Interactive Spaces for Advanced Communication using 3D Video

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Architects integrate more and more modern information technologies in their projects. Based on this background the use of 3D video in an architectural context is discussed. The combination of real-time 3D video and blue-c technology for a distributed shopping experience in shared virtual shops is described.

IN: SHOP illustrates an approach to enhance physical environments in shopping areas and connects geographically distant persons. These technologies offer new architectural design possibilities. The traditional understanding of location, space, and time may be redefined. Interactive spaces are being designed, modified and experienced. We believe that information technologies have an impact on buildings and architecture.
1. Introduction
In our private and business world we are increasingly influenced by information and communication technologies. In the future, buildings will more and more adapt to their users and provide individual comfort. Buildings are needed to support communication and cooperation [1]. Therefore, designing these buildings starts by regarding the real physical space. The architectural space reflects characteristics of rooms, buildings, their environment and functioning. The challenge in designing modern spaces is bringing information technologies closer to the users and make them part of their physical environment. Our life is getting more and more dynamic, flexible and mobile. What can architects contribute to this effect? How can they design environments that are more flexible and dynamic?

2. Architecture and information technologies
At the Swiss Federal Institute of Technology the Chair of CAAD under the direction of Professor L. Hovestadt investigates appropriate integrations of novel information, communication, and presentation technologies into buildings.

As it is well known, Diller and Scofidio [2] use technical innovations to redefine the objects of architecture. As opposed to the common understanding of architecture (shelter, comfort, and functionality) they cross media boundaries in their work. They unite architectural design, performance, and electronic media with cultural and architectural theory and criticism. Using digital technology and video images they manipulate space and time, and make the invisible visible. Over the years they have investigated the technological possibilities and integrated them into the contemporary built environment. The themes of their work include domesticity, daily life, rituals, control, security, and surveillance. The technologies used in their work, for example Para-site (1989), Slow House (1991), Jump Cuts (1995), The Brasserie (2000), do not produce something new. In fact, they reframe the reality by visually and temporally altering it.

Over the past few years showroom design has offered a vital space for experiments and creative research. The Prada store in New York, for example, is equipped with technical innovations from the IT sector. AMO, Rem Koolhaas’ research company, developed the virtual part of the shop. Innovative display technology, intelligent mirrors, and interactive dressing rooms are integrated into the shop. [3]

A shoe section that converts to a theatre for performances and other “non-shopping events”, an electronic customer-identification and service system that tracks shoppers and their needs, and smart dressing rooms are provided. The dressing rooms feature simultaneous, digitally-produced front, back, and side views of the customer. Phones inside the dressing room allow for requesting assistance from the sales personnel or for communicating.
with people outside. The walls can be switched from transparent – so the customer can model for his friends – to opaque for privacy. In the near future, customized web pages support shopping at home.

These examples show that with the help of information and communication technologies it will soon be possible to equip and net the main components of a building with computer performance. These technologies offer new ways to reduce spatial and temporal interdependencies between different activities. Therefore they provide new ways for architects in their design task. The integration of media and information technology into architecture allows us designing spaces that are actively dynamic and communicative. Aspects of information and communication technologies are included in social life concerning town planning. Appropriate technologies make the cooperation between spatially and temporally distributed persons and objects possible.

3. Architecture and branding

Branding and Corporate Design are getting more and more popular in the field of architecture. Originally, branding comes from the Wild West. In order to make the possession visible, the cattle were provided with brand mark. Nowadays, branding is understood to provide products with additional immaterial values which characterize the manufacturer. Each medium – whether analogue or digital, whether changeable or static – can be used as carriers of mark contents. Commercially a pronounced identification of the customer with the product is promoted. In former times, advertisement and customer information was centred on the presentation of goods and their qualities. Today, modern shopping worlds produce shopping experiences which address the customer personally. In Nike’s flagship store “NikeTown” the centre of attention is sporty activities and their cultural social environment. Prada combines reality and product with culture and commerce in its epicentre in New York. In the automotive industry a car’s purchase has become increasingly a shopping experience. Volkswagen, for instance, established the Transparent Factory in Dresden to distribute its latest luxury designs. The customer not only selects and orders the car, but also follows its production in real time. In BMW’s new distribution centre, as another example, customers can experience the brand by visual impressions. An individual preferential treatment as well as a world-wide openness are most important. How can architects contribute to the design of such shopping experiences? They are challenged to not only design static spaces, but also to design accompanying worlds of dynamic arrangements. The role of architecture is to make brands visually present. Clients want even more than implementing the latest technology into a building. They want a complete architectural setting, a building which vividly reflects the latest technology.
4. Blue-c

