Dagstuhl Seminar 10011: Pervasive Public Displays

The participants of the Dagstuhl Seminar

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Contents

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Chapter 1

Introduction

This Dagstuhl seminar has focused on bringing together researchers from a diverse set of fields of Computer Science to discuss the next generation of pervasive public display environments. The state-of-the-art in software control of display environments is best represented by commercial products that enable advance scheduling of content on a network of displays. Essentially such systems offer a traditional broadcast model based on linear playout of content and offer no support for user recognition or interaction with displays. Other display environments, e.g., in offices or conference centres, might simply run single, isolated applications, such as video conferencing or video players. In addition, current systems typically function as small isolated networks consisting of a limited number of displays under a single management domain (e.g. in a single shopping centre). In this respect, a parallel can be drawn with the state of computing prior to the invention of the Internet - machines were networked together in small clusters to facilitate resource sharing, control and communication but there were no mechanisms for interconnecting these networks.

The focus of the seminar was on future systems designed to be fundamentally different to the current display systems that are being deployed in public, semi-public, and private spaces. Specifically, instead of displays showing linear presentations that have been created and scheduled in advance it is possible to imagine that future displays will be highly interactive and show information personalised to viewers and their context. Such personalization could be achieved by, for example, detecting the proximity of individuals to the display through detection of the presence of a personnel device such as a mobile phone with Bluetooth enabled. Secondly, it is envisaged that these advanced display systems will transition from small, isolated islands to a single global network of interactive displays and associated sensors. Such a platform would enable the removal of the traditional static, tight coupling between display owners and content producers and create a new dynamic system in which display ownership and content production are decoupled. This would, in turn, create the potential for new business models to emerge within the context of a new global communications medium.

The seminar has considered key areas related to next generation display networks including:

- Protocols and Services to Support Next Generation Display Networks
- User Interaction with pervasive displays
- Tensions between privacy and personalisation

- Business and legislative requirements for pervasive display networks

This Dagstuhl seminar presented an unique and exciting opportunity to bring together representatives from these fields with the explicit aim of advancing the state of the art in public display systems. The main goal was to help kickstart international collaborative research and deployments and to begin to define the shape of future display networks. There will be plenty of opportunities for participants to present and discuss their own work as well as participating in discussions. We hope that the seminar has the potential to be noted as the birth-place of new ideas in an area with enormous potential impact in academia, industry and everyday life.

This PDF was created from the open wiki for participants of Dagstuhl Seminar 10011. It was a secured wiki by a password and not shared with other events at Dagstuhl. This PDF tries to summarize the main points in a single PDF, which can be used as a reference to the results of the seminar. **Please note: this document contains many ideas and text fragments (due to the nature of the underlying wiki). Therefore do not expect a fully polished text.** With these words of caution, we hope that you will still find this document useful.

The Participants of Dagstuhl Seminar 1001

Chapter 2

Biographies of Attendees

Florian Alt is a PhD student in the Pervasive Computing and User Interface Engineering Group of Albrecht Schmidt at the University of Duisburg-Essen, Germany. His focus of research is on *context-sensitive advertisements* and *interaction with public displays*. He investigates how pervasive technologies can be used to sense the audience as well as learn the users interests in advertising environment and investigates different interaction techniques with public displays. Further, he is interested in novel advertising spaces such as cars and mobile display systems. Florian earned his diploma in media informatics from the University of Munich in 2007. He completed his master thesis at the Fraunhofer Institute for Intelligent Analysis and Information Systems; the topic was An Annotation Platform for the WWW. During and after his studies he worked for Pinnacle Systems Inc. and Schreiner MediPharm LP in the United States.

Keith Cheverst is a Senior Lecturer in the Computing Department at Lancaster University. His research over the last decade has focussed on exploring the obdurate problems associated with the user-centred design of interactive systems in complex or semi-wild settings and the deployment and longitudinal study of these systems in order to gain insights into issues of adoption and appropriation by users. Keith has been principle investigator on a number of projects which have exploited the use of technology probes in sensitive and/or semi-wild settings including workplaces, homes, rural communities and care facilities. Relevant projects include: CASCO, CASIDE and the Digital Care experience project which was part of the EQUATOR IRC.

- main interest: applications, user aspects, design of situated display systems
- likes situated: understand the place and requirements for deployments
- user centered design aspects, can lead to greater acceptability
- adoption and appropriation: usage logs, content analysis
- applications: supporting collaborations of communities and workers, support for connectedness

Chi Tai Dang is a PhD student at Augsburg University, Germany in the group of Elisabeth Andre. His research interests are user interaction and user interface design on interactive surfaces, such as multi-touch interaction on horizontal direct-touch tabletops or small mobile surfaces. He received a masters degree in computer science in 2008 from Ulm University and joined the Lab for Multimedia Concepts and their Applications at Augsburg University afterwards, where he is also working as a research assistant.

Nigel Davies is a professor of computer science and head of department at Lancaster University. He has worked in the area of mobile and ubiquitous computing since 1994 and has published extensively in the field. He has served as program chair for ubicomp and mobisys and is currently chair of the hotmobile steering committee and the new editor in chief of IEEE Pervasive.

Tanja Döring studied computer science and art history at the University of Hamburg (Germany) and the University of Valladolid (Spain). In 2008 she joined the group "Pervasive Computing and User Engineering" at the University of Duisburg-Essen (Germany) as a research assistant and PhD student. Her research interests are in the area of tangible user interfaces and interactive surfaces in work and learning contexts.

Tobias Hesselmann: graduated from Oldenburg University with a diploma in Computer Science in 2007. He is currently working in the intelligent user interfaces group at the OFFIS Institute for IT. His research interests include Interactive Surfaces and Tabletops and Touch-Based interaction. He is currently doing his PhD with Susanne Boll. Visits: HCI conferences (CHI / Tabletop, ...)

Chris Kray studied computer science and AI in Saarbrueken and Berlin, worked on verbalization of navigational instructions, PhD on tailored instructions for mobile devices, Post-doc in Lancaster, worked on relative positioning and spatial relations to make interaction with computers easier, navigational instructions on public indoor displays, Lecturer in Newcastle: how to evaluate public displays, immersive video, formal aspects of information presentation on PD, cross-modal cues on PD, use dynamic signage to guide crowds.

Antonio Krüger studied UG/PG/PhD in Saarbrucken, started out with (non-classical) AI, e.g. automatic abstractions of graphics to communicate certain aspects. Founded smart graphics conference series, also kept working in this area. Then started to work on location/context-aware services in the domain in intelligent user interfaces. First mainly in mobile domain, now also a lot in area of instrumented environments. First professorship in Munster (geoinformatics), now professor/director of innovative retail lab in Saarbrucken - technology for future supermarket, e.g. displays, sensors, etc. Publishes in IUI, UMAP, Ubicomp, Pervasive, HCI conferences

Tsvi Kuflik PhD in information filtering, started work on user modelling, spent a year in Italy with Olivero Stock, Massimo; looking into instrumented environments; today, mainly in-

terested in personalisation in ubicomp, particularly large embedded displays. Visits: UMAP, IUI, UbiComp

Marc Langheinrich is an assistant professor in the Faculty of Informatics at the Universita della Svizzera italiana (USI) in Lugano, Switzerland. Marc received a masters degree (Diplom) in computer science from the University of Bielefeld, Germany, in 1997, and his PhD (Dr. sc.) from the ETH Zurich, Switzerland, in 2005. Before joining USI in September 2008, Marc worked as a researcher at the ETH Zurich, at NEC Research in Tokyo, Japan, and at the University of Washington in Seattle, USA. Marc has published extensively on security and privacy issues in ubiquitous computing, RFID, and the Internet of Things. He has been the program co-chair of the the 5th Intl. Conference on Pervasive Computing (Pervasive 2007), the First Intl. Conference on the Internet of Things (IOT2008), and is the general co-chair of the 11th Intl. Conference on Ubiquitous Computing (Ubicomp 2010).

Alexander De Luca is working as a research assistant and PhD student in the Media Informatics Group at the University of Munich (LMU). He was part of the European IST project DISCREET on privacy respectful service provision in pervasive environments, which ended in February 2008. His main research interest is on private authentication on public terminals. His main publications are on authentication systems for public terminals, their design and evaluation. He also published work on private interaction with public terminals.

Nemanja Memarovic is a PhD student at the Faculty of Informatics at the Universitá della Svizzera italiana (USI) in Lugano, Switzerland under the guidance of professor Marc Langheinrich. He received MSc in Computer Engineering from the Faculty of Technical Sciences at the University of Novi Sad, Serbia in 2007 and MSc in Electrical Engineering from the Electrical and Computer Engineering Department at the University of New Hampshire, USA in 2009. His research interests lie in privacy with Pervasive Public Displays.

Joeg Müller is a postdoc at T-Labs. His research interests are context adaptive digital signage and advertising in pervasive computing. In particular, he is interested how audience measurement (e.g. via cameras) can be used to implement self-optimizing advertising schedules on digital signage (similar to Google AdWords on the Web). In this context, he deployed the iDisplays (with Muenster University) and MobiDiC (with German Telekom) digital signage networks. Joerg studied computer science at the universities of Freiburg and Saarbruecken and worked on user interfaces for hand-held projectors (with Sony), driver workload estimation (with Daimler), and Mind Mapping (FreeMind).

Helder Pinto leads R&D of Ubisign, Portugal, PhD student with Rui Jose (worked on middleware and ubiquitous computing-based interaction models for supporting visitors to public spaces Ubisign provides playback and content management solutions for digital signage. Ubisign has customers in several public and private institutions.

Michael Rohs is a senior research scientist with Deutsche Telekom Laboratories at TU

Berlin. His primary research interests are in pervasive computing and mobile interaction. This includes the integration of physical and virtual aspects of the user's environment, sensor-based mobile interaction, and handheld augmented reality. His research currently focuses on small-display interaction, in particular navigation and visualization techniques for spatially aware displays. An example is using camera phones as magic lenses for large-scale paper maps in order to overlay personalized, up-to-date information. As part of his doctoral dissertation he developed camera-based interaction techniques for mobile devices, like optical flow control for large public displays and a marker recognition system for camera phones that uses device orientation as an input parameter. He has a Ph.D. in Computer Science from ETH Zurich, Switzerland. In 2000 he received a Diplom in computer science from Darmstadt University of Technology, Germany, and in 1998 a Master's degree in Computer Science from the University of Colorado at Boulder, USA.

- mobile devices and mobile interactions, how to uses sensors, how to detect resources (e.g. public displays)
- mobile phones and public displays
- user acceptability (single vs. many displays) addressing scarce attentional resources of users
- how to people behanve in a public setting, what is appropriate
- internet scale of displays will be interesting

Enrico Rukzio is working as an academic fellow and lecturer at the Computing Department at Lancaster University. Enricos research interests are physical mobile interactions and applications as well as context-aware mobile services. Enrico believes that mobile devices which were so far mostly used for interactions between the user and the device itself will more and more be used for interactions with objects in the real world. Currently he works new interaction techniques for projector phones and mobile interactions with floor displays, interactive surfaces and public displays.

Sarah Rutlidge is a second year PhD student at Lancaster University, UK. Supervised by Nigel Davies, she is working within the topic User Appropriation of Public Displays. Her work on the topic so far has been within the context of the e-Campus project - a set of networked displays on the Lancaster University campus. Sarah completed her undergraduate and masters degrees in Computer Science at Lancaster University.

Albrecht Schmidt is a professor for Pervasive Computing and User Interface Engineering at the University of Duisburg-Essen in Germany. Previously he was head of department at the Fraunhofer institute for intelligent information and analysis systems. From 2003 to 2006 he headed the embedded interaction research group at the University of Munich. Albrecht studied in Ulm, Karlsruhe and Lancaster, where he completed his PhD on the topic ubiquitous computing computing in context. His teaching and research interests are in media

informatics and ubiquitous computing, and in particular in the area of user interface engineering. Albrecht enjoys creating new interaction techniques and interfaces technologies for specific environments such as the home or the car. Over recent years he organized several workshops and conferences and served in various committees in pervasive computing community.

Lübomira Spassova studied computer science at Saarland University in Germany and is currently doing her PhD at Prof. Wahlster's group at the same university. At the same time, she is working as a researcher at the Innovative Retail Laboratory of Prof. Krueger. She is doing research in the area of projected displays and is particularly interested in finding interesting scenarios for projected displays in public spaces and in metaphors and techniques for interaction with projected displays.

Frank Steinicke is a senior researcher at the Department of Computer Science at the University of Muenster. He received his Ph.D. (2006) in computer science from the University of Muenster. Currently, Frank Steinicke works as a visiting assistant professor in the Department of Computer Science at the University of Minnesota Duluth. His research interests include human-computer interaction with special consideration on VR, perception and cognition in computer generated environments and visualizations. His research efforts aim on the challenge to provide natural and effective user interfaces for VR-based environments. Frank Steinicke is a principal investigator of several international research grants.

