The Aachen Media Space

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1 Research Vision

New media technologies often distinguish themselves through their capability for interaction. For example, "Interactive TV" adds to classical TV the capability of reacting to user input, and electronic books add search capabilities to the traditional paper-based medium.

The user interface to multimedia, however, often lags far behind the technical potential of today's computer systems. For example, the controls of Apple's latest QuickTime player still closely resemble a 1950's tape recorder (and it does not even include recording).

Along with the remaining user interface, multimedia interaction has gotten stuck in the desktop metaphor invented in the early 1970's that's perfect for document work, but not for media processing. This has become a bottleneck for innovative applications that could deploy new media technologies. This situation is giving the field of Human-Computer Interaction (HCI) a "significance push" that may lead to a similar development as the explosion of Computer Graphics around a decade ago. It enables and requires a rethinking of central paradigms in the interaction with media and information.

1.1 Interactive Exhibits

Researching new interaction techniques can re-enable established routines from the pre-digital world, or create new ones unique to the interactive medium. As an example, our *interactive exhibits* such as "WorldBeat" and "Personal Orchestra" [2, 4] have enabled users to access and interact with the rich structure of musical data streams, by allowing them to find a piece in a musical database by humming it, to improvise to a piece with computer support, or to conduct an actual audio and video recording of the Vienna Philharmonic, for example.

These visions inevitably lead to fundamental research questions in computer science. For example, our work on music conducting systems has led to research in real-time time stretching of A/V streams, real-time recognition of conducting gestures, and cognitive modeling of the human conducting process.

1.2 Media Spaces

Beyond such individual systems lies the realm of *media spaces*, entire environments in which several key dimensions of complexity increase—multiple users interact with multiple media, using multiple systems, devices, and applications. History has shown that, as technology matures, it fades into the background of a newly augmented reality, instead of leading to virtual realities. But which devices and interaction modalities, if any, will be playing an equally dominant role in this post-desktop scenario as mouse, keyboard, and monitor in today's desktop-centered systems, is just one of the exciting questions to ask as this new ground is explored.

When trying to rapidly prototype new, physical post-desktop user interfaces for such interactive spaces, the problems we encountered have led to the development of the *iStuff* toolkit [1], which facilitates this research activity. As a result, questions such as how to handle inevitable latency in a decentralized user interface, new forms of feedback, and preferred modalities when interacting with media in such environments, have now become tractable.

1.3 Interaction Design Patterns

Finally, on the process level, the increasing momentum in this field calls for new, more efficient ways

to capture, structure, pass on, discuss, and ultimately formalize and standardize the rapidly growing body of knowledge and experience in interaction technologies and techniques with multimedia. One way to express and distribute this kind of knowledge is described in our *Interaction Design Patterns* approach, combining the advantages of existing widely used formats such as general design guidelines, design rationale, and specific style guides.

1.4 Impact

Our prior work has led to results that have put us ahead of the respective research communities. For example, *Personal Orchestra* has been the first and to this day only system to conduct an actual A/V recording (on display in the HOUSE OF MUSIC VIENNA), and *A Pattern Approach To Interaction Design* [3] was the first book on the topic of patterns in HCI, helping to establish an active new research field within HCI.

The Media Computing Group at Aachen builds upon these research accomplishments, and continues to chart new territory in interactive multimedia research, creating a steady flow of research results and publications.

1.5 Industry Collaboration

The method-oriented and systems-oriented research sides of our work have cross-fertilized each other well in the past. Interactive exhibits and similar projects provide a way to ground our research, and offer an excellent framework to make our work visible and significant to a broader audience. We are continuing this double-stranded approach to research in computer science (CS).

These projects have also provided a major source of research funding to support human and other resources above the baseline provided through the academic institution. At the same time, interactive exhibits and similar public systems designed for particular environments offer the advantage of a broader venue while avoiding the administrative overhead of software development for large-scale distribution.

