Social Aspects of Cooperating Objects Technologies

International Workshop
of the Coordination Action Embedded WiSeNts (IST-004400)

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Workshop Report

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Eric Töpfer & Martin Meister

Center for Technology and Society
Technical University Berlin
www.ztg.tu-berlin.de

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Introduction

In the early 1990s Mark Weiser outlined his vision of the computer for the 21st century at Xerox Palo Alto Research Center as ubiquitous "calm technology" which weaves itselves into the fabric of everyday life until becoming indistinguishable from it (Weiser 1991; Weiser & Brown 1995). Since then progress made in the domains of processing power, data storage capacities, wireless networks technologies, human-machine interfaces, miniaturization and convergence of devices is impressive.

As Greenfield (2006) notes there are many ubiquitous computings, which (or at least aspects of have it) are also called pervasive computing, physical computing, tangible media, ambient intelligence, Internet of Things, or – to use his term – "everyware". The assembly of this puzzle, Greenfield argues, has "reached something like a critical mass of thought and innovation by 2005". Thus, he concludes, information technology is prepared to colonize everyday life "to remake the very relations that define our lives".

The dramatic social implications that might arise from this emerging field of technology have also caught the attention of the Embedded WiSeNts consortium, a network of leading European academic research labs and institutes in the areas of embedded systems, ubiquitous computing and wireless sensor networks. The Embedded WiSeNts consortium aims to push the vision of so-called cooperating objects by supporting the integration of existing research, developing a roadmap for technology adoption and promoting excellence in teaching and training.

Given both their fascination and concerns the lead researchers of Embedded WiSeNts commissioned the Center for Technology and Society (CTS) of the Technical University Berlin (TUB) to organize a workshop on the social aspects of cooperating object technologies and ubiquitous computing. Therefore the CTS invited 15 experts in technology assessment, sociology of technology, participatory design, system analysis, communication science, privacy protection, psychology, micro economics and the philosophy of law from across Europe to provide an opportunity for both an interdisciplinary exchange and a discussion of the issues at stake with computer scientists and engineers from the Embedded WiSeNts network.[1]

This expert workshop was held at November 1-2, 2006 at the TUB. In total 37 persons registered for participation and 35 were eventually present. The central objective of the workshop was to present state-of-the-art research from different disciplines, and to identify the key challenges arising from the current technological developments across these different strands of research. Moreover, it aimed to discuss approaches of socio-technical design that integrate engineering and social research at the meta-level of devising

[1] *Social Aspects of Cooperating Objects Technologies*, International Expert Workshop, Website: http://www.embedded-wisents.org/workshop/.

regulation and at the micro-level of shaping applications and devices. Last but not least the findings of the workshop were meant to inform and support the efforts of the Embedded WiSeNts consortium to map the future of cooperating objects technologies.

This report summarizes the presentations given at the workshop and the discussions they provoked. It is organized according to the five panel sessions of the workshop and finally outlines key challenges for future research and policy making.

Summary of Panel Sessions

Following the welcome notes by Adam Wolisz, director of the Telecommunication Networks Group at TUB and coordinator of Embedded WiSeNts, and Werner Rammert, Professor for technology studies at TUB and speaker of the CTS, Marcelo Pias from the Computer Lab of the Digital Technology Group at the University of Cambridge gave an introduction into the technological state of the art. He presented selected visions for application and a framework for discussion. The central question that Pias raised was whether the presented visions are sufficiently useful to justify their impacts. The key issues he proposed for discussion in the following panel sessions were:

- privacy,
- digital divide,
- usability,
- role of governments and the private sector,
- ethics,
- sustainability.

The following five panel sessions were organized around five topics:

1) Grand challenges as identified by recent surveys on ubiquitous computing and ambient intelligence,
2) the governance of risk, privacy and trust in cooperating objects environments,
3) the assessment of user expectations and the anticipation of practices of use,
4) the calibration of distributed agency in human-machine interaction,
5) the management of complexity in socio-technical networks of cooperating objects and humans.

Panel Session 1: Grand Challenges: Lessons Learned from Recent Surveys

Albert Kündig, retired Professor from the Swiss Federal Institute of Technology (ETH) Zurich and member of the steering committee of Technology Assessment (TA) Swiss, began his talk with the statement that computing – understood as a metaphor for the totality of ICT and their applications – does not introduce a fundamental new aspect into human life and the social fabric as information handling is a key characteristic of human existence at least since the invention of script. ICT, he continued, only changes the performance of our information handling tools but this, however, dramatically as these tools have become globally available. What is new about ICT in general and about cooperating objects in particular is that in contrast to mechanic systems like the early locomotive the rules for the cooperation of the components of these information systems are increasingly dissociated from the physical objects while at the same time

embedded into virtual bonds that are defined by logic rather than physics. Given the increasing complexity of ever wider networks of cooperating objects Kündig predicted that life might become more comfortable on the one hand while becoming more adventurous on the other hand. Having said this, he raised the questions, how adventurous life shall and will become with computing heading towards ubiquity, and how we can prevent people from becoming incapacitated cyborgs. To approach these questions and reach fair and differentiated answers, Kündig argued, clear definitions and a valid and differentiated taxonomy are required as technology assessment based on catch-all definitions usually faces the problem only being able to conclude that "technology is ambivalent". He stressed that technology assessment must look at technologies at the application level and proposed a set of descriptors for the development of taxonomies: 1) *scope* of the new systems in space, time, scale and functionality, 2) the *degree of coupling* of components, 3) their *autonomy* and *capabilities*. According to Kündig most of the published studies have not been made with such a proposed differentiated view. Given the manifold problems that are likely to be posed by the new applications, he notes, that still a lot of research has to be done. Finally, Kündig suggested to study socio-technical constellations rather than to follow traditional approaches of focusing either on the genesis or the impacts of technology. Thus, he concluded with an appeal for multidisciplinary, comparative and historic research as implied by the analysis of socio-technical constellations.

A recent study [2] commissioned by TA Swiss was presented by **Lorenz Hilty** from the Technology and Society Lab at Empa Sankt Gallen. What Hilty described as the main problem of the study was the fact that is aimed to assess a technological vision before it materializes. Thus, the team eventually chose a qualitative approach and developed a "filter" to rank those risks that are already discussed by the relevant literature. The following key issues were identified as most relevant from the perspective of the precautionary principle: 1) *Stress imposed on the user* by, for instance, poor usability, disturbance and distraction, concerns because of potential surveillance or possible misuse, and increased demands on individuals' productivity and other rebound effects. 2) *Restriction of freedom of choice* as pervasive computing may drive certain groups of the population into a situation in which they are compelled to use such technology or to co-finance it against their will. 3) *Setbacks for ecological sustainability* in face of the likely increase in consumption of scarce raw materials for the production of electronics and the energy consumption of stationary ICT infrastructure. Furthermore, the electronic waste generated by millions of very small components might result in an irreversible loss of resources and serious environmental pollution. 4) *Dissipation of responsibility in computer-controlled environments* is very likely to result in situations where it is not possible to

[2] Hilty et al. (2005): *The Precautionary Principle in the Information Society - Effects of Pervasive Computing on Health and Environment*. Swiss Center for Technology Assessment (TA-SWISS), Bern (TA46e/2005) and Scientific technology options assessment at the European Parliament (STOA 125 EN). http://www.ta-swiss.ch/www-remain/reports_archive/publications/2005/050311_STOA125_PvC_72dpi_e.pdf.

isolate the cause of damages due to the combined effects of several components from computer hardware, programs, and data in networks, and thus to assign liability. In more detail Hilty elaborated the implications of pervasive computing for ecological sustainability and for responsibility and liability.