The research project blue-c, as applied in this paper, demonstrates that modern information technologies can generate virtual spaces in which remote users and objects can communicate and collaborate. blue-c provides a collaborative tele-presence environment with simultaneous acquisition of 3D video and projection. Each user experiences an immersive virtual environment that displays a 3D representation of the common virtual space and the other user’s 3D video representation.

blue-c [4] is an interdisciplinary research project of the ETH Zurich. It brings together the knowledge of the Computer Graphics Laboratory, Computer Vision Laboratory, Center of Product Development and the Chair of CAAD. The aim of the project is to develop an immersive virtual reality environment for tele-cooperation, which allows the representation of persons and objects using 3D-video technology. This concept enables spatially separated users to communicate in real-time within shared virtual worlds. In a three-year time span, the 20 members of the blue-c team created a portal at ETH Hönggerberg (Figure 1) and one at ETH Centre (Figure 2).

4.1. System overview

In this section a few technical summaries are presented, without entering into detailed descriptions, to emphasize, from an architectural view, how we developed and implemented our experimental system. Technical details are published in the blue-c paper [5].
Figure 3 displays an overview of the system architecture. Our setup is asymmetric. Besides costs, the major reason for this asymmetric design is to demonstrate scalability and the integration into buildings.

The portal at ETH Centre represents our experimental development of the core blue-c technologies between 2000 and 2003. Using six projectors, the virtual world is projected onto three shuttered glass screens. The user experiences the virtual world in full 3D using stereo glasses. Simultaneously, 16 cameras create a 3D video representation of the user in real-time. The resulting video inlays are transmitted to the remote blue-c portal. During the acquisition process, the cameras can "look through" the projection walls by employing screens with switchable opacity. During a short time slot we "open" the walls for image acquisition. But since the shutter glasses are totally opaque in this phase, the user is not aware of the cameras or the transparent walls.

The shuttered projection screens, actively shuttered projection system with six projectors, and the shuttered stereo glasses are synchronized. Therefore, the user enters a blue-c portal without going through any initialization phase.

As opposed to the portal at ETH Centre, the portal at ETH Hönggerberg consists of 16 cameras, a regular projection screen, and a stereo projector. The installation at ETH Hönggerberg was especially developed to create a public presence for the blue-c project, and to represent a multifunctional room for the whole Department of Architecture.

In each portal, spatial audio rendering enables exact location of sound sources of virtual objects. This technology also allows real-time speech transmission of participants.

4.2 3D video technology

From multiple video streams, we create a 3D video representation of users or objects in real-time. The resulting 3D video inlays are transmitted to the remote site [6].
These video fragments are integrated into the virtual world using hardware-accelerated point rendering. Since we are not using a model-based approach for extracting geometric information we can also introduce arbitrary objects into the system besides the user, such as a sweater. Unlike similar systems for tele-collaboration we provide simultaneous, real-time 3D video acquisition and projection. Persons and objects within our virtual worlds are no longer modelled. Thus, we are not using so called avatars, synthetic, model representations such as 3D graphical representation of persons, prepared in advance.

Our recording technology [7] allows us to present interactive 3D objects within the scenes. Static 3D objects are acquired using our multi-camera scanning system. They are represented as surfaced objects [8] and integrated into the virtual world using multi-pass point rendering. We are able to integrate real-world objects into our virtual environments without a major modelling effort.

The Chair of CAAD currently develops various scenarios in the field of architecture integrating information and communication technologies developed within blue-c. The application IN: SHOP [9] demonstrates how architecture, presentation media, communication and information technologies, and computer graphics may be combined in designing a new enhanced immersive shopping environment.

5. IN:SHOP concept
IN: SHOP is our first example scenario to investigate and analyze the integration of blue-c technology into buildings. IN: SHOP is based on our architectural framework for tele-communication [10]. The framework is implemented on top of the blue-c API [11] and supports designers spatially scenarios within blue-c. The main goal of the framework is to integrate different media used in the CAAD education including geometry, image-based objects, video and audio streams into a collaborative virtual reality system. blue-c technology allows the implementation of a solution for distributed shopping. Combining our architectural framework with blue-c technology and surpassing traditional 3D geometry, we introduce different kinds of media types into the virtual shopping space.

