Three-year report on the SSF-funded programme DAPHNE: Digital And PHysical interaction and Experience

Summary

The DAPHNE programme has several connected objectives:

- To develop new theories and concepts to understand how interaction can be supported across a wide range of physical settings each offering different levels of digital support.
- To generate new design and evaluation methods appropriate to these technologies based on a combination of approaches from cognitive science, social science and design.
- To create new devices to establish new relationships between users, activities and devices across a broad set of physical environments.
- To develop new forms of adaptive infrastructure to support heterogeneous environments offering different levels of support and enabling different classes of device as they move between varied locales.

In the first three years of the programme this has been accomplished through a loop of application projects from which the user experience informs and develops knowledge on research challenges, within infrastructure, interaction, design and evaluation methods, which in turn call for technical development and research (on infrastructure and tools) for new applications.

The applications built and experienced and studied in context all combine physical and digital "material", exemplified by

- an exhibit for a submarine exhibition, installed in four incarnations around Sweden, where sonic detection of other vessels and objects at sea was illustrated through simulation and with a digitally operated physical periscope as a main feature.
- a 3D interface for mobile devices, e.g. phones, building on a room metaphor for different activities, buddy lists etc.
- an interactive environment, including a physical machine telegraph, sensors and display for presenting and interacting with a "heatmap" on where the action is, or was, in a public environment
- the "pondcaster" where the user connects her digital audio player (MP3, mobile, radio etc) by walking up to a physical artefact, a "pond", for sharing experiences.

The research group consists to equal parts of CID at KTH and ICELab at SICS. The total group has strong multidisciplinarity, with competences in technology, ethnography, industrial design, film and music. This gives good conditions for combining technology and human user aspects.

Content-wise we have learnt that the combination of physical and digital "material" into artefacts and services is very fruitful as demonstrated in several instances. Close involvements of users in these kinds of applications have been easier and more obvious in public settings, such as museums, than in workplaces and homes, but a focus on those, "everyday", situations is very important and a challenging focus for the future.

Another focus coming out of our work as a challenging and potentially very rewarding area for the future is support for communication in groups needing frequent and close contacts, such as work teams and families.

In the DAPHNE description we made another "dichotomy", between "digitally rich" and "digitally poor" environments. That has not been so fruitful in our deliberations, partly because of the previously "poor" environments, such as mobile settings, developing "richness" very fast.

0. The objectives and goals of the programme

Objectives

The current convergence of interactive digital systems, networks and mobile devices is transforming the ways that we carry out our everyday life, e.g. how we entertain ourselves, work, shop and converse. In contrast to the existing visions of ubiquitous computing, our vision was to recognise from the outset the variable levels of digital richness available in the world and to construct both design techniques and supporting infrastructures that recognise this variability as a fundamental feature.

To achieve our vision of the integration of devices into a universe constructed of a tapestry of different regions each offering different digital capabilities we set ourselves the following basic research objectives:

- To develop **new theories and concepts** to understand how interaction can be supported across a wide range of physical settings each offering different levels of digital support.
- To generate **new design and evaluation methods** appropriate to these technologies based on a combination of approaches from cognitive science, social science, and art and design.
- To create **new devices to establish new relationships** between users, activities and devices across a broad set of physical environments.
- To develop **new forms of adaptive infrastructure** to support heterogeneous environments offering different levels of support and enabling different classes of device as they move between varied locales.

Our approach to realizing these fundamental research objectives embodies a number of unique characteristics, each of which is intended to facilitate the public exposure and opportunities for uptake of the results of the work.

We informed our fundamental research with **direct experience** of how these technologies can be used to support interaction, exploration, and communication by real users in a variety of everyday settings. These include augmented control rooms, museum settings, public spaces and homes.

We designed and developed **prototypes** of the technologies in direct partnership with users and user communities as a means of ensuring the practical utility of our research results.

In addition to disseminating the results of this research to the international research community, industry and user groups we directly engaged with the general public by placing devices within public spaces, specific work settings and domestic environments (**public demonstration**).

Goals

The initial goals were formulated

Half-time goals (18 months)

1. Novel supporting infrastructure to support heterogeneous devices
2. Workshops and seminars presenting new digital approaches
3. Demonstration of novel devices to link physical and digital

Full-time goals (36 months)

4. Public domain open platform for digital electronic landscapes
5. Scenario demonstration of a range of devices
6. Design and assessment techniques as a service delivery kit

Revised goals from start and during the programme

As we got 60% of the funding applied for, we already at the start had to limit some of the goals and milestones. Thus we omitted the goal and milestone no 6 and the content and work month resources in each work package were reduced to

WP1 The Platform	30
WP2 Understanding Interaction	20
WP3 Design and Assessment Techniques	15

Based on experience from the research activities in the programme we observe the following changes ("what the programme actually was about").

- Stronger emphasis on public environments (exhibitions and museums) than on work and home influenced by easier access and strong need for and readiness to experiment with new technology
- Stronger emphasis on mobility, influenced by fast development and possibilities for expanded research cooperation
- Stronger emphasis on technology for homogeneous and powerful interfaces to very heterogeneous applications

1. History of the programme

Background, motivation and vision

As digital technologies have matured, they have begun to move beyond the workplace to other domains in our everyday lives: our homes, neighbourhoods, what we carry with us. At the same time, the phenomenal spread of the Internet has enabled the public to participate in a variety of new on-line experiences, such as email, distributed hypermedia and even virtual reality. The current convergence of interactive digital systems, networks and mobile devices is further transforming the ways that we carry out our everyday life, e.g. how we entertain ourselves, work, shop and converse.

A number of researchers have started to explore a future vision where a diverse set of computational devices are routinely interacted with by people undertaking everyday events. Evolving from the work of Mark Weiser on 'ubiquitous computing'[1] this work has led to the development of visions of 'everyday computing' [2], the 'invisible computer'[3] and more recently research initiatives such as the EU's 'Disappearing Computer' (http://www.disappearing-computer.net/) have started to explore how best to design future applications in this domain and to realise the dynamic infrastructure needed to support this domain.

However, despite these ongoing developments and the explosive growth of a mobile communications infrastructure, we are still some way from realising a vision first articulated a decade ago. It still remains unclear how we might achieve the original ubiquitous computing vision of being surrounded by always-available digital interactive services delivered to users across a heterogeneous range of devices wherever they are. Even so, this remains a compelling vision offering significant potential for new services, devices and the associated markets they provide for the IT and communications industry.

One reason that they have failed to materialise in any significant manner in our everyday lives is that these visions of a ubiquitous computing world are all essentially dependent on the deployment of a universal network providing either direct or indirect access to sophisticated online services. The design of the interactive arrangements envisaged in these ubiquitous environments take limited account of what happens when users move from environments that are *digitally rich* (with a wide range of available sensors and services) to those that are *digitally poor* (with a limited number of sensors and much reduced network connectivity).

As we live our daily lives we are routinely moving between environments with massive variability in the level of support they provide for digital interaction. Our daily routine of moving from home to work will normally mean that we will face different levels of network access and sensor availability and that the ways in which we may interact with digital information may radically alter. The reality of our situation is one of uneven distributions of digital resources.

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[1] Weiser. M. (1991). The computer for the 21st century. Sci. Am., 265, 3, 94-104.

[2] Abowd, G. D. and Mynatt, E. D. (2001). Charting past, present, and future research in ubiquitous computing. ACM TOCHI, 7, 1, 29-58. Norman, D. A. (1998).

[3] Norman, D. A. (1998). The invisible computer. Cambridge: MIT Press

Our vision is to allow people to experience the physical and the digital as integrated and interdependent aspects of our everyday world in a manner that is tolerant to the level of digital interaction and reactivity afforded by the surrounding environment. Realising this vision requires long-term research into new models of interaction, new interface and distribution technologies, new applications and design methods.

Partner institutions with finances

The programme complements the activities of CID at KTH and ICELab at SICS, who both have a long tradition of work in this area, not the least as partners and coordinators of EU IST research programmes 1998-2003: Erena and Escape within Intelligent Information Interfaces , KidStory within Experimental School Environments and interLiving, SHAPE and Accord within the Disappearing Computer, totally about 5 MSEK/year.

As a VINNOVA competence centre CID had basic funding from VINNOVA (6 MSEK/year), from KTH (the same amount, mainly as infrastructure and research student support) and from 24 industrial partners (7.5 MSEK/year, 1 MSEK/year in cash, the rest in kind, i.e. project work and equipment).

ICELab has similar support and activities with EU, funding agencies, industry and industrial partners in the basic SICS framework programme, totally about 6 MSEK/year.

Thus the SSF support to DAPHNE, 4 MSEK/year, was about 15% of the total funding at CID and ICELab.

