox		
Start date or starting event:	0		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	6	8	2

Objectives

The outlining of the common concepts and methods underpinning the Tangible Toolbox with exemplars. This workpackage will focus on outlining the core toolkit component model. This will consist of

- A taxonomy of components
- A set of composition rules

The initial outlining of a supporting architecture and the configuration techniques needed in the toolkit to combine these components will support the component model.

Description of work

The composition of the Tangible Toolbox will be formulated, using input from WP1, in order to understand and support the design and development of tangible interactive environments. The initial scenarios identify a set of services to support the composition and use of a range of different devices.

Workshops will be held between project partners, and also inviting other DC projects, to discuss the development of the Toolkit. There will be considerable interaction between this workpackage and WP2.2, which realises the actual Toolkit, and WP3.1 prototyping tangible environments. The concepts developed here will be used to develop environments in practice, which will be assessed within WP3 to inform the further refinement of the toolbox.

Deliverables

Month 3 **– D2.1** *Initial description of the Tangible Toolbox* describing early important concepts of the tangible toolbox.

Month 9 **– D2.2** *Report from Workshop on devices and concepts of Interactive Environments* including both internal results as well as results from other DC projects and external participants.

Month 15 **– D2.4** *Final report on concepts and component model of the Tangible Toolbox*

Milestones and expected result

Month 9 **–** workshop to share the results to date between WP2.1 and WP2.2, and inform future development work.

Month 12 **–** workshop to share the results to date between WP2 and WP3, and inform future development work.

Expected results are:

- Description of core components underpinning the toolkit in terms of different presentation techniques, sensors, events, re–configurability and transparency.
- Specification of toolbox composition facilities.
- Specification of a reference architecture and supporting infrastructure for the toolbox.

Workpackage description

Workpackage number :	WP 2.2 Realising the Tangible Toolbox		
Start date or starting event:	6		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	10	8	8

Objectives

To develop the infrastructure and the tangible devices that makes up the Tangible Toolbox.

Description of work

The primary focus of this workpackage is the establishment of a toolbox and associated infrastructure that provides generic support for the devices used to enable future communities undertaking their everyday activities. The conceptualisation of the toolbox in WP2.1 will drive the development of the Tangible Toolbox. The overview of the toolkit provided in the introduction to the workpackage highlighted that the toolkit will take a component based approach allowing a selection of components to be realised during the project. This workpackage will exploit, as far as possible, existing services developed previously by SICS and the University of Nottingham. We will extend this using already available technologies, such as those used in JINI and JavaBean, and where necessary contribute to new and emerging standards.

This workpackage will populate the component taxonomy to emerge from WP2.1. We would envisage developing the following forms of component. :

- Components that embody devices utilising different display and sensory techniques.
- Components that provided communication and event mechanisms to link between different devices.
- Components that exploit the novel technologies offered by ACREO to allow new forms of display and sensor to be rapidly prototyped.
- Tools that allow components to be combined in order to specify different forms of application and behaviour within the environment.
- A component "backplane" that allows the tangible environment to be as transparent as possible within existing environments and allows components to work in tandem

A set of identified scenarios emerging from WP1 will drive the development of these different components and prototypes and these will be realised and used in partnership with trial users. This will involve a series of internal and external workshops where the toolkit is used in practice to develop environments. These workshops provide us with a dissemination mechanism for the toolkit.

Deliverables

Month 12– **D2.3** *Report from initial Understanding and using the Tangible Toolbox workshop* including both internal results as well as results from other DC projects and external participants. (this deliverable is shared with WP3, where it is number D3.1).

Month 18 – **D2.5** *Internal Release of the tangible toolbox* is a refined version of the platform and services able to be used by users in the formation of the demonstrators in WP3.

Milestones and expected result

Month 9 – workshop to share the results to date between WP2.1 and WP2.2, and inform future development work.

Month 12 – workshop to share the results to date between WP2 and WP3, and inform future development work.

Expected results are:

- A communication infrastructure and services to support tangible environments
- Set of tools to amend and augment existing environments
- Development of toolbox composition facilities supporting a re–configurable environment
- Development of illustrative components selected from the overall component technologies.

Workpackage description

Workpackage number :	WP2.3 Finalisation of the Tangible Toolbox		
Start date or starting event:	15		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	8	3	3

Objectives

To developed a finalised version of the Tangible Toolbox for public release.

