Bachelor Thesis

NEW WU: NEW CONCEPTS AND APPLICATIONS FOR LECTURING INFRASTRUCTRES

A NEW CONCEPT SHOWS HOW TO SETUP THE NEW WU FOR PROVIDING A MAXIMUM OF FLEXIBILITY, MOBILITY AND COMPATIBILITY FOR BOTH, STUDENTS AND LECTURERS.

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FOREWORD

I decided to work out this paper for my bachelor thesis because I thought that it is an interesting topic to discuss. Especially the term education infrastructure is a very current topic of big interest at the moment, due to the new WU building, that is being built.

"EDUCATIONAL INSTITUTIONS HAVE SOME CHARACTERISTICS IN ATTITUDE THAT RESULT IN SPECIAL REQUIREMENTS FOR THE UNDERLYING TECHNICAL INFRASTRUCTURE USED FOR THE EDUCATION PROCESS" [Mohr, Simon, & Krcmar, 2005]. This quote underlines the idea, that the Vienna University of Business and Economics needs a special integrated infrastructure adopted and for educational purposes implemented, integrated infrastructure that will provide an allover information system, making the day-to-day life for students as well as for the lecturing personnel easier, giving them the opportunity to create their tasks more efficiently.
"INFORMATION TECHNOLOGY (IT) PROFESSIONALS HAVE DISCUSSED THE POTENTIAL VALUE OF AN ORGANIZATION'S IT INFRASTRUCTURE. UNIQUE CHARACTERISTICS OF THIS INFRASTRUCTURE DETERMINE ITS VALUE TO THE ORGANIZATION. ONE CHARACTERISTIC, FLEXIBILITY, HAS CAPTURED THE ATTENTION OF MANAGERS IN ORGANIZATIONS. A FLEXIBLE IT INFRASTRUCTURE HAS EVEN BEEN TOUTED BY SOME AS THE NEXT COMPETITIVE WEAPON" [Byrd & Turner, 2001].

The vision that enveloped throughout gathering information and developing ideas was a Utopia of information. When talking of Utopia, one thinks of an unrealistic and futuristic picture of society that is not realizable. My main aim while writing this thesis was to create a place where everyone has the same abilities and chances objectively offered to them by an unknown dimension not only of information but also of well prepared data that comes to people well structured in order to be internalized to specific knowledge.

This thesis is - as far as possible – is written in gender neutral language. Therefore, proponents like "he" or "she" are replaced by "they", even in the singular. The author wrote this thesis with clear conscience, nevertheless errors in neutral language are excepted.

KEY WORDS:
IT INFRASTRUCTURE, UBIQUITOUS COMPUTING, PERVASIVE COMPUTING, INTERACTIVE ENVIRONMENT, DISTANCE LEARNING, ADAPTIVE ROOMS, ADAPTIVE INFRASTRUCTURE, DYNAMIC POSITIONING, INDOOR POSITIONING, MULTI-INTERFACE ENVIRONMENT, INTUITIVE INTERACTION

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1.2. SELECTION OF TOPICS

As the groundbreaking of the new WU is planned for the beginning of 2010, a comprehensive concept for equipping the new WU with IT infrastructure is fundamental. Although there is already an existing concept, the primary target of this paper is to analyze the existing concept, add innovative ideas and aspects that come from students' perspective, and design a new concept.

Why not take the actual concept?

There already exists a concept of equipping the new WU with IT infrastructure, so the question arises: Why should one want to envelope a new concept instead of taking the existing one?

The actual concept is relying closely on recent developments and IT infrastructure solutions. Of course, new, innovative applications and ways to interact with each other are represented by the existing concept. To my mind, it is relevant and necessary to make broad thoughts about what and how applications should be implemented into the new building, since it will be a part of all the students' and lecturers' lives in the future.