Another recent study [3] which was commissioned by the German Federal Office of Information Security (BSI) was presented by **Ernst Andreas Hartmann**, Acting Professor for ergonomics at the University of Magdeburg. The aim of the PerCEntA study was to deliver a prospective analysis of the technology impacts of pervasive computing. In detail, it should develop application scenarios, describe development paths and identify critical applications with respect to privacy and IT security. A multi-method approach was chosen combining desktop research, in-depth interviews with five experts using a modified conceptual structuring technique derived from psychological studies, and an online questionnaire sent to 300 experts in the field of pervasive computing. Hartmann reported that 83 experts eventually answered the questionnaire in summer 2005 with a bias of the sample towards scientists and Germans. The findings suggest that the experts believe that most application areas develop within the next ten years – with mobile communication and logistics in less than five years. Among the features of pervasive computing the experts believe mobility and ad-hoc networking to be fully realized within less than five years while energy autarky and autonomy is only believed to be realized within the next decade. The experts identified energy supply, the development of adequate human-machine-interfaces and technical safeguards as most crucial technological challenges for the further evolution of pervasive computing. Most experts agreed that "design for privacy" methods should be implemented right from the beginning as otherwise privacy issues are very likely to emerge with the diffusion of pervasive computing applications. In addition, most experts agreed that the recycling of electronic components will become a serious challenge and need to be addressed as soon as possible. But most experts were convinced that the overall benefits of pervasive computing outweigh its drawbacks. Only a minority thought that it might entail dramatic changes in social behavior. On the basis of the survey, Hartmann concluded with the forecast, that stand-alone devices will dominate the field of pervasive computing for the next five years while full networking will be realized with increasing capabilities in 2015.

Panel Session 2: Governing Risk, Privacy and Trust in Cooperating Objects Environments

Martin Meints from the Independent Center for Privacy Protection Schleswig-Holstein presented the findings of two recently published studies: 1) the project *Technology*

[3] *Pervasive Computing: Entwicklungen und Auswirkungen* (PerCEntA), http://www.bsi.bund.de/literat/studien/percenta/index.htm. The English version of the study is published by SecuMedia Verlag, Ingelheim (ISBN 3-922746-76-4).

Assessment of Ubiquitous Computing and Informational Self-Determination (TAUCIS) [4] which was funded by the German Federal Ministry for Education and Research, and 2) the study "Radio Frequency Identification (RFID), Profiling, and Ambient Intelligence (AmI)" [5] edited by the European Network of Excellence *Future of Identity in the Information Society* (FIDIS). Though both studies address issues of data protection, liability, criminal law and the social and socio-economic aspects of ubiquitous computing and AmI Meints focused in his presentation on privacy and data protection in relation to both the right to informational self-determination as declared by the German Federal Constitutional Court in its Census Verdict in 1983 and the German Federal Data Protection Act (addressed by TAUCIS) on the one hand and the European Data Protection Directive 95/46/EC (addressed by the FIDIS) on the other hand. As a key feature of current visions of ubiquitous computing and AmI is the candid collection of large amounts of (personal) data both studies conclude that these technical visions run against fundamental data protection principles as data minimization and informed consent by the data subjects to the collection of their data. Moreover, it is very likely that decentralized and multilateral service models and the different functions and roles of service providers increase the complexity and opaqueness of data processing in the context of ubiquitous computing and AmI, and therefore challenge traditional notions of liability, trust and risk management. Therefore Meints raised the questions how traditional data protection solutions such as informed consent and opt-in by the data subjects could be realized in AmI environments and which legislation could apply to a globally dispersed processing of personal information extracted from data subject. Meints reported that both studies conclude that no pure legal solutions can be found to these challenges but that they instead propose a combination of law and law enforcement, technical solutions and business models. Regarding the legal domain the following measures were discussed among others by the TAUCIS study: (1) strengthening the liability of operators of ubiquitous computing systems and domestic authorities and include also immaterial damages, (2) strengthening the possibility of users to enforce their data protection rights and (3) application of the strongest data protection standards in systems that are run by service providers at an international scale. In the FIDIS study concepts for (1) transparency enhancement and corresponding technical implementations and (2) "ambient law", i.e. the inscription of legal principles into technology, are discussed.

Safeguards in a World of Ambient Intelligence (SWAMI),[6] another project addressing issues such as privacy, risk and trust, was presented by **Ralf Lindner** from the Fraunhofer Institute for Systems and Innovation Research. The objective of SWAMI was to identify social, legal, organizational and ethical implications and risks of AmI in relation to privacy, identity, security, trust and digital divide, and to identify research and policy options on

[4] TAUCIS, http://www.taucis.hu-berlin.de/content/de/ueberblick/english.php.
[5] Hildebrandt, Mireille and Martin Meints (ed.): RFID, Profiling and AmI, FIDIS Deliverable 7.7., http://www.fidis.net/fileadmin/fidis/deliverables/fidis-wp7-del7.7.RFID_Profiling_AMI.pdf.
[6] SWAMI, http://swami.jrc.es/pages/index.htm.

how to design and implement appropriate safeguards in AmI systems in order to ensure user control and acceptance. To meet this aim SWAMI developed four "dark scenarios", i.e. undesirable scenarios of a possible and realistic AmI environment for the year 2020, in order to highlight potential threats and vulnerabilities. (Dis)trust turned out to be a key issue for AmI applications due to their potential abuse, inadequate profiling, loss of control and discrimination. The problem of dealing with trust in AmI and its translation into "computational trust", Lindner argued, is that trust is a social phenomenon which is still far from being fully understood – trust is mutable, highly context dependent and largely determined by individual characteristics. Given the unclear and fluid nature of trust, Lindner concluded that the incorporation of human trust mechanisms into AmI systems is extremely challenging as even a comprehensive collection of user's data pose the challenge of adequate interpretation. Thus, Lindner raised the question whether the nature of human trust is compatible with "computational trust" which aims to imitate the former. As possible approaches to counter these problems it was recommended 1) to limit computational trust solutions to specific and clearly defined situations, 2) to confine AmI applications to the assistance of users' decisions rather than allowing technical systems to make decisions on their behalf, and 3) to develop non-technical solutions such as independent trust audits and seals, credibility-rating systems, ISO guidelines etc.

Panel Session 3: Assessing User Expectations and Anticipating Practices of Use

This panel session was opened by **Somaya Ben Allouch**, PhD candidate at the Department for Communication Science of the University of Twente. In her talk she presented the findings of two studies on the representation and design of AmI applications for private homes: The guiding question of both studies was how users of AmI are conceptualized by marketing experts and designers. To study the visions and portrayals of users brought by companies and their marketing branches to the public Ben Allouch analyzed the textual and visual content of public relation material promoted by eight companies. To study the assumptions of designers with both a technical and a non-technical background she carried out expert interviews with 27 persons. The study of the textual promotion material showed that slogans of correctedness, easiness, control and personal dominate the representation of AmI while, for instance, privacy and security are not mentioned. Users portrayed in the visual advertisements are mostly represented as male young adults situated in their living room or in front of neutral backgrounds. The interviews with designers revealed that the easy-to-use vision as well as the low interest in privacy issues is shared by them. As target groups the designers approach "people who are highly interested in technology with a lot of affinity in that area and with a bit of money" as Ben Allouch quoted one interviewee. Interestingly the design experts pursue a push strategy and hope that people will get attached to their new AmI environments and therefore complement the ease-of-use vision with usefulness as a crucial characteristic.