Martin Strohbach is a research scientist at NEC Laboratories Europe (NLE) in Heidelberg, Germany. Since 2008 he is leading a research project on Pervasive Display Networks that focuses on advancing existing Digital Signage solutions with context information and real-time audience measurement data. Martin received his Dipl.-Inf. (MSc in Computer Science) from University of Karlsruhe in 2001. After that, he worked as a research associate at Lancaster University, UK and contributed to research on the Internet of Things by developing context-aware services offered by wireless sensor networks and smart, physical objects. He received his PhD from Lancaster University in November 2006. As part of his PhD he developed a framework for physical everyday objects that use P2P rule-based reasoning to detect situations in their environment. In July 2006, Martin joined NLE as a Research Scientist. As part of the EU project SPICE, he has been responsible for the development of a novel context management systems targeted at large scale network operator environments. Since 2008 he is also contributing his expertise on context management systems to the SENSEI project that seeks to integrate existing sensor and actuator islands in a global framework. In particular he is responsible for developing an actuation framework and architectural support for quality of information and actuation. Martin has also significantly contributed to several other European, national and company internal research projects. He has published in key international conferences and workshops has been active as peer reviewer and program committee member and chair for several conferences and workshops.

- context management middleware for local and wide area networks
- platforms for networked displays

Axel Sylverster is currently working as an internet consultant. He received his degree (Diplom-Wirtschaftinformatik) from the University of Hamburg. He is interestet in novel User Interaction and the technique behind.

Lucia Terrenghi is a designer and a researcher working in the field of Human-Computer Interaction. Her interests address the relationship between humans and technologies and the ways in which technological artifacts can enhance social engagement, self-expression, and creativity. Since March 2008 she has worked as researcher and interaction designer at Vodafone Group R&D in Munich, where she investigates concepts for cross-platform user interfaces and the ways in which expressive interaction techniques can enhance inclusivity and sustainability. Prior to that, she worked for three years as research assistant at the Ludwig-Maximilians-Universitaet Muenchen, in Germany, where she attained with honor her PhD in Computer Sciences, in December 2007. In that context, her research developed in the setting of the FLUIDUM project (www.fluidum.org), which explores techniques for interacting with ubiquitous computing technologies, in settings of everyday life. In the past, she also worked as intern at Microsoft Research Cambridge, and her research on direct touch interfaces was co-advised by Abigail Sellen and Bill Buxton. Prior to that, she worked for two years as researcher and user interface designer at the Fraunhofer FIT, Institute for Applied Information Technologies, in Sankt Augustin, Germany. Prior to that, she worked as brand designer for the Organizing Committee of the XX Olympic Winter Games Torino 2006, in Italy. Lucia also holds a Master of Science in Industrial Design, which she gained with honor in 2000 at the Politecnico di Milano, in Italy.

Massimo Zancanaro is the head of the i3Intelligent Interfaces and Interaction research unit at FBK-irst. His primary research interest is in the area of collaborative interfaces. At present, he works on some projects involving multi-touch and multi-user tabletop devices in educational setting and for ambient-assisted living. He is also interested in automatic behavior analysis, that is, how the computer can recognize who you are and what you are doing. He is thinks that in the field of pervasive displays he can combine the two things together.

Chapter 3

Attendees Project List

This section lists the projects that participants of the **10011** Dagstuhl Seminar have been involved in.

3.1 The e-campus Project

The e-campus Project The e-Campus project is a major multi-year project investigating the creation of an open public display network. The project began in 2004 and has since created a a deployment of over 100 public displays at Lancaster that has been explicitly built as a research testbed for work on public display systems. The system includes support for interaction with displays using mobile devices.

- Timeframe: 2004-2008
- More info: http://ecampus.lancs.ac.uk/
- Selected Publications
  - Storz, O., A. Friday, N. Davies, J. Finney, C. Sas, and J. Sheridan, Public ubiquitous computing systems: Lessons from the e-campus display deployments, IEEE Pervasive Computing, 05(3):40-47, 2006.

3.2 CASCO and CASIDE Projects

The CASCO and CASIDE Projects includes work on the Wray village photo display and Hermes digital door displays and asscoiated photo displays. Projects had an emphasis on user centered design and technology probe approaches coupled with longitudinal usage studies.

- Timeframe: 2001-2009
- More info: http://www.caside.lancs.ac.uk/
- Selected Publications
  - Taylor, N. and Cheverst, K. Social Interaction around a Rural Community Photo Display, to appear in International Journal of Human-Computer Studies special issue on Collocated Social Practices Surrounding Photos, 67, pp. 1037-1047, 2009

– Cheverst, K., Dix, A., Fitton, D. and Rouncefield, M. 'Out To Lunch': Exploring the Sharing of Personal Context through Office Door Displays, in Proc. of International Conference of the Australian Computer-Human Interaction Special Interest Group (OzCHI03), pp. 74-83, ISBN 1-8649-9738-9. November 2003

3.3 PD-NEt

PD-NET is a new project starting in spring 2010 and funded under the EU FET-OPEN programme. It involves Lancaster University, University of Duisburg-Essen, University of Lugano and University of Mino. The PD-NET project aims to lay the scientific foundations for a new form of communications me-dium with the same potential impact on society as radio, television and the Internet. The goal is to explore the scientific challenges and to assess the new technologies required to enable the emer-gence of large scale networks of pervasive public displays and associated sensors. This display net-work will be designed and implemented to be open to applications and content from many sources and thus provide the foundation for work on a new global communications medium for information access and interaction.

- Timeframe: 2010-2012 (30 months)
- More info: n/a

3.4 Public Display Research at DFKI

Product Associated Displays: projected displays that appear at locations which can easily be associated with the corresponding objects they show information about. See PADs publication

- Beam-Its: virtual sticky notes created on a PDA and projected in an instrumented environment. See Beam-Its publication
- SearchLight: a search function for pervasive environments using visual markers (AR-ToolKit) for the identification of objects and a projected spot as visual feedback. See SearchLight publication
- Virtual Room Inhabitant: projected virtual character moving along the surfaces of an instrumented environment, acting as an assistant. See VRI publication

3.5 IMUTS

The goal of this project is to develop strategies for multi-touch interaction with 3D geo-data on stereoscopic projection surfaces. Projected is funded by the DFG and performed in collaboration with the IRL of the DFKI in Saarbruecken and the University of Muenster

- Timeframe: 2009-2011
- More info: webpage
- Selected Publications:

– J. Schoning, F. Steinicke, D. Valkov, A. Kruger, and K. H. Hinrichs. Bimanual interaction with interscopic multi-touch surfaces. In Proceedings of 12th IFIP TC13 Conference in Human-Computer Interaction (INTERACT), Lecture Notes in Computer Science (LNCS), pages 40-53. Springer-Verlag, 2009.

3.6 Public Display Research at the University of Muenster

- **MobiDiC** is a display network in the city center of Munster which shows adverts for small local shops and measures the advertising effectiveness with coupons. See: Muller, Jorg & Kruger, Antonio (2009): MobiDiC: Context Adaptive Digital Signage with Coupons. European Conference on Ambient Intelligence, Salzburg, 2009.
- **iDisplays** (See iDisplay) is a display network at the university of Munster which shows information that students can take action upon, as well as data from local and remote sensors. See Muller, Jorg & Paczkowski, Oliver & Kruger, Antonio (2007): Situated Public News & Reminder Displays. Proceedings of European Conference on Ambient Intelligence 2007, Darmstadt
- **ReflectiveSigns** (running on the iDisplays network) measure audience attention towards content with cameras+face detection and schedule for each context (time, location) the content that is expected to attract maximum audience attention. See Muller, Jorg & Exeler, Juliane & Buzeck, Markus & Kruger, Antonio (2009): ReflectiveSigns: Digital Signs that Adapt to Audience Attention. Proceedings of Pervasive 2009, Nara, 2009.
- **Responsive Signage** measures the audience behaviour with sensors and responds immediately to it.
- **LOCUI** (Frank) The objective of this project is to develop omni-directional locomotion user interfaces for immersive virtual environments based on redirected walking. Projected is funded by the DFG and performed in collaboration with the Psychology Department in Munster.
- **AVIGLE** (Frank) In this project Avionic Digital Service Platforms will be developed. It is a joint project with 13 cooperation partners from industry and research funded by Federal Ministry of Economics and Technology. The objective is to develop Micro Unmanned Aerial Vehicles (MUAVs), which are equipped with cameras. Our responsibility in this project is to generate a virtual 3D model based on the real-time data of the MUAVs.
- virtual globes on interactive surfaces (Toni) - NASA worldwind on FTIR surface
- Innovative Retail Lab (Toni) - Innovative retail Laboratory

3.7 Public Display Research at the University of Duisburg-Essen

- **CADET-Context aware ADvertising EnvironmenT**[1] (Florian): In this project we explore how to adapt content to the users based on profiles. We further look into how

people interact with public displays (explicitly via a mobile application vs. implicitly via sensing BT devices in the vicinity)

- Selected publications:
  - Florian Alt, Moritz Balz, Stefanie Kristes, Alireza Sahami Shirazi, Julian Mennenoh, Albrecht Schmidt, Hendrik Schroder and Michael Goedicke: Adaptive User Profiles in Pervasive Advertising Environments. In: Proceedings of the 3rd European Conference on Ambient Intelligence (AmI '09). Springer Berlin / Heidelberg., Salzburg, Austria 2009.

- **Mobile Contextual Displays [2] / TaxiMedia [3]**(Florian): These student projects focus on how content can be adapted based on a displays (frequently changing) context (location, weather, people in the vicinity). Examples / Prototypes include displays integrated in backpacks, t-shirts, or cars.

- Selected publications:
  - Florian Alt, Albrecht Schmidt, Christoph Evers: Mobile Contextual Displays. In: Pervasive Advertising Workshop @ Pervasive 2009. Nara, Japan 2009.
  - Florian Alt, Alireza Sahami Shirazi, Max Pfeiffer, Paul Holleis, Albrecht Schmidt: TaxiMedia: An Interactive Context-Aware Entertainment and Advertising System (Workshop). In: 2nd Pervasive Advertising Workshop @ Informatik 2009. Lubeck, Germany 2009.
  - Florian Alt, Christoph Evers, Albrecht Schmidt: Users' View on Car Advertisements. In: Proceedings of the Seventh International Conference on Pervasive Computing, Pervasive'09. Springer Berlin / Heidelberg, Nara, Japan 2009.

- **Interaction with public Displays** (Albrecht) (Student Projects). In a set of students projects we explore new ways of interacting with public displays. This includes explicit interaction with devices (e.g. mobile phones) or implicit interaction (e.g. by walking by).

- Analysis and Design of Content for Interactive Kiosk Systems on Campus: online survey about students preferences on content (Student Project)

3.8 Public Display Research at Vodafone

- **UK-INDIA Network on Interactive Technologies for the End Users**[4], is an academic-industrial network where Vodafone R&D as well as the University of Lancaster are partners. Throughout the collaboration of UK and India researchers in the field of HCI, the idea is to further explore the potential of combining mobile and public displays for broadening users'interaction possibilities in different domains.

- **SmartSpace** is a research project at Vodafone R&D which focuses on cross-platform collaborative interfaces, enabling real-time collaboration of co-located as well as remote users. It builds on an interactive room where wall displays and a tabletop are installed: such as an environment serves as a platform for developing and exploring collaborative applications, co-working with several Universities with expertise on this topic (e.g., Fachochscule Hagenberg, Fachochscule Augsburg)

- **Second Screen** is a development at Vodafone R&D which demosntrates how multiple windows of a browser can be visualized and controlled across different displays (e.g., controlling a photo slide show of a web-based collection from a mobile device, which is connected via UWB to a peripheral display). It applies a cloud-based architecture.

- **Multi-user games with public displays** (Student project, Lucia with the Fachochscule of Medien Gestaltung Augsburg): in the project a game was designed, using public displays in different subway stations as playground for multiple players, who interact with their smart phones as remote controllers.

- **Comparative evaluation of interaction techniques for mobile-large display coupling** (student project, Lucia with University of Dublin)

3.9 Public Display Research at LMU Munich

- Fluidum (Lucia) - pervasive display interaction

- Discreet (Alex) - discreet service provision in smart environments

- Perci (Alex) - pervasive service interaction

3.10 Public Display Research at Newcastle University

- SaveME (Chris) - EU project focussed on evacuation in the context of tunnels/transportation hubs, uses public displays to help people evacuate

- interactive display artefacts for kids (Chris) - encourage children to engage with literature in the Seven Stories Museum

- Alternate Reality Experience Middlesborough (Chris) - use really large display near NEMA with scanner beacon to facilitate city-wide alternate reality game/experience/artwork

- Navigation/task support for large, diverse crowds (Chris) - support large numbers of people in performing their (individual) tasks and in navigating (without requiring them to carry/use any mobile device)

3.11 Public Display Research at NEC Laboratories Europe

- Pervasive Display Networks (PDN) - Platform for context-aware digital signage facilitating semantic integration of heterogeneous sensing technologies for real-time content adaptation. Also investigates the idea of a Digital Signage AppStore and managing applications that span multiple displays

  – M. Strohbach, E. Kovacs, M. Martin: Towards Pervasively Adapting Display Networks, in Proceedings of 1st International Workshop on Pervasive Advertising, in conjunction with Pervasive 2009, Nara Japan

- OPEN - Open Pervasive Environments for migratory iNteractive services. Develops a platform for migratory services, e.g. services and applications can be migrated from mobile phones to public displays and back.