Changes in the programme

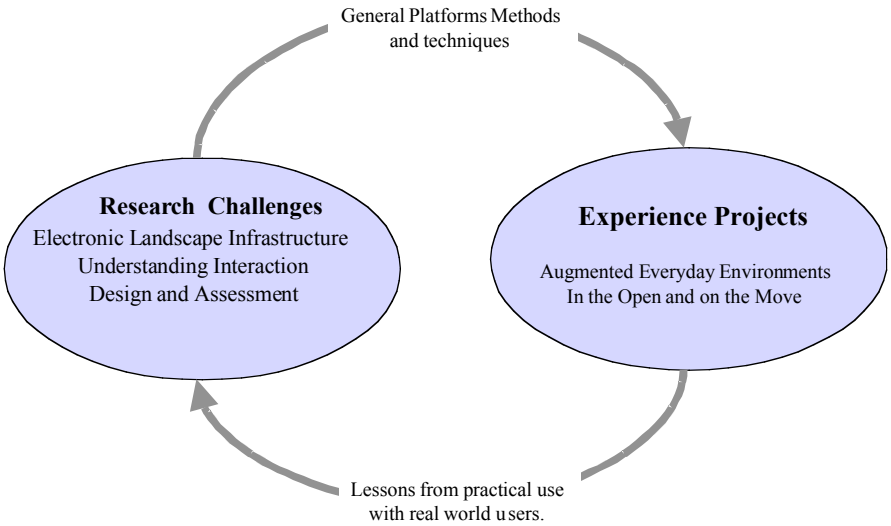
In the activities based on vision there was a slight change of balance of emphasis, that was put more on the combined digital and physical than on the division between digitally rich and digitally poor environments as the technical development made this divide less obvious. Otherwise there were no major changes except the revised goals and milestones mentioned above under objectives and goals.

Steering group

See appendices A1 and A2.

2. The scientific results of the programme

Approach



Our research combines long-term research into new technologies and methods with practical and focused experiences. The work of the project employs a twin track approach with focused **research challenges** alongside **experience projects** that apply a combination of technologies and methods to a particular domain. The research challenges provide generic platforms and techniques which are used in practice within experience projects and the lessons of use then guide further refinement of the general research platforms and methods. The key to combining fundamental research with practical

experience is an iterative project plan so that lessons can be learned, fed back into research, solutions developed and then fed back into further experiences.

Below we start the descriptions with experience projects and use them as a background for the projects and results on the research challenges:
new infrastructures, understanding interaction, design methods and user evaluation, and digitally rich and poor environments.

In the design methods section some activities in work and family areas are described which for various, stated, reasons did not lead to experience projects.

Experience projects

In the experience projects we have used the already existing infrastructure and platforms as well as the new infrastructures and platforms described below. We have also used and developed design methods and evaluation methods in this context, as described below. The projects are examples of fruitful mixtures of physical and digital environments as well as of digitally rich and digitally poor environments supporting each other.

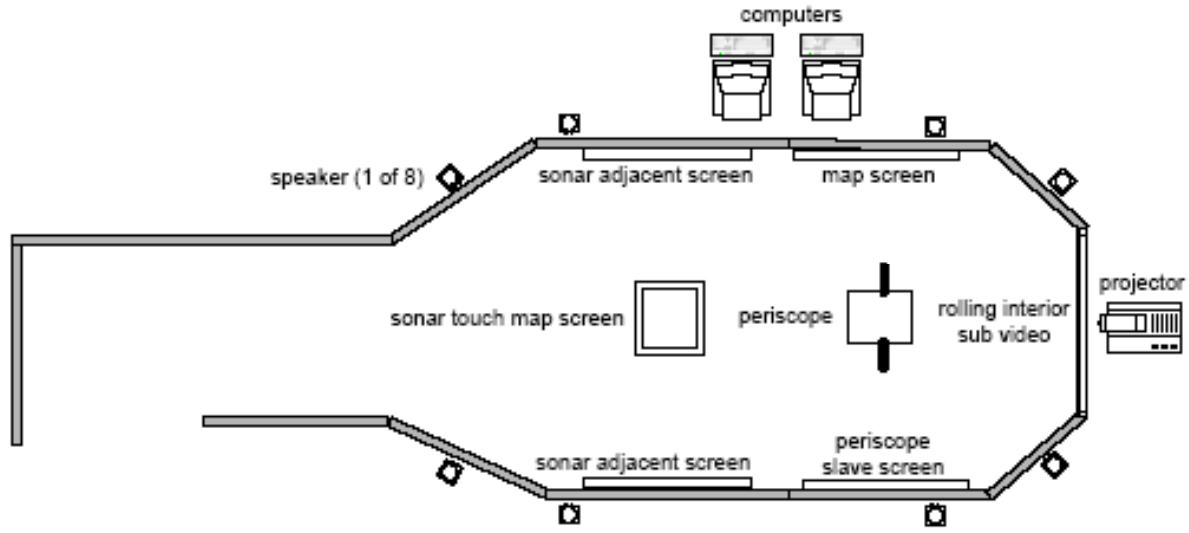
Submarine exhibit

The Swedish National Maritime Museums commissioned us to build an exhibition celebrating the 100 year anniversary of the Swedish submarine force. The exhibition is conceptualized and implemented within Daphne and has been shown in Gothenburg, Stockholm and Karlskrona, where it is now permanently located. Visitors get a chance to explore the process of navigating a submarine. How was this realized? Sound is the key to navigating a submarine and the key to understanding what is like to navigate in total darkness in deep waters.

The whole exhibition was therefore sonified using eight loudspeakers and this sonified environment mimicked the plethora of sounds hitting a submarine. In a real submarine incoming sounds are constantly monitored and analyzed and in the exhibition the visitor could get a sense of this process through a sonar installation. There was also a video wall in the exhibition with footage from inside of a submarine and it showed a crew on active duty. Lastly the visitors could also look through a periscope installation: a simulation of a real periscope.

Visitor scenario

The visitors walk into the exhibition and can try the two interactive installations (sonar and periscope) on their own or with a helper. Several helpers, that had been stationed on submarines, participated during the exhibition. The exhibition was laid out according to the following floor plan.



At the sonar installation visitors could learn about the sound environment of a submarine and how sonar is used to identify elements in the water. The sonar touch map screen reveals a number of sound producing elements in the water around the submarine. These elements are shown graphically as simple geometric shapes with thick borders. The visitor can choose to listen to the elements by

pushing on their graphic representations and, through a second step, identify the elements. When an object is being identified information is shown simultaneously on the two identical sonar adjacent screens.

The periscope is an old and here innovative interaction device, further described below in the section Understanding interaction. Here visitors could play with a simulation of a working periscope. The visitor could turn the periscope and locate different ships on the sea. The periscope could also be raised and lowered, its viewing angle could be tilted up and down and it was possible to change magnification.

The periscope is described as an interaction device below in Understanding interaction. A study of exhibition visitors as users is described in the Design methods and User evaluation section.

mBlog

The mBlog project looked into bridging Internet-based weblogs with the physical world through providing a platform for moblogging (mobile blogging). While moblogging is now a recognised phenomenon and while there exists a number of commercial and free solutions, mBlog was one of their precursors. Technically speaking, weblogs (blogs in short) are web pages that present usually short articles in a timely manner and can easily be updated by novice users. In just a few years time, they have become an important vector for opinion building on the Internet. Due to their format and ease of use, writers will often update blogs (several times a day). Recognising and encouraging further this dynamism was the lead idea behind the mBlog sub-project.

The mBlog project also looked into extending blogging ideas into the mobile world, making use of the increasing number of camera phones and of Internet-ready telephones. mBlog provides an application solution to update and read weblogs from mobile phones and other devices, thus addressing the demands both from writers and readers. Additionally, the system looked into ways to associate location information to blog articles whenever necessary.

From the user's point of view the system works as follows. Users send SMS, MMS or email messages to a dedicated number or email address. mBlog creates a new entry for each message. This entry is placed at the top of the web page. Previous entries are moved down. Upon posting, entries are automatically given a geographical position as well as being time stamped. Alternatively, users can direct their browser to a specific web page and fill in a simple form. Upon completion, an entry is created as above. The resulting blog can be viewed from any web browser or WAP phone. A geographical map shows the location of the entries. Note that new multimedia phones now include full-fledge web browsers.

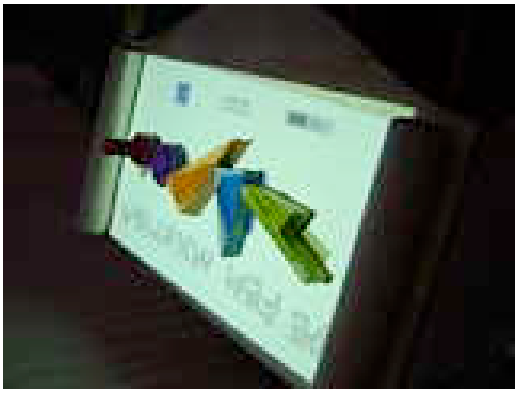
The mBlog project bridged the physical and the digital worlds in different ways. It offered ways for individuals to continue reading and following discussion occurences in the digital world once they had stepped away from their regular terminal. Inversely, it provided ways to quickly enhance the digital world with physical information in form of pictures and location information.

In order to gather further observations on this duality, an experiment was conducted in order to see if a regular blog could be used as an awareness mechanism. One of the members of the DAPHNE project used a blog gathering work activities descriptions as a way to ensure that his colleagues would keep contact with his working context wherever he was working from and wherever they were working from. Close to his office's door, a screen and a mouse were made at the disposal of any colleague passing by. This presence point soon acted as a discussion trigger and observations have shown that the screen created a daily reading routine within his direct colleagues. To complete the awareness mechanism, the web page would show a regularly updated dump of his screen (whichever workstation he was working from), together with a web cam. As any available web page, the blog could be accessed from anywhere, which also allowed remote colleagues to access this information. The commenting function supported by the blog system allowed the remote colleagues a level of participation in discussions.