Description of work

This workpackage focuses on preparing the toolbox for public release, influenced by the results obtained in WP3.1. Toolbox functionality that has emerged through our experiences with the Toolbox to date will be realised here. This will consist of the packaging of

- A set of components that combine software elements and physical devices.
- Configuration facilities for putting combining toolbox components
- A set of illustrative "starter projects" that show how the different components can be used
- An set of guidelines embodied within a "DIY manual" that guides potential users through the process of developing a tangible environment.

Deliverables

Month 24 – **D2.6** *Final Release of the tangible toolbox* is a completed version of the platform suitable for public release outside the project using shareware facilities.

Milestones and expected result

Major milestones correspond to above deliverables. Expected results are:

- A packaged set of devices, tools and supporting environment
- Descriptions of devices and tools available via the web

WP3: Use and refinement of the Tangible Toolbox

While the development of a Tangible Toolbox represents a considerable challenge, it is in understanding how to use the Toolbox that we face one of the most significant issues to be addressed by this project. It is clear that whole new sets of interaction may become possible but it is still unclear how to best exploit the potential.

Given the scope of this project it is clear that we must focus on producing a small number of exemplars to drive the evolution of the Tangible Toolbox. An equally important goal is the development of techniques and methods for the design of future applications using this approach and the dissemination of the lessons learned during the project. This we plan to do by studying the use of the tangible toolbox prototypes in particular settings.

A particular challenge we are addressing in this project is the envisionment of radical changes in both technologies and the settings in which they will be used. Addressing this issue will be a major focus of the output from this workpackage. The packaging of these lessons offers additional opportunities for exploitation and these methods will be folded into the general learning programmes of the commercial partners and the courses supported by the academic partner.

This workpackage focuses on the use of the toolbox in practice to inform its refinement and further development. The workpackage takes place in close partnership with the development of the toolbox (WP2) and also informs the development of a guidebook explaining the toolbox–based approach and how inhabitants of tangible environments should exploit the toolbox.

Workpackage description

Workpackage number :	WP 3.1: Developing Tangible Environments with the Tangible Toolbox		
Start date or starting event:	6		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	11	9	7.3

Objectives

To use the Tangible Toolbox in selected user–environments, and to study the use of the Tangible Toolbox to inform design and guidelines.

Description of work

This workpackage will focus on the construction on tangible environments using the tangible toolbox in practice. This will combine an understanding of these environments from studies with the emerging properties of the toolkits and will focus on the scenarios selected in WP1.

These environments will be selected in partnership with users but will focus on the development of supportive technologies. Home environments of use include the support of the elderly and the maintenance of relationships with distributed family members as outlined in the description of task 1.2 above.

Deliverables

Month 12 - **D3.1** *Report from initial Understanding and using the Tangible Toolbox workshop* is a report presenting the results of a workshop. It will consider how the Tangible Toolbox can be used to support activities in domestic environments and emerging enterprises. (this deliverable is shared with WP2, where it is number D2.3)

Month 16 - **D3.2** *Understanding and using the Tangible Toolbox* is a report presenting the activities and concepts of the Tangible Toolbox and how they may support current and future activities.

Milestones and expected result

Month 12 - workshop to share the results to date between WP2 and WP3, and inform future development work.

Expected results are:

- Description of the Tangible Toolbox within particular use scenarios
- Feedback for future re–design of the Toolbox
- The development of exemplar tangible environments

Workpackage description

Workpackage number :	WP 3.2: Reflecting on the use of the Tangible Toolbox		
Start date or starting event:	12		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	3	6	0

Objectives

To develop guidelines for the formation and maintenance of Tangible Environments, and to outline the potential of the Tangible Toolbox in different domains

Description of work

This task reflects on the lessons learned from the development of the Tangible Toolbox in WP2 and the prototyping of tangible environments in WP3.1, before outlining suggested areas of refinement for the toolkit.

The toolkit will be developed in line with on-going developments in the study and understanding of distributed families and how these can be supported through the development of new forms of communication and sensing in supported tangible environments.

Example environments to be developed are of the form of:

- the future study, and how this can be augmented to support work from home
- the development of novel play areas and nurseries within homes
- the development of areas of relaxation and reflection (for example bedrooms)

Deliverables

Month 24 - **D3.3** *Study of the use of the Tangible Toolbox*

This deliverable will present an initial assessment and evaluation of the Tangible Toolbox.