The new WU should provide possibilities for students and lecturers to interact with each other on a so far unknown way. The main goal is to provide an infrastructure that makes learning and teaching easier by using innovative, interactive instruments. The new WU building will offer more space and more flexible teaching and learning rooms that could be perfectly complemented by a fitting IT infrastructure.

As the old WU, the actual building in the ninth district in Vienna, is bursting at the seams, it was obviously a task of necessity to replace the old campus by a new, a bigger one, as approximately 7000 students keep inscribing every year. Also the infrastructure at the actual building seems at it has had its best days. At the WU there is not enough space for modern and computer supported ways of teaching and learning. It seems like a light in a tunnel when one is thinking of a new WU. Now it is the challenge to plan and to conduct the arranging of the new building with a system that is flexible and compatible enough in order to provide students and lecturers a perfect zone for studying, teaching and researching. It is necessary to design a concept that keeps students and lecturers away from conventional ways of collaboration, and create a concept that supports teamwork and modern ways of interaction between the students and the lecturers.

The new WU affects lots of the nearly 27000 students that are currently studying at this university and nearly all of the assistants and professors who currently work there. That is a sufficient reason for doing research and analysis in this topic. This is a huge project and it deserves and is worth to write a bachelor thesis about.

1.3. STRUCTURE OF THIS THESIS

For supplying the reader with an overview of the actual market of infrastructure technologies, a short description and classification of recent concepts is made. Afterwards, the new WU campus is described and the idea and vision of how to implement lecturing infrastructure. Then, the core of this thesis, the infrastructure applications are defined and described. The infrastructure applications are split into software applications and lecturing technologies that should support users' daily lives on campus. Moreover, lecturing rooms are sketched and it is shown how they could be equipped.

Further, a list of technologies included in this concept is brought to the reader and the themes privacy and handling of handicapped is mentioned to complement the thesis.

2. Concepts and applications for IT infrastructure

2.1. Inspirations for this thesis

When thinking of a new WU campus and further thinking of new lecturing infrastructure, the first thing that comes to ones' mind is a futuristic vision that is created by different ideas observed in science fiction movies or observed in not yet established concepts or even other visions. One of the most impressive and when thinking of the period it was invented, also very surprisingly established idea is the "Venus Project - beyond politics, poverty and war" [The Venus Project, 2009], mainly invented by Jacques Fresco. It is a relatively abstract idea of a socio economic city, invented in 1994 talking about his optimistic vision of a clear, efficient, well working and not finance based association. Although this idea of cities built in the ocean, connected with magnetic monorails and suspended railways is very abstract and not a matter of realization when thinking of the next decades, it was an inspiration which helped to extend the personal imagination and process of building a completely new environment for living and studying together.

Figure 1: The Venus Project describes cities, where poverty, war, and political power play no role anymore. Here, a city, built in the ocean is shown [The Venus Project, 2009].

Of course, while creating the concept of new lecturing infrastructures a lot more ideas and concepts where integrated but it was necessary not only to see single developments but to realize a vision.

2.2. Definition: Concept for IT infrastructure

A concept is described as an idea, especially an abstract idea or when thinking of engineering or industry, a concept is a model that is built to show, to test and to analyze how a new invention works, and what its failures in terms of production and functions are [BusinessDictionary.com, 2010]. It could also be something that is only formed in mind or a plan how to build up or handle something. In this case the term concept is used as the idea of different infrastructure applications and on the other hand the plan how to implement those applications, whereas the plan is also abstract and not yet practicable because also the single applications are concepts and at this time only an idea and not ready constructed and produced.

IT infrastructure is defined as the physical hardware that is used to make interaction between IT users and computers possible. IT infrastructure is also defined as infrastructure to interconnect hardware and software.
However, in this paper the term IT infrastructure is defined as infrastructure which has the purpose to support interaction between students, lecturers and the whole WU as an information system. In other words, IT infrastructure in this framework on one hand is used to implement applications that interact with users, and on the other hand, to make interaction between those users possible.