3.12 Further Projects by Dagstuhl Participants

- **Augmented Caffe Table** at the museum at FBK. A tabletop system that tries to induce people to talk about their museum experience while at the cafeteria (http://itch.fbk.eu/activities/ta

- RAFT - Remote Accessible Field Trips (Lucia) - pervasive learning experiences interatcing with multiple devices

- SENSEI Scalable integration of globally distributed sensor and actuator networks including public displays. See for instance the scenarios (Martin).

- PIL (Personal Acces with Active Cultural Heritage - PEACH (Tsvi) Israeli-Italian research project that focused on building an "Active Museum" a museum visitors guide system providing context aware information and communication services to groups and individuals in a museum setting. Ways of interaction with large displays in cultural heritage visits...

- ubiSign (Helder) - commercial display network system (includes content management and delivery)

- campus-wide content and network of pervasive displays management system (Tsvi) - needs better name but says it all

- Room 9 3/4 (Tobias) - connecting two rooms at two different sites

- **Interactive illuminated portal** (Axel) The customers and employees of an e-business company should get a subtle positive feeling and associate this kind of entrance to an innovative image of the company. This was achieved by recognising the person and changing the ambience (rgb-lighning , sound) of the hallway.

- **Visualisation of sociotechnical processes** (Axel) The focus of this project was to identify and visualise the needs of heterogeneous stakeholders and the reinforcement of their action through the use of computer systems.

3.13 External Projects

- **Always take the stairs** (that is, how to convince people not to use elevators): http://www.yankodesign take-the-stairs/

- Ubiquitous Sensor Portals: a sensor network that functions as portals between remote locations to convey social cues and sensor information amongst locations, http://www.media.mit.edu/rese

Chapter 4

List of Publications

4.1 Suggested Reading List In Public Displays

Books

- Kenton O'Hara, Mark Perry, Elizabeth Churchill, Dan Russell. **Public and Situated Displays: Social and Interactional Aspects of Shared Display Technologies**. Kluwer Academic, 2003

Interaction with Displays

- Rui Jose, Nuno Otero, Shahram Izadi, and Richard Harper. **Instant places: Using bluetooth for situated interaction in public displays.** IEEE Pervasive Computing, 7(4):52-57, 2008.

- O. Stock, M. Zancanaro, P. Busetta, C. Callaway, A. Krueger, M. Kruppa, T. Kuflik, E. Not and C. Rocchi: **Adaptive, Intelligent Presentation of Information for the Museum Visitor in PEACH.** User modeling and User Adapted Interaction Vol. 17 (3), pp. 257-304, 2007.

- Mark Perry, Kenton O'Hara: **Display-Based Activity in the Workplace**. Proc. of INTERACT 2003

Social Issues

- Huang, E. M., Koster, A., Borchers, J., **Overcoming assumptions and uncovering practices: When does the public really look at public displays?** To appear in the Proceedings of the Sixth International Conference on Pervasive Computing. Sydney, Australia (2008)

- Huang, E. M. and Mynatt, E. D. 2003. **Semi-public displays for small, co-located groups.** In Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (Ft. Lauderdale, Florida, USA, April 05 - 10, 2003). CHI '03. ACM, New York, NY, pp. 49-56, 2003

- Harry Brignull, Yvonne Rogers: **Enticing people to interact with large public displays in public spaces**. Proc. of INTERACT 2003

- Saul Greenberg, Michael Boyle and Jason Laberge. **PDAs and shared public displays: Making personal information public, and public information personal.** Personal Technologies, 3, 1 (March), 1999. See http://www.springerlink.com/content/m6j67n5244l2711

Experience Reports

- Storz, O., A. Friday, N. Davies, J. Finney, C. Sas, and J. Sheridan, **Public ubiquitous computing systems: Lessons from the e-campus display deployments**, IEEE Pervasive Computing, 05(3):40-47, 2006.

Systems and Implementations

- Storz, O., **A Distributed Systems Infrastructure for Open Public Display Research Networks**, PhD Thesis, Lancaster University, 2008.

- Storz, O., A. Friday, and N. Davies, **Supporting content scheduling on situated public displays**, Computers & Graphics, 30(5):681-691, 2006.

Content and content distribution

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Chapter 5

Dimensions to describe Public Displays

5.1 Display Size

5.1.1 Traditional Displays

- can easily be joined or extended vs. format cannot be changed
- any size
- fixed format, e.g., newspaper, poster (DIN / ISO)
- Shapes
  - curvy displays
  - normally rectangular
- virtually unlimited (extendability)

5.1.2 Digital Displays

- less trivial to seamlessly join (display frame)
- any size
- limited (not extendable) vs. size can be changed (for projected displays)
- the larger the more noticed / size matters
- maybe different shapes possible in the future
- pixel size matters
- much more variable, but difficult for content producers (no standard formats / ratios)
- scalability (better?)

5.2 What is a Display

General definition

- if it delivers information then it is a display
- a digital display, literaly, is when the information displayed is stored in digital format (?)
  - is the distinction *digital* vs. *traditional* meaningful?

Traditional Displays

- something that presents static information
  - posters, photos, sign posts, billboards, bus schedule, exit signs, traffic lights
  - is a clock or a train schedule a traditional display?
- can any object be a display under some circustamnces (for example in a show window)

- mostly visual content (?)

Digital Displays

- something that is capable of presenting dynamic information
- not only visual: multimodal, possibily all senses

Open questions

- what is the difference between *display* and *device*
- there is a set of modalities that act as display, should we focus on some of them as a research community?

5.3 Update Rate

correlation between update rate and resource expense (e.g. energy) **Traditional Displays**

- mode of operation: manually and locally -> more restricted
- at the moment lower

Digital Displays

- mode of operation: automatically and remotely -> more flexibility
- depends on technology and resources
- at the moment higher

5.4 Display Technology

Traditional Displays

- Fluorescent tubes
- Materials: Paper / stone / wood (carvings) / glass / plastic / metal / liquids
- Physical / Tangible / Tactile
- nice in sunlight
- unpowered
- Billboards
- needs manual interaction for visibility control
- LED
- rotating signs
- environmental friendly

- printable / paintable
- analogue
- continuity of actions
- uniqueness of physical artifacts

Digital Displays

- ePaper
- OLED
- Plasm
- LCD
- front / rear projection
- retina projection
- LED
- light, power, electricity
- (visibility) can be remotely controlled
- wearable displays
- projection over variety of surfaces
- sound
- vibration
- odor
- sensing vicinity, integrated sensors
- mobile displays
- physical reconfiguration
- depends on modalities and interaction techniques
- power consumption
- digital content
- plants that grow or die
- dangling string
- digital, infinite multiplication of copies
- cheap reproduction of content

5.5 Means for Interaction

Traditional displays

- interaction is obvious
- none/passive?
- writing
- reading
- erasing
- using post-its
- physical interaction
  - scratching
  - touching?
  - turning a page (e.g. newspaper), flip-book
  - kicking
  - bending it
  - ripping off parts of it (this probably wouldn't work with a digital display unless it will regrow)
  - rotating/turning it
- use embedded markers/image recognition on phone/overlay
- looking/staring
- shining a light onto it

Digital displays

- interaction may be not always obvious
- all means applicable to traditional displays plus:
- body-based interaction:
  - whole body interaction
  - gestures
  - presence/proximity
  - shouting at it
- device-based interaction
  - mobile phone (e.g. camera, RFID, Bluetooth, etc.)
  - keyboard, mouse

  - other devices (e.g. RFID-tag, camera, media-player, laptop)
- shadows
- multi-touch
- throwing things at it
- mood recognition

5.6 Physical Location of Displays

Traditional and Physical Displays

- outdoor vs. indoor
- office hallway
- train stations
- airports
- launderette
- nice spaces
- museums
- shopping malls
- city centers
- shop windows

Traditional Displays

- everywhere, ubiquitous
- dirty street corners
- on building facades
- floor/street drawings and markings ("look right", speed limits, mainly outdoors)
- ceiling
- supermarkets
- public transportation (trains, busses)
- decision points in the wilderness (navigation, hidden?)
- on vehicles (busses, cars, trains)
- shirts, clothing, scarfs, backpacks

- trash bins
- rural places
- developing countries (no need for infrastructure)
- movable signage, tent cards, flexible position

Digital Displays

- more careful selection (expensive hardware)
- physical protection (casings, physical inaccessibility, technology choice: projection)
- on building facades (projection, "festival of lights", blinkenlights: pong, xmas tree)
- in furniture (embedded in furniture)
- floor projection (mainly indoors)
- dynamic areas (body shadows, dynamic interaction of content with people)
- technical constraints of outside deployment (readability in sunlight and low-light conditions, temperature, humidity, needs power)

Observations

- traditional displays are really ubiquitous, while digital displays are much more constrained
- constraints: power, readability, reliability, movability

5.7 Purpose of Displays

Traditional displays:

- Providing information
- Instructing
- Advertisement (personal, social)
- Announcemnts (Looking for lost/mising items/persons, political campaigns, looking for people with shared inetersts)
- Warnings (safety, security, norms)
- Art
- Sybolized "old fashioned"

Digital Displays:

- Engage and Motivate

- Provoke interaction
- Connection with personal devices
- Advertisement
- Annoying
- Interactive art
- Collaboration
- Symbolize innovation

It seems that the differences can be viewed along several dimensions:

- Interactivity - from low on traditional displays to high with digital displays
- Engagement - from low on traditional displays to high with digital displays
- Specific purpose - from high on traditional displays to low with digital displays

5.8 Business Model of Displays

See Etherpad: http://etherpad.com/d7oQ2tpOec **Traditional**

- "Stadtmöblierung" – using ads to pay for public toilets, bus waiting halls, info boxes (e.g., see http://www.stroeer.de/Stadtmoeblierung.297.0.html or http://www.jcdecaux.de/stadtmoeblie
- Rental Billboards
- Cheap upfront deployment costs, higher update costs (changing content is expensive)
- Higher mechanical production cost of individual display item (printing, montage)
- Relatively robust
- Large city advertising: quasi-monopoly by J.C.Decaux
- Display space rented out on a weekly/daily basis, long-term planning
- Typically relativeyl regulated

Digital

- High upfront deployment costs, low update costs (changing content is cheap)
- Maintenance costs? Cleansing, inspection, repair, recycling...
- Content production involves interactive components
- Not just ads, but what else could it be?
- Display space rented out dynamically, can be on short notice

- Indiviudal owners rent out their displays
- What about business models for displays at home?
- How to involve individuals in the busines?
- Measuring "Click-through"?
- Can support changing business models on demand
- Still in evolution: platform provider vs. content provider vs. service provider vs. hardware owner. Value chain?

5.9 Ownership of Displays

Traditional Displays:

- Institutional (governement, company, community)
- Private (personal, family, company)
- Unknown (graffiti)

Digital Displays:

- Institutional (governement, company, community)
- Private (personal, family, company)
- Content providers

Ownership may have the following dimensions:

```
* Ownership of the hardware and the infrastructure
* Ownership of the presentation space (advertisement agency for instance)
* Content proividers (that rented a certain space in specific displays)
```

5.10 Control over Displays

Traditional Displays

- Access
- Direct - proximity
- Physical control - control of the hardware = control of content
- Control/modification through replacement - most traditional displays follow a disposable model

Digital Displays

- Potential for remote control
- Software control - Control of the hardware not the same as control of content
- High flexibility/change

5.11 Impact on People

- Traditional
  - Typically more subtle, less annoying
  - Asthetically pleasing (calm design)
  - Can be fun(ny)
  - Static content less helpful
  - Static content less visible (short glimpse)
  - Hurt more if Billboard falls on people's heads:-)
- Digital
  - Attention grabber (moving stuff)
  - Can be interactive, reactive
  - Can be more timely
  - Engaging, fun
  - Community building
  - Distracting, annyoing, offensive (moving stuff)
  - Hurt more if LCD falls on people's heads:-)

Etherpad: http://etherpad.com/d7oQ2tpOec

5.12 Regulations and Conventions

Traditional Displays

- There are important signs(emergency etc) where the authorities want that they are working all the time.
- There are strict, established, well-defined regulations on traditional displays (local laws)
- No flexibility to change the content depending on context (e.g. no public alcohol advertisement if children are looking at the display).
- Handcrafted posters are subject little regulation.
- You are not allowed to put up a sign wherever you want.