Milestones and expected result

Major milestones correspond to above deliverables. Expected results are:

- Installation of the tangible toolbox in particular settings
- Study of use of the tangible toolbox
- Issues of refinement and development of the tangible toolbox.

Workpackage description

Workpackage number :	WP 3.3: Development of the Toolbox Guidebook		
Start date or starting event:	18		
Participant:	SICS	UNOTT	ACREO
Person–months per participant:	3	3	0

Objectives

Packaging experiences and lessons from using the Tangible Toolbox.

Description of work

This workpackage will focus on the development of a supporting guidebook and guidelines for the use of the tangible toolkit. This will combine an overview of the toolkit with the development of a toolbox "recipe book" that outlines the appropriate and suggested uses of the toolbox. The aim of this work will be to promote the transfer of the project's results into future projects and to help future users and researchers make use of the toolkit.

Deliverables

Month 24 - **D3.4** *Tangible Toolbox Design Handbook* is a multimedia package that supports the future use of the Tangible Toolbox to maximise the benefits of a Tangible Interactive Environment.

Milestones and expected result

Major milestones correspond to above deliverables. Expected results are:

- Description of the use of tangible toolbox in its final form.
- Manual for use available to those outside the project.

WP 4: Dissemination and Use

This workpackage will develop a plan for the dissemination of knowledge.

Workpackage description			
Workpackage number :	WP 4.1: Dissemination and Implementation		
Start date or starting event:	0		
Participant number:	SICS	UNOTT	ACREO
Person–months per participant:	1	1	1
Objectives Planning for dissemination of knowledge gained during the work.			
Description of work The workpackage will develop a plan for the dissemination of knowledge.			
Deliverables *Month 6 –***D4.1** *Dissemination and use plan*			
Milestones and expected result Major milestones correspond to above deliverable. Expected results are: • Report detailing plans for dissemination of results.			

WP 5: Project Management

This workpackage realises the project management and co–ordination arrangements.

Workpackage description			
Workpackage number :	WP 5: Management		
Start date or starting event:	0		
Participant number:	SICS	UNOTT	ACREO
Person–months per participant:	12	2	2
Objectives To manage and disseminate deliverables ensuring timely, coherent and relevant progress and communication.			
Description of work Fulfil management plan.			
Deliverables *Month 4* – **D5.1** *Project Presentation*			
Milestones and expected result Major milestones correspond to above deliverable. Expected results are: • Project Handbook. • Project description available from project web site.			

9.4. Deliverables list

Del. no.	Deliverable name	WP no.	Lead particip –ant	Estimated person–months	Del. type*	Security**	Delivery (month)
D2.1	Initial toolbox specification	2	SICS	3	Report	Int	3
D5.1	Project Presentation	5	SICS	1	Web based report	Pub	4
D1.1	Initial fieldwork report and technical study (to be incorporated into D1.3)	1	UNOTT	6	Report	Int	5
D4.1	Dissemination and Use plan	4	SICS	3	Report	Int	6
D1.2	Report of opportunities and implications from cooperative design sessions	1	UNOTT	2	Report	Int	6
D1.3	Presentation of use and development scenarios for the Tangible Toolbox.	1	UNOTT	10	Report	Pub	9
D2.2	Progress report on conceptualisation of the toolkit	2	SICS	6	Report	Int	9
D3.1/ D2.3	Report from initial Understanding and using the Tangible Toolbox workshop (to be incorporated into D3.2)	3	UNOTT	17.3	Report	Int	12
D2.4	Final report on Toolbox Conceptualisation	2	SICS	7	Report	Pub	15
D3.2	Understanding and using the Tangible Toolbox	3	UNOTT	10	Report	Pub	18
D2.5	Internal release of the Tangible Toolkit	2	SICS	26	Prototype	Pub	18
D2.6	External Release of the Tangible Toolbox	2	SICS	14	Prototype, Demonstration	Pub	24
D3.3	Study of the use of the Tangible Toolbox	3	UNOTT	9	Report	Pub	24
D3.4	Tangible Toolbox Design Handbook	3	SICS	6	Report	Pub	24