2.3. Classification of recent concepts

In order to design a new IT infrastructure concept for the new WU, it was necessary to reflect and analyze recent developments and their position and the advantage these applications are bringing to business.

Nowadays, there exist a lot IT infrastructure frameworks that have the purpose to be implemented in teaching constitutions or companies. In the following chapter, only a few of these concepts or already complete infrastructure frameworks are listed and described. For deeper examination with recent developments, the reader is pleased to use the given sources for gathering more information.
In general, one could say that the trend of recent developments concerning IT infrastructure is going to ubiquitous computing, virtual co-working via the Internet and more and more intuitive usable interfaces that provide more than a simple monitor or desktop surface.

HELLO.WALL AND VIEWPORT

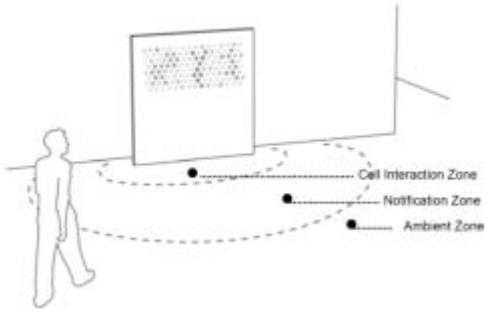

FIGURE 2: HELLO.WALL AND VIEWPORT SHOWING THREE ZONES OF INTERACTION [PRANTE, ET AL., 2003].

Hello.Wall is an approach of a ubiquitous computing environment that serves as an information system consisting of two components. "HELLO.WALL IS A NEW WALL-SIZED AMBIENT DISPLAY [4 METERS X 2 METERS] THAT EMITS INFORMATION VIA LIGHT PATTERNS AND IS CONSIDERED INFORMATIVE ART" [Prante, et al., 2003] [Prante, Stenzel, Röcker, Streitz, & Magerkurth, 2004].

This display communicates with a device called Viewport which is a wireless, portable RFID (Radio Frequency Identification) reader and writer with a built-in Wireless LAN (Local Area Network) module. Hello.Wall together with Viewport make up an application that was intention for the WU applications and the ideas are included in the WU infrastructure concept.

I-LAND

In the publication of i-Land, the concept is described as an "... ENVIRONMENT WHICH CONSTITUTES AN EXAMPLE OF OUR VISION OF THE WORKSPACES OF THE FUTURE, IN THIS CASE SUPPORTING COOPERATIVE WORK OF DYNAMIC TEAMS WITH CHANGING NEEDS" [Streitz, et al., 1999]. The development first arose at the ACM Conference on Human Factors in Computing Systems in 1999. It was one of the earlier developments that included ways to enable human interacting with computers intuitively. It was one of the first approaches that mentioned roomware components, understood as computer-augmented objects integrating room elements with information technology [Streitz, et al., 1999]. Innovative workspaces and virtual information spaces where the keywords mentioned in the publication of the conference.

FIGURE 3: PEOPLE COOPERATING VIA "TAKE AND PUT" AT THE DYNAWALL, A COMPONENT OF THE I-LAND [STREITZ, ET AL., I-LAND: AN INTERACTIVE LANDSCAPE FOR CREATIVITY AND INNOVATION, 1999].

Unfortunately, ten years later, there is still no chance to integrate such systems, and with those systems, another way of working together in the day-to-day business of common companies, research, or teaching institutions. Ten years later, touch screens with a diameter of more than four meters are common, video projectors are affordable, even for private households. But the point where the integration sticks is the implementation of a combination of all those developments. IT infrastructure should be planned to make business easier and should be integrated into every common task one is fulfilling during a day. Still a noteworthy obstacle that disables a new way of interaction is the well-known desktop surface of usual computers. Today it is needed to think away of the so often used desktop PC and make an approach towards ubiquitous computing. "IT IS OUR VISION OF THE WORKSPACES OF THE FUTURE – FOR INDIVIDUALS AS WELL AS GROUPS – THAT THE ENVIRONMENT AROUND US BECOMES MORE OF AN INTER-

face to information which can and should be (re)presented in many more different forms than it is currently the case" [Streitz, et al., 1999].