Finally, Ben Allouch pointed to her ongoing but not yet finished research which, in a last step of the overall study, examines how users respond to the promises of marketing people and the visions of designers.

A microeconomic perspective on experimental testing of people's responses to the negotiation of privacy in exchange for rebate incentives was presented by **Dorothea Kübler** from the Faculty of Economics and Management at the Technical University Berlin. A first approach proposed by Kübler examines the emergence of mutual expectations concerning the use of technical artifacts in relation to the users´ privacy concerns. This is done by an experimental setup where test persons negotiate privacy contracts. In this approach expectations mediate between user strategies and technology (human-machine-interaction). The second approach draws on economic models of users and investigates by formal modeling the following puzzle: Why do people often share data though they claim to be concerned about their privacy? Finding reference points for collective expectations through formal modeling can contribute to the forecast of consumption patterns.

Matt Jones from the Future Interaction Technology Lab, Department of Computer Science, Swansea University in Wales challenged in his talk some of the key visions of ubiquitous computing and illustrated his arguments by drawing on his recent work in the area of mobile interaction design. Under the slogan "Not making things but making sense of things!" he showed how approaches to enroll people as "cooperating objects" of technically mediated interaction often fail as they do wrongly anticipate a certain style of user behavior as a precondition to make the applications work. Jones used the iPod as an example that innovative technology must not necessarily be hidden because people often like to embrace and display technology. Moreover, he pointed out that users are not technological but ecological people and, thus, do of course use all senses and available resources rather than only the digital. He reported that he and his team do experimentally test new applications that they have developed in order to study user expectations and experiences. As an example for this approach Jones concluded with a hint to an ongoing project, Story Bank,[7] a "sandpit" for participatory planning of human-centered computer technology to enhance life in an Indian village.

A related approach of participatory design was presented by **Dan Shapiro**, Professor of sociology at the Lancaster University, with the EU-funded international project *Palpable Computing: A New Perspective on Ambient Computing* (PalCom).[8] Shapiro explained that palpable computing shall complement the vision of ubiquitous computing: paradigms of invisibility, automation, or heterogeneity shall be complemented – or even replaced for selected applications – by visibility, user control and coherence. To address real needs when developing ICT applications the PalCom-project employs an interdisciplinary design

[7] Story Bank, http://cs.swan.ac.uk/storybank/index.php.
[8] Palpable Computing. A New Perspective on Ambient Computing. PalCom, http://www.ist-palcom.org/.

approach which integrates computer scientists, engineers, product designers and sociologists. As a test case PalCom studied work practices and the use of pilot devices and applications in a training situation for disaster management and victims treatment at the Major Incidents Future Lab in Aarhus (Denmark) in September 2005. In this test case several typical situations and settings such as the on-site use of biomonitors for victims, a medical coordination center or a surprise emergency drill were simulated. The (inter)actions of personnel and technology were studied by different methods of social research. To examine what needs to be done, for instance, to make biomonitors or visualization technologies useful the involved medical and emergency staff were asked what they need and how they assess the technology. Thus, Shapiro and his colleagues, found that their test persons demand solutions to confirm the correct association of biomonitors (solved by blinking in a synchronized pattern), on-site staff claiming that they need to control cameras for supervision by themselves, or command-and-control personnel in need to validate incoming information. What was more, to go beyond this interview-based approach of participatory design the team of sociologists studied situations by video-supported ethnographic observation to unveil more or less subconscious individual behavior and collective interaction that is also crucial for dealing with emergencies. To demonstrate the importance of such (inter)actions and the ethnographic method as a tool of its analysis Shapiro showed the "dance" of a firemen and an emergency doctor: With subtle gestures ("embodied conduct") both display their "overview" and understanding to each other and the other people on the scene. Drawing on this example of involved human behavior and coordination in (extra)ordinary situations Shapiro concluded that it is always more complicated than it seems at a glance. Therefore he recommended that developers and designers should keep their applications specific and simple in order to avoid problems by unsuccessfully simulating and substituting complex social interaction. Moreover, Shapiro concluded, they should never deliver fixed and final solutions but first test them with potential users.

Panel Session 4: Calibrating the Distribution of Agency in Human-Machine-Interaction

In his introduction to the fourth panel session **Werner Rammert** raised the question how to balance the cooperation of humans and objects. To approach this question he firstly described trends in the recent development of socio-technical constellations. According to Rammert technology becomes increasingly active, mobile and cooperative. Passive instruments and isolated, strongly coupled systems are replaced and superimposed by cooperating ensembles and open networks of learning and highly complex and loosely coupled chains of action. Secondly, Rammert developed a typology of agency levels of technical objects, i.e. passive, semi-active, pro-active, co-operative and trans-active objects. With the emergence of the advanced types of technical objects, he argued further, relations between people and objects change and move from the

instrumental use of craft tools or machines to the interactive communication in which intelligent agents assist, offer services and profile users, thus, transforming the human-machine relations into more complex and contingent inter-activity. Thirdly, Rammert outlined levels of agency and their respective grades. 1) *Causality* on a continuum between short-time irritation and the permanent restructuring of action 2) *contingency* on a continuum between the selection of pre-selected and the self-generation of actions, and 3) *intentionality* on a continuum between the ascription of simple dispositions and the guidance by complex semantics. Finally he concluded that the emergence of distributed agency in socio-technical constellation implies the distribution of control. The consequence for design, according to Rammert, is to decide the following questions: How much agency should be assigned to the objects? How autonomous should be the networked systems? What should be the media and loci of control? Given the wide range of options, such as technically implemented control, self-monitoring, transparency for the user or regulatory institutions, Rammert recommended, to tune and test the interactivity before marketing final solutions.

Mireille Hildebrandt, lecturer for law and legal theory at the Erasmus University Rotterdam and senior researcher at the Institute of Law Science Technology and Society at Vrije Universiteit Brussel, contributed to the issue of the distributed agency in cooperating objects environments by informedly speculating about the legal implications of IBM´s vision of "autonomic computing". Hildebrandt explained that IBM claims autonomic computing to be the solution for the complexity that arises from the rise of networked environments. The visions entails the development of computer systems that are capable of self management, self configuration, self optimization, self healing and self protection in order to prevent a breakdown and to facilitate real time adaptive environments being able to cater to our inferred preferences without human intervention. In face of this vision Hildebrandt considered the challenges that emerge when it becomes impossible to attribute criminal liability to any node in an intelligent hybrid system which may require us to qualify the network as a whole as the responsible actor. Hildebrandt argues that in as far as artificial intelligence does not develop self-consciousness it lacks the capacity to reflect and this means that censure and punishment make no sense, unless they are understood as mere discipline. Next to this she explores the issue of technological normativity and discusses the way in which technological devices and infrastructures can constrain our actions in comparison to the way legal norms achieve this. Hildebrandt warns that we should think twice before introducing technological infrastructures that enable unaccountable consequences. She concludes that the legal-political implications of multi-agent intelligence at this point will be the need for democratic legitimization and the invention of new ways to organize democratic participation at an early stage of the introduction of new technologies.