Digital Displays

- Asks for more regulation as there is a tendency for more annoyance (e.g. distracting people on motorways if there is animated contend displayed).
- For the present there is a lack of regulations. Might require ad-hoc regulations if new situations occur.

- Flexibility to change the content depending on the person looking at the display (or the location of the display or the time) and thus respect regulations.
- Social interaction conventions (e.g. Multiuser interaction, shared control, it is my turn).
- Need for audit trails.
- Privacy issues / personal rights; endless possibilities of misuse.
- Ensure perception of important informations (e.g. ensure that it is displayed long enough to be read by people).

5.13 Display Modalities

Traditional Displays

- Mostly visual (lights, panels)
- Generally static (content, shape, form, number/type of modalities)

Digital Displays

- Potentially greater number/all modalities
- Brain display interface!
- Dynamic combination of modalities

Is there a requirement for visual stimulus? - E.g. what about lift music?

5.14 Beauty of Displays

Traditional displays

- patina (e.g. wood sign)
- hand crafted
- shared experience, awareness of persistent content
- functional
- people can have emotional bounds to them
- crude
- low update values and aging and irreversible changes
- graphics design
- is in the eye of the beholder:-)

Digital displays

- digital art
- engaging
- dynamism of content. Possibility of showing motion/animation.
- interactivity
- content
- limited in design for making beautiful displays
- May be crappy, can be changed anytime like software
- may be "colder". Should be nice and aesthetic.
- form follows function
- more possibilities, art/design wise
- user contributed / user interaction possible
- is in the eye of the beholder:-)

5.15 Form factor of displays

Traditional Displays Form Type

- Column
- Citylight
- Blow-Up figure
- Billboard
- Poster
- Clothes
- Flourescent Tubes
- Waterfall displays
- Cylindrical
- Dangling from the ceiling

Other

- Constrained by physical properties

- Physical / tangible objects
- Arbitrary shapes
- Static form
- Bendable

Digital Displays Form Type

- Flat
- Squared
- Landscape / Portrait
- Any form, e.g. projection
- Umbrella
- Roof
- Whistle
- Large Wall
- Single LED
- 3D arrangements of nanobots
- Cylindrical

Other

- Wearable
- Embedded in everyday objects (situated)
- Bendable
- Can be adapted

5.16 Security and Privacy

Traditional Displays

Privacy

- Non personizeable, no profiles possible, same content for everyone, cannot be used for private purposes
- Privacy only possible if viewer is not seeable by others

Security

- Easier to control (s.b. must have physical access)

- Vandalism-Proof
- Location important (proof against fire, wind, water)

Related to Both

- Not a big issue, danger (5x)
- Explicit interaction, content creation

Digital Displays
Privacy

- Personizeable content, privacy invasive
- Can be used for private purposes
- People don't want to show personal stuff on shared displays
- Implicit (possibly hidden) content creation
- "Plausible denyability"
- Using optical filter technologies
- Avoid personalization
- Distribute between private and public displays to maintain privacy

Security

- Bombproof displays
- Vandalism
  - Vandalism is expensive
  - Hard to detect damaged screens
- Everything digital can be hacked

Related to Both

- Problematic
- Depends on sensors applied
- Context-sensitivity, regulations
- Harder to control (SW)

5.17 Hackability

5.18 Entertainment

Traditional:

- limited / static
- might be more authentic
- more mature guidelines for design

Digital:

- could lead to annoyance/stress
- possible higher entertainment value
- dynamic: movies, sounds etc.
- interactivity
- multi-user interaction / engagement
- higher novelty factor
- faster innovation cycle

5.19 Collaboration of Displays

Multidisplay settings in which displays react to or influence each other.

Traditional:

- latency:
  - longer update cycle and preparation phases
  - displays cannot react to each other as quickly
  - doesn't enable spontaneous interaction
- manual

Digital:

- low latency:
  - enables spontaneous/ad-hoc interaction
- automatic
- can offload content to nearby displays
- communication protocols

5.20 Resolution

5.21 Misuse

Traditional Displays

- Physical tampering: cutting, burning, scratching, chewing gum, spraying, tear (a pure physical result)
- Appropriating the display surface: graffiti, replacing content, scratching, spraying (a symbolic result)
- Motivation: vandalism vs expression, propaganda, misleading people, advertising, embarrasing people,

Misuse of Access rights (e.g. breaking a lock of a message board)
Digital Displays

- Physical tampering: covering the display, changing physical property of pixels, laser & lights, theft, provoking bluescreen
- Anti-tampering measurements: in case of tampering remove content underneath the tampered area, change access control quickly
- Appropriating the display surface: hacking, replacing content, greater oppurtunity for misuse in dynamic situations (e.g. coordinating criminal activities), flash mobs
- Motivation: less if greater mediation of content provided through digital form

Chapter 6

Scenarios

6.1 Florian Alt's Scenario

After a stressful day, Steve on his way back home when he sees an interesting advertisment on the train. An electronic store in his hometown is offering a cheap point-and-shoot camera which certainly is a fast seller and expected to be sold out quickly. The store is not exactly on Steve's way but requires a 30 minute detour. Since Steve is tired he does not want to waste half an hour for nothing and decides to post a message via the PDN (Pervasive Display Network). In the post he asks if somebody could tell him how many of the items are left in the store.

The PDN consists of hundreds of static and mobile location-aware displays, such as display-augmented backpacks, t-shirts, etc. Once the network receives Steve's message it distributes the request to a bunch of mobile displays situated in close proximity of the electronic store.

Rick, currently queuing at the cashier in the electronic market sees Steve's request. He takes our his cell phone and provides the requested information. In return he receives a small discount on his purchase.

6.2 Chi-Tai Dang's Scenario

Some day in future, the floors within airports are public displays and assist customers in terms of getting to the right terminal, finding a nearby bathroom or smoker cabin (if there is one at all). Let's say Alice gets into the airport and has already got a ticket some days before. This ticket is her private flexible display as well (even if we don't use it in this scenario), which identifies her to the airport system wirelessly.

After Alice entered the airport, the interactive public display system shows her in front of her on the floor how much time she has until the flight departs. It also has noticed that she's been late and she should hurry to catch the flight. Therefore she gets that information in a gently way through the public display and the airport system invites her to move quickly to the terminal through showing her blinking arrows on the floor that guide her directly to the right terminal. While she's walking to the terminal, the airport system calculates ETA and provides Alice with that information. Because Alice isn't that fast at walking the system notices that she will not arrive in time and negotiates with the boading team to delay the departure. Meanwhile the ETA vanished from the floor display for Alice and indicates that she still can catch the flight...

6.3 Alexander De Luca's Scenario

6.3.1 The lazy, straight forwards scenario

Alice arrives at Saarbruecken main station and wants to find her way to Karstadt City where she is supposed to meet a friend. Since she is not familiar with the city at all, she goes to an info map, which is located outside of the station. The info map is actually a pervasive display, which allows her to interactively search for the location of her destination. Once she found the place, she confirms it and synchronizes the display with her mobile device.

The phone automatically connects with all public displays in its vicinity. Now that the destination is uploaded to her phone, the mobile device controls the displays in her vicinity to inform her about the fastest way to the shopping mall.

6.3.2 The (over-)caring mother

Bob's mother loves her boy. She loves him so much that she always needs(!!!11one) to know where he is and what he is doing. Since he is still underage, she subscribed to the AMS (annoying mother service), which costs her around 10 Euros per month.

AMS (some call it PMS) provides a network of pervasive displays all over Germany. There is basically no space in any German city that is not covered with AMS displays. Even everyday objects like doorknobs, trash cans and the like can be used as displays. So whenever her soon is out without her, she tracks him with the AMS service and keeps on sending messages to him.

So one evening, Bob is out in a bar with Alice. He is into her for 2 years already and wants to ask her to become his girlfriend. When Bob finally finds the courage to ask her, taking a last sip from his coke. Just in that moment, a message pops up on his glass. The message is sent by his mother and displays reads: "Bob, I think u forgot to wear your long underwear. It is cold outside and I know how sensitive you are to this weather. I love my little poo-monkey. Kisses, your mother.≪≪

He never asked Alice out again.

6.4 Tanja Doering's Scenario

The single mother Anne and her four year old daughter Emily are sitting at the kitchen table of her apartment. From her seat, Anne glances through the window to the neighborhood community display that had been integrated into the canopied courtyard, when they built the house two years ago. She sees, that it is almost 8 o'clock É soon time to leaveÉ the clock looks funny this morning, the teenager boy from above must have designed the new skin, with all the punk symbols. The display also shows the current temperatureÉ 4 degrees Celsius ... brr too cold ... and the display also suggests to take an umbrella ... it might rain this afternoon. Anne sighs. How nice would it be to be in Australia now, like Sarah, the girl from next door, who is traveling for half a year there now and from time to time sends pictures to the neighborhood community display. Her pictures bring some sun into our courtyard! By the way ... that thought reminds Anne that she promised Emily to upload her drawing from yesterday afternoon to the display. And she also wanted to add the event dates from her knitting club to the news area .... Anne really likes living in this place, as all the housemates build a real community with the courtyard as shared social place with playground, bookshelves, get-together tables and the neighborhood community display.

6.5 Tobias Hesselmann's Scenario: Cloths Store of 2010

Linda goes shopping for clothes. She enters a clothes store and is identified by her mobile phone. Her former shopping tours were recorded and are used to present other items that may be interesting for her on lifesize displays in the store. Linda is interested in one of the presented shirts and walks up to the display to access more information about the shown item. She touches the shirt on the screen and gets information about material, available colours and matching accessories. She wants to take a look at the real thing and activates a navigation function. Projectors in the store are used to guide her to the shirt in a subtle way, e.g. by projecting a light arrow on on the floor / on the cealing, following her as she

moves. She finds the shirt and tries it on in a changing room. She is quite satisfied with the shirt, but finds that she doesn't own some matching pants. She steps in front of a mirror with her new shirt. She touches the mirror, and a menu showing various functions pops up. She selects "find matching clothes" / "pants", steps back from the mirror and sees herself in a matching pair of trousers. She browses some other alternatives by using hand gestures in mid air, waving from left to right with her hand. She finds a satisfying item, again uses the navigation system to find it, tries that on, too, pays and goes home.

6.6 Christian Kray's Scenario: scenario - improve the neighbourhood

This is one of many similar streets on the outskirts of a large city in the second world. Lots of people live here but it is not a very safe place: there are drug problems, violence and other issues. Virtually all streets lack clean water, electricity, sanitation and other basic services. Since displays and simple circuitry can now (let's say: 2020) be easily printed, they've become extremely cheap. As re-building the area from the ground up would be very expensive, the city council has decided to set up interactive displays at all major crossings in this area and to connect them all up in order to help the inhabitants to 'improve the neighbourhood' by addressing some of their most pressing problems. The displays could provide:

- a persistent and situated one-to-one, one-to-many, many-to-many messaging system
- a self-organising street/person directory
- broadcasting services (e.g. for the city council)
- a communication hub to organise the local economy (currencies, advertisements, etc.)
- a means to beautify the rather unpleasant appearance
- a way to raise awareness about particular issues
- a way to provide education of different types
- a means to organise crime

What would be the best service? What would the interface look like? What could be the impact of setting up such a system?

6.7 Tsvi Kuflik's Scenario

6.7.1 Public displays on the wild

Information for personalized hiking: Nowadays we are familiar with the small signs marking hiking trails. Usually such hiking trips starts at a visitors center where the hikers gets some initial information about the area, the trails, the weather and sometime register. The Safe Hiker system will replace the wooden markers with public displays and enhance the overall support and safety of hikers. At the visitors center and in various trail heads and central points at the park/along the trails (junctions, resting points), there will be general displays,

presenting general information about the trails, weather conditions along the trails, including weather forecast (+ webcams) and additional relevant information like public transportation to/from trail heads, status of parking lots and the number of hikers along the trail. The displays along the trails (smaller ones) will provide regular information about the trail (like number + average time to destination etc) and in addition, they will provide important information like weather forecast along the trail, sunset time, information about public transportation at the end of the trail (back to the visitors center for instance or last cable car going down), number of hikers along the trail. This general information will be also personalized to the hiker - hikers registered at the visitor's center will be monitored. Hence the calculation of time to destination will be estimated bnased on their pace, as well as additional information (like weather conditions that may be more important to families with small kids rather than to young adults). Information to visitors, both general and personal will be delivered on these displays. In addition, these displays will be used for warnings - in cases of emergencies - drastic weather changes etc - they will be used to notify the hikers and even instruct them to abandon the trails. Moreover, visitors monitoring will be used to manage and guide rescue operations in case needed (as well as to monitor the traffic on the routes) - central displays will show the overall status of the park trails at the visitors center.