** A short, self–evident description e.g. report, demonstration, conference, specification, prototype…*

***Int.*	*Internal circulation within project (and Commission Project Officer if requested)*
Rest.	*Restricted circulation list (specify in footnote) and Commission PO only*
IST	*Circulation within IST Programme participants*
FP5	*Circulation within Framework Programme participants*
Pub.	*Public document*

9.5. Project planning and timetable

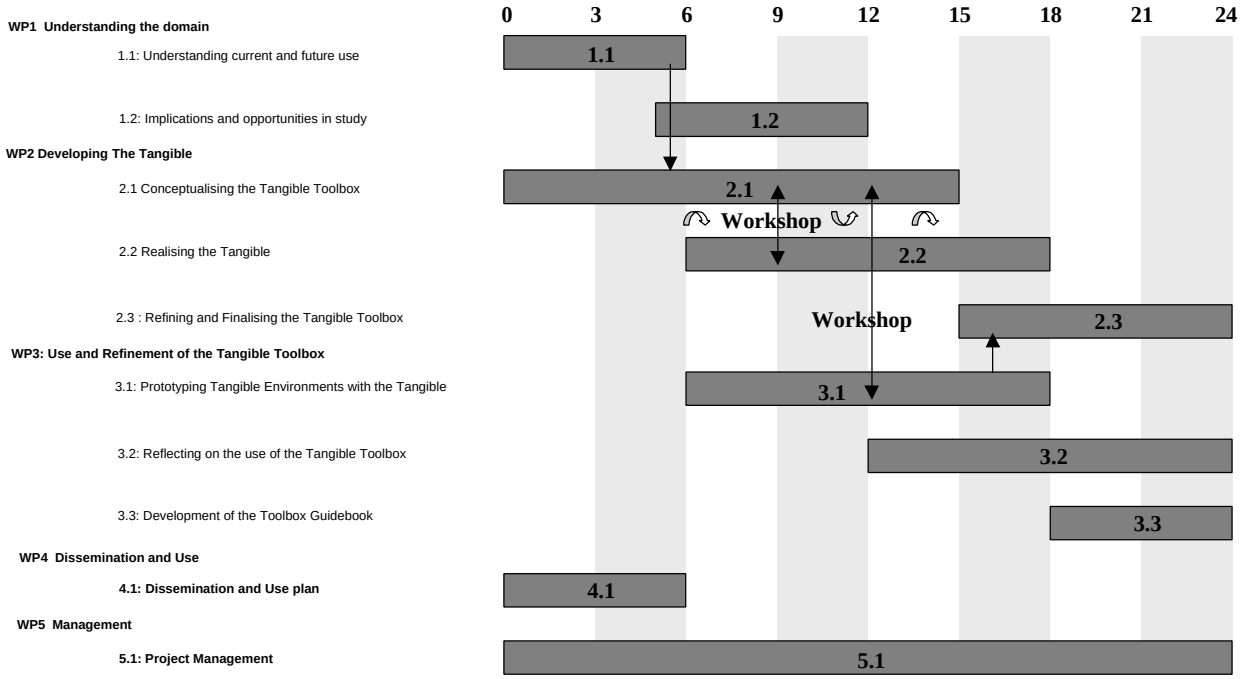

Figure 9.2 Project Plan

9.6. Graphical presentation of project components

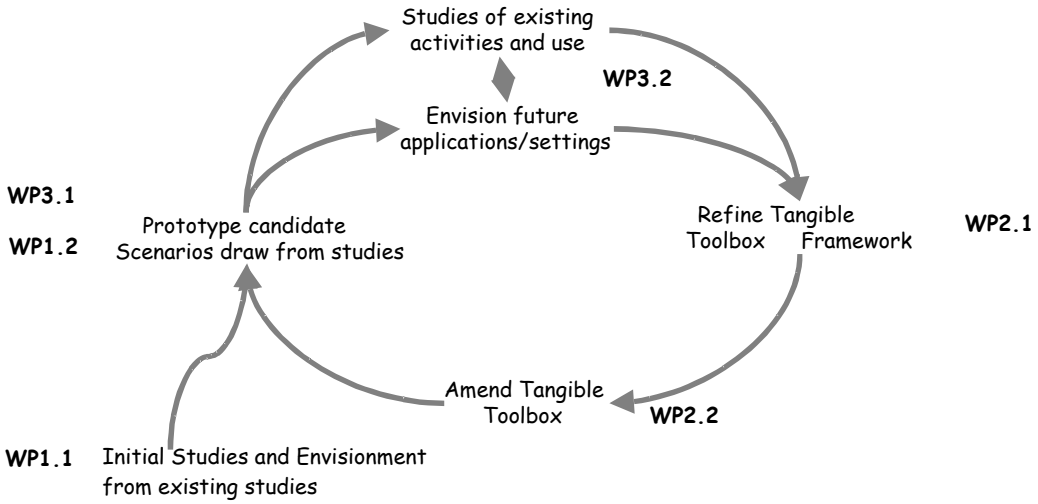

Figure 9.3 Project activities and dependencies

9.7. Project management

The ACCORD project will exploit the structure of the workplan to provide a focused approach to research management. Nottingham will co–ordinate the requirements capture work package and SICS will co–ordinate the development of the toolkit and guidelines. SICS will also provide overall co–ordination and project management, with dedicated staff with extensive expertise in managing EC and nationally funded research projects. The expertise of these staff is complemented by extensive administrative resources that will be used to both manage the project and co–ordinate the exploitation of emerging results. Much of the infrastructure to co–ordinate the project at SICS has been developed over a number of years in a series of joint projects including COMIC (Esprit 6225), the i^3 eSCAPE (N$^{o.}$ 25377) and KidStory (N$^{o.}$ 29310) projects.

The **Project Manager** is responsible for:

- technical and administrative co–ordination on a monthly basis;
- control of planning and deliverables;
- identification of deviations and correcting actions in contact with a Project Management Committee and Project Technical Committee (see below);
- assembling documentation.

Each partner (including the co–ordinating partner) nominates a **Project Leader** who is in charge of the management of the tasks associated to their organisation and acts as the partner's focal point of contact.

An ACCORD Project Management Board is composed of the Project Leaders from each site and is chaired by the Project Manager. Its main activities are:

- overall management;
- consortium agreement;
- proposing and approving major changes on project plans in response to unexpected problems or conflicting situations (for all these topics, a voting procedure will be settled during the first meeting);
- early detection of problems during the project.

The Management Board will meet on a regular basis (approximately every 3 months). The meetings will be scheduled such that they coincide with milestones/deliverables of the project. Tasks of the board meeting are: review of the progress achieved so far compared to the workplan, decision on changes to the workplan and reallocation of resources, planning of publication and publicity activities, as well as the dissemination of the results, and planning of the next 6 month.