Michael Decker, Vice Director of the Institute for Technology Assessment and System Analysis (ITAS) at the Research Centre Karlsruhe, presented the lessons learned from

technology assessment (TA) of robotics in order to gain insights into cooperating objects as another field of emerging non-passive technology. Decker reported that robots are among the rare technical systems that have already been comprehensively described and discussed in terms of their possible construction and effects before actually being built. However, recent developments in robotics, Decker continued, make the replacement of humans in formerly untechnicized contexts more likely in the near future. In order to develop criteria to assess the replaceability of humans by robots in specific contexts of action an interdisciplinary expert group met monthly for intense discussion over a period of two years in a TA-project[9] coordinated by Decker. The group discussed issues of technical, economic, legal and ethical replaceability. Decker's presentation highlighted the findings concerning the issue of responsibility and liability: Who is liable for damage caused by a robot? Do robots require special equipment for "unexpected" encounters with laypersons? Is it necessary to prepare people for the possibility of such encounters? Are there additional aspects to be considered for "learning" robots? Do contexts exist in which the integration of robots should be excluded by modern societies, e.g. in the domains of geriatric care or the education of children? Decker reported that several recommendations were made regarding the issue of unpredictability of learning robots. Among others it was proposed to enable the robot user by technical means to take over responsibility for the robot action: The robot should indicate what it has identified as "worth to learn" and the robot user should need to explicitly accept this proposal, if the robot should learn that task. But Decker finally reminded that such transparent learning algorithms are, on the other hand, likely to cause problems which are rooted in one of the basic challenges of artificial intelligence: They might lack context awareness.

Panel Session 5: Managing Complexity in Socio-Technical Networks of Cooperating Objects and Humans

The presentation of **Johannes Weyer** dealt with hybrid systems, where human actors and non-human agents meet and interact. Weyer showed that the release of smart technology may lead to a transformation of society and consequently asked how social order emerges in hybrid systems. Discussing different sociological concepts, he identified two modes of governance: central control and decentralized self-organization. But, Weyer continued, smart technology allows to go beyond this traditional distinction. Referring to a case study on collision avoidance in aviation (and especially the mid-air collision at Überlingen in 2002), he showed that hybrid systems create new opportunities, but entail new risks as well, especially because of the new relation between man and (smart) machine. Weyer argued that the release of smart agents seems to intensify well-known problems of automation, especially if systems get out of control, and concluded that aviation is one of the societal fields, where experiments with new modes of

[9] *Robotik. Optionen der Ersetzbarkeit des Menschen*, Europäische Akademie Bad Neuenahr-Ahrweiler GmbH. TA-Nachricht zu dem Projekt unter: http://www.itas.fzk.de/deu/tadn/tadn993/deck99a.pdf.

governance currently take place that combine features of central control and decentralized self-organization.

Another complex system and the problems of its management were presented and discussed by **Leon Hempel**, researcher at the Center for Technology and Society at the Technical University Berlin. Hempel´s case study was the extensive CCTV [10] surveillance system operated by the Traffic Policing Enforcement Directorate of Transport of London. Given the number of several thousand surveillance cameras both deployed fixed at roadsides and mobile on public busses or in cars and vans of the Enforcement Directorate Hempel noted that the highly centralized system is already ubiquitous. Moreover, in the near future the surveillance systems of all London Transport services will be integrated into the Traffic Police Enforcement Directorate, including the CCTV systems of the Underground, the river services, the traffic congestion scheme etc. Given the convergence of these CCTV systems and, what is more, their convergence with other surveillance and monitoring technologies, such as tracking devices, location sensors and Geographic Information Systems Hempel coined the term the "enforcement assemblage" thus referring to Haggerty and Ericson (2000) who borrow Gille Deleuze´s notion of the "assemblage" in which traditional forms of hierarchic integration of individual components is being replaced by rhizomatic networks. Hempel showed that the CCTV network despite its ubiquitous and technologically sophisticated character is not necessarily fit for purpose and very difficult to manage. In particular learning effects of the environment challenge the static character of its main components. Responding to these problems often entails new management problems that contradict the original purpose.

[10] CCTV stands for *closed-circuit television* the British term for video surveillance.

Conclusion

This final chapter aims firstly to highlight and summarize central questions and key issues which were repeatedly mentioned and discussed in presentations and discussions of the workshop. Secondly, it will discuss the wide range of methodological approaches, their contributions and shortcomings. Finally, it will suggest to rethink design principles and to consider the social aspects of cooperating objects and related technologies. This new paradigm of socio-technical design directs towards a shaping of technology informed by computer and engineering sciences as well as social research.

Defining the Research Subject(s)

The problem and advantage that social researchers face when approaching the emerging technologies known as cooperating objects, ubiquitous computing or ambient intelligence is that they most often have to study pilot applications, application scenarios, concepts and visions rather than stable technical artifacts embedded into everyday life. The clear advantage is that social research has the opportunity to have a say, become involved into the process of design and shape technologies and thus the societies embracing these. On the other hand the obvious problem is that the subject of research is vague and hard to determine, and therefore resists empirical analysis and instead nurtures informed speculation.

In his concluding remarks Albert Kündig noted that the terms ubiquity and/or pervasiveness are often used without specifying to what they relate. While it hardly contested that they apply to the level of basic technology (hardware or software) and the basic data transport functions (network protocols such as IP, UDP or TCP), the labels ubiquitous and pervasive become problematic when talking about standard platforms which provide unified application programmers interfaces, or about the application layer that suggests cooperating objects with a rich functionality and universally accepted standards. In addition, Kündig reminded that technology assessment should focus on applications rather than on technology. Making judgments on the advantages and drawbacks of networked ubiquitous computing is only reasonable when the subject of reflection is clearly defined and limited to particular contexts.

However, to allow an assessment not only of very specific and unique applications but also at a more general level Kündig called for the development of clear taxonomies and typologies. As a good starting point he recommended the concepts for defining the degrees of autonomy and levels of agency as contributed by Rammert and Schulz-Schaeffer (2002).

Not Making Things but Making Sense of Things: In Search of Usefulness and Usability

"Not making things but making sense of things!" is the leitmotif of Matt Jones´ research at the Future Interaction Lab in Swansea. Jones, Kündig and others reminded that the seductive visions of scientists and engineers are not necessarily attractive and useful for John and Jane Doe. Ben Allouch showed that marketing departments and designers who currently develop AmI applications target a "creamy layer" who skillfully embraces new technologies. The demands and needs as well as the abilities and skills of these segments of the population are not necessarily the same as those of the less affluent, less techno-savvy people (not to speak about the poor and illiterate population of the world) who might be envisaged as users when investors, products and applications are in search of mass markets. Therefore developers should avoid charging such new technologies with extremely positive connotations which might at the end disillusion users and scare off customers.