6.7.2 Public displays for personalized shopping

Assuming food products are tagged (quantities, expiration dates), the central kitchen display presents the status of food supplies. Once the quantity of a product is reduced below a certain level, then is changes its color and added to the "to buy" list. The list may be also manually edited. Items on the list can be marked "private" so they may not be visible to others. Once the user decides to go shopping, s/he goes to the nearest supermarket, s/he can either download the shopping list to a personal device and/or send it to the store, where s/he is identified by a personal mobile device. The shopping cart has a small multi function display, where upon explicit user consent, it interacts with the users' "smart home" or gets the shopping list from the personal device. At the entrance, large displays present "hot deals" - they greet the customer and suggest personalized "hot deals" that can be accepted by gesture-based interaction with the displays (and then added to the shopping list). At the supermarket, the cart display shows the optimal path through the shop - for collecting the needed items, where while moving along the isles, the shelves display point to the products, while providing additional information like prices comparisons of alternatives and additional information. Large displays at the end of the isles help the user to navigate and suggest personalized deals to the user, based on her/his habits, preferences and needs. The shopping cart may (or may not) help the user find also the private items, not available to the store server. Price information is accumulated and presented on the shopping cart display.

6.8 Helder Pinto's Scenario

It's thursday evening and I have to prepare my trip back to Portugal. I log in to the MyActivity.com personal planning and support tool and create a new activity. I assign it a name, a classification (travel), and specify the locations where it is going to have place: Schloss Dagstuhl, St. Wendel Train Station, Frankfurt Airport, and Porto Airport. I assign to St. Wendel and Frankfurt locations the times I have to be there, because I don't want to be late

in those places. I check whether my phone's Bluetooth ID in my profile is updated (it is going to be used during the journey to identify me in the several places I'll be) and it's done.

Friday after lunch, I call a taxi to St. Wendel. In the back of the driver's sit, there's a little display that automatically opens up MyActivity application, says me hello and tells me that I have yet 55 minutes before the train departs to Frankfurt. MyActivity asks me if I want to buy a ticket. Why not? I press the confirmation button and it's done! The attached printer gives me the e-ticket.

When arriving at St. Wendel train station, all the public displays (PD) detect my presence and show me the way to track 2, where I'll take the train to Frankfurt. I finally get there and, while I wait for the train, I rate the train-station PD system by taking a 2D code picture with my MyActivity phone application!

Finally, at Frankfurt Airport, I'm guided by PDs to the check-in area. After checking in, I'm presented with suggestions for dinner, based on my preferences, in the first PD I see. I select the one I'm going to and I'm then guided there. That's cool!

6.9 Michael Rohs's Scenario

Michael is looking for a new lens for his DSLR. He has surfed the Web for potential models, read a couple of reviews, and narrowed down the list of possible lenses to a few models. However, he cannot decide what to buy yet. So he stores his search history and related documents with an intelligent digital agent to collect further information for him. The agent continues the search for him based on his search history. The search is not only executed when he is sitting in front of his PC, but also when he is mobile. The search query becomes part of his profile that his stored on his device as well as on the Web. The pervasive public display infrastructure in the city can access aggregated and anonymized information from the profile of the set of people currently passing by a public display (only if at least three persons are in viewing distance) and can update the display accordingly. As Michael is passing by a display that shows an advertisement for a DSLR lens, Michael's mobile phone plays a particular tactile feedback pattern to inform him that display content in the vicinity matches his profile. Michael recognizes that the offered lens is indeed interesting and sees that it is available in a nearby shop. The display says that it is 300m away. He does not know that exact location, but the display system can guide him. He does a double-tap on the phone in his pocket. This signals to the system that he would like to be guided to the shop. A unique "guide-me" icon that is shown together with the advertisement will from now on appear on public displays along to way to the shop, replicated on each of these displays.

In the system, as Michael double-taps his phone this is recognized as an expression of interest in the advertisement. The location and time of the event is recorded and the provider of the display surface receives a micropayment for this event. When Michael actually enters the shop the display surface provider receives three times this amount. The display system is responsible for where and when the advertisement of the photo shop is scheduled. The shop only has to pay for the advertisement when a user expressed interest in the advertisement or if the system determines that someone directly moves from the point of the personalized advertisement to the shop.

6.10 Enrico Rukzio's Scenario

2015: Two friends, Bob and Ben, are both having a projector phone (as everybody does nowadays) and are waiting at the bus stop. In order to kill the time till the bus arrives, they both play a strategy game called Lord of the Rings they downloaded recently from the app store. Both of them are able to place three virtual fighters (e.g. 3 dwarfs, 3 elves or 3 orks) by projecting them onto a certain location with their projector phone. They place them on the pavement, street, trash bin, ceiling of the bus stop, the bench, etc. While doing this, two further persons join the game (as they know it and as they downloaded the game also beforehand) and place three fighters as well. After those placements which take just a few seconds the fighting begins. The four players have to find their fighters by projecting at their location and can give them instructions like "Go to the trash bin and fight there" through simple gestures and movements of the projector phone. All the four players are busy with searching for their own fighters, giving them directions and finding also the fighters of the other three players. The other people at the bus stop are watching the game and some of them are downloading the Lord of the Rings app as well...

6.11 Luebomira Spassova's Scenario: the personalised museum Experience

Often when you go to a museum alone or in a small group, you usually cannot have a personal guide. Sometimes you can have some kind of brochure in which some facts about the exhibits are written down, but usually you are not really willing to always switch your attention between the exhibit you are standing in front and the brochure in your hands. Moreover, in the brochure, there are often many facts that might not be interesting to you.

That's why it would be great to have an instrumented museum environment which uses either projection or wall-sized digital paper displays in order to show you the information that you would like to have about a certain exhibit right next to it and even guide you to the next interesting exhibit. Of course, the system would know perfectly well what information you would like to receive without you having to tell it (a thoughts reading interface might be useful here :-)).

The same setup would be also very useful for getting information about products in a supermarket or for sightseeing tours, where in the latter case, the outdoor version might be a little bit more difficult to set up.

6.12 Frank Steinicke's Scenario

One day in the future, somewhere in a cyberspace cafe or library... displays may be transparent (and almost invisible therefore) and show only content if desired. When a users request information (by talking, viewing, or touching such a display) a virtual avatar may appear, who interacts with the user naturally by speech. Requested information, which can be presented in 2D, are projected onto the surface of the display, where the user may perform multi-touch-based interaction. The avatar as well as all kinds of 3D content may be displayed (auto-)stereoscopically on such displays.

6.13 Axel Sylvester's Scenario

January 6, 2035 9:14am

Sam is 86 years old. Every morning he goes for a walk to buy some rolls for his breakfast. On his way he passes this anno 2016 public display which was those days painted using an animatable wall coating. And actually it was Sam who painted this wall within his last job before he got retired. He remembers very well how proud he was and how good the design of the animated content fit to the shape of the display. It really refered to the window and it used to be interactive when people were passing it. Sam did a lot of those arbitrary shaped displays. But now almost 20 years later the kids don't even know how they used to be produced, how they worked and not even what they were used for. The modern kids just show of with their brainplugs(tm) DTS or their silly GoLyYs! Sam doesn't know why they are so keen on those things and to be frank he does not care. But he likes 'his' good old display.

6.14 Lucia Terrenghi's Scenario

6.14.1 Scenario 1

Apple has acquired a set of connected large displays, which it has installed in its physical stores, as well as in commercial centres. On those displays, videos are shown demonstrating cross-platform applications which combine iPhone and larger displays. For example, a video shows how a user can share her Photo collections on Picasa by interacting with her iPhone and displaying the slideshow on the LCD at a friend's place, by just connecting the handset to the larger display (for example, via NFC?). After the video is played, a menu of cross-platform applications appears on the public display, similar to Apps Store. The users in the physical store can try out some of these applications by grabbing it form the screen (for example, pointing and grabbing the application) and playing around with the iPhone and the screens available in the physical store.

6.14.2 Scenario 2

Users can download a mobile application from the IKEA website: by taking a 360 degree photo of the room they want to decorate, a 3D model of the environment is created by the software provided by IKEA. Users can store the model online. Once they are at the IKEA store, users can retrieve their model and interact with the interactive tabletops that IKEA has installed in its stores. Here they can import articles from the IKEA catalogue to see how they would look in their environment back at home. Additionally, by putting physical samples of textures and materials on the images of the articles, they can visualize different versions of the articles and check how they would look like. Once they have made their choice, they just need to save the order: a visual marker appears on their mobile then, which can be scanned at the exit for paying directely.

Chapter 7

Challenges

7.1 Hardware/Technology

7.2 Energy / Power

- sustainability (in terms of energy consumption): compute (and display?) carbon footprint;
  - low consumption displays (e-paper); use of solar energy
- strategies for limiting power consumption: when to power down unused displays? when to power them on? how to communicate latency time to users?
- bringing displays where no power grid available: remote suburban areas, third world villages, ...

7.3 Theory / Models

7.4 Systems / Middleware

7.5 Business Models

7.6 Social Issues

- **Value and Engagement** - What can the global display network do for you today? How to give value to end users via public display? How to engage users to 'sign up' for public displays services? How to encourage people to intensively interact wit a public display? Preserving public interest (not just ads), base democracy. Displays for public engagement.
- **Vandalism**
- **Misuse** - Avoiding misuse. Propaganda. What is misuse? Can public displays be used for indie/underground communication?
- **Environmental Effects** - Light pollution. Look and feel - aesthetical fit to surroundings.
- **Culture** - Models for the use of public displays for art and architecture. Aesthetics.
- **Equality and Social Division** - How to address different user groups? Single users/-multi users. Avoiding the digital divide. Cultural differences.
- **Social Protocols** - How to understand and influence social protocols? What are/will be/should be acceptable means of interaction. How to keep face when interacting with public displays?
- **Legislation** - What is the fit with existing categorisation/legislation - is a public display some kind of media or a broadcast station? Telemedien vs Rundfunk. How will existing legislation be applied/what new legislation will need to be developed?

7.7 Privacy / Safety / Security

- **Technogological** - How to identify users without violating their privacy? How to avoid phishing attacks - disguise of a place, tricking people, scams...
- **Legal** - Lawful interception. How does the legislation change/how is it applied?
- **Interface/Interaction** - How to allow privacy on a public display
- **Social Value** - Personalisation vs. Privacy (The Big Brother effect). How to balance personalisation vs "intrusiveness" of tracking?

7.8 Evaluation

- **what's special about public displays in terms of evaluation?**
  - often interaction is extremely short
  - often interaction is extremely sparse
  - usually no training/prior experience
  - display usage may not be primary goal of user
  - user base very diverse
  - situatedness - location as a factor, e.g., different displays may be connected at different locations
  - interaction with environment, e.g., distraction by cars, people etc.
- Important to measure: user experience
  - methods: attrakdiff
- related research areas and methods:
  - VR, Games, mobile HCI, Marketing, Urban planning evaluation
- what could you evaluate?
  - quantitative/factual factors:
    - physical factors: visibility, density of the content, size, number of nearby distracting objects
    - user-related factors: error rate, interaction time, perceptual aspects, memory-related aspects, attention, etc.
- what should you evaluate?
  - depends on content/purpose
- what can you not evaluate?
- potential evaluation standards (e.g. benchmarks?)

- how can you evaluate (methods)?
  - questionnaires
  - observation
  - log analysis
  - eye-tracking/gaze tracking/motion tracking (lab/field)
  - recognition/recall/priming
  - immersive video/panoramas/VR (controlled environments)
  - bio-metrical/physiological response
  - long-term studies
  - ethnographical studies
  - focus groups
  - interviews
  - collecting informal feedback (e.g. Keith's guest book)
  - experience sampling
  - simulation studies (without users)
  - think aloud
  - Wizard of Oz
  - personas?
  - follow-up action tracking (e.g. did they really buy the thing your ads showed)
  - repertory grid
- how should you evaluate?
  - depends on purpose/content
  - time-related aspects (traffic sign vs. information kiosk)
- limitations/benefits of diverse evaluation methods?
- meaningful/stupid combinations of methods? complementation?
- other considerations:
  - purpose of display: grab/deter attention
  - which aspects are specific to public displays
  - the continuum: web-based, lab-based, simulation, field studies
  - acceptance of PDs

7.9 Conte{n/x}t Management and Creation

7.9.1 User and Community Generated Content

- Content Moderation: How is content creation and moderation organised? Is one person reponsible for all the content, or are concerned seperated along content or along display locations. What kind of access control is used (MAC-Adresses, Access-rights, phone number?).

- Content creation tools: WYSIWYG tools for displays, designing content alternatives for displays, content creation in front of the display. How to easily define Mash-Ups, how to include existing web 2.0 apps (e.g. twitter, flickr...).