Multimedia elements such as large projection screens and media installations, as well as information technologies such as networked information terminals, represent state of the art in designing modern public buildings. IN: SHOP takes this trend one step further by combining traditional shopping and marketing structures with internet paradigms, 3D video technology, and tele-presence. We create a flexible and adaptable commercial environment which extends and connects the physical shopping floor into virtual and remote spaces. The application is not intended to supplant physical shopping or the shop itself, but it redefines experience and architecture of commercial spaces.
Figure 4 shows IN:SHOP’s distributed application concept. Connecting several sites allows remotely located users to meet, communicate, and collaborate in the virtual shopping space. Already existing display technologies and glass walls with switch-able transparencies form the portals into the computer generated shopping world. These portals make distributed shopping in a real space possible and allow connecting different shops and locations. The shop-in-the-shop concept (Figure 5 Left), for instance, allows geographically separated customers, sales assistants, and experts to meet, communicate and collaborate in real-time in a shared virtual shopping environment. They communicate with each other and interact with 3D representations of real objects in real-time. IN: SHOP allows pooling a worldwide network of branch offices and subsidiaries in a single virtual space. This concept also provides a strong sense of corporate identity.

The customer has direct access to his individual shopping environment. The system identifies the customer and loads his personal profile (Figure 5 Right). This profile includes personal data, bought items, interests, demands, and so on. The virtual environment is customized based on recorded customers’ shopping habits. Also his personal sales assistant from his patronized store is virtually included. The customer and the sales assistant browse together through the personalized catalogue of requirements and offers. If the customer
has indicated interest in certain items, the sales assistant selects and presents them using a variety of traditional and virtual reality based media. Different forms of data can be presented in the immersive space, ranging from pre-recorded 3D representations of people and objects, 2D movies and images, to hand drawn graphics and text (Figure 6). During the shopping process the customer sees the object gradually becoming more detailed and interactively approaching the finally agreed purchase.

Our concept allows presenting a large, multifaceted product range. The real shopping floor persists clearly arranged, the shelves are not stuffed and the storage space is reduced. Undoubtedly, it is also interesting from an economical point of view to create a unified shopping environment among distant branches using tele-presence and networked systems. For example, travelling customers are able to contact their familiar sales assistant from miles around. Also experts of different areas of expertise can be hooked up linked to an item of interest. Technological and cost expenditures, of course, mainly aim at specialised expensive and custom-made products where additional information about the customer, the product, and its use by the customer is important. Other examples than fashion and cars might be jewellery, furniture, musical instruments, yachts.

The appearance of a fully realized 3D representation of a person allows for a great sense of presence. This makes to a large extent a natural interaction possible. The sales assistant has direct access to databases including detailed product information and their visual and text based descriptions. He retrieves, visualizes and modifies this data according to the customers’ demands. In the sales conversation the new product is generated interactively and presented accordingly.

In the following we describe the concept of IN:SHOP for a fashion shop and a car seller in more detail.

5.1. FashionShop

FashionShop is our example application of the IN:SHOP concept for the fashion industry. FashionShop features a fully immersed personal fashion
show (Figure 7). 3D representations of mannequins present selected garments. The customer gets further information such as production, washing guidance, and fitting items. Together with the sales assistant the customer selects some base models for further customization. An overview of the configuration decisions is shown as two dimensional detail images, allowing direct access to change previous customizations. Before agreeing to buy a product the customer is able to interact with a 3D representation of the real object, to put it into his virtual closet or to discard the selection. The obvious next step is the physical object itself, either “prêt a porter”, as a custom manufactured object created from the consumers’ data profile, or from measured body data acquired within the portal itself.

5.2. CarShop

CarShop is another scenario for selling luxury cars to prove the applicability of IN:SHOP. The product presentation and the databases are adapted to the slightly different selling process of FashionShop. The customer and the sales assistant commonly configure the desired car. The configuration process runs through different selection steps: series, base model, colour, interior design, extras, and financial services. The individually configured car is presented on a rotating platform as a 3D model (Figure 8). The car becomes experienceable for the customer in its real dimensions. Due to an audio system the customer is able to experience the engine sound, too. The configuration data are directly sent to the delivering plant. The traditional shopping basket metaphor is visualized using a virtual garage. The customer puts and stores his virtually configured cars in the garage and is able to compare them later.