Papyrus exhibit

We collaborated with the Museum of Science and Technology in Stockholm in making an exhibit, Papyrus, and studying its use. Part of the Museum's Science Centre is devoted to five mechanical principles: the screw, the plane slope, the lever, the wheel and the wedge. We designed an exhibit that utilises our system to present messages (images and text) from visitors on the subject of the five

principles in the science centre itself. It was also possible to access the messages through a public Web page. The exhibit was based on an improved version of the mBlog system, together with a station that looked like a magic papyrus roll. The roll would show the messages related to the different mechanical principles in an attractive manner. This metaphor was chosen after the design was evaluated following a semi-public showing. At first, we experimented with a book-like metaphor, which was rejected after it had been shown to a number of IT professionals.




Papyrus exhibit and Heatmap exhibit

Heatmap exhibit

As sensor technology is moving ahead at full speed, it is easy to envision in the not-so-far future a world where we are surrounded by the in almost all environments, all day long. While this technologies come with promises of improved solution to certain life problems, they also come coupled with a number of potential problematic issues. The first one that comes to mind is the privacy issue.

Our goal with this project was to investigate how human activity can be captured and visualised. Our focus is not to see how the activity of one given person can be traced but rather on how activity of a number of “anonymous” people can be recorded and visualized. We decided that it is of interest to investigate how the collected sensor data could be left un-interpreted by the computer and could be presented to the user in a direct way so that the user can retain the right to interpret the data. In order to do this we started working with the National Museum of Science and Technology in Stockholm. Their interest is in understanding the pattern of use of their different hand-on exhibitions. The resulting prototype is a set of sensors placed in one of the exhibition areas, called the Teknorama. Using infrastructure developed within the Daphne project, the information collected by the sensors is distributed and saved. This data is used to represent the activity in the exhibition on a screen where a 3D model as the area is superimposed with heat-like sensor information. Visitors can use an old machine telegraph for “navigating” back in time.

The prototype is now installed and we are moving ahead with evaluations of it. The prototype was developed together by CID and SICS with the direct involvement of the Museum curators.

Pondcaster

Pondcaster is an attempt to “socialise” the solitary activity that podcast listening is. In its current form, podcasting is a way for individuals and/or existing radio stations to broadcast shows in a different way by making these accessible as MP3 files on the Internet. Listeners will typically decide upon the type of program that they wish to listen and see to download the shows without observation, so that they will be able to listen to them offline from their portable audio players. In the pondcaster project sharing of the podcasting experience is realised through interaction around a table-top artefact and through "public" radio-like devices matching the preferences of surrounding listeners.

In pondcaster, the user experience is as follows. Users approach the table-top artefact and connect their audio players (MP3 player, mobile phone, etc) to the artefact. The artefact employs an aquatic metaphore where stim of creatures related to one another stim in concert. Each creature represents one radio show. At device connection, (part of) the content of the audio player is represented as one or several stims and all present users will be able to interact with the creature so as to listen and discuss

the radio shows so represented. The artefact also accepts SMS sent by users. These will be understood as textual queries in the mass of existing Internet radio shows and the results of all shows which audio content matches the query keywords will be pushed back into the pond. Finally, the artefact tracks the mobile phones of surrounding users and they will be able to drag the creatures matching shows in which they have an interest to the representation of their mobile phones. Such associations will be remembered by the system and can be used in the radio-like public devices described below.

The Pondcaster also tries to bring back radio listening aspects that were present at the very beginning of the radio days and that disappeared with the venue of television. A century or so ago, people would sit around radio devices and listen and comment the shows. In the pondcaster scenario, users will be able to listen to the shows that they have chosen using the table-top artefact at special radio-like stations. Surrounding users will be recognised, their preferences retrieved and their chosen shows played using a queue system. This encourages discovery of new topics and discussion.

Pondcaster is one of the latest DAPHNE projects and has only been demonstrated to a wide audience twice. Consequently, we only have a number of initial observations. These observations tend to point at problems with both with the table-top artefact and the listening station. We based our artefact on results from a prior artefact that favoured shoulder-to-shoulder collaboration in similar ways. However, the new artefact is smaller for practical reasons. Our initial observations have shown that interaction with the device is less natural and less engaging than in the previous larger artefact that we have had on display and demonstration a large number of times. Also, while a first version of the listening station was demonstrated without any possibilities for users to express preferences. While that version turned out to be an engaging experience for a many of the users, interest in the listening station has shrunk as soon as it has become a satellite for the tabletop artefact.

The pondcaster acts shares a number of common design principles with the mBlog sub-project. In particular, it pursues the idea of a distributed system of communicating processes targeting well-defined tasks. For example, one application is intended to push the content of a portable audio player into the interactive pond used as the central metaphor on the tabletop display; another application will allow users to perform textual queries through sending an SMS to the pond and pushing the result of all podcast which audio content matches the query keywords into the pond; and yet another application will store the preferences of listeners and see to allow them to continue listening for their chosen podcasts when moving from one radio-like listening station to the next one.

Apart from these services, pondcaster acts as the first application entirely based on top of the newly formed TIL and its set of libraries and services. It acts as a test-bed for the modularisation that was performed when abstracting the components from the mBlog sub-project.

Mobile 3D Portal

The Mobile 3D Portal demonstrator was developed at the end of the Daphne project. It was triggered by the (at the time) emerging possibility to viably use 3D graphics on mobile handsets. The project aimed at developing a prototype as a basis for further discussions with industry on mobile phone interaction regarding in some aspects better, more exiting, different, or extended interfaces.

One of the main ideas concerned the possibilities for a dynamic branded integrated operator service environment. The familiarity and popularity of navigating 3D environments among young people was another trend seen as supporting this prototype. Some early ideas for group concepts, data sharing, and collaboration were also investigated.

Regarding the goals and outcome of the project, the prototype implements a 3D room metaphor with a powerful but simple navigation. The room context is seen as a possible replacement or enhancement of the current cumbersome and context-less menu system. The metaphor would make use of our spatial ability to provide context and memory cues. The prototype is seen as both integrating current services as well as providing different ways of viewing same data based on e.g. time or location.

In particular, the implemented system shows the possibilities of personalizing your data, using the room metaphor to share data, and group concepts. These new services integrates with existing phone services such as the address book.

Infrastructure and platform projects

While exploring the research challenges of DAPHNE, we soon realised that in order to bridge the gap between the physical and the digital, and in order to perform the transfer from the digitally poor to the digitally rich environment, we had to put new demands on the underlying platforms. The first phase included the evaluation of older platforms like DIVE (Distributed Interactive Virtual Environment) from SICS and EQUIP (the EQUATOR Universal Platform) from the British research program EQUATOR in relation to the demonstrators and prototypes we wanted to develop in DAPHNE. The second phase was to combine some new ideas with those existing concepts, and develop some example platforms more suited to meet the thematic demands.

TIL

The TIL (a.k.a. the Tcl ICE Library) is a further development of the various software components that were developed for the mBlog and the Papyrus sub-projects. Tcl (Tool Command Language) is a mature scripting language with a large user-base. In its almost 15 years of existence, Tcl has found its ways into a wide range of applications: from web servers to internet routers, through code to run oil rigs.

All of the code of generic interest behind both previous DAPHNE activities have been packaged according to the guidelines enforced by the Tcl community and published as a separate open source project on sourceforge. Currently, the TIL is a collection of libraries and applications aiming at addressing two key issues that have been recurrent during the development of past systems. The TIL provides a backbone for the realisation of real-time interactive applications in a Web environment. The TIL also provides support for deploying distributed application systems that are intended to run for long period of time.

At first, TIL is a set of well-packaged libraries with a clean and standardised application programming interface. This set of libraries can be divided into three groups of components. The network components provide facilities such as distributed storage and access of application parameters, firewall-aware client-server communication or storage, access and caching of Internet data, with a particular focus on RSS technology. The interactive components provide facilities to handle and route file according to their media type, together with a play list manager. The system components provide facilities for system introspection, spooling and regular scheduling of tasks.

Secondly, the TIL is a set of tiny applications providing a run-time backend to the remainder of the library and of other utilities fitting with the goal of the TIL as a whole. These utilities provide support for distributed system introspection and control, for distributed parameter access and storage and for Internet resource monitoring and access.

Dapper

During the development of the submarine exhibition, ideas came up that involved using mobile devices to interface and interact with the 3D virtual submarine world. By tracking visitors in the museum, they could take on the roles of different vessels and collaborate or compete in order to find and possibly even sink one or more virtual submarines. However, in order to realise this vision we needed a distributed software platform capable of running on handheld devices like PDAs and mobile phones.

The Dapper activity was focused on developing a distribution middleware focused on handheld or embedded devices. It needed to be small in size (binaries should ideally be less than 100 Kbytes) and consume a have a small run-time footprint. Dapper was realised as a

C++ library supporting event distribution and synchronised objects, running on most Windows platforms, including Microsoft's Smartphone OS for mobile phones.

For various reasons the mobile device addition to the submarine exhibition was never completed. However, much of the work that was put into the Dapper development has now been carried over into the EU financed IPerG project. The ICE laboratory is in the lead of a work package focusing on infrastructure and platforms for pervasive gaming, which has just recently released a Java version of a platform that to a large extend builds upon the Dapper ideas.