2 The Environment

The space of our research group is located within the Computer Science Department at RWTH Aachen, Germany's top-ranked university according to the German National Research Council (DFG) [5]. It is growing over the next two years, encompassing a total of 400 square meters by 2006, and includes space for individual office workers, a student laboratory, and our central research space, the "Media Space".

2.1 The Laboratory

Students will be able to carry out their Diploma thesis and similar projects in a laboratory space dedicated to development work. Its spatial design and layout emphasizes project-centered, group-based learning and working styles that have proven effective but are underrepresented in a typical academic CS environment.

In its final form, it will feature workstation seating for 24 students, enough to cover a typical lab size, but only with half the number of desktop machines, and seating arrangements in groups of two in front of each machine, to foster team work. The infrastructure (desks, computers, displays; these can partly be laptops) will be mobile and reconfigurable to allow quick restructuring for other scenarios such as a round table or groups of four.

A bench on one side of the space will be dedicated to hardware work, a vital part of many research projects in new multimedia interaction technologies and devices. Another bench will offer digital/analog bridging services needed for media computing such as printing, scanning, etc. The walls will contain one interactive whiteboard per group of four, which can be used to quickly sketch and discuss issues, and directly use the results in a digital format. These interactive whiteboards will be mounted on movable easels with wheels to allow them to also be part of the reconfigurable environment (e.g., moving several side-by-side for panoramic display studies, creating circular setups for 360-degree video work, etc.) Display area becomes a flexible commodity that can be handled easily and configured to fit the research task at hand.

A dense array of retractable ceiling drops provides power and network access so that the desk setup can actually be reconfigured without connectivity problems. They are an advantage over floor box arrays

in terms of ease of cleaning, cable strain, and construction effort since most rooms already have lowered ceilings but not raised floors.

If anything, experience from various interactive room projects, from the Ars Electronica Center KnowledgeNet in 1996, to the Stanford iRoom, the iLounge at KTH Stockholm, and next-generation seminar rooms in Stanford's new Wallenberg Hall, has taught us that "the" right setup for such an augmented-reality environment does not exist. Therefore the environment has to be designed for change, embracing the idea of easy reconfiguration to optimally support a wide variety of tasks that occur in research and learning. Naturally, this is true for both the Laboratory and the Media Space.

2.2 The Media Space

While the laboratory is still essentially computer-centric, the adjoining Media Space will feature a notable non-presence of computers in their traditional form. Instead, it will have the general atmosphere of a relaxed environment that invites collaborative activities. Its primary users are the research group members and senior students working on projects in the group. Typical tasks include interaction with multiple media, but also brainstorming, meeting, and presentation activities.

The space serves several functions: It provides an everyday social space to meet, discuss, and present work. It also serves as a test bed for new developments in multimedia computing done by students and researchers. Finally, it will house a gallery of outstanding projects (such as various interactive exhibits) that can be demonstrated directly in the Media Space, or moved out to external venues (conferences, etc.)

This makes the Media Space not only a crucial "melting pot" providing an integrating theme and focus for the work of the group, but also turns it into an excellent environment to demonstrate our research projects (and possibly those of other interested CS groups) to visiting academic peers and current and future industrial partners. Experience from working at several prior universities has shown that, as project artifacts, these running systems frequently become highly sought after by the institution in order to serve as a showcase during public-relations events and on similar occasions, helping to attract prospective students, researchers, and support from funding agencies and industry, and even to give the institution a more interesting profile among the local community.

The space will feature mobile high-contrast, high-resolution interactive wall displays distributed around the room that can be read conveniently despite daylight conditions, several group tables with built-in displays that can be joined into a large structure, and informal seating in a corner.