"The i-LAND environment introduces new forms of human-computer interaction" [Streitz, et al., 1999]. New forms of human-computer interaction is the main topic discussed in this thesis, i-LAND was therefore a precursor when talking about ubiquitous computing and interactive environment.

Drag-and-Pop and Drag-and-Pick

Drag-and-Pop and Drag-and-Pick are techniques for users of pen and touch operated display systems. These concepts should enable users to interact with devices, including PDA's (Personal Digital Assistant), tablet PC's and other touch screen systems by providing innovative ways to access screen content more easily [Baudisch, et al., 2003].

This concept is another approach to get away from usual user interfaces with indirect input devices. The authors of the concept also come up with the matter that indirect input devices are, especially when several displays are used, more compatible. "Indirect input devices can be used on arbitrary display configurations, because they can simply be mapped to the respective topology" [Baudisch, et al., 2003]. The possibly arising problems that the authors mention are the restriction to the physicality of the display systems. Users must adopt their behavior to the displays' space, that means that touch or pen input is based on the correspondence between those devices. It is therefore necessary to design applications that bring the ability to integrate external, plugged in monitors, interactions across different display units and bridging long distances over screens. Drag-and-pop and drag-and-pick are interaction techniques that address exactly these issues [Baudisch, et al., 2003].

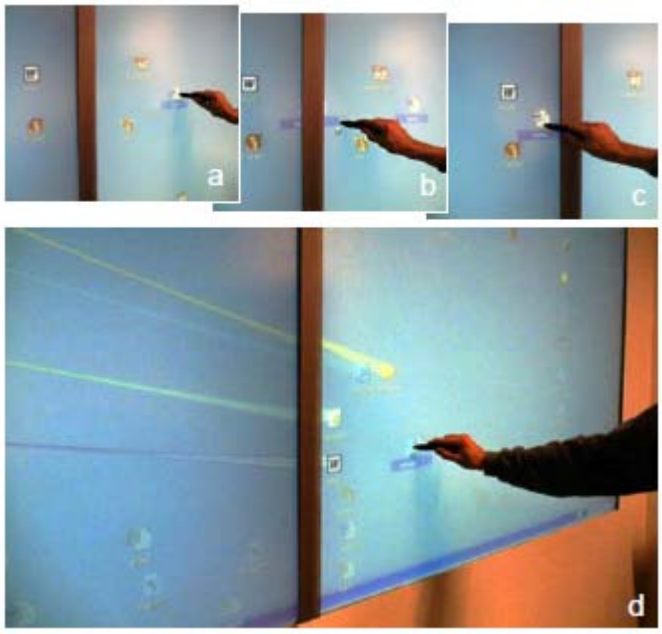

Figure 4: Drag-and-drop (a-c) and Drag-and-Pop (d) across multiple graphical interfaces [Baudisch, et al., 2003].

These interaction techniques describe only one background on which several functions of the WU applications are based. As Drag-and-drop a well known interaction technique for transferring or copying information using a pointing device is [Baudisch, et al., 2003], this technique provides an innovative and practicable way to make cooperating and co-working easier. To provide a broad usability, and make devices and software for not-professional users, who should handle the applications without comprehensive introduction, a lot more interaction techniques need to be integrated. Nevertheless, Drag-and-Pop and Drag-and-Pick brought substantial perspectives in order to implement a broad concept including developments that enable to throwing documents between users.

POINTRIGHT

PointRight is a system that is designed for multi-machine and multi-user environments. It is a model that implements the idea of pointer motion across screens. As the reader may know, such techniques already exist, but PointRight is able to redirect input across multiple independent machines and operating systems. It is developed to work with large, shared displays included in interactive workspaces but it can also be used on workstations that are spread around any network [Johanson, Hutchins