Within the Understanding Interaction work package we set out to focus on the two main themes based around the concepts of ‘composition’ and ‘control’. We foresaw these to be the two most important

aspects of electronic landscapes, specifically while moving between impoverished and digitally rich environments. Our initial view of these two themes has slightly changed during the project.

Composition – within this theme we aimed to study how different forms of interaction and types of input can be combined to provide the most suitable interface. Rather than restricting the concept of composition to explicit sensor information we now view this as being the composition of both input information and input actions, e.g. the Rullen use both phicons and the turn knob, but each provide an explicit interaction with the system. Another view deals with finding the balanced composition of different interaction constraints as in the Periscope project.

Control – a theme that would focus on the feedback users receive in an interactive system since that is a crucial question. The user has to be in command of the situation. In an electronic landscape with hundreds or thousands of computers this get crucial. Through our different prototypes we have come to understand that control is not only about receiving feedback from what is currently is being used but also to receive feedback from other users action, i.e. to be able to understand their contribution to the system.

The following sections deals more specifically with the explicit findings from different projects and activities within Daphne.

Visualising action

Within the Heatmap project the concept of control was explored. The focus for Heatmap is to use sensors for recording human activity and present the readings in an easy way. While a number of similar system choose a solution where the computer system makes educated guesses and decisions based on the sensor data, our approach is rather opposite. We believe it is the user that should have the control on how data is interpreted and as such our focus is on how sensors data can be presented to the use in an intuitive way that will allow the user to "collect" the proper meaning of the sensor data. Our prototype is an exploratory tool to this goal. A couple of iterative versions of the visualisation have been tested in demo settings and currently a real life test is undergoing installation and evaluation at the Technical Museum in Stockholm. We hope that the prototype will not only trigger responses about the way in which we visualise sensor data but we also hope to spark reactions and discussion about the presence of sensors around us, a presence that we can count to increase in the near future as miniature sensor networks are becoming of-the-shelf technology.

Another concept around interaction that we have tested with great success in the Heatmap prototype is that of “recycling affordance”. Instead of creating a new device of interaction we have in this case chosen to reuse an older technology but one that had a strong interactive affordance. In order to control the time element in our visualisation we are using an old machine telegraph, a technology used in the first half of the 20th century on ships. While most of the people that interacted with our system in demo settings (including both adults as well as kids) did not know what the name of the device was, all of them had no problem understanding how to interact with it. This successful result shows that in certain given situations it might be more interesting to reuse interaction technologies and devices that have proven to work well instead of creating some new device that might be less clear in terms of interaction.

Periscope

Experiences from The Submarine Exhibition showed the periscope as being a device that encourages interaction. It seemed to help people break out of a state of plainly observing the exhibition and was the first point of interactivity for many visitors. The periscope constitutes an interesting balance of interaction constraints with simple and powerful controls (i.e. swiveling head, rotating handlebars and pushbuttons). As a result we decided to carry out a sub-project further examining the periscope as an interaction device.

Periscope-like devices for information presentation have been used in other projects as well. In an Equator project an application was developed where users are able to experience a historical world (including sounds) using a periscope.

In the Daphne sub project the periscope is used in mixed reality environment with a 3D graphics map used for navigation and interaction. The map makes available a number of networked cameras that may be selected to get live feeds from each camera. When a camera is selected it can be pitched and yawed by controlling the periscope in the same manner as the virtual interaction map. Care has been

taken to supply an intuitive transition between overview (interaction map) and camera view (live video). This application may easily be extended to accomodate other sensor data as well, creating an alternative way of visualising and interacting with Heatmap data.

Gestures

The use of hand gestures for various interface situations has been explored throughout the project. Using computer vision techniques, and focusing on semiotic and deictic hand gestures, we have developed and evaluated a number of new contact-less, non-intrusive interfaces within the scope of Daphne.

Early work on controlling multi-functional equipment with computer vision detected hand gestures showed upon the need to more closely study the design space for such gestural command sets, an issue often neglected. Three major dimensions can be identified; cognitive, articulatory and technological aspects. We have studied how to address these aspects when building gestural commands by combining hand gestures with specially designed menu systems. The pie menu design showed to have strong benefits and in a series of prototypes, hierarchical marking menus (Lenman et al. 2002) and, later, hierarchical flow menu systems were evaluated when controlled by basic hand gestures. The combination of simple hand gestures and flow menus was shown to address all three aspects, and promising results from user studies were reported in (Bretzner et al. 2005).

The natural pointing gesture has been explored in a couple of interface scenarios. The basic idea of the first scenario is that an invisible information layer can be put on top of any object and the user can access the information related to a part or detail of the object simply by pointing at it. Computer vision based detection techniques allow for minimal effects on the environment the interface is installed in, and makes it suitable for places that are either fragile or exposed to rough use. A prototype exploring this concept was presented in (Bodda 2003). The other scenario incorporates pointing gestures in interaction with projections on walls or other objects. The combination of a video projector and a camera is well known to give rise to a versatile and flexible interface. In our prototype, we have e.g. explored how different forms of visual feedback provided via the projection can improve the transparency and make the interaction smoother. The system has been demonstrated in different forms at a number of events (Ammer 2005). The full potential of this rather new type of interface is not yet explored. With this in mind, the system is designed to minimize the development time of new application prototypes within the framework.

In all, the inter-disciplinary collaboration between computer vision experts, graphical interface programmers and HCI researchers within Daphne has been fruitful and has resulted in important insights communicated in publications, presentations and course material on computer vision based interface design.

Two Masters theses were made within this project:

- Ammer, A., “Projector-camera system for flexible interactive projections”, MSc Thesis in Comp. Sc., KTH/Stockholm University, 2005.
- Bodda, G., “A computer vision based prototype for human-computer interaction via pointing gestures”, MSc Thesis/Tesi di Laurea Comp. Sc., Polytecnico di Torino and KTH, 2004

Sensors

Early in the project a workshop around sensors was held to establish a broader knowledge on sensors within the whole project. This workshop was in collaboration with Dr Albrecht Schmidt at the Embedded Interaction group at Ludwig-Maximilians-University in Munich, Germany. The workshop was based on a technical sensor platform called Smart-Its. This platform has been developed in a EU funded project also called Smart-Its. At the workshops a majority of the researchers in Daphne participated, yielding a large variety of backgrounds. Each and everyone assembled a sensorboard that has later on been used in different parts of Daphne, e.g. early experiments in Heatmap, the navigation handles in the periscope.

Another aspect of sensor technology within Daphne is the use of Bluetooth enabled devices as radio frequency identification (RFID). Through modifying the antenna of a Bluetooth radio the effective range of that unit can be decreased to only a meter radius. Due to the wide spread commodity of Bluetooth devices it is possible to easily allow users to be identified by a system but still empower the

user with the option of choice. Through the decreased radio range only users within the direct proximity to the Bluetooth enabled artefact are detected and only if the user has enabled his or her Bluetooth radio. This has been used in the Pondcaster.

Furthermore the use of sensors within Daphne has created an insight in the demands from someone who will design an interactive physical space. Not only is their a demand to use sensors to sense physical activities but also the designer must be given ways to understand and elaborate with the specific behaviours of the sensors being used for a certain installation. This insight has been pursued in two other projects that use a large number of sensors. The two projects have quite different goals, the first to establish effective solutions for sensornetworks while the other pursue the building blocks for pervasive games.

Design Methods and User Evaluation

Video prototypes

We have developed a methodology for gaining experience and knowledge of how technology could enhance collaboration and other aspects of everyday life for people with disabilities. It is a workshop methodology where the participants themselves produce video prototypes that are grounded in their own experience.

The methodology is technically simple. The objective is to ground the ideas in the lives of the participants. Instead of general descriptions that are reduced and without detail, we focus on actual descriptions of real situations that make sense to the participants. These narrations shall cover the whole context of the situation. We encourage the group to think of collaboration and communication situations that they have conceived as problematic. From that they make scenarios, both written and drawn and most importantly stage and videotape them into video-prototypes. 'Quick-and-dirty' prototypes help to illustrate the scenarios.

Since all participants collaborate in the making of the video-prototypes, as actors, directors or cameramen, the event leads to shared experiences where the understanding for all stakeholders' views and skills grows. The users find that their ideas are important for the developers. The video prototypes show ideas for meaningful solutions on how technology in the future can enhance peoples lives. The results are useful for the developers who get a good understanding of the users' needs, desires, problems, etc.

Exhibit design and evaluation

It is not uncommon for museums today to be involved in different forms of educational activities, and the museum is often regarded as an important tool for educating the public. However, the nature of the learning that takes place in the museum has been the focus of both research and numerous debates during the last few decades.

The most recent research on museum learning shows that learning does not end when visitors leave the museum. Indeed, it seems that many people draw conclusions that are related to their visit outside the museum, after the visit, when they encounter a situation that allows them to "make a connection". Documenting these situations is, naturally, quite difficult. The literature contains reports on a number of studies where researchers have telephoned visitors some time after the visit and asked them to recall the museum visit and how it has shaped later encounters and experiences. Although important and valid, this data consists of the learners' recollection of their experiences and there is typically no "hard" data from the actual situation itself (e.g., video or tape recordings).