Example of a building displaying twitter feeds from inside: http://www.youtube.com/watch?v=n1ANVCD

- Constrained tools for user generated content

Sophistication of content structure: from flat structured single media types to rich complex multimedia collections

7.9.2 State-of-the-Art:

Co-Located content transfer/creation

- SMS Wall at Federation Square, which displays sms of square visitors on displays of a building.

- Use bluetooth friendly names to change content on a public display:

http://portal.acm.org/citation.cfm?id=1555816.1555832 (Davis et al)

- Use bluetooth to upload images on displays:

Keith Cheverst, Alan J. Dix, Daniel Fitton, Christian Kray, Mark Rouncefield, Corina Sas, George Saslis-Lagoudakis, Jennifer G. Sheridan: Exploring bluetooth based mobile phone interaction with the hermes photo display. Mobile HCI 2005: 47-54

- snap and grab: Creating and sharing multi-media packages using large situated public displays and mobile phones, Maunder, Marsden and Harper, CHI 2008

Remote content transfer/creation

Examples: IDisplays and Wray Photo Display, Hermes Display, where content is uploaded through a template on a web page.

Taylor, N. and Cheverst, K. Social Interaction around a Rural Community Photo Display, to appear in International Journal of Human-Computer Studies special issue on Collocated Social Practices Surrounding Photos, 67, pp. 1037-1047, 2009.

Mueller, Joerg & Paczkowski, Oliver & Krueger, Antonio (2007): Situated Public News & Reminder Displays. Proceedings of European Conference on Ambient Intelligence 2007, Darmstadt

7.9.3 Content Description Languages and Guidelines

- Tagging
- Syles, Themes
- MIME types
- MIDP
- How to ensure that legibility is high enough?
- How to ensure that attention span of users is long enough?

7.9.4 MVC for Display Environments

7.9.5 Personalised Content Capturing and Management

7.9.6 Content Scheduling

- Scheduling across time and space
- On a display or across displays
- Synchronization of displays
- Preamptive Scheduling, reactive scheduling of content, e.g. Saul Greenbergs work on reactive video:http://grouplab.cpsc.ucalgary.ca/Publications/2009-ProximityToolkit.Report2009-946-25

7.10 Attention / Perception

- grabbing user attention
  - location (posture) of displays
  - screen content
  - multi-modality
  - responses to user action (passing by, standing close etc)
  - integration with/into vs./and standing out of environment
  - focus of attention guiding during interaction

  - personalized grabbing of target groups (e.g., only select users, which potentially want to interact, identification)

- encouraging of user interaction
  - communication of affordances
  - focus of attention guiding during interaction

- avoiding information overload
  - seamless integration with/into environment
  - scheduled content
  -

- factors influencing perception
  - display properties, e.g., brightness, contrast, resolution etc.
  - position/posture of interacting user in front of PDs
  - variety of users
  - multimodal measurements (e.g., gaze measurement and models of gaze-prediction)
  - physical (e.g., reflection) and indexicality of interaction with environment
  - aesthetics, design

7.11 Interaction Techniques / Shared Interaction

7.11.1 Interaction

- How to enable interaction quickly / easily (in 2 secs max)?
  - Direct touch
  - Preinstalled app on mobile that allows to establish interaction by pointing at display
    * Communication via IR?

- How to establish globally accepted interaction methods?
  - May be difficult because of cultural differences
  - Must be easy to use / intuitive
  - Direct manipulation
  - Joy of use / Added value

- Public displays vs. mobile phones

- How can people know that a display is interactive? How do they know which modalities to use?

- Patterns for command-based interaction (SMS, BT, etc.)

- Design space of pervasive public displays (PPD) interactions. Possible dimensions:
  - direct / indirect
  - explicit / implicit
  - single / multi-user
  - private / public
  - context
    - time
    - space
    - user

7.11.2 How to create awareness of interactivity?

- Symbol (probably the easiest alternative)
- Info on display itself
- Info on personal (mobile) device

7.11.3 Shared interaction

- indirect vs. direct
- multi-user interactions
- How to share a display collaboratively / individually?
- How to share in time / space?

7.11.4 Scalability

- How does interaction scale?
- Scalable user navigation

7.11.5 Modalities

- Direct vs. remote
  - Which modality for which setting?
- Implicit vs. explicit
- Appropriate interaction modality in certain contexts (location, task)
- Multimodal approaches (e. g. localized sound)
- Different access controls on public displays

7.11.6 Remote interaction

- "Universal iPhone App"
- Remote vs. direct
- Mobile interaction: How to select / interac?
- Means of interaction
  - Mobile device
    - Input
      - SMS, Bluetooth, Buttons, Call, Internet, TouchScreen, NFC, 3d gestures in space (accelerometers), compass, cam light, Voice
    - Output
      - Vibration, Display, Sound, SMS, Call, Mail, Projection
  - Body (Face detection / Eye detection, Body gestures, Pointing)
  - Virtual Reality
  - RFID
  - Laser Pointers (probably built in mobile device, probably IR)
  - Markers (Visual)

7.11.7 Direct interaction

- Touch (Multi/Single)
- Keyboard
- Mouse
- Pressure sensors (built in floor, table)
- Voice
- Pointing with finger / hand

7.12 Context and Personalizatoin

Two main sub-challenges

- personalized and context-aware informotion
- context technologies

7.12.1 Personalized and Context-aware Information

- motivatoin/goal
  - give value to display viewers
  - integrate public display technologies seamlessly in the environment
- user modelling [2,3]
- personalized content (usermodeling.org)

7.12.2 Context technologies

- references http://www.ubisworld.org/ Ubisworld], Context Toolkit, SENSEI Project, MAGNET Beyond project
- motivation/goal: display content at the rigth place, time
- measuring public display context
  - user identification (chepaly, robustly, easily)
  - unified access to mulitple technologies
- identification management is needed for privacy rasons
- globally available context service (see SENSEI project) [1]
  - discover display context
  - integration of sensor and context information

Challenges related to personalization and technologies

-
  - consolidated user identification mechanisms
  - consolidating different user models as there are differnet systems using different models
  - how to realize personalized content (design + technology)

7.12.3 Summary

- personalized information and content at the right time and place adds value to public displays
- personalization requires access to context information, measuring display and user context
- user modeling and and integrating context technologies is a key enabler for adding value to public displays

References [1] Strohbach, M. Vercher, J. Bauer, M.: A case for IMS, in IEEE Vehicular Technology Magazine, vol. 4(1), page 57-64

[2] Shlomo Berkovsky, Tsvi Kuflik, Francesco Ricci, 2008. Mediation of user models for enhanced personalization in recommender systems. User modeling and User Adapted Interaction Vol. 18 (3), pp 245-286.

[3] Advances in Ubiquitous User Modeling, LNCS volume 5830, Tsvi Kuflik, Shlomo Berkovsky, Francesca Carmagnola, Dominik Heckmann and Antonio Kruger (eds.), 159 pages, Springer, 2009. http://www.usermodeling.org/

Chapter 8

Results from Field Trips

8.1 Field trip group 1 (Keith Driving)

Team Members

- Keith Cheverst
- Tsvik Kuflik
- Joerg Mueller
- Massimo Zancanaro
- Antonio Krueger

8.1.1 Photos and labels for displays (both traditional and digital)

Below some photos and the corresponding labels we have applied.

geographic representation, benefit for the user, read-access;public, ownership;public, container, traditional, static, ground mounted, eye level, legibility 0-2, view distance: medium, attention:0-10min, indexicality:medium, audience-purpose-entropy:high, salience:high

A static city map. A digital version could make this interactive

ground mounted, view distance: high, sytle:mixed, pay-on-use, shelter, legibility 2-10, functional, container, static, indexicality:low

digital, dynamic, panopticon

ownership;public, visibility:low, interactive:local, misuse, augmented functionality

salience:medium, interactive, indexicality:high

8.1.2 Your suggested "standard" criteria for describing displays, installations, content, interactions etc.

- Placement Properties: mounted from the ground,entrance,shelter,window,audience-purpose-entropy:medium,audience-purpose-entropy:high,waiting area,eye level,wall mounted,above eye level
- Attention: attention:0-10min,attention:0-2sec,attention-entropy:low
- Benefit: audience benefit, owner benefit
- Functionality: single purpose,augmented functionality
- Containeryes,no
- Shape: cylndrical,landscape,portrait
- Type:traditionaldigitalhybrid
- Style/content: style:non-branded, style:physical, style:scribbled, style:mixed, content:animation, content:mixed, legibility 0-2, style:static, content:scribbled, content:slideshow, style:teletxt, geographic representation, sytle:animated, style:3D-physical, style:dtp,
- Salience: visibility:low,visibility:medium,view distance: high,salience:medium,view distance: medium
- Indexicality:low,medium,high
- Owner:public,private
- Service Design:free service,pay-on-use
- Purpose:decorative,panopticon,secondary usefunctional
- Physical design properties:mobile,rotatable,fixed,container
- Content design properties:legibility 1-15,legibility 2-10
- Collection design properties:replicated,spanned
- Interaction design properties:multi-user,social exposure,interactive,misuse,appropriation,interactive:loca
- Acces control:read-access;public,read-access:private,write-access public,write-access private, Update rate:daily,minute,seconds,milliseconds, weekly

8.2 Field trip group 2 (Marc Driving)

Team Members

- Nigel Davies
- Helder Pinto
- Nemanja Memarovic
- Marc Langheinrich

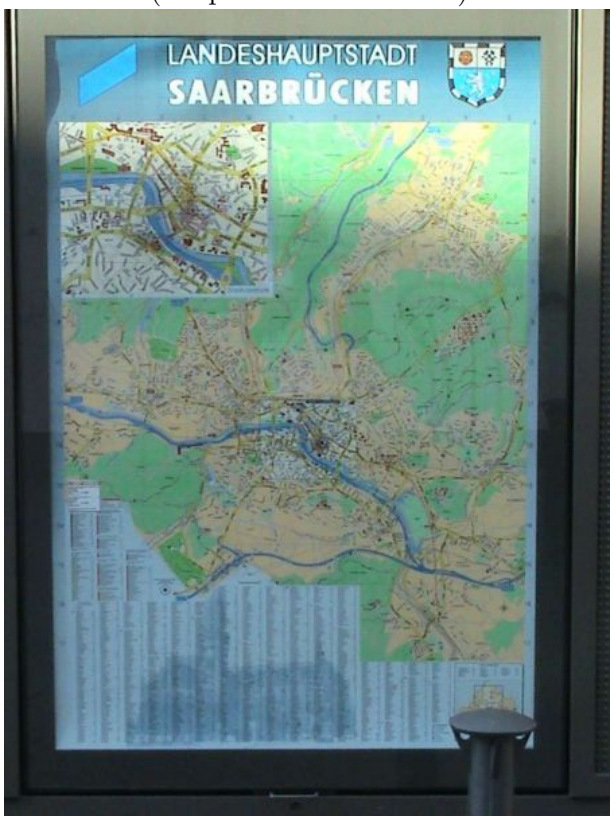
8.2.1 Examples of traditional displays where an upgrade to digital would NOT make sense

Multiple handwritten restaurant signs.

- Handwritten menus of restaurants. Upgrade requires manual erase, can be erased by rain, multiple signs require synchronization. A digital display would ease updates, could be shielded from elements, and automatically synch across multiple displays. HOWEVER, several issues with this:
  - Might not be cost-effective to change
  - Labor is cheap. Hardware is cheap. Robust.
  - No skills needed to operate by staff, except for nice handwriting – creating a pleasing menu digitally might be very hard (templates might look too generic).

8.2.2 Examples of traditional displays where an upgrade to digital would make sense

Printed menus of restaurants. A digital version would allow updates, also support direct user interaction (see pictures of the food)



A static city map. A digital version could make this interactive

A ticketshop featuring posters of bands. A digital version could allow downloading music samples, viewing concert videos.

An advertising column. A digital version would allow cleaner presentation, easier update, time sharing.

8.2.3 Examples of digital displays where the upgrade to digital appears to have made sense


A digital tramstop display.

- The few examples we saw were mostly product slideshows. Obviously, you can squeeze more images/posters into the same spot by rotating imagery.
- Tramstops

8.2.4 Examples of digital displays that could be improved

- Dead displays could be turned on
- TV-set-like displays (footlocker)
- Hard-to-see displays could have increased brightness, be larger
- Boring slideshows could be improved (how?)

Records of observations

- We did not observe any interaction with any kind of display (traditional or digital)

8.2.5 Your suggested "standard" criteria for describing displays, installations, content, interactions etc.

Here is a first stab at how one might categorise/describe a display install. This is really difficult because even something as simple as describing a physical space is known to be hard!