Kündig rose the question what the "Model T" [11] of pervasive computing might be and recommended to learn from past "killer applications" such as the telephone, the personal computer and the World Wide Web. He gave the hint that all these cases leave the "tricky" problems associated with the application of these tools to the user – meaning that problems due to cultural or linguistic diversity, application-specific rules etc. are overcome by exploiting the still unmatched human cognitive and intellectual capabilities.

Protecting Privacy and Building Trust

Another issue that frequently came up throughout the workshop was, not surprisingly, the issues of privacy, data protection and trust. Current developments in computing direct towards the collection and processing of an increasing quantity of personal data and, what is more, are in search of new qualities of data (e.g. biometric identifiers extracted from the human body or very intimate data displaying emotions and thoughts). They therefore pose a serious challenge for efforts to protect privacy and personal data. However, it is often pointed out that among human rights privacy is perhaps the most difficult to define (e.g. Lyon 1994: 14-17). Even Warren and Brandeis´ classic and very basic definition of privacy as the "the right to be let alone" raises the questions when people and users wish to exercise this right and when not, and under which conditions they are willing to accept disturbance in exchange for economics or other benefits. It is clear that privacy in this very informal and personal sense is nothing fixed but is highly contingent upon the specific context. What people are willing to reveal about their multi-layered identity and self depends on their trust in and their knowledge about the addressee of this information.

[11] Here Kündig was referring to Henry Ford´s "Model T" which was the first car produced in assembly lines and of which 15 million units were sold between 1908 and 1927.

In networked ubiquitous computing environments data might be collected of even very simple and insignificant incidents that might be never forgotten by the hardware memories of huge databases, they could be combined, sorted and reinvented by sophisticated algorithms and transferred at a global scale to other entities for further processing for unknown purposes. It is obvious that such complex multi-lateral systems of data processing resist attempts (not only by the common user) to know and understand their underlying purposes and rationales. Given this it seems very difficult to request users to make informed decisions about revealing their personal data and to generate trust in these new systems. And even if opt-in decisions are offered the multitude and complexity of choices in smart environment might simply overwhelm the users.

Besides traditional approaches to adapt data protection legislation to the new challenges other solutions for these problems were discussed at the workshop: Tentative concepts were presented such as "transparency enhancing technologies" which unveil how options are offered and, thus, enable a user response, or "ambient law" which inscribes legal requirements (such as the minimization of data) into technology and operation procedures. To reduce the complexity of decision making it was proposed to make systems simple and enable users to choose pre-defined privacy profiles which can be automatically cross-checked when entering a new environment of ambient intelligence or even to simply offer non-technical solutions. However, it became clear that the development of future applications cannot be left to the market alone because, as for instance Ben Allouchs presentations showed, permanent privacy violations are likely when suppliers pretend to offer trustworthy applications being in fact invasive only to generate their markets. While ethical and legal considerations might be the starting points to protect privacy and build trust in smart environments, questions of how to adequately communicate information about the privacy implications of applications and how to enable different types of user groups to make a deliberate choice about the fate of their data requires more than that and should also be part of design considerations.

Distributing and Locating Responsibility and Liability

An issue partly overlapping with privacy and trust that draw the attention of the workshop was the changing nature of responsibility and liability in socio-technical environments of distributed agency. It was consensus among the experts that it will become impossible to assign responsibility for faults or malfunctions to individual human or technical components of the extensive networked systems of cooperating objects and related technologies. Though Hilty pointed out that the increasing capability to log and track activities in such systems could help to reconstruct events in the aftermath of a possible disaster, Hildebrandt's and Weyer's case study of the plane crash in Überlingen showed that disasters might occur even when each component is working properly if different governance regimes interfere.

From a legal perspective a simple solution to the problem could be to attribute liability to service providers or users and thus urge them to cautiously select their applications. Decker, on the other hand, showed that the solution to make users responsible for their learning robots might cause new problems: The safeguard to request decisions by users regarding learning algorithms might, on the one hand, help to make their actions transparent and calculable, while limiting a key function of learning robots, i.e. context awareness. What is needed is a careful assessment of how to distribute agency in human-machine-interaction. Fair and reasonable decision about this issue will be highly contingent upon context and application and therefore require detailed research.

Bridging the Digital Divide and Being Sensitive to Digital Discrimination

While Pias already mentioned the challenge to bridge the digital divide in terms of access of all sexes, generations, classes and geographical areas to ICT at the very beginning, another issue touching the broader question of social justice came up in the course of the workshop. Digital discrimination, the automated social sorting and prioritizing of user preferences and needs, was demonstrated by Lindner when he gave the example of two users with different preference for lighting or temperature entering a room in a smart building. Given such as situation the system steering the relevant conditions will be required to make a decision: It can opt either for the lower or the higher temperature, or it can opt for a compromise found in between the two user preferences with both of them eventually feeling uncomfortable.

While the example might be trivial it illustrates the general problem and it is clear that scenarios with more serious implications for the users can be envisioned. Though the problem of right choice itself is not generated by the smart home but by different user preferences, the automation of environmental adaptation might hinder the dynamic negotiation between the users. Thus, visions of social relations, status and power that are intentionally or unintentionally inscribed by engineers and software programmers into design and code might be cemented and petrified over time and space (cf. Lyon 2003; Graham & Wood 2003). As these issues are closely related to issues of responsibility it is again serious research that should inform decision making and design.

Contributing to Ecological Sustainability

Several presentations addressed the issue of sustainability – with contradictory scenarios. Pias talked about the promises of ubiquitous computing to help saving energy, water and other essential resources. Hilty noted that energy consumption might rapidly increase in face of the rising power demand for network servers and other infrastructures that are supposed to be on(line) 24 hours a day at seven days a week. Furthermore, the spread of millions of very small components or devices might result in the inevitable diffusion of smart but toxic dust causing an irreversible loss of resources and serious environmental

pollution. This scenario would be the culmination of what was described by the economist Nicholas Georgescu-Roegen as the law of entropy in economical process. If and how ideas of modular design and self-healing or redundant sensors will contribute to prevent such undesirable scenarios is a question for further research.

Methodological Challenges

Many methodological approaches to study and assess the social aspects and implications of cooperating objects and related technologies have been presented in the course of the workshop: scenario building, expert interviews with marketing people, developers and users, media analyses and ethnographic observation. The networked character of the emerging technologies at stake and the problems to limit analyses pose a serious challenge to traditional methods of TA and technology studies.

Studies of cooperating objects technologies and applications demand a multi-method approach combining instruments from historical analyses, laboratory studies, user surveys and forecast. Each method has its advantages and drawbacks: For instance, scenario building – even if the scenarios are supposed to be realistic and likely – means to reduce the complexity of a possible future and therefore poses the threat to miss crucial issues. For expert and user interviews the selection of the interviewees is of crucial importance in particular when used as an oracle to forecast future developments of make choices about technology to be implemented. Ethnographic observations could make an important contribution for testing and tuning pilot applications, as Dan Shapiro showed, but they need an actual test case which is often missing. This eventually leads us again to scenario building tools despite their shortcomings. The right choice of methodology is depending on the respective application and field of research.