Project Communication

The project will rely strongly on electronic communication for the exchange and sharing of information during the course of the project. All partners will also use the technology and tools to be employed and developed within the project for their technical and administrational co–operation. In particular

- Several BSCW shared workspaces will be set up at a central server by SICS.
- These workspaces will be organised according to individual task areas (e.g., dedicated to project management, different workpackages, user groups, etc.).

- All internal project documents will be stored in these workspaces – i.e., document flow will be realised by document interchange via shared workspaces. (This approach has been proved as very reliable and convenient in previous EU projects)

If applicable, similar techniques will be applied for communication with the Commission. Communication between the partners and with the Commission will be in English.

In addition to electronic communication, the whole consortium will meet at least every 4–6 months. During these *plenary meetings* the ongoing work and results of each workpackage will be presented to the whole group for discussion and assessment. In addition to these meetings the partners involved in a single workpackage will meet more frequently as the work requires.

Deliverables Handling

External deliverable integration will take place at the site that has responsibility for the corresponding Work Package prior to being sent to the Project Co–ordinator for final verification. Documents and reports may include videotapes, computer based presentations and associated multimedia data.

Demonstrations will be arranged at the site responsible for the corresponding Work Package. Networking demonstrations can be arranged at any of the networked sites and will preferably be carried out at the site that offers the most convenient facilities.

Software deliverables will be assembled at the site responsible for the Work Package and delivered to the site(s) who should then integrate them.

A detailed list of all internal and external deliverables, including delivery list will be kept updated during the project.

Project Handbook

A Project Handbook will be developed immediately after the start of the project and will be agreed by the Management Board. The Project Handbook will address issues such as status reporting, rules for meetings, rules and conventions for electronic communication, documentation procedures, etc.

A quality assurance plan, taking into account commonly accepted procedures, will be prepared in the initial phase of the project. For example, software developments will be carried out with a version control management system. Similarly, a version control system for document management will be used as it is available in the BSCW.