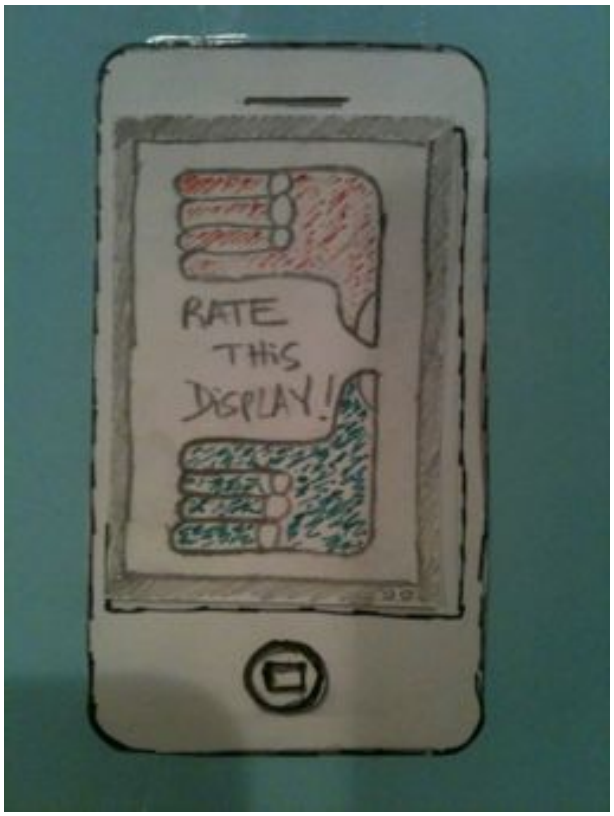
- Physical Setting
  - Indoor vs Outdoor
  - Height
  - Max/min/typical viewing distance
  - Size
  - Vertical vs Horizontal (landscape, portrait)
  - Facing in, facing out
  - Flush with surface, raised, or lowered
  - Single (even multiple) or grouped (synchronized) display
  - Space setting
    - transient
    - waiting
    - lingering
    - recreational
  - Noise level
  - Network availability
  - Proneness to light reflection
- Intended Audience
  - Demographics
  - Numbers
- Technology
  - Resolution
  - Display Technology
  - Sound
  - Daylight visible
  - 2D or 3D
- Interaction style
  - level of attention engagement
  - level of directness at pragmatic interaction level (e.g., direct touch vs. remote 3D gestures)
  - # of users supported simultaneously (multi-user vs. single-user)
  - push/pull
  - level of directness in communication (central vs. peripheral)
  - collaboration vs. sharing
  - support of private displays (e.g., mobile phones)
- Content
  - Dynamism: DVD vs Powerpoint vs interactive
  - user generated vs. broadcast by service provider

Mobile Data Gathering Application

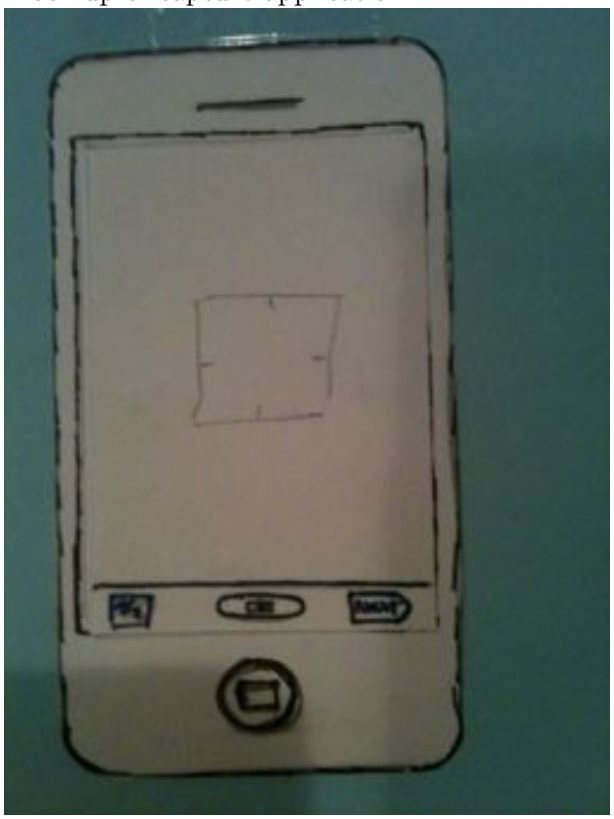
It would be nice to create a simple application that we could use to capture data on digital display installations. This could then be a community resource that many could upload to. We will try and post mock-ups of this application soon!

Here are some screen shots from our application.

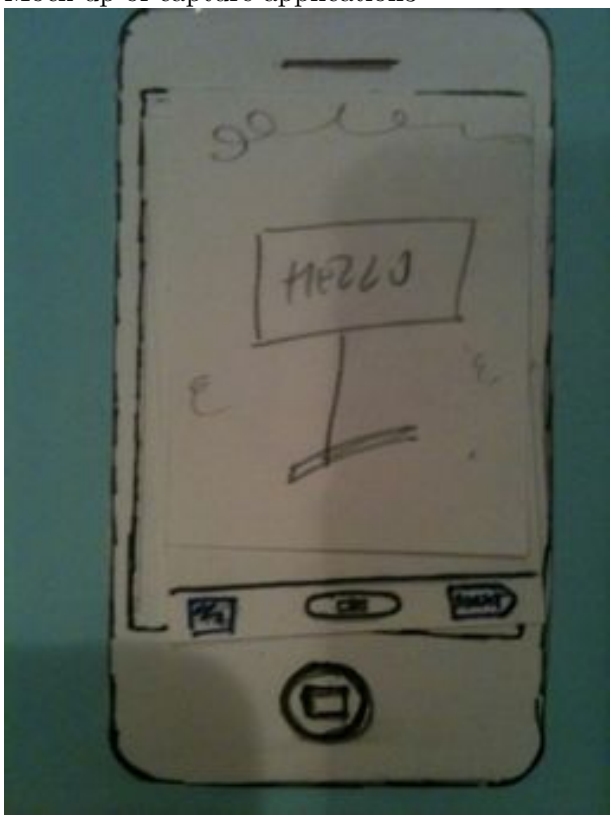
Mock up of capture application1



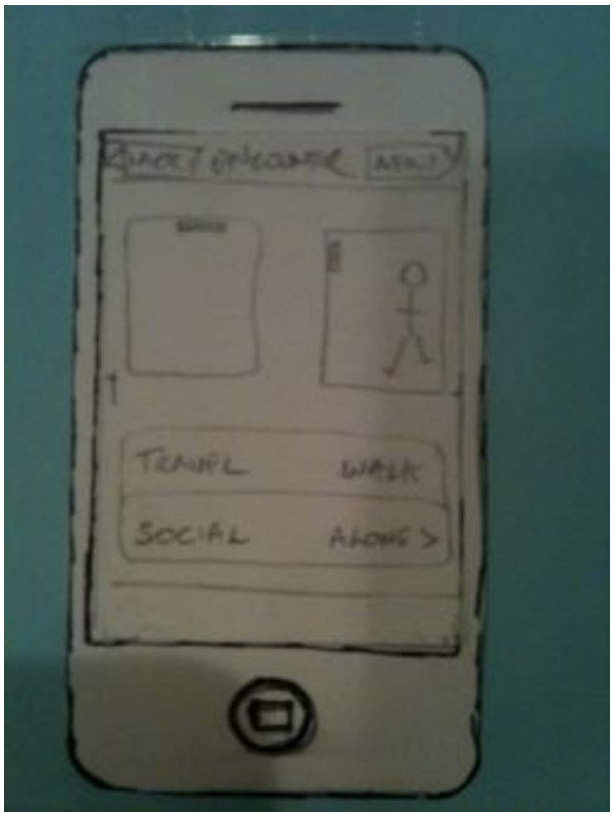
Mock up of capture application2



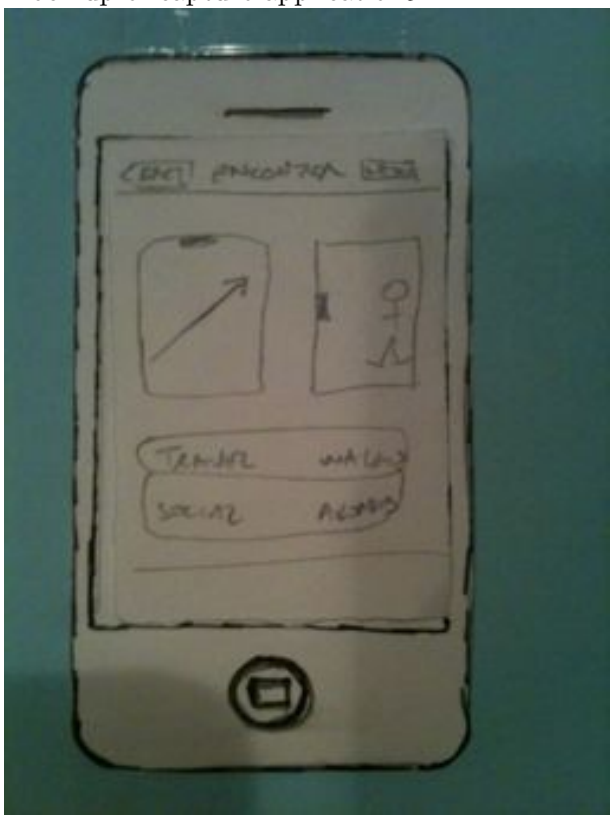
Mock up of capture application3



Mock up of capture application4



Mock up of capture application5



Mock up of capture application6

Mock up of capture application7

Mock up of capture application8

Mock up of capture application9

Mock up of capture application10

Mock up of capture application.

And here's a video: Media:RateThatDisplay.ogg

8.3 Field trip group 3 (Chris Driving)

8.3.1 Team Members

- Chris

- Chi-Tai
- Martin
- Michael

8.3.2 Photos and labels for displays (both traditional and digital)

City redevelopment information. A digital version could show, e.g., the detailed state of completion, a camera view of the construction site, floor plans, a 3D view of the completed site.

(2) You are here map collocated with signs. Helps to make the mapping from large scale map to the physical environment.

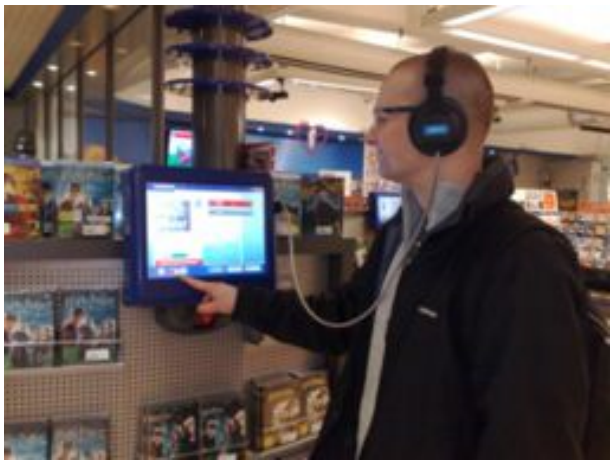
(3) A stamp dispenser. This can be used by anyone, so it can be regarded as a public display. However, it is single user only.

(4) Navigation information for people with special needs. A digital sign could show this information only when needed thus reducing the attention span.

(5) An interactive terminal for browsing the Web, sending SMS, and making (video) phone calls. The camera opens up a range of possible interactions.

(6) Paper attachment to terminal. The interactivity offered by the terminal does not offer this capability.

(7) Mobile public displays on vehicles.



(8) Interactive music station in shop.

(9) Situated content using digital AND traditional signs: departures times (digital AND traditional), locall related advertisement for saving the church, advertisement of construction company, ticket machine

(10) People interacting with traditional displays.

(11) A hybrid display showing parking locations and information about free parking spaces.

Photo set on Flickr

8.3.3 Examples of traditional displays where an upgrade to digital would make sense

- Karstadt Passage, pictograms for wheelchair users and prams: half A3-size; static; pictograms with arrow; directs target audience to take alternative route; owned by city? non-interactive (benefit of digital: hide display if content not relevant to people present in order to reduce info overload)
- Bahnhofsstrasse, temporary display announcing city redevelopment: double poster size (2-3m tall); non-interactive; owned by city; provides information about redevelopment; three-sided, only one visible at a time; (benefit of digital: access specific information, leave comments on redevelopment, update as plans are changed, reduce size?)
- Karstadt, directory next to escalator - person standing in front of it, scanning it for information, slightly blocking the way (benefit of digital: speed up search, personalise but would need efficient way to interact)

Examples of digital displays where the upgrade to digital appears to make sense

- Ludwigskirche, metro stop; information relating to travel split over three displays, one static, one hybrid, one fully digital; all roughly poster-size; one self-illuminated; owned

by city; interaction via keyboard and/or payment system; produces tickets (would it make sense to integrate those three displays into one system?)