It has turned out that pure physical size is not the real advantage of interactive wall displays. They are often used at a distance of .5–3m, a distance at which a typical display such as a 70" SMART Board is physically larger than required (making getting an overview hard from close by) , but lacks resolution—the pixelation becomes clearly visible. In order to actually make use of the display space, higher dpi resolution is required. Recent advances in display technology have made displays in the 150–250dpi range one option, although these have not reached satisfactory display sizes for multi-user collaboration yet. Lightweight large LCD panels in the 40" range currently offer the best tradeoff between resolution and size. Turning such displays into interactive surfaces can be accomplished using external sensor systems (such as the SMART Technologies overlays or e-Beam or Mimio pen input subsystems). Research around the Stanford mural has shown that such displays fundamentally changes the way people interact with them, since the increased real estate influences the patterns of organizing information across the display.

A video conferencing unit links the space to research institutions around the world, fostering the continuation of existing international collaborations with institutions such as the Royal Institute of Technology Stockholm and Stanford University, and the establishment of new research contacts.

Several untethered tablets are available for sketching, browsing, and interacting with multimedia data streams within the Media Space.

A speaker array allows for localizable audio signals at high quality. The array is handled by a room-wide audio server that any machine in the room can access to route its acoustic output to the array. (A diploma thesis on this topic has just been assigned.) Acoustic shielding, using drapery and similar soft materials, is in place so that no equipment operating noise from the infrastructure is noticeable within the space.

The room will feature raised floor and ceiling cable trays to facilitate cabling, installing sensors, cameras,

microphones, and other technology necessary for a multimedia environment. This also improves robustness and safety of the technological setup.

The Media Space distinguishes itself from the Laboratory through the tasks it is designed for. Basic everyday development is not an activity to happen in the Media Space since by definition it hides that technology (no access to multiple keyboards, mice, monitors, CPUs, etc.). The periphery to operate the Media Space machines will instead be outsourced into the Laboratory. While KVM (Keyboard/Video/Mouse) switches that route the input and output to periphery in the Laboratory are one solution to this problem that has the advantage of giving "hard" access to the equipment, we will use software solutions (such as Apple Remote Desktop, Timbuktu, or VNC) that are more elegant, less costly, and easier to maintain and modify.

In the final setup the rooms are adjacent to each other to ensure that the development-oriented work in the Laboratory and the activities in the Media Space evolve in tight coupling with each other. Students can also go to the Lab room in order to access a Media Space machine for administrative tasks. Due to its focus on interactive media, the Media Space and Laboratory will be based on Apple Power Macintosh machines.

2.3 Media Informatics at B-IT

The "Bonn-Aachen International Center for Information Technology" (B-IT) was established in Fall 2002 with support from the B-IT Foundation and the state. It offers M.Sc. programs for selected students in applied IT and summer/winter schools for CS students. The M.Sc. in Media Informatics is a 2-year course starting in Fall and taught in English in Bonn.

In addition to our normal teaching at RWTH, we are offering courses in Multimedia Technology and Human-Computer Interaction in Bonn. Our Aachen Media Space will also be an environment that will attract B-IT students to conduct their final M.Sc. thesis project at Aachen.

3 Summary

In all, the Aachen Media Space is a next-generation augmented space facilitating collaborative activities that include the handling of time-based media such as audio and video. It is part of a larger space design that encompasses the facilities of an entire research group. It will serve as a testbed for new technologies to augment meeting, presentation, design, brainstorming, and other activities, but also as a space used by ourselves every day, and a showcase with frequent external visitors from industry and academia. Consequently, the Aachen Media Space will be highly visibible to the public both inside and outside our university, and provides a good opportunity to showcase modern technology for interactive spaces.

References

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[3] Jan Borchers: *A Pattern Approach to Interaction Design*, John Wiley & Sons, 2001.

[4] Jan Borchers, Eric Lee, Wolfgang Samminger, and Max Mühlhäuser: A real-time audio/video system for interactive conducting, *ACM Multimedia Systems Journal Special Issue on Multimedia Software Engineering*, in print.

[5] Deutsche Forschungsgemeinschaft (DFG): *Förder-Ranking 2003*, published by the DFG, also available online at http://www.dfg.de/en/ranking/institutions/dfg_bewilligungen_3_5.html.