Rethinking Design Principles

Many speakers have mentioned that design paradigms developed in the context of ubiquitous computing and AmI do not meet the purpose of particular applications. Visibility was mentioned as being of crucial importance for some devices to satisfy demands for representative aesthetics and as essential for CCTV cameras to deter certain types of behavior. The need to validate information and correct functioning of a technical system in emergency situations – activating empowerment rather than seductive convenience, as Rammert put it – challenges the paradigm of peripheral operation but claims for tangible, physically present technology.

To neglect such issues might result on the one hand in the development of useless products and applications which simply fail to generate a market and finally prove as a waste of money. On the other hand such ignorance might turn out as user nightmares when, for instance, applications are imposed on people in a top-down approach by technophile managers dazzled by spin doctors of the supplying companies.

Identifying the areas where it is crucial to choose between competing design principle and finding the balance between them in order to meet real user needs and improve human life instead of revolutionizing it into confusion is therefore a serious challenge for the future development of cooperating objects and related technologies. Mastering this challenge will also need sociological and anthropological rather than simply technical expertise. Only by trying to understand these different perspectives we will be able to see where we are heading and how new socio-technical constellations might evolve. Kündig noted in his concluding remarks that this is a prerequisite for the success of new technologies because the past has shown that wishful thinking alone does not suffice: Potential users must be convinced that behind all marketing hype there are people who know about the pros and cons, and use their knowledge in proper socio-technical design.

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Annex

Workshop Program

Wednesday | November 1, 2006

1:00 pm | Introduction

- Prof. Dr. Adam Wolisz
  Telecommunication Networks Group, Institute for Telecommunication Systems, Technical University Berlin
  Welcome Note: Introducing "Embedded WiSeNts" and Aim of the Workshop

- Prof. Dr. Werner Rammert
  Centre for Technology and Society, Technical University Berlin
  Rationale and Organization of the Workshop

- Dr. Marcelo Pias
  Computer Laboratory, Digital Technology Group, University of Cambridge
  Cooperating Objects and Wireless Sensors: The Impact of the Technical Visions on Society. A Framework for Discussion

2:00 pm | Panel 1: Grand Challenges. A Review of Recent Surveys

- Prof. em. Dr. Albert Kündig
  Swiss Federal Institute of Technology Zurich and Member of TA-Swiss Steering Committee
  Incapacitated Cyborgs? Approaches to the Systematic Assessment of Pervasive Computing

- Prof. Dr. Lorenz Hilty
  Department for Technology and Society, EMPA St. Gallen
  Social and Environmental Aspects of Pervasive Computing

- Prof. Dr. Ernst Andreas Hartmann
  Head of Socio-Economic Section, VDI/VDE Innovation + Technik GmbH
  Ubiquitous Computing - Developments and Impacts

3:30 pm | Coffee Break

4:00 pm | Panel 2: Governing Risk, Privacy and Trust in Cooperating Objects Environments

- Dr. Martin Meints
  Independent Center for Privacy Protection Schleswig-Holstein, Kiel
  Technical Concepts of Ubiquitous Computing and Potential Legal Consequences
- Stephan J. Engberg
  Priway - Security in Context
  (This presentation was cancelled as weather conditions hindered Engberg to participate)

Security and Dependability in a World of Ubiquitous Computing. From Identification to Context Adaptable Recognition

- Dr. Ralf Lindner
  Fraunhofer Institute for System and Innovation Research, Karlsruhe
  Trust in a World of Ambient Intelligence

5:30 pm | End of Day I

7:30 pm | Workshop Dinner

Thursday | November 2, 2006

9:00 am | Panel 3: Assessing User Expectations and Anticipating Practices of Use

- Somaya Ben Allouch
  Department of Communication Science, University of Twente
  Ambient Intelligence in Private Spaces. The Confrontation of Design and Use

- Prof. Dr. Dorothea Kübler
  Microeconomics, Faculty of Economics and Management, Technical University Berlin
  Ubiquitous Computing and Economic Experiments - A Perspective

- Dr. Matt Jones
  Future Interaction Technology Lab, Department of Computer Science, Swansea University
  Mobile Interaction Design

- Prof. Dr. Dan Shapiro
  Sociology Department , Lancaster University
  Designing Ubiquitous Computing: Palpability and Participation

11:00 am | Brunch

12:00 am | Panel 4: Calibrating the Distribution of Agency in Human-Machine-Interaction

- Prof. Dr. Werner Rammert
  Center for Technology and Society, Technical University Berlin
  Distributed Agency and Control in Socio-Technical Constellations: How to Balance the Cooperation between Humans and Objects?

- Dr. Mireille Hildebrandt
  Center for Law, Science, Technology and Society Studies, Free University Brussels
  Distributed Agency and Legal Responsibility. Speculations about the Legal Implications of Autonomic Computing

- PD Dr. Michael Decker
  Institute for Technology Assessment and System Analysis, Karlsruhe

Autonomous Controlling of Sensors and Actors. Lessons learned from Human-Robot-Interaction

1:30 pm | Panel 5: Managing Complexity in Socio-Technical Networks of Cooperating Objects and Humans

- Prof. Dr. Johannes Weyer
  Sociology of Technology, Department for Economics and Social Science, University Dortmund
  Managing Complexity. Risks and Challenges of Hybrid Systems

- Dr. Leon Hempel
  Center for Technology and Society, Technical University Berlin
  Organizing (Visual) Surveillance: CCTV, Image Processing and Data Management in Public Transport

2:30 pm | Concluding Remarks and Final Discussion

- Prof. em. Dr. Albert Kündig
  Swiss Federal Institute of Technology Zurich and Member of TA-Swiss Steering Committee

3:30 pm | End of Day II

List of Participants

Name	Institution	Email
Somaya Ben Allouch	Department of Communication Science, University of Twente	s.benallouch@utwente.nl
Andras Budavari	Center for Technology and Society, Technical University Berlin	andrasbudavari@gmx.de
PD Dr. Michael Decker	Institute for Technology Assessment and System Analysis, Karlsruhe	Michael.Decker@itas.fzk.de
Laura Marie Feeney	Computer and Network Architecture Laboratory, Swedish Institute of Computer Science	lmfeeney@sics.se
Michael Hahne	Center for Technology and Society, Technical University Berlin	hahne@ztg.tu-berlin.de
PD Dr. Ernst Andreas Hartmann	Socio-Economic Section, VDI/VDE Innovation + Technik GmbH	Hartmann@vdivde-it.de
Dr. Leon Hempel	Center for Technology and Society, Technical University Berlin	hempel@ztg.tu-berlin.de
Prof. Dr. Mireille Hildebrandt	Center for Law, Science, Technology and Society Studies, Free University Brussels	hildebrandt@frg.eur.nl
Prof. Dr. Lorenz Hilty	Department for Technology and Society, EMPA St. Gallen	Lorenz.Hilty@unisg.ch
Mario Hoffmann	Fraunhofer SIT	mario.hoffmann@sit.fraunhofer.de
Dr. Matt Jones	Future Interaction Technology Lab, Department of Computer Science, Swansea University	always@acm.org
Corinna Jung	Center for Technology and Society, Technical University Berlin	jung@ztg.tu-berlin.de
Tom Kramer	Center for Technology and Society, Technical University Berlin	tom@zughafen.de
Prof. Dr. Dorothea Kübler	Microeconomics, Faculty of Economics and Management, Technical University Berlin	d.kuebler@ww.tu-berlin.de
Prof. em. Dr. Albert Kündig	Swiss Federal Institute of Technology Zurich and TA-Swiss Steering Committee	kuendig@tik.ee.ethz.ch
Dr. Eva Maria Lijding	Embedded Systems, University of Twente	M.E.M.Lijding@ewi.utwente.nl
Dr. Ralf Lindner	Fraunhofer Institute for System and Innovation Research, Karlsruhe	Ralf.Lindner@isi.fraunhofer.de
Gaia Maselli	CS Dept., Rome University "La Sapienza"	maselli@di.uniroma1.it
Dr. Martin Meints	Independent Center for Data Protection Schleswig-Holstein, Kiel	ld102@datenschutzzentrum.de
Martin Meister	Center for Technology and Society, Technical University Berlin	meister@ztg.tu-berlin.de
Dr. Marcelo Pias	Computer Laboratory, Digital Technology Group, University of Cambridge	marcelo.pias@cl.cam.ac.uk