10. Clustering

Of the other Disappearing Computer projects we expect the work of the following projects to be most closely related to ACCORD.

SMART–ITS (25428)

This project has similar goals to ACCORD, to enable everyday objects as interconnected information artefacts using small devices, but focuses on the production and functionality of wireless, self–sufficient devices, while ACCORD is more concerned with how these devices are used and configured. While the main focus of SMART-ITS is on issues such as power management, ad-hoc networks and protocols for devices, the functionality of the device is also important, and this is where we see fruitful collaboration between the two projects.

PAPER++ (26130)

This project is examining how paper is currently used in a number of settings, and then developing prototypes to enrich paper–based practices. These prototypes will concern enhancements to everyday paper, using invisible inks and location devices. This obviously ties in very closely with the background of ACREO, one of the ACCORD partners, who are developing paper–based displays using special ink technology. Much of this work is proprietary however, and inter–project collaboration will be dependent upon non–disclosure agreements between ACREO and other organisations.

WORKSPACE (25290)

This project will develop software and hardware to enable augmented reality work places, environments and fields. It considers work situations, rather than the home scenario that ACCORD adopts, but is otherwise similar in nature assuming work takes place across many cooperating devices. We will be able to see how differing the devices are that are developed for home and work use, and what the major differences between these settings are. As with SMART–ITS, the sharing of developments and results at inter–project workshops will be a valuable resource.

MIME (26360)

This project will develop intimate media artefacts and interaction techniques where the computer disappears into the artefacts, rather than experiences disappearing into the computer. The easy, familiar closeness to intimate media that MIME talks about is an essential element of the work of ACCORD. The experiences of MIME in developing intimate media artefacts will guide ACCORD in enabling users to create and embed functionality into devices around the home.

INTERLIVING (26068)

This project studies technologies to allow different family generations to live together. In particular the work on in–home communication will be of interest to ACCORD, giving another input to the ethnographic studies of activities in the home.

SOB (25287)

The SOB project has offered, with their knowledge in sound design, to collaborate in the design of sonic objects and interfaces for the Accord toolkit. To the SOB project Accord offers a novel application domain.

11. Other contractual conditions

A non–disclosure agreement will be drawn up between the partners concerning the use of the paper display technology being developed at ACREO.

Appendix A: Consortium Description

Description of the consortium

ACCORD is an interdisciplinary collaboration that combines key research groups in digital technologies. The project will take advantage of a broad and interdisciplinary perspective, pulling together expertise from diverse disciplines such as distributed systems, software engineering, and human computer interaction as well as ethnography and trend research. The collection of expertise in the ACCORD consortium provides a significant baseline of expertise, tools and sets of services and platforms for the realisation of these spaces. These include

- Extensive experience in understanding the nature of interaction to inform development at the University of Nottingham.
- A series of editors and toolkits for the construction of environments to allow the cooperative sharing of resources at the University of Nottingham and SICS.
- An existing and established web based infrastructure for asynchronous interaction based on spaces in the form of the BSCW system.
- An established real time collaborative virtual environment system at SICS in the form of the DIVE system.
- The development of novel mobile devices and applications and the supporting architecture by SICS.

This consortium brings together organisations with a set of skills needed to realise a tangible toolkit. The skills associated with each consortium member and their role in the project is summarised in the table below.

Partner	Research Skills	Role
SICS	Distributed Interactive Environments, CSCW and Mobile Applications, Development of novel interaction devices. Project management	Developing the tangible toolkit Developing exemplar applications and novel interaction artefacts Overall coordination and management of the project Management
Nottingham	CSCW, Software Architectures, Studies of work, Ethnographic studies, Web Based Development.	Understanding domestic environments. Developing applications and services to support domestic environments and the development of editors and toolkits for the platform. The development and envisionment of new application scenarios and new devices
Acreo AB	Material and surface science and technology, production technology, electronic design, large area processing, optical communication and imaging	Providing novel carriers for information, such as paper displays Providing novel interactive functions using this display technology

Description of the participants

SICS

The Swedish Institute of Computer Science, SICS, is a non–profit research foundation. SICS mission is to contribute to the competitive strength of Swedish industry by conducting advanced and focused research in strategic areas of computer science, and actively promoting industrial use of new research ideas and results in industry and society at large. SICS works in a close collaboration with industry and the national and international research community.