CarShop allows potential buyers to interactively configure and experience 3D representations of the car they are purchasing. Thus, the customer gets a detailed overview of the brand and of product varieties. CarShop allows presenting a wide range of models and their accessory varieties in a real showroom.
5.3. Virtual shop environment

Our experimental virtual shop consists of three information displays and a ground platform (Figure 5 Right to Figure 7). The platform is an interactive map that illustrates the possible geographical disparate locations the customer can access. The main screen is for presentations and for advises to the customer. It is connected to the customer and the content database. Therefore, it displays all kinds of information ranging form the product catalogue to product suggestions. The side screens provide the customer with background information such as campaigns, production processes, technical explanations, history, and so on. The screens can display different media types such as images, slide shows, and movies. In a next step it will be possible to feed the screens with live and recorded footage from video cameras. Text and image based data sheets can additionally be introduced in the virtual scene supporting the counselling interview. Customer and sales assistant use them for discussing details in the configuration process. The virtual shop is surrounded by a large cylindrical video wall. The shop environment changes according to different configuration stages. Depending on the configuration step the ground platform moves like an elevator to the relating stage. This on the one hand supports the user’s orientation and on the other hand demonstrates the spatial changeability that is only possible in virtual space. At any point in time the customer can jump between different stages.

Sound is used to generate the appropriate acoustical ambiance as well as to support the user interface. Sound sources can be placed anywhere in 3D space. We also use sound service as a voice communication channel between the participants.
6. Ongoing work
Given the results achieved with 3D representations of users in a shared virtual environment, we are sure that in the future physically distant persons together with their environment can be brought together in a virtual space. Virtual refers to the situation where people are not in one common physical location, but in remote, distributed locations. For example, people of a virtual space are still people in real physical spaces – only at different locations. blue-c enables us to bring users at different physical locations together in a shared virtual environment. Our system works without avatars. In a next step we cover larger areas with novel data presentations for 3D video of complex scenes. This approach allows us to reconstruct complete physical spaces as well as persons. Therefore, we are able to extend and connect physical spaces into remote spaces. We believe that in the future people are going to communicate, to naturally collaborate, and to share information independent of their individual physical location.

7. Conclusion
Over the past decades architects dealt with the issues of technology in theory, design and production. It can be observed that architects since ever, combine different and the latest technological developments in their building design. Therefore, architects are currently, in their education and profession, challenged by combining applied information technologies in their designs. Due to their novelty and the focus on their development, most of modern information technologies lack of useful and inspiring application possibilities. It is obvious, that the novel opportunities of digital media are not restricted to generate almost perfect, with photographic precision operating project visualization or to produce computer aided customized building components. Today, the computer is more than a drawing machine or a technical help at realization. Technologies may also be used for creating active and dynamic spaces. Technologies are no longer just design and fabrication tools for architects supporting their design tasks. In fact, treating them like design materials integrated into the building design process, they provide architects with the opportunity to generate interactive and communicative spaces.

Over the last few years we observe that displaying of objects and situations is becoming more and more important. Acceptance, attractiveness, and performance are leading marketing goals. Production is no longer the pivot of our economic and cultural life. Looking at the Prada Soho store in New York, architecture and design are used to frame, state, and represent the objects to be sold. As a result, the role of architects extends beyond designing and constructing of buildings. They are also going to create places and scenarios for display. Display takes place in stores, restaurants, bars, theatres, sport and vacation facilities, and many more.
People come to different kinds of places in order to see, to be seen, to purchase, and to get compressed information. Since architects are concerned with appearances and staging they are designers of our urban environments where display takes place. In other words, architects are also engineers of display [14]. They define appearance of goods and control the flow of people.

Combining real and virtual worlds allows us to design enabling interfaces that build on the best affordances [15] of everyday reality and vitality. Video streams of advanced information technologies offer new ways to reduce spatial and temporal interdependencies between different activities. Video stream systems help us to bring information closer to the users and make them part of their physical environment. Therefore, they offer a promising contribution to bridge the gap between virtual and actual reality.

With IN:SHOP we are able to introduce a novel approach to distributed shopping. The application allows geographically disparate customers and sales assistants to communicate and interact with fully realized 3D representations of real objects in real-time. The 3D representation of real persons or any other real world object is a novel visual presentation media for communication and man-machine interaction.

We combine architecture, information technology and computer graphics.

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References


12. Fashion and store images within the application are courtesy of OMA/AMO and Prada, 2001.

13. Content images within the application are courtesy of BMW. http://www.bmw.de [10-12-2003].


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