Roomware and Intelligent Buildings

– buildings and objects become computer interfaces!

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Abstract

Information Technology until recent years mainly have been driven by technological possibilities based on research methods developed within engineering and natural science. The capacity and the ever-decreasing size of IT enable penetration into almost any object. IT can no longer be regarded as an isolated technological possibility; through networks and telecommunication it has become an integrated part of our everyday life. We illustrate this perspective with a point of departure in supporting work practices for Designers and Architects by examples from our interactive room laboratory, the iRoom. IT alters the ways we connect both cultural and social. On the basis of this aesthetic research perspectives have become essential in the further development of IT research regarding the environmental impact and cultural changes imposed by the use of IT. Furthermore IT has the potential to alter the premises for design and architecture in more general terms. This paper will discus ways and premises for enabling a common basis of both scientific and aesthetic research in this domain and ways of including architectural and artistic approaches to integration of IT in living and work environments.

1 Introduction

In the article ”The End of the Mechanical Age” (1990) Ezio Manzini describes how the act of designing have developed during the 20th century based on the premises of technology, while considering technology throughout history as an inseparable part of design. The article is written in response to articles that acclaimed the victory of the manmade world over nature, among others Hannes Meyers article “Die neue Welt” (1926) and later Sigfred Gideoens article, “Mechanization takes Command” (1948). In the article Manzini argues that the premises of mechanisation has come to and end, it is no longer adequate to “*…simplify and clarify…complex phenomenon’s …based on reductionistic and deterministic models…that define precise and unambiguous relationships of cause and effect… and that the observer always can be regarded as external to the system observed*”. Manzini concludes the article by arguing “*Matter…has become ductile and malleable into every conceivable form*” and that “*we are no longer confronted with a given taxonomy of materials and manufacturing techniques, but a continuum of possibilities.*” This leads to the conception that materials can no longer be regarded as a premises for design, a notion which is supported by the present increasingly use of IT in new products. IT, though being real i.e. endowed with properties that can be sensed, its character is immaterial.

2 The “Fourth Machine Age”

By relating Manzinis article to Reyner Banhams (1950) “Theory and Design in the first Machine Age”, one could say that we live on the border of the fourth machine age. Large and heroic machines like cars, airplanes and heavy industry characterized the first machine age, the second utilised the mechanics of the first to invent small and pervasive mechanics like the refrigerator, vacuum cleaner and other household machines. The third machine age is characterised by the emergence of the computer originally designed for specialised use in work settings, a tool for work from technologist to technologist. Today the computer seems to undergo an equivalent development as to what happened to mechanics in the second machine age, they become ordinary and penetrates into every object of our daily lives.

The notion of this paper is to pick up where Ezio Manzini left in 1990, and to continue the development of theories and descriptions of the contours of the “Fourth Machine Age” as among others done by Anthony Dunne in the book “Hertzian Tales” (1999). The aim is to describe what might be some of the premises of design of this “Fourth Machine Age”, by taking departure in the fact that IT increasingly enables and represents the qualities of products and illustrating

this point of view through examples of current marketed products as well as prototypes and research carried out in the iRoom (http://www.daimi.au.dk/ispace).

That physical artefacts are endowed with digital properties is in international research described as ”Augmented Reality”(Wellner et al 1993), ”Pervasive” and ”Ubiquitous Computing”(Weiser 1991). While the notions ”pervasive” and ”ubiquitous” describes what is actually happening, that computation is embedded into everyday objects and environments, the notion of ”Augmented Reality” is an abstract idea of what IT enhancement of physical objects does to our perception of reality. This ”augmentation” of our environment alters the premises of design and architecture. Traditionally within design and architecture material is considered as the basis of form, and a guiding parameter for the realisation form. IT can in its merge with physical objects be considered as a new material, but its properties and extensive influence on our environment challenges our perception of form. To design no longer mainly leads to the creation of physically finished static works of art, but merely to the emergence of dynamic artefacts and spatial constructions that develop through their usage. IT enhanced artefacts are dependent of their context of usage, informing and influencing the expression related to its architecture and design.

The cultural and aesthetic premises of design are changed when objects of design no longer can be regarded as solitary entities but as artefacts which are comprised by activities mediated by networks and/ or direct human manipulation and interacting with the our context. Our perception of space will be challenged while having to include both physical spaces as well as metaphysical dimensions as mediated by e.g. media spaces (Ishii 1998). In such an environment space can no longer be comprehended by the notion of physically demarcation, but merely as an environment defined by social and cultural relations among the involved people and occurring activities.

The dynamic nature of IT has always been the work premises of computer science. But until now developments within Computer Science mainly have been aimed at the usage of applications running on PCs or controlling large machines equipped with displays serving as interface between man and machine. The ever decreasing size of IT hardware while at the same time an extreme acceleration of capacity enables the aforementioned penetration of IT into almost any object. The interface to the underlying software changes from being screen-based and/ or based on dedicated bottoms to be extremely complex i.e. tracking of ordinary human activities e.g. speech, gestures etc. and the handling and placement of physical objects.