SICS research focus is on distributed and networked interactive real–time multimedia systems and applications – spanning from infrastructural issues to software methodologies to human–computer interaction. SICS collaborates actively with industrial and academic partners. The core of SICS research is supported by major companies associated with Föreningen för Datateknisk Forskning (FDF), by the Swedish National Board for Technical and Industrial Development, NUTEK, and by the state–owned Ireco Holding AB supporting industrial research institutes in Sweden. Research contracts assigned by the FDF members and other organizations, Swedish and foreign, speed up dissemination and uptake of research results in industry and public sector. SICS participates also actively in collaborative R&D programs, both national and international, such as Esprit and ACTS funded by the European Commission, and Real World Computing funded by the Japanese government. SICS has a well developed collaboration pattern with high–tech SMEs in Sweden, carrying our joint projects, and acting as an external R&D resource for selected SMEs. SICS has also a proven record of disseminating and promoting industrial deployment of its research findings, including establishing of spin–off companies, as well as licensing of its software and patents.

Facts

Turn–over 1999: 74 MSEK.

Staff: In January 2000 SICS had a research staff of 85.

Research Results:

- approx. 70 refereed papers and articles in international journals per annum
- 2–4 research degrees (doctor and/or licentiate) by SICS employees per annum
- 1–3 people move to academia for tenured positions (professor, lecturer) per year

Industrial results:

- on average 10 people per year move to the industry
- 2–4 SICS projects and patents are transferred to the industry
- 2–3 spin–off companies are formed
- distribution of software is responsible for approx. 5% of the turn–over.

Key researchers

Lennart E Fahlén is the director of the Interactive Collaborative Environments Laboratory, ICE, at the Swedish Institute of Computer Science, SICS. He has several scientific publications in the domain of tools and techniques for distributed virtual environments as well as being a well–known presenter at international conferences. The ICE lab is the main developer and maintainer of the DIVE VR system, an effort originating back to 1991. Mr Fahlén's current interests lie in the areas of future interactive television, new metaphors for computing and man machine interfaces and he has a special interest in the use of VR and associated technology for artistic purposes and in combination with disciplines such as dance and music. Mr Fahlén holds a patent in area of computer architecture.

Adrian Bullock has worked as a researcher at the Interactive Collaborative Environments Lab at the Swedish Institute of Computer Science since 1998. His research interests lie in the areas of CSCW and Collaborative Virtual Environments. He previously worked at the University of Nottingham in the Communications Research Group on projects including COMIC and COVEN, and gained a BSc in Maths and Computer Science and a PhD in Computer Science while at Nottingham.

Karl–Petter Åkesson has worked as a researcher at the Interactive Collaborative Environments Lab at the Swedish Institute of Computer Science since 1997. Within the lab he is mostly affiliated with the Lucid Augemented Collaborative Experience group but also active within the Applied Collabortive Environments group. His research interest is on the boarder between the virtual and the real, to mix and blend virtual worlds with the real world to create a homogeneous transition between them. His interest is mainly in designing and constructing these novel interfaces, which is influenced and inspired by themes like ubiquitous computing, ambient media, tangible interfaces, ad hoc virtual environments, reactive environments, unecumbered interaction and mobility. Mr Åkesson has a M.Sc. in Electrical Engineering.

Pär Hansson has worked as a researcher at the Interactive Collaborative Environments Lab at the Swedish Institute of Computer Science since 1997. He holds a M.Sc. in Computer Science and Engineering focused on image and signal processing. His work within the lab has been associated with the Lucid Augmented Collaborative Experience and Applied Collaborative Environments groups. Previous work and research interests encompass all forms of tangible interface techniques and the connection between software and hardware. He has previously been involved in a number of EU projects, developing different technologies spanning areas such as electronic art and children's pre–literate edutainment

University of Nottingham

The School of Computer Science and IT at the University of Nottingham has an international reputation for research in computer–support for co–operative work, mixed reality and distributed multimedia systems. The School has 22 academic staff (Professors and Lecturers), 34 full–time research staff and about 40 research students. Its current income from research projects is approximately 1.5 million euros per year.

The School is concerned with how computer technologies can support the merging of the physical and digital worlds and how this can enable groups of people to cooperate in new ways. Its CSCW research has an international reputation for developing co–operative applications and infrastructures. We have strong international and industrial research links with SICS, GMD, BT, IBM, NatWest Bank, GPT/Marconi, Digital, NCR, Philips, Thompson, TNO, Division, BICC and Xerox. We have had significant international research visitor exchanges with the Swedish Institute of Computer Science, GMD in Germany, and KTH in Sweden.