Irina Piens	Telecommunication Networks Group, Institute for Telecommunication Systems, Technical University Berlin	piens@prz.tu-berlin.de
Jörg Potthast	Social Science Research Center Berlin	potthast@wz-berlin.de
Prof. Dr. Werner Rammert	Center for Technology and Society, Technical University Berlin	werner.rammert@tu-berlin.de
Dr. Kay Römer	Institute for Pervasive Computing, ETH Zurich	roemer@inf.ethz.ch
Silvia Santini	Institute for Pervasive Computing, ETH Zurich	santinis@inf.ethz.ch
Fabia Schäufele	Institute for Sociology, Technical University Berlin	fabia.schaeufele@tu-berlin.de
Dr. Ingo Schulz-Schaeffer	Institute for Sociology, Technical University Berlin	schulz-schaeffer@tu-berlin.de
Prof. Dr. Dan Shapiro	Sociology Department , Lancaster University	d.shapiro@lancaster.ac.uk
Jonas Spengler	Institute for Sociology, Technical University Berlin	jonas.spengler@tu-berlin.de
Eric Töpfer	Center for Technology and Society, Technical University Berlin	toepfer@ztg.tu-berlin.de
Rene Tuma	Institute for Sociology, Technical University Berlin	rene_tuma@web.de
Prof. Dr. Johannes Weyer	Sociology of Technology, Department for Economics and Social Science, University Dortmund	johannes.weyer@uni-dortmund.de
Prof. Dr. Ing. Adam Wolisz	Telecommunication Networks Group, Institute for Telecommunication Systems, Technical University Berlin	awo@ieee.org

Short Bios of Invited Speakers in Alphabetical Order

Somaya Ben Allouch is a PhD candidate at the New Media and Communication group at the University of Twente, the Netherlands. Her research focuses on the design and use of (new) media and ICT. In her PhD project she looks specifically at the design and use of ambient intelligent applications.

Michael Decker, PD Dr rer. nat., studied physics (minor subject economics) at the university of Heidelberg, 1992 diploma, 1995 doctorate with a dissertation on temperature measurements in high pressure combustion by laser-techniques at the university of Heidelberg, 1995-1997 scientist at the German Aerospace Center (DLR) in Stuttgart, 1997-2002 member of the scientific staff of the Europäische Akademie GmbH. He was manager of the project "Robotics. Options of the replaceability of human beings" and the study group "Miniaturization and Material Properties". He coordinated the EU-Project TAMI (Technology Assessment in Europe. Between Method and Impact). Since 2003 he is member of the scientific staff and since February 2004 vice-director of the Institute for Technology Assessment and System Analysis (ITAS) at the Research Centre Karlsruhe, 2006 habilitation at the faculty of applied sciences of the university of Freiburg with a study on interdisciplinary research for technology assessment. He chairs the coordination team of the German-speaking Network Technology Assessment. Main research areas: TA of robotics, pervasive computing and nanotechnology, comparison of TA-methods and interdisciplinary research for policy advice.

Stephan J. Engberg is member of the Strategic Advisory Board of the EU ICT Security & Dependability Taskforce and as such involved in roadmapping and writting the Recommendations Report. He is founder of Priway and the spin-off company RFIDsec based on a private research project "Privacy Highway" focussing on ways to reconcile the security requirements in both ambient and integrated digital networks. Priway is partner in a IST IP project HYDRA on Networked Embedded Systems and has been involved in EU Security and Identity Roadmapping since pre-FP6 and a range of workshops and conferences such as Trust in the Net, SWAMI, Public Services Summit, NATO Advanced Research Workshop and the upcomming EU-US Cybertrust Workshop on System Dependability & Security. Engberg holds an M.Sc. in Business Adminstration and Computer Science at Copenhagen Business School together with studying International Strategy at Londong Business School. He has been lecturing at Copenhagen Business School and the IT University for a number of years on Trust Socio/Economics and Context Security especially in mobile environments. He is dedicated to the work of designing Empowerment & Dependability into ICT systems for the purpose of balanced trustworthiness.

Ernst Andreas Hartmann, Prof. Dr., is Head of the Socio-Economic Section of the Association of German Engineers' VDI/VDE Innovation + Technik GmbH and Acting

Professor for Psychology at the Department for Ergonomics and Work Science at the University of Magdeburg.

Leon Hempel, Dr., studied German, Comparative Literature and Political Science at the Technical University Berlin. After his graduation in 1999 he started to work at the Centre for Technology and Society. At the Center he was involved in the EU-funded projects TeleCityVision (2000-2001) and Urbaneye (2001-2004) that analysed the impacts of ICT for urban changes, respectively video surveillance in public accessible space. He finished his PhD thesis in 2004 and published in "Bild – Raum – Kontrolle" (with Jörg Metelmann, Frankfurt/Main: Suhrkamp, 2005), an anthology about video surveillance. Hempel currently evaluates CCTV systems of several transport systems in London and Berlin.

Mireille Hildebrandt, Dr., teaches law and legal theory at Erasmus University Rotterdam. In 2002 she wrote her PhD thesis in the field of criminal procedure and legal philosophy, with special focus on issues of epistemology. From 2002 she has been seconded as senior researcher to the institute of Law Science Technology and Society at the Vrije Universiteit Brussel to participate in a multidisciplinary research project on the relationship between law, technology and democracy, supervised by Serge Gutwirth, Bruno Latour and Isabelle Stengers. She is involved in the European Network of Excellence on the Future of Identity in Information Society (FIDIS) as a coordinator for the subject of profiling technologies. From 2003-2006 she also taught comparative legal traditions of the world in the LLM Program on International Legal Cooperation at the Vrije Universiteit Brussel.

Lorenz Hilty, Prof. Dr. rer. nat., head of the Technology and Society Lab at the Swiss Federal Laboratories for Materials Testing and Research (Empa) and lecturer at the University of St. Gallen (HSG), studied Computer Science and Psychology at Hamburg University and received his Ph. D. in 1991. In 1998, he became a Professor for Information Systems at the University of Applied Sciences Northwestern Switzerland. In 2000, he initiated the research program "Sustainability in the Information Society" (SIS) at Empa, co-funded by the ETH board (2001-2005), from which the Technology and Society Lab emerged in 2004. Lorenz Hilty is the vice chair of the Technical Committee "Computers and Society" of the International Federation for Information Processing (IFIP TC 9) and member of the board of the Swiss Informatics Society (SI). He is the author of many influential publications in the field of environmental and social impacts of ICT, including the study "The Precautionary Principle in the Information Society", commissioned by the Swiss Center for Technology Assessment (TA-SWISS).