Thus, one of the goals of our exhibit design and evaluation study (Papyrus) was to see whether it was possible to obtain such *in situ* data through the help of modern communication technology. To this end, we designed a system that allows visitors to send images and text messages to a central server through e-mail, SMS or MMS. The data from the server can then be visualized as a weblog (see the section on "mBlog" below) or in some other suitable form. The museum we worked with has been planning a re-design of its science centre for some time, and is evaluating the current exhibits. Thus, our work had the opportunity to provide data that might support the evaluation process.

However, for our given context it was very difficult to motivate visitors to contribute with SMS/MMS/e-mail messages from outside the museum in the way we intended, unless they agreed to do this as part of a specific activity. On the other hand, our data collection and analysis shows that our

exhibit had pedagogical benefits for the museum. We have evidence that it has the potential to offer a "real life" context for the principles presented in the science centre, and the exhibit appeared to be very useful as a target for pedagogical activities within the museum. Also, the technology we used system worked very well in practice and has led to numerous ideas for other applications with our system as a key component.

Further details can be found in (Taxén and Frécon, 2005).

Evaluation of submarine exhibition

At the exhibition we received a wide group of visitors from toddlers to senior citizens and this gave us the possibility to clearly see a variety of roles that the visitors take on, i.e., the observers, explorers, tinkerers and gamers.

One question that one could ask is naturally what are we to make of this? Should we try to design for a particular role such as explorers? Should we design for all of them? Whom was the exhibition designed for? If we design for gamers then how is this going to work for observers? These questions are tricky to answer, but they are the kinds of questions that we need to tackle when we design exhibitions. The current exhibition lended itself well for all the above roles.

As mentioned earlier observational learning played an important part in how visitors came to interact with the installations. There were signs that described how to get started with the installations, but relatively few people read those signs. Simply observing someone else interacting and then doing the same thing was more frequent. This suggests that the way to get people started with the submarine exhibition and similar interactive exhibitions is by letting them observe other visitors or helpers. One possible alternative would be to provide a demonstration video or videos of the exhibition that visitors could look at. Of course there us also always room for usability improvements and such improvements could lessen the need for any kind of tutoring.

Studies of families

From the very beginning of our acquaintance with the Red family, their wish for "some sort of central that helps them with communicating information and coordinating people" has been expressed many times. Their wish is that it should work without any extra efforts from the family members and that it should sort information so that it was delivered to the right person. Our shared understanding of their way of being as a family wanders along in the same direction as they have expressed. We can see that they really need a shared central for information, a shared structure for handling notes from school, time tables for hockey training and matches and coordination of events and people.

To understand how the Red family would use such a central in real life scenarios we had a joint workshop in early January 2003 with the Red family and the Accord project at SICS, Swedish Institute of Computer Science in Kista. The aim was to look at the whole chain of usage, to narrow down the over all wish for a central where everything can be organized to real use scenarios.

First, we split into two groups where all three generations were represented. The scenario making was divided into two steps. First, each group tried to find a real scenario form their common life, a scenario where every one of the family members had a role and could fit in. There should be a communication difficulty involved. Second, each group tried to find a solution to the problem in the same scenario.

After a couple of hours we had several revealing and interesting scenarios and prototypes that we could use to inform our further work.

At the time we were discussing how and how much the people should be able to adapt the technology for their purposes. It seemed that the less constraints there are the more room for personal strategies to evolve there were. This was clearly also the results form the workshops.

Further work with different low-tech paper prototypes that the family members 'used' also pointed in the same direction. They developed conventions and strategies that had meaning to them. A blank interface afforded the user to use it in any way that seemed meaningful with no predefined path of activity that must be followed.

Study of workplaces

In order to define the design space and to get input to the design of new interfaces for communication and collaboration in work environments, we have in multi-disciplinary groups, conducted field studies in noisy and dirty workplaces such as power stations and in a bakery.

Digital power production

Vattenfall's hydroelectric power plant in Älvkarleby was in operation in 1917. The main turbine hall more or less looks the same, with the same basic functions and work activities – but much smaller on location staff and the plant is actually run remotely, in this case from Storuman in Lappland (approx. 600 kilometers away).

Via DAPHNE, Vattenfall and CID co-operated in exploring digital information layers in the plants to get the correct information, in the best possible way, on the site or at a distance – be it via video, audio, vibrations, or other sensory data – presented in a variety of ways optimised to the use situation. Parallel studies were also conducted in the heating plants in Jordbro and Bollmora.

Through careful documentation of work processes and close co-operation with end-users, the implemented services will have long-term sustainability and will be established firmly in the work organisation.

Bakery

The bakery study was successful in terms of understanding a workspace, but for DAPHNE technology development it did not give much. But, the study gave important knowledge about organisation and logistics in a small family enterprise, with less than 10 employees. The know-how in the bakery is not just the knowledge of baking, but also what to bake and how much and at what time, not just over the year but also monthly, weekly and daily. The know-how is also knowledge about the other persons working there, their particular skills, knowledge and internal roles. It is a complex system of layers of knowledge and communication, and to disturb that order, which was working perfectly fine from what we could see, with any new technology for logistics, economy or communication is a delicate matter, and in this particular case not even necessary or desirable.

Digitally rich and poor environments

"If you're not living on the edge you are wasting space"

Most things in the human world falls in one of two categories: the physical, things to be touched, felt, run into etc and the virtual, ideas, dreams, facts, emotions etc. To go from one to the other is often clumsy, one directional, static, costly or even downright impossible. I.e. an idea can be realized but this process is costly and the result not easily modified.

There are also other dimensions to this: the above classes are available in the plentiful or more scarce. People can of course be rich and poor in both the domains, countries and geographical areas as well. The DAPHNE programme took an information technology perspective on the above and set out to explore in prototype form (see methodology) some means whereby the digital (we constrained ourselves here) and the physical can be made more conversational, we also wanted to look into how

the digitally rich could be even further enhanced as well as trying to make the digitally poor approach the rich in the affordances available.

In hindsight we have had a focus on the traversing the physical/digital activities, i.e. Papyrus, pondcaster, the periscope, HeatMap and maybe a less emphasis on rich/poor, i.e. Mblog and Mobile 3D portal. The reason for this is twofold: the physical/digital seemed to offer a richer set of unique research issues and secondly many of the rich/poor issues are being addressed by many commercial interests and just seems to be a lot closer to market than the more ephemeral services of the physical/digital domain. Nevertheless, our results from the rich/poor activities are interesting and at the forefront of state of the art, and interestingly some of the results are currently being evaluated for commercial exploration.

Participating researchers, publications, external activities

In appendix 3 we give a list of participants, in appendix 4 publications and in appendix 5 conferences, workshops, summer schools, industry meeting we have been involved in.

3. The graduates of the programme

Improved graduate training

Two new doctoral student courses at MDI, NADA, KTH have been developed inspired by, and useful for the project, see appendix A6. 40 + 30 students have followed the courses.

In undergraduate and Master's education several student projects and Masters' theses have been supervised by Daphne project members, who have also acted as guest lecturers in some courses.

Doctoral students and exams

During the three years Daphne has produced 4 doctors of technology and three more are expected to take doctoral exam in 2006 and 2007, see appendices 7-10.

4. Impact of the programme – to industry and society

The idea behind the Vinnova Excellence Centre Initiative is one of close project collaboration with industry and society. CID presently has 24 interested parties, several of which are participating in DAPHNE, e.g. Vattenfall and Tekniska muséet.

SICS, as an industry research institute, also has close cooperation with industry and society, specifically Ericsson, TeliaSonera, Saab Tech Systems, FMV, Green Cargo and ABB.

For Statens Maritima muséer (in Gothenburg, Karlskrona, and Stockholm) and Tekniska muséet in Stockholm the DAPHNE researchers have been a driving force for IT supported projects which combine the physical and digital, and this has resulted in permanent exhibitions (se Appendix A5). The Sonar Simulator developed in cooperation with Statens Maritima Museer, is a simulator aiming to give visitors an understanding of how submarines use passive sonar to create an understanding of its position and surroundings.

There is an ongoing cooperation with Vattenfall regarding water power and how the, often century old, power stations could be remotely monitored and operated using new digital technology. A broader perspective has been adopted, based on the concept of virtual presence and also how new forms of interaction, such as haptics, gesture, and eye control could be applicable for different divisions of Vattenfall. Service technicians doing field work often have very little or no experience of the power stations they are sent to inspect. As support for training and giving an understanding of the locations, a interactive power station 3D simulation of photographic quality was developed.

For home automation applications, there is an ongoing cooperation with Jorsater Innovation. This collaboration aims to commercialize the results of the ACCORD EU research project. Initial work has been focused around the fast growth of wireless networks in domestic homes over the last few years. Using the ACCORD puzzle configurator developed in the DAPHNE project we have made a demonstrator using software and hardware to make a commercially attractive solution for home control via Wifi. A problem with home control is that it must often be rather complex in order to provide real customer benefit. Complexity typically requires programming which normally is to

advanced for the average user. In our prototype we have used the puzzle editor as a simple programming interface to control the interactivity of various home devices. Together with CoFund AB, these ideas have also been taken further for exploitation in future EU research projects.

Research results of the programme implemented by industry/society

The Submarine Exhibition was shown in four cities during. When in Stockholm, the exhibition had an average of 1000 visitors per day.

The Home Configurator is under exploration by

Mobile 3D Portal is discussed for exploration with industrial partners

Activities, directed towards the general public or to younger people

Towards the general public there has been strong media exposure, especially of the exhibits, notably the four installations of the submarine exhibit.