IT is increasingly used in buildings for controlling the various technical installations such as elevators, doors, security systems and the indoor climate all based on and enabled by tracking the activities of people just doing what they normally do (LonWorks). The interface of the system has disappeared for the ordinary user, and the building can to some extend be regarded as “intelligent”(Grønbæk et al 2001). Furthermore the systems can be operated remotely over the Internet enabling e.g. turning on and off heat, lights etc. in a home or an office (Echelon 2001).

An example of an object that has become ”intelligent/smart” could be the toy ”Furby”: a cute small teddy that has been stuffed with electronics, sensors, actuators and a communication port *fig. 1 & 2*. Natively the toy arrives with the ability to speak “Furbish”, but enabled by Artificial Intelligence software the toy is capable of “learning” up to 1.000 English words and sentences. Furthermore it is capable of relating its speak to a context e.g. is it hugged, tickled which is detected by its built-in sensors and hereby the toy is capable of mediating a sort of feelings, seemingly generated by the toy. By the appearance of the Furby independent web sites have emerged informing how to hack the Furby and apply it with new software!

The above-mentioned examples serve as illustrations of the shared interests, challenges and merging properties of architecture, design and computer science. It is with the prospects of the examples and developments like the above that a laboratory for interactive rooms, the iRoom, has been established, though the work in the laboratory has less focus on autonomous systems as it has on enabling and showing the actual relations between physical objects and related actions performed by computers comprising into an transparent and information rich environment with an overall notion of enabling intuitive interaction with computation.

Figure 1 & 2: Furby Autopsy

3 The iRoom

The idea behind establishing the iRoom was to begin experimenting with interactive environments for the support of the work practice of designers and architects, taking departure in making the computer disappear into the elements constituting the room as well as objects residing in the room, and having the computers react upon intentional acts of the people rather than being adaptive to activities in the room. The initiative was to build upon already inherent

knowledge represented by the a interdisciplinary research team formed by people coming from multimedia science, computer science and architecture while challenging existing research methods of all fields.

3.1 Research approach and related work

The work in the iRoom draws upon experience and techniques from a number of different fields: Collaborative Virtual Environments (Churchill & Snowdon, 1998), Human-Computer Interaction and usability practice (Madsen & Borgholm 1999), and Computer Supported Cooperative Work.

Specifically, this work draws upon and expands on a number of studies of design rooms (Karat & Bennet, 1991, Madsen & Petersen, 1999) and design spaces (e.g. Büscher et al., 2000), by focusing on the development of a particular design practice, supported by interactive technologies.

Technologically, we have been inspired by interactive room technologies (e.g. Streitz et al., 1999), electronic meeting environments, (e.g. Pedersen et al., 1993), and whiteboard-based interaction, (e.g. Rekimoto, 1998). The iRoom constitutes an augmented environment for design work – an interactive design collaboratorium addressing some of the challenges and conflicts in present design work, as identified in (e.g. Bødker et al. 2001) The iRoom enables the exploration of the usefulness of recent technological gadgets, and show how questions arising out of a particular empirical case can inform general problems of interactive design rooms.

Figure 3. The interactive wall

3.2 Prototypes and experiments

We have developed a room-sized prototype combined with a concept for how information and materials can be brought in and out of the room, and for shift between private and shared forms of information and materials (Grønbæk et al 2001). The prototypes take advantage of the Open Hypermedia application "Manufaktur" (Büscher et al 1999) as interface in the prototypes. This interface provides a link structure that supports users working with "live" documents and objects in a 3D environment where "workspaces" are used as a structuring mechanism. Furthermore the application supports annotations in the shape of notes and as separate sketches or at notes attached to documents.

Figure 4. The Designer's workbench

All interaction with the prototype applies an IR-pen and a wireless keyboard. The room has interactive walls with rear projections *fig 3*, serving as enhanced whiteboards. The interactive wall can be used as an ordinary 2D white-board and seamlessly move into a 3D mono interface allowing users to place documents and objects in the background, in clusters, on top of each other, etc.; creating more room for work while maintaining awareness of collaborative manipulation of other relevant documents and objects. It further contains a designer's workbench *fig. 4* with a projection in the tabletop showing the projected workspaces either in 2D or 3D. Moreover, it supports a seamless transition to passive stereo visualization of digital models (requiring polarized glasses), such that digital models of design objects can be directly compared to physical models and previous versions placed on the table. The Designers' Workbench attempts to fill the gap between visualization systems and pure 2D digital desks in that it provides support for ordinary 2D documents and 3D models in the same integrated environment.

Figure 5. Evaluating with users

Through palmtops users can bring electronic link structures to and from the room, to be accessed on the palmtop or on walls and boards elsewhere. Objects can be moved between walls, the table and the personal palmtop.