Matt Jones, Dr., has recently moved from New Zealand to Wales where he is helping to set up the Future Interaction Technology Lab at Swansea University. He has worked on mobile interaction issues for the past ten years and has published a large number of articles in this area. He is the co-author (with Gary Marsden) of Mobile Interaction Design (John Wiley & Sons, 2006). He has had many collaborations and interactions with

handset and service developers including Microsoft Research, Orange, Reuters, BT Cellnet, Nokia and Adaptive Info; and has one mobile patent pending. He is an editor of the "International Journal of Personal and Ubiquitous Computing" and on the steering committee for the "Mobile Human Computer Interaction" conference series.

Dorothea Kübler, Prof. Dr., is Chair in Microeconomics at the Faculty of Economics and Management of the Technical University Berlin. She studied Economics at the University of Konstanz and the Free University Berlin, and finished her PhD thesis at the Humboldt University Berlin in 1997. After fellowships and research visits in Berkeley, Bergen and Harvard she became Assistant at the Institute for Economic Theory of the Humboldt University Berlin where she submitted her habilitation in 2003. Her main research interests are game theory, information economics, and psychology and economics. She is currently leading the research project "Strategic uncertainty in experimental games" funded by the German Science Foundation DFG.

Albert Kündig, Prof. em. Dr., received MS degrees from Swiss Federal Institute of Technology ETH Zurich (Electrical Engineering) and Harvard University (Applied Physics) in 1961 and 1964 resp., and a PhD from ETH in 1974. At the former Swiss PTT research lab, he participated in an effort to build one of the first experimental digital switching systems. From 1972 to 1983, he took gradually more responsibilities in the Swiss PTT research division. Kündig joined the ETH Department of Information Technology and Electrical Engineering as Professor for Systems Engineering in 1983. His research interests centered on multimedia communication in high performance networks, and design and development methodology for real-time highly dependable systems. Albert Kündig retired from ETH in 2002, however continuing with research in the history of technology and studies regarding the impact of information technology on society, economy and culture. His association with the Technology Assessment board of the Swiss Council for Science and Technology reflects his keen interest in this field.

Ralf Lindner, Dr., joined the Fraunhofer Institute for Systems and Innovation Research (ISI) as a project manager and senior scientist at the department of Emerging Technologies in 2005. He received his degree in political science and economics from the University of Augsburg, completed graduate work at the University of British Columbia (Vancouver) and post-graduate studies at Carleton University (Ottawa). His doctoral dissertation, which he completed at the department of political science at the University of Augsburg, focuses on the application and integration of digital networks in the communication strategies of intermediary organizations in North America. He is particularly interested in the diffusion processes of ICTs, emerging and future trends of media convergence and ubiquitous networks. Additional research interests include cognitive policy analysis, epistemic communities and processes of policy learning. Among his projects at the Institute are SWAMI (Safeguards in a World of Ambient Intelligence) and FAZIT (Foresight for future media and ICT sector trends).

Martin Meints, Dr., studied chemistry and computer science at the University Kiel. He worked in various enterprises and public organizations as IT project manager and in technical management functions. Main focus of his latest work was preparation and implementation of security concepts for large private networks (LAN and WAN) and integrated mobile computing solutions basing on the methodology of the Baseline Protection Manual from BSI, the German Federal Office for Information Security. Since 2004 researcher for the Independent Centre for Privacy Protection Schleswig-Holstein (ICPP); he is mainly involved in the project "FIDIS - Future of Identity in the Information Society".

Marcelo Pias, Dr., has been a Research Associate in the Computer Laboratory at the University of Cambridge (UCL) since Sept. 2004. In his prior post doctoral position at Intel Research Laboratories Cambridge, he worked on decentralized P2P systems and wireless sensor networks. He obtained a BEng in Computer Engineering from FURG (Brazil) in 1999 and a PhD degree in Computer Science from UCL in February 2004. He is involved in two wireless sensor projects: SESAME - SEnsing for Sport And Managed Exercise is a UK EPSRC project that aims at tracking the performance of athletes in sports events, and the EU funded Embedded WiSeNts project is preparing a research roadmap in the area of wireless sensor systems for the EC.

Dan Shapiro is Professor of Sociology at Lancaster University in the United Kingdom. He is co-author of five books and many papers. He has a longstanding track record of research in the ethnographic study of social practice to inform the design of information systems, in participatory design and evaluation with end users, and in interdisciplinary theory for information system design and spatial computing. He has been a principal researcher on a succession of EU funded projects since 1995 on computer-supported cooperative work, collaborative working environments, spatial computing, and ambient computing.

Werner Rammert, Prof. Dr., is Professor for Sociology and Technology Studies at the Technical University of Berlin and Speaker of the Centre for Technology and Society since 1999/2000. After his degree in Sociology he served as Research Fellow and Assistant at the Universities of Bochum and Göttingen and Lecturer in Sociology at Bielefeld. Rammert passed his PhD in 1981. His Habilitation in Sociology was granted in 1988. He was appointed to the position of a Full Professor for Sociology at the Free University Berlin in 1991. Later he changed to the Technical University of Berlin, where is Professor of Sociology and Technology Studies. Rammert held guest lectures at the universities of Vienna, Bradford, Birmingham, Paris, Montreal, Trondheim, Basel, Zurich and Copenhagen, acted as research director of various programs and co-edits the yearbook “Technology and Society” since 1982. Special areas of research interest are the assessment of information and communication technologies, innovation and organizational

learning and the newly created research field of Socionic, the inquiring and modeling of artificial societies.

Johannes Weyer, Prof. Dr., is Professor for Sociology of Technology at the Department for Economics and Social Science of the University Dortmund. He studied at the University Marburg and made his doctorate in 1983 with a dissertation on the history of German sociology after 1945. From 1984 to 1999 he was assistant Professor at the University of Bielefeld in the field of science and technology studies. In 1991 he completed his habilitation with a study on space policy in Germany from 1945 to 1965. After three years in a consultant firm for e-logistics he was appointed Professor in Dortmund in 2002. His main research interests are: social shaping of technology, technology policy, network analysis, and innovation management in highly automated systems, especially in the field of transportation and aerospace. He also has written a biography of the German space pioneer Wernher von Braun.

Adam Wolisz, Prof. Dr., (Diploma in engineering, 1972, Doctoral Degree, 1976, Habilitation 1983 - Silesian University of Technology, Gliwice) works since 1980 on computer networks and distributed systems. He has been with Polish Academy of Sciences (until 1990), and later with the Research Institute GMD-Fokus in Berlin (1990-1993). Since 1993 he has joined the Technische Universität Berlin (TUB) where he is chaired Professor for Telecommunication Networks and since 2001 Executive Director of the Institute for Telecommunication Systems. He has served as the Dean of the Faculty of Electrical Engineering and Computer Science in the period 2001- 2003. Since summer 2005 he is also Adjunct Professor at the Dept. EE&CS, University of California, Berkeley. His research interests are in architectures and protocols of communication networks. Recently he is focusing mainly on wireless/mobile networking and sensor networks.