The museum installations have also in themselves meant a good exposure to the general public, not the least young people, who have often more directly taken in the interaction ideas of the exhibits.

DAPHNE participants have used the yearly Open Houses of CID at KTH and ICELab at SICS for extensive demonstrations of prototypes and results 2003, 2004 and 2005. The same holds for the yearly SITI conference and exhibition.

The web is of course used for popular presentation, on daphne.sics.se

DAPHNE participates in “Utbrott på Lava” at Kulturhuset in Stockholm, a youth science fair organised by Vetenskap & Allmänhet, a Swedish association aimed at promoting dialogue, openness and trust between the public – especially the young – and researchers.

5. Impact of the programme – to the academic system

Scientific collaborations between different disciplines and departments

Especially within CID but also at SICS there is an inherent multi-disciplinary collaboration. Among the senior people working at CID there are five computer scientists. The remaining five have degrees in ethnology, cinema studies, industrial design and psychology.

CID is one of Vinnova’s 28 centres of competence and the DAPHNE researchers collaborates with other researchers at CID as well as other centres of competence, especially CTT (Centre for Speech Technology) at KTH.

Direct project cooperation has mainly occurred with the Computer Vision group at KTH, which also has a SSF programme, see below.

The ICE laboratory has a close collaboration with other research laboratories within the SITI organisation, for instance at the Viktoria Institute and the Interactive Institute.

The ICE laboratory has had a collaboration with the EU financed Pepito project that involved integrating a blog system partially developed within DAPHNE with a peer-to-peer platform developed within Pepito.

Nationally, DAPHNE collaborates with the Interactive Institute, Viktoria Institute in Gothenburg, School of Arts and Communication in Malmö and Umeå Institute of Design.

DAPHNE has a close collaboration with the British Equator IRC (Interdisciplinary Research Collaboration), see below

Cooperation with other Foundation programmes

The understanding interaction research challenge of DAPHNE has materialised in an interest in using and studying gestures as a means of interaction. The gestures are recorded and recignised through computer vision, where we have good contacts with CVAP at KTH and its SSF programme VISCOS - Vision in Cognitive Systems, led by Jan-Olof Eklundh. Lars Bretzner, who has a hD in Computer Vision, has divided his research time between DAPHNE and CVAP.

International collaboration, including EU projects

Equator is a research collaboration that runs 2001-2006 in which researchers from eight different British institutions and a variety of disciplines collaborate to address the technical, social and design issues in the development of new inter-relationships between the physical and digital. The funding, 11 MGBP, comes from EPSRC. The coordinator is professor Tom Rodden, University of Nottingham, who is also working as a part-time member of the ICE laboratory. The Equator projects focus on the areas of infrastructure, interaction technology, public environments, domestic environments, digital care, digital play and e-Science. The first four of these are very close to the focus areas of DAPHNE, and researchers from DAPHNE and Equator have been collaborating, for instance, via workshops.

DAPHNE has had close collaborations with a number of EU-projects, especially from the ”Disappearing Computer” initiative where CID/KTH was the coordinator of interLiving and SHAPE, and ICELab coordinated ACCORD. Other collaborations include the Pepito and IPerG projects coordinated by SICS and where DAPHNE researchers from ICE has been and are active.

DAPHNE has a collaboration with University College London (UCL) concerning the DIVE system. DIVE has been used and modified within DAPHNE, for instance within the submarine exhibition and the Pondcaster activities. UCL has been using DIVE in their research on virtual environments for many years, for instance within the Equator initiative.

DAPHNE also has active collaborations with the universities in Lancaster, Limerick, Nottingham, Paris Sud and King’s College London, Aarhus, Tampere, Ulm, München and Sydney as well as Georgia Tech and MIT Media Lab. Furthermore, DAPHNE has had collaborations with Philips Design, Intel Research, UCSB, PARC and IDEO.

Improved academic research

An international evaluation of CID in 2003 came to the conclusion that its research is internationally leading as is evidenced by publications and demonstrations in leading conferences and journals:

“It is clear that CID provides an environment that fosters multidisciplinary research and thinking. This is evident not only in the quality of individual research projects but also in the level of energy in the Centre. Few places bring together the disciplines evident at CID; even fewer do it with its level of enthusiasm and success demonstrated. It is clear that this environment has been constructed to encourage those involved with CID to undertake research in new areas and to think in new ways. CID should see itself as an equal to most international labs including those at MIT, Georgia Tech, PARC. “ (From international evaluation by John Baras, Per Stenius et al, 2003)

Handling of immaterial rights

The experience from the DAPHNE programme has highlighted some deficiencies in the handling if immaterial rights:

Shortsighted industry needs stimulation to realise the potential and possibilities generated by the research.

Especially the universitiy but also the institute needs much better entrepreneurial developers, with experience in doing business, that stimulates transfer of research findings to SMEs.

SSF should offer (but not prescribe) and stimulate cooperation with competent venture capitalists and exploiters.

We are interested, but can at most be enthusiastic amateurs, our time spent on exploitation is lost research time.

6. Lessons from the programme

Important lessons concern both the research content and the operation of the programme, which can and would be improved in a continuation.

Content-wise we have learnt that the combination of physical and digital “material” into artefacts and services is very fruitful as demonstrated in several instances. Close involvements of users in these kinds of applications have been easier and more obvious in public settings, such as museums, than in workplaces and homes, but a focus on those, “everyday”, situations is very important and a challenging focus for the future.

Another focus coming out of our work as a challenging and potentially very rewarding area for the future is support for communication in groups needing frequent and close contacts, such as work teams and families.

In the DAPHNE description we made another "dichotomy", between between "digitally rich" and "digitally poor" environments. That has not been so fruitful in our deliberations, partly because of the previously "poor" environments, such as mobile settings, developing "richness" very fast.

In our organisation cooperation between the many competences within the partners, taking both technology and humans into account, has been a strong positive factor. We should strive for even more close such contacts and cooperations though, sharing user experience and technology development in close teams of ethnographers, designers and technical researchers.

7. Outlook

Depending on future development a number of different predictions can be made about the impact from the program. We can already see the interest the programme has had among museum and similar institutions.

One of the most likely predictions about the future is that it will become more and more common to use several different means of electronic communication, and thus the border between the digital and the physical will become increasingly important. Thus the transition over the border becomes increasingly important. The transition has to become both more seamless, to ease the use, as well as it has to become more seamful, for users to realise the transitions.

Another direction that will increasingly be part of our daily lives is the ever-increasing number of digitally enhanced physical artefacts. We have just witnessed the shift from film-based cameras to digital cameras. Other artefacts will follow and we will see an increasing production of new digital content. Blogs are one such trend, while podcasts are a fledgling technology on the horizon. These new options will give an increasing number of problems related to the border between the digital and the physical.

As the intensity of communication over the border between the physical and the digital increase one problem that we already see but that will increase is how systems allow users to adapt them to their needs. For instance today each mobile phone producer presents at least 10 new models each year, that is one new model per month. All of these having different physical appearance to attract different consumer groups but if one looks at the software they are all more or less identical. And there are very few options to customize to the individual needs. Our research in DAPHNE indicates the importance to open up systems to users. Allowing users to appropriate devices to their needs. This is something that will be increasingly important, to such extent that it should be considered a design feature of every system

These different future directions all indicate the need for further research in the area on the border of the physical and the digital. There is a demanding need to find completely new paradigms that break out from our existing perceptions of existing systems today.

The DAPHNE program has been an important funding source for the two participating organisations. Both strive to continue to pursue research in the area defined by the program but since both are organisations are totally dependent on industrial funding and governmental research program funding the exact directions for future research is hard to predict. Both organisations have already established projects that build on the results from the DAPHNE programme but there are currently no funding established to continue with the core research of exploring the border between the digital and the physical.

8. Economic report

CID at KTH	TOTALT	ht 2002	vt 2003	ht 2003	vt 2004	ht
Inkomster						
91. Överskott- / underskott 2001			12,8	74,1	53,6	-
92. Projektbidrag och programgemensamma utgifter	6 000,0	1 000,0	1 000,0	1 000,0	1 000,0	1
Avgår: högskolemoms redovisad av bidragsmottagare	480,0	80,0	80,0	80,0	80,0	
93. Andra inkomster (t ex ränta eller bidrag från högskolan)	0,0					
90. SUMMA	**5 520,0**	**920,0**	**932,8**	**994,1**	**973,6**	
Utgifter						
Forskarstuderande						
11. Löner/motsvarande	1 663,8	122,6	226,6	260,3	337,1	
12. Övriga direkta utgifter för enskilda forskarstuderande	0,0					
10. SUMMA FÖR FORSKARSTUDERANDE	**1 663,8**	**122,6**	**226,6**	**260,3**	**337,1**	
Forskarutbildning (kursutveckling- och genomförande)						
21. Löner/motsvarande	0,0					
23. Övriga direkta utgifter för forskarutbildning	0,0					
20. SUMMA FÖR FORSKARUTBILDNING	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	
Forskning						
31. Löner/motsvarande	1 808,8	497,4	366,3	309,8	391,0	
34. Utrustning direktfinansierad med SSF-anslag	12,3					
37. Utgifter i samband med resor	35,7	15,7	0,3	19,7		
38. Övriga direkta utgifter för forskning	18,5	18,5				
30. SUMMA FÖR FORSKNING	**1 875,2**	**531,5**	**366,6**	**329,5**	**391,0**	
Utåtriktad verksamhet (information m m)						
41. Löner/motsvarande	0,0					
42. Utgifter i samband med resor	69,9				23,1	
43. Övriga direkta utgifter för utåtriktad verksamhet	37,1				8,1	
40. SUMMA FÖR UTÅTRIKTAD VERKSAMHET	**107,0**	**0,0**	**0,0**	**0,0**	**31,2**	
Programadministration						
51. Lön/ motsvarande för Programdirektör	0,0					
52. Löner/ motsvarande för Programstyrelse	0,0					
53. Löner/ motsvarande för övriga administrativa tjänster	292,5	28,5	28,5	62,7	79,0	
54. Övriga direkta utgifter för administration	0,0					
50. SUMMA FÖR ADMINISTRATION	**292,5**	**28,5**	**28,5**	**62,7**	**79,0**	
Högskoleavgifter (fördelade kostnader)						
61. Lokaler	390,8	41,3	58,5	62,4	80,1	
62. Institutionsgemensamt	493,3	72,8	88,0	68,9	122,1	
63. Högskolegemensamt	843,4	110,4	90,6	156,8	210,9	
60. SUMMA HÖGSKOLEAVGIFTER	**1 727,4**	**224,5**	**237,0**	**288,1**	**413,1**	
SUMMA UTGIFTER	**5 665,9**	**907,2**	**858,7**	**940,5**	**1 251,4**	**1**
ÖVER-/UNDERSKOTT	**-145,9**	**12,8**	**74,1**	**53,6**	**-277,8**	**-**

ICELab at SICS	TOTALT	ht 2002	vt 2003	ht 2003	vt 2004	ht
Inkomster 2002 och reservation från 2001						
91. Överskott- / underskott 2001			583,0	692,0	680,4	
92. Projektbidrag och programgemensamma utgifter	6 000,0	1 000,0	1 000,0	1 000,0	1 000,0	1
Avgår: högskolemoms redovisad av bidragsmottagare	0,0					
93. Andra inkomster (t ex ränta eller bidrag från högskolan)	0,0					
90. SUMMA	**6 000,0**	**1 000,0**	**1 583,0**	**1 692,0**	**1 680,4**	**1**
Utgifter 2002						
Forskarstuderande	0,0					
11. Löner/motsvarande	0,0					
12. Övriga direkta utgifter för enskilda forskarstuderande	0,0					
10. SUMMA FÖR FORSKARSTUDERANDE	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	
Forskarutbildning (kursutveckling- och genomförande)						
21. Löner/motsvarande	0,0					
23. Övriga direkta utgifter för forskarutbildning	0,0					
20. SUMMA FÖR FORSKARUTBILDNING	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	
Forskning						
31. Löner/motsvarande	5 476,0	417,0	891,0	1 011,6	1 549,5	
34. Utrustning direktfinansierad med SSF-anslag	0,0					
37. Utgifter i samband med resor	0,0					
38. Övriga direkta utgifter för forskning	0,0					
30. SUMMA FÖR FORSKNING	**5 476,0**	**417,0**	**891,0**	**1 011,6**	**1 549,5**	
Utåtriktad verksamhet (information m m)						
41. Löner/motsvarande	0,0				0,0	
42. Utgifter i samband med resor	0,0					
43. Övriga direkta utgifter för utåtriktad verksamhet	0,0					
40. SUMMA FÖR UTÅTRIKTAD VERKSAMHET	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	
Programadministration						
51. Lön/ motsvarande för Programdirektör	0,0					
52. Löner/ motsvarande för Programstyrelse	0,0					
53. Löner/ motsvarande för övriga administrativa tjänster	0,0					
54. Övriga direkta utgifter för administration	0,0					
50. SUMMA FÖR ADMINISTRATION	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	
Högskoleavgifter (fördelade kostnader)						
61. Lokaler	0,0					
62. Institutionsgemensamt	0,0					
63. Högskolegemensamt	0,0					
60. SUMMA HÖGSKOLEAVGIFTER	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	
SUMMA UTGIFTER	**5 476,0**	**417,0**	**891,0**	**1 011,6**	**1 549,5**	
ÖVER-/UNDERSKOTT 2002	**524,0**	**583,0**	**692,0**	**680,4**	**130,9**	

Appendices

A1. Programme Board, whole period

Tom Rodden, professor in Computer Science, University of Nottingham
Yngve Sundblad, professor i datalogi/MDI, CID, KTH, projektledare
Lennart E. Fahlén, forskningsledare, ICElab, SICS, biträdande projektledare

A2. Programme Board activities and responsibilities

Regular meetings and exchange of information and discussions, physically and via email, at least monthly for initiating, planning and follow-up of activities and projects and economy.

A3. List of researchers (research students in A7 and A9)

Yngve Sundblad, professor in Computer Science / Human-Computer Interaction, CID, KTH, programme leader, born 1943, male
Lennart E. Fahlén, research leader, ICElab, SICS, assistant programme leader, born 195x, male
Anneli Avatare, PhLic, researcher, ICElab, SICS, b.1967, female
Lars Bretzner, TechD, researcher, CID, KTH, born 1968, male
Pär Bäckström, MSc & Eng, program and grahics developer, CID, KTH, born 1973, male
Pär Hansson, MSc & Eng, researcher, ICElab, SICS, born 1971, male
Olov Ståhl, forskare, MSc & Eng, researcher, ICElab, SICS, born 1971, male
Jonas Söderberg, MA, researcher, ICElab, SICS, male
Anders Wallberg, MSc & Eng, researcher, ICElab, SICS, male
Bo Westerlund, MDesign, researcher, CID, KTH, born 1951, male

A4. List of publications

Reveiwed journal papers and book chapters

- Emmanuel Frécon, "DIVE - A programming architecture for the prototyping of IIS", in Snowdon, Churchill and Frécon (eds), "Inhabited Information Spaces: Living with your data", Springer-Verlang London Ltd, ISBN 1-85233-728-1, January 2004, pp. 211-231.
- Emmanuel Frécon, "DIVE: communication architecture and programming model", IEEE Communications Magazine, 42(4), April 2004, pp. 34-40.
- .Sinna Lindqvist, Bo Westerlund.(2004) Artefacts for understanding) in Working Papers in Art and Design, Vol 3. ISSN 1456-4917. CID-272 June 2004
- Anthony Steed and Emmanuel Frécon, "Construction of Collaborative Virtual Environments", in Maria-Isabel Sanchez Segura (ed), "Developing Future Interactive Systems", Idea Group, ISBN 1591404126, pp. 235-268, November 2004.

Reviewed conference papers with only DAPHNE members

- Bretzner L., Thuresson B. and Lenman S. ‘‘Combining hand gestures and flow menus in computer interfaces’’, Proc HCII 2005, 11th International Conf. on Human-Computer Interaction, Las Vegas, July 2005
- Emmanuel Frécon, "DIVE: A generic tool for the deployment of shared virtual environments", Proceeding of the IEEE Conference on Telecommunications, Zagreb, Croatia, June 2003, pp. 345-352.

- Frécon, E., Ståhl, O., Söderberg, J., Wallberg, A., Visualising Sound Perception in a Submarine: A Museum Installation, Proceedings of Eighth IEEE International Symposium on Distributed Simulation and Real-Time Applications (DS-RT'04), 2004.
- Lenman, S., Bretzner, L. & Thuresson, B., Using Marking Menus to Develop Command Sets for Computer Vision Based Hand Gesture Interfaces, Proceedings of the Second Nordic Conference on Human-Computer Interaction, pp. 239-242. Aarhus, Denmark, November 2002
- Taxén, Gustav, and Frécon, Emmanuel: The Extended Museum Visit – Documenting and Exhibiting Post-Visit Experiences, Museums and the Web 2005: Proceedings, Toronto: Archives & Museum Informatics. April 13-16, 2005, Vancouver, Canada.
- Westerlund, Bo, Lindqvist, Sinna, Sundblad, Yngve: Co-designing with and for families, Proceedings of the , COST269 conference Good | Bad | Irrelevant: User aspects of ICTs, Helsinki, Sept. 2003
- Bo Westerlund, Sinna Lindquist, (2005) Reality based video-prototyping, Video accepted and presented ar ECSCW'05, Paris, Sept 2005

Reviewed conference papers with international co-authors

- Humble, J., Crabtree, A., Hemmings, T., Åkesson, K-P., Koleva, B., Rodden, T., Hansson, P., Playing with the Bits - User-configuration of Ubiquitous Domestic Environments, Proceedings of the Fifth Annual Conference on Ubiquitous Computing, UbiComp 2003, Seattle, Washington, USA, 12-15 October 2003
- Rodden, T. Crabtree, A., Hemmings, T., Koleva, B., Humble, J., Åkesson, K-P and Hansson, P., "Between the dazzle of a new building and its eventual corpse: assembling the ubiquitous home", Proceedings of the 2004 ACM Symposium on Designing Interactive Systems, August 1st-4th 2004, Cambridge, Massachusetts: ACM Press.
- Rodden, T., Crabtree, A., Hemmings, T., Koleva, B., Humble, J., Åkesson, K-P. and Hansson, P. "Configuring the ubiquitous home", in Proceedings of the 6th International Conference on Designing Cooperative Systems, May 11th-14th 2004, French Riviera: IOS Press.
- Taxén, Gustav, Hellström, Sten-Olof, Tobiasson, Helena, Back, Mariana, Bowers, John: The Well of Inventions – Learning, Interaction and Participatory Design in Museum Installations, Proceedings of the Seventh International Cultural Heritage Informatics Meeting, Ecole du Louvre, Paris, Sept. 2003.
- Westerlund, Bo, Lindqvist, Sinna, Mackay, Wendy, Sundblad, Yngve. Methods for Co-designing For and With Families, Proceedings for 5th European Academy of Design Conference, Barcelona, April 2003
- Åkesson, K-P., Bullock, A., Greenhalgh, C., Koleva, B. and Rodden, T., A Toolkit for User Re-Configuration of Ubiquitous Domestic Environments, Companion to Proceedings of the 15th Annual ACM Symposium on User Interface Software and Technology, UIST02, Paris, ACM Press, October 2002

Licentiate and doctoral theses

- Emmanuel Frécon (2004), "DIVE on the Internet", PhD Thesis, IT University of Göteborg, ISBN 91-628-6134-4, May 2004.
- Anders Hedman (2004): Visitor Orientation in Context - The historically rooted production of soft places, .TechD thesis in Human-Computer Interaction, Royal Institute of Technology, Department of Numerical Analysis and Computer Science, Stockholm, ISBN 91-7283-674-1, Januari 2004

- Kai-Mikael Jää-Aro (2004): Reconsidering the avatars: From user mirror to interaction locus. TechD thesis in Human-Computer Interaction, Royal Institute of Technology, Department of Numerical Analysis and Computer Science, Stockholm, March 2004
- Taxén, Gustav (2003): Towards Living Exhibitions, Licentiate Thesis TRITA-NA-0311, KTH, NADA, CID, May 2003
- Gustav Taxén (2005): Participatory Design in Museums. PhD Thesis in Human-Computer Interaction, Royal Institute of Technology, Department of Numerical Analysis and Computer Science, Stockholm, ISBN 71-7178-082-3, June 2005

Technical reports

- Hedman, A. Evaluation of the Daphne submarine exhibition, Technical report, TRITA-NA-D0409, October 2004.
- Emmanuel Frécon, "A Survey of CVE Technologies and Systems", SICS Technical Report, T2004-03, ISSN 110-3154, 2004.

Pictures from various projects

http://ada.sics.se/daphne/archives/cat_presentation.html

A5. List of events

Conferences

DAPHNE researchers have participated with presentations at the following conferences.

- ECSCW'05, European Computer Supported Cooperatove Work conherence, Paris, Sept 2005
- HCII 2005, 11th International Conf. on Human-Computer Interaction, Las Vegas, July 2005
- Museums and the Web 2005, Vancouver, Canada, April 2005,
- Eighth IEEE International Symposium on Distributed Simulation and Real-Time Applications (DS-RT'04), 2004.
- DIS 2004 ACM Designing Interactive Systems, August 2004, Cambridge, Mass.
- Designing Cooperative Systems, May 2004, French Riviera: IOS Press.
- COST269 conference Good | Bad | Irrelevant: User aspects of ICTs, Helsinki, Sept. 2003
- CHI 2004, ACM Computer-Human Interaction, Vienna, April 2004
- UbiComp 2003, Seattle, Washington, USA, October 2003
- International Cultural Heritage Informatics Meeting, Ecole du Louvre, Paris, Sept. 2003.
- IEEE Conference on Telecommunications, Zagreb, Croatia, June 2003
- European Academy of Design Conference, Barcelona, April 2003
- Nordic Conference on Human-Computer Interaction, Aarhus, Denmark, Nov 2002
- UIST02, Paris, ACM Press, October 2002

Workshops

DAPHNE researchers have arranged the following workshops.

- Workshop with the British Equator project: ”Smart-its”, building sensor nets for Physical and Digital, SICS, Jan 2003
- Design workshop with Equator and INRIA, Paris, at KTH, March 2003
- Design of innovative interaction, workshop in conjunction with SITI conference, June 2004

DAPHNE researchers have also participated and contributed to the following workshops.

- Workshop with Equator: Physical and Digital in the home, Nottingham, Sept 2002

- Workshop on Interaction design at CHI2004, Vienna, April 2004

Exhibits

DAPHNE has participated with exhibits at the following event periods

- Exhibit ”Well of inventions” at the Technology and Science museum, Stockholm, Jan 2003 – Jun 2005
- Exbibit “Submarine - Sonar simulator and periscope” in Malmö, Teknikens och Sjöfartens hus. May-July 2003
- Exbibit “Submarine - Sonar simulator and periscope” in Göteborgs Maritima Center August - October 2003
- Exbibit “Submarine - Sonar simulator and periscope” in Karlskrona, spring 2004 and since Sept.2004
- Exhibit “Papyrus – five basic mechanical elements”, Technology and Science museum, Stockholm, Summer 2004
- Exbibit “Submarine - Sonar simulator and periscope” in Stockholm, Djurgården, August 2004
- Exhibit “Heatmap – where the action is”, Technology and Science museum, Stockholm, from Summer 2005

Open Houses

- DAPHNE prototypes have been demonstrated 2003, 2004 and 2005 at yearly Open Houses at CID/KTH and at SICS as well as at the yearly SITI conferences and exhibitions.

Summer schools

Several DAPHNE researchers, including Yngve Sundblad as organising director, have been strongly involved in the EU Convivio Summer Schools 2003 in Rome, 2004 in Split, Croatia, and 2005 in Timisoara, Romania, as teachers, atelier leaders and students. Each school had about 40 students from about 20 countries working in 5 ateliers, with about 5 participants from DAPHNE.

A6. List of graduate courses

Physical Computing, 5 credits, Course at NADA, KTH, for HCI and Computer Science graduate students on sensor technology and design and use of them in ubiquitous environments

Design for HMI, 5 credits. Course at NADA, KTH, for HCI graduate students on design principles with user involvement for interactive environments

A7. PhD Exams

Emmanuel Frécon, born 1971, male, thesis title: “DIVE on the Internet”, supervisor Prof. Bo Dahlbom (IT University of Göteborg), department: IT University of Gothenburg, June 2004. basic training from INSA, Lyon, funding from SSF: 12 full doctoral months. Works at ICELab, SICS.

Anders Hedman, born 1967, male, thesis title: “Visitor Orientation in Context - The historically rooted production of soft places”, supervisors prof. Yngve Sundblad and guest prof. John Bowers, subject: Human-Computer Interaction, dept: NADA, KTH, degree January 2004, basic training at Stockholm University, SSF funding: 12 full doctoral months. Works as a post-doc at University of California at Berkeley

Kai-Mikael Jää-Aro, born 196x, male, thesis title: “Reconsidering the avatars: From user mirror to interaction locus”, supervisors prof. Yngve Sundblad and guest prof. John Bowers, subject: Human-Computer Interaction, dept: NADA, KTH, degree March 2004, basic training at KTH, SSF funding: 12 full doctoral months. Works at the company Popwire Technologies in Stockholm

Gustav Taxén, born 1972, male, thesis title: “Participatory Design in Museums”, supervisor prof. Yngve Sundblad, subject: Human-Computer Interaction, dept: NADA, KTH, degree June 2005, basic training at Stockholm university, SSF funding: 12 full doctoral months after licentiate exam. Works at CID, NADA, KTH.

A8. Licentiate exam

Gustav Taxén, born 1972, male, thesis title: "Towards Living Exhibitions", supervisor prof. Yngve Sundblad, subject: Human-Computer Interaction, dept: NADA, KTH, degree May 2003, basic training at Stockholm university, SSF funding: 6 full doctoral months. Works at CID, NADA, KTH.

A9. Future exams

Kristina (Sinna) Lindquist, born 1965, female, supervisors: prof. Yngve Sundblad, docent Ann Lantz. subject: Human-Computer Interaction, dept: NADA, KTH, basic training in ethnology at Stockholm university, SSF funding: 12 full doctoral months. Works at CID, NADA, KTH.. Expected to graduate 2006. Started 2002 thus not yet even nominal time expired.

Ovidiu Sandor, born 1970, male, supervisor: prof. Yngve Sundblad, subject: Human-Computer Interaction, dept: NADA, KTH, basic training in computer science at technical university, Timisoara, Romania. SSF funding: 9 full doctoral months. Works at CID, NADA, KTH. Expected to graduate 2006. Started 2002 thus not yet even nominal time expired.

Björn Thuresson born 1968, male, supervisor: prof. Jan Olsson, Cinema studies, Stockholm University, subject: Cinema Studies, basic training in Cinema Studies at Stockholm university. SSF funding: 15 full doctoral months. Works at CID, NADA, KTH. Expected to graduate 2007. Started 1999, half-time studies.

Karl-Petter Åkesson born 1972, male, supervisor Prof. Bo Dahlbom, IT University of Gothenburg), basic training from Elecrical Engineering, Chalmers, Gothenburg funding from SSF: 12 full doctoral months. Works at ICELab, SICS.

A10. No exams

There is no case where doctoral student has left without passed or future exam.

A11. List of prototypes

All the following physical prototypes are described in section 2 in this report.

- HeatMap exhibit
- Mblog
- Mobile 3D portal
- Papyrus exhibit
- Periscope
- Pondcaster

In chapter 2 also the following software prototypes are described.

- TIL
- Dapper