Two of the prototypes in the iRoom i.e. the "interactive wall" and the "designer's workbench" has been evaluated with users performing a brainstorm session (Bødker et al 2001) *fig 5*. The evaluation showed benefits such as: enabling the accumulation of knowledge, sharing of materials that can be directly referred to in discussions and altered if needed, and an immanent possibility for rearranging materials to fit a collective view of the project at hand. The evaluation also showed a series of needs yet not implemented, especially regarding the interaction with the materials displayed. When wanting to rearrange the materials the users expressed a wish to do that by just grabbing the document by hand and moving it, while when they wanted to ad content to a document they'd want to use a pen or alike, patterns of actions known from manipulating physical documents.

4 Future work and strategies

The iRoom was as stated above originally established with the notion of computer augmented rooms. The work in the iRoom has revealed the need for an extended concept of the relation between spaces and computation, which we will develop in the newly started research project WorkSPACE (http://daimi.au.dk/workspace). We call that concept Spatial Computing aiming to take advantage of the more general notion of spatiality and enhance it by tracking spatial arrangement in the real world and combine it with the enabling of spatial arrangements in the computer while emphasising that computing takes place inside many artefacts/components of distributed spaces and fields and recognizing e.g. that the spatial arrangement of documents and objects in our environment often is used to prioritise and show the significance and importance of the materials in e.g. an office. Computing isn't confined to dedicated rooms and places but can and will occur almost anywhere.

The emerging research fields indicated in this paper, among others the concept of Augmented Reality is often considered based on interdisciplinary ways of working. Though the WorkSPACE project takes departure in known and well-documented research methods derived from computer science, sociology and architecture the ambition within the project is to challenge these methods by applying a post-disciplinary approach rather than an interdisciplinary approach. By the concept of post-disciplinary research methods we seek to establish a common research approach that is comprised of selected methods derived from the involved research disciplines, while adding new ones that can bridge the disciplines and become common to all the involved parties. Through this approach we aim to enable the description of aspects, which today goes beyond each discipline e.g. how to design experiences, how to design for users unforeseen and creative use of provided artefacts. One of the major challenges within the project is to work with the experience of the dynamic environment that will emerge when implementing Augmented Reality. To perceive and react it is necessary to be able to relate sensations to something known and/ or learned, but how can we endower points of reference in a dynamic context and how will they manifest them selves in a dynamic environment where the possibilities at hand constantly is evolved through users interactions and manipulations changing the cultural framework for the perception of an artefact or the whole environment. Dealing with questions as above will indicate the possibilities for forming a new design paradigm embracing the never concluded design artefact and what in the future will be subject to design while products alone cannot be regarded as the result of a design process, but merely designing the act and limitations of using an artefact inspiring and enabling the user to form the provided artefact.

5 Architectural research and IT, towards a new discipline

As indicated above not only design and architecture faces new challenges but almost any other discipline will be affected by the increased use of IT. Concepts and fields of research touched on in this paper will influence architectural research both on the level of what can be examined and analysed by means of new applications and devices changing the way of presenting architecture and design from abstract representations as plans, facades and cardboard models to enable a more accurate verification of the architectural initiative in context. But perhaps most evidently the change will happen in that design and architectural objects will be tied to the use of IT as an inherent property of the product as well as IT will mature from being aimed at specific tasks confined to a grey box with which one only can interact through mouse and keyboard. By applying IT to design and architecture the whole concept of interacting with computers will change. The research initiatives described in this paper together with a wide range of projects and competencies involved in research at the Centre for Pervasive Computing situated at Katrinebjerg in Aarhus forms a plateau for a planed new education denoted e-Design. The education will be at master's level and carries the ambition to comprise diverse competencies ranging from art and aesthetics, architecture and design, multimedia, computer science, media and information science potentially forming a new discipline. While taking advantage of the academic skills and approaches of the students achieved by a bachelors degree from either of the mentioned disciplines e-Design will focus on common challenges that bridge disciplinary boundaries while enabling the students to maintain and extend their basic approach being either aesthetic, technical or humanistic.

The challenges of augmented reality and pervasive computing are interdependent between disciplines e.g. computer science will increasingly have to support the use of arbitrary objects e.g. ordinary paper, furniture and accessories as means of interaction with computers as well as to support customised interaction tools, while the challenge within architecture and design is to manage the plethora of properties inherent in both physical objects and in IT products to form consistent and perceivable atmospheres related to the activities conducted in the environment enabling appropriate feedback to computational systems. Furthermore other disciplines will have the focus on how information is displayed and what kind of activities this might initiate. These challenges can be conceived to form spheres of contact between the user and artefacts emphasising that many types of activities can be related and connected to computation. These challenges have been indicated though not fully dealt with in research areas as interactive rooms and buildings, wearable computing, ambient media, tangible bits described by among others (Ishii 1997 and Mitchell 1999).

The various aspects that will be a part of the new education will take departure in the approach of supporting work or task related activities by means of IT, but this approach will be challenged by the fact that not all we do as human beings can be related to a specific functions or needs. Today IT supports work, consumption and leisure, but there is much more to human life than this. Much of our activities are related to social chitchat, irrational thinking and even idiosyncratic behaviour. How these aspects can inform and inspirer the design of augmented reality environments and pervasive computing will be one of the major issues in the coming years of teaching and research with this emerging discipline of e-Design.

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