Main purpose of displays found

- advertisement
- directions
- local information (announcements, asking for support, events, looking for a job)
- instructions (for using a machine, where not to go, how to behave - don't smoke)
- labelling (name/type of shop, function of an object)

8.3.4 Records of observations

- dynamic park guidance sign: hybrid, digital, analog, poster size, above head height, illuminated, semi-commercial, owned by city; no two-way interaction; influences flow of people/cars; provides information (to drivers); update rate?
- Karstadt, media explorer display: 17", digital, means of interaction: headphone, touch, barcode scanner; about 1.20m above floor, dynamic, high resolution; owned by Karstadt, 'controlled' by user; content: buyable media (music, dvd); advertisement
- Rathaus, collocated city map and sign post: static, poster-size and half A3 size, partly illuminated, non interactive; usable together; helps people to find their way; owned by city
- challenge: limiting visual pollution by replacing many displays with one/few digital displays (example tram stop)?
- challnege: reduce visual pollution by reducing signs with appropriate design of objects (–>Don Norman, e.g. trash bin in tram stop picture)
- Hybrid Signs: When best to combine digital and traditional signage?

8.3.5 Your suggested "standard" criteria for describing displays, installations, content, interactions etc.

The following is a proposed list of label categories and values for describing displays:

- size: mini (up to 15"), midi (up to 40"), large, huge (facade size)
- purpose: information, navigation, point-of-sales, advertisement, interaction, alerting, local search, narrowcasting, broadcasting, decoration, request for behaviour change
- nature of environment: public space, museum, school, shop
- media type: textual, graphical, video, audio
- interaction period: fraction of a second, second, seconds, minute, more than a minute

- typical usage (view/interaction) distance:
- size of target audience: single person, many, crowded
- context-aware: yes, no
- interaction modality: barcode, toucscreen, RFID,
- dwell time: passing by, waiting
- predominant use of environment: shopping
- display density of environment: low, medium, high
- update rate capability: slow (e-Paper), fast (all other digital displays)
- target audience

Tagging Excersise

Fig 8	Fig 9	Fig 10	Fig 11
mini	mini, midi-large	midi	large
interaction, information/point-of-sale	information, advertisement, point-of-sale	navigation	navigation
shop	public space	shop	public space/street
all	textual	textual	graphical, textual
minutes	fraction of a second to minutes	seconds	fraction of a second to seconds
touch distance	reading distance	reading distance	viewing distance
single	many	few	many
yes	yes	no	yes
touching, scanning	reading, touching	reading	viewing
short stay	long stay	passing by	passing by
shopping	waiting	shopping	driving
high	medium	medium	low
dynamic	dynamic (electronic time table), static (poster)	static	dynamic/static
customers	local travelers	customers	local travelers

Category	Fig 1	Fig 2	Fig 3	Fig 4	Fig 5	Fig 6	Fig 7
size: mini (up to 15"), midi (up to 40"), large, huge (facade size)	large	large	mini	mini	mini	mini	midi
purpose: information, navigation, point-of-sales, advertisement, interaction, alerting, local search, narrowcasting, broadcasting, decoration, request for behaviour change	information	navigation	point-of-sale	information	interaction, point-of-sale	local search	information, advertisement
nature of environment: public space, museum, school, shop	public space	public space	shop	shopping mall	public space	public space	public space/street
media type: textual, graphical, video, audio, photo	textual, graphical	graphical, textual	textual	graphical (icons)	all except audio	textual, physical (rip-off pieces of paper)	textual
interaction period: fraction of a second, seconds, more than a few seconds	minutes	up to a minute	up to several minutes	fraction of a second	up to several minutes	seconds	fraction of a second to seconds
typical usage (view/interaction) distance:	touch distance	touch distance	touch distance	viewing distance	touch distance	touch distance	reading distance
size of target audience: single person, few, many, crowded	few	few	single	many	single	few	many
context-aware: yes, no	no	no	(yes)	no	(yes)	no	no
interaction modality: barcode, toucscreen, RFID,	reading	reading, pointing	touching	viewing	touching	tearing	reading
location dwell time: passing by, short stay, long stay	passing by	passing by	passing by	passing by	passing by	passing by	passing by
predominant use of environment: shopping	walking through, shopping	walking through	entering/exiting	walking through, shopping	walking through	walking through	walking through, driving
display density of environment: low, medium, high	low	low	low	high	low	low	low
update rate capability: slow (e-Paper), fast (all other digital displays)	static	static, easily updatable	dynamic	static	dynamic	low	dynamic (bus), static (van)
target audience	locals	non-locals	service customers	people with special needs	service customers	people matching specific criteria (service request)	bus: local travelers, van: people looking for specific service (service offer)

8.4 Field trip group 4 (Tobias Driving)

8.4.1 Team Members

- Axel Sylvester
- Sarah Rutlidge
- Tobias Hesselmann

8.4.2 Photos and labels for displays (both traditional and digital)

Commented / tagged photos are available here: http://picasaweb.google.de/tobias.hesselmann

8.4.3 Examples of traditional displays where an upgrade to digital would make sense

See comments of photo collections for detailed descriptions

- City map (Could be turned into navigation system)
- Public toilets (Could indicate whether they are free or not, could display advertisements)
- Traffic signs (Only indicate currently needed information)
- Digital mirrors in a clothes store (Previewing of selection of clothes, augment image with other information)
- Price tags (Always indicate the right (discounted) price and other relevant info (e. g. clothes fits customer or not)
- Restaurant menu of the day

8.4.4 Examples of digital displays where the upgrade to digital appears to make sense

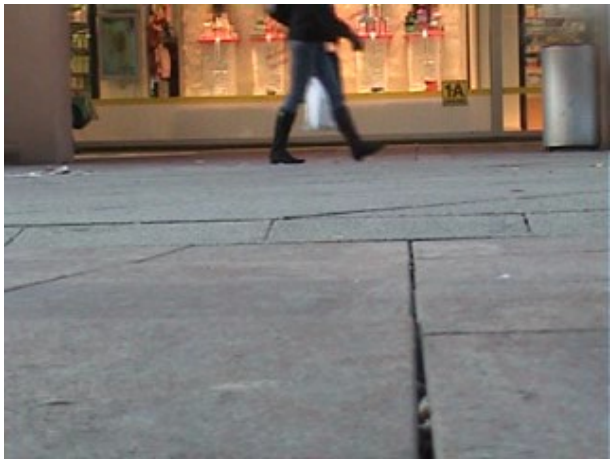
- Ticket automats are an improvement over mechanical machines, but probably not over a person selling tickets
- Bus signs (They can be updated on the fly)

Examples of digital displays that could be improved

- Ticket automats (if turned into one large interactive surface, the user interface design could be far more adaptive and usable)
  - It doesn't make sense to put a display where no kid can see it

8.4.5 Records of observations

- People probably move slower when distracted by a display. Please follow this link for a presentation of an attentiontracking aproach.



- A consistent interface design is needed to avoid "Microsoft Office Clip-Art Style"

8.4.6 Your suggested standard criteria for describing displays, installations, content, interactions etc.

Adding to the other criteria, we'd suggest to use size measures that anyone can make sense of, leaving less room for interpretation (e. g. "billboard size", "life size" in contrast to "mini", "large").

8.5 Field trip group 5 (Alex Driving)

- Albrecht
- Alex
- Frank
- Tanja

8.5.1 Photos and labels for displays (both traditional and digital)

Examples of traditional displays where an upgrade to digital would make sense

Fig. 1: updating service hours, availability, waiting times

Fig. 2: multilingual labeling and interactive navigation (zooming, panning, etc.), and detail information of points of interest

Fig. 3: providing previews content for movies, grabbing attention, encouraging interaction

Fig. 4: change of locations, destination, schedules, new service providers

Fig. 5: easy update of adverts or special offers

Fig. 6: highlight or zoom of current train schedules, provision of multiple viewports

8.5.2 Examples of digital displays where the upgrade to digital appears to make sense

Fig. 7: show real-time schedules and bus delays

Fig. 8: iPhone advertisement, attention grabbing, showing affordances

Fig. 9: advertisement, attention grabbing, showing affordances

Fig. 10: showing availability with a one bit display

Fig. 11: attention grabbing to warn persons

Examples of digital displays that could be improved

Fig. 12: Currently: simple slogans. Improvement: showing special offers, times of operation, available personal, alternative open pharmacies

Fig. 13: Currently only information scheduled departure time and final destination. Improvement: additional information about intermedia stops and times of arrivals, more precise about actual departure times

Fig. 14: Currently: two displays: one showing adverts behind person, who is serving (only static image), and small display on the till, which shows price very small with static text around. Improvement: Showing information about prices, special offers, sample products, making better usage of till display by providing a larger font, personalized advertisement (people who bought this bought ...)

8.5.3 Records of observations

- access to digital/traditional public by single vs. multiple users
- viewing digital first and viewing traditional afterwards

8.5.4 What is a public display?

A display is defined as public display if the number of observers cannot be named by the owner of the display.

8.5.5 Your suggested "standard" criteria for describing displays, installations, content, interactions etc.

- purpose
- audience
- location + environment
- content + media type + update rate
- interactivity
- technology

Reasons for a shift from traditional to digital. Can you answer one of these questions with "no"?

1. Can I reach the desired degree of interactivity with a traditional display?
   - Fig 1: yes, no interactivity required
   - Fig 2: no, a tourist might require more detailed information or other languages
   - Fig 3: yes, advertisment
   - Fig 4: yes, users should not change bus lines
   - Fig 5: yes, advertisment
   - Fig 6: no, users might want to choose specific lines, dates and get more info like delays etc.
2. Are the update rates reasonable for a trad. display?
   - Fig 1: yes, update rates rather seldom
   - Fig 2: yes, reprinting the map each month is reasonable
   - Fig 3: no, movies are update frequently
   - Fig 4: yes, bus lines change seldomly
   - Fig 5: no, frequent offers
   - Fig 6: no, should be update everytime somethign changes
3. Is the complexity of my content appropriate for a trad. display?
   - Fig 1: yes, few information
   - Fig 2: no, hard to find the desired information
   - Fig 3: yes, advertisment
   - Fig 4: yes, bus lines
   - Fig 5: yes, special offers
   - Fig 6: no, complex information

8.6 Field trip group 6 (Lucia Driving)

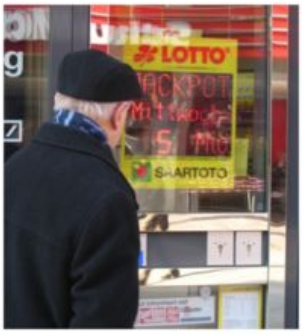
Team Members

- Lucia Terrenghi
- Enrico Rukzio
- Luebomira Spassova
- Florian Alt

8.6.1 Photos and labels for displays (both traditional and digital)

informative

Important Information



informative

Thank you / Acknowledgement

awareness

Time table / outdated

warning

Warning & Convention

-

advert

Dynamic / Form Factor / Content

advert

Digital Display showing static content

communication

Contrast: Digital vs. analogue

advert

Forced Perception through space multiplexing

informative

Analogue design for update

informative

Information / Interaction / Advertisement

informative

Awareness (timetable)

decorative

Art & Decoration

informative

Non-rectangular Forms

advert

decorative

Very large Displays

advert

informative

Multiple Functions

informative

advert

What is the audience looking at?

orientation

Maps

orientation

Languages / Scalability

orientation

Directions

advert

Eyecatcher

advert

"3-d" display boxes

Personal Expr.

Wearable Displays

Personal Expr.

Misuse



advert

Disguise & Extension

Personal Expr.

Vandalism

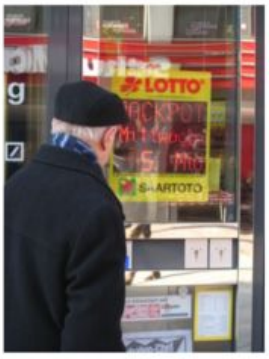

informative

Instructional Design

informative

advert

Mixed analogue & digital



informative

Digital: 1-bit vs. n-bit

informative

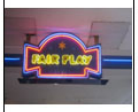
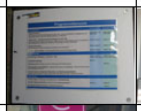
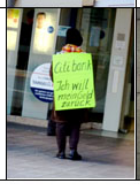
advert

Analogue: add / remove

Intended visible update

Not designed for updates

8.6.2 Your suggested "standard" criteria for describing displays, installations, content, interactions etc.

	Form factor			Update rate			Dynamism	
	s	m	l	low	medium	high	yes	no
advertisement								
instructive								
Informative								
Awareness (time schedules)								
Communication (looking for…)								
warning								
decorative								
Orientation (maps, navigation)								
personal expression (complaints, graffiti)								

8.6.3 Merge Area

See http://etherpad.com/C1ewcFLT35
Merged Categories

Chapter 9

Links

- Seminar Homepage
- Dagstuhl Arrival Information
- Info for arriving participants
- Question to the Dagstuhl staff