Professor Rodden has collaborated in studies of work at NatWest Bank, Aerospatial, Volvo, British Aerospace, BICC and the UK Air Traffic Control Centre. He has recently been involved in a series of ethnographic studies of technology in domestic environments for GPT with a view to informing the development of future on–line services.

A theme of our research over the last few years has been the use of novel support mechanism for co–operative systems. Our interest in this area is focused on shared information and the development of techniques to support co–operative work in distributed environments. We intend to build upon this theme of work in this project.

The proposed research builds on our experience in the development of co–operative applications over the last ten years and the different forms of infrastructure they require. We have developed a range of different CSCW supporting facilities and toolkits that exploit access to shared information. While initially exploiting shared desktop systems more recent developments have focused on the construction of a variety of co–operative environments. This has been supported by the UK EPSRC; the EC projects COMIC , eSCAPE, eRENA, KidStory and COVEN and by direct funding from Fuji Xerox, NCR and BT Laboratories.

Nottingham's work has also included studies of extensive trials of distributed co–operative environments including those between a number of British universities supported by British Telecom. A range of tools to allow the rapid construction of different supporting structures supports Nottingham University research on co–operative environments. For example, the shareware AC3D editor allows virtual worlds to be realised in a wide variety of formats. These will be made available to other partners in the project.

Key researchers

Tom Rodden has recently been appointed Professor of Interactive Systems in the School of Computer Science and IT at the University of Nottingham. Prof. Rodden's areas of interest have centred on CSCW. He has been involved in a wide range of projects including initial work investigating the interaction between ethnography and design sponsored by the JCI Initiative, the Virtuosi and SYCOMPT projects, sponsored by the DTI/EPSRC CSCW initiative and the COMIC project, sponsored by the EC's Basic Research Action programme. He has just finished leading the EC–sponsored COVEN project that is investigating mechanisms for supporting co–operative work using virtual reality and is the prime contractor on the eSCAPE project, an EC i3 project investigating the innovative application of novel display devices.

Steve Benford is Professor of Collaborative Computing Systems in the School of Computer Science and IT at the University of Nottingham. His research interests centre on support for on–line social interaction and the development of mixed reality technologies. He is currently leading the KidStory project under the European i3 programme, investigating collaborative tangible storytelling technologies for children aged between five and seven years old.

ACREO AB

Acreo is the largest institute in Sweden for research in electronics and optics. Our goal is to industrialise inventions and ideas in the field of electronics and optics. Our areas of competence span material and surface science and technology, production technology, electronic design, large area processing, optical communication and also imaging. Today, ACREO holds a unique competence in large area produciton techiques. For instance we are currently involved in two projects developing printing techniques for production of electronics on flexible surfaces. In our laboratory facilities we are equipped with full process lines for silicon chip, packaging substrates and circuit boards. In parallel to this we have invested in printing machines today used in several projects. Polymer electronic and paper electronics are here main targets. A characterisation laboratory dedicated for both electronic materials as well as circuitry is established. We characterise from 1 Hz (low–end) to 50 Ghz.

Facts

- Turn–over 1999: 125 MSEK.
- Staff: In January 2000 ACREO AB had a research staff of 125. 1/3 of the employees are holding a PhD degree.

Research Results:

- Engaged in more than 50 research projects.

Industrial results:

- Acreo is responsible for establishing center of excellence in design in Norrköping.
- 15 spin–off companies are formed.

Key researcher

Magnus Berggren is a project manager at ACREO and is heading the activity in the PAELLA project (Paper Electronics Low–Cost Applications) today employing seven people. Also, he head the research activity in Organic Electronics Group at Linköping University were he is ass. professor. The research background has been the polymer electronics field were development and research of novel polymer electroluminescent devices were performed. After dissertation he spent one and a half years at Bell Labs in Murray Hill, USA, focusing on laser action in solid polymer films – novel approach on realising low–cost laser devices for optical communication. Then he started the TFE AB company in Linköping today employing 40 people. Here the activity is focused on memory technology realised in organic materials – mass storage at low cost. Since 1998 he is employed at ACREO in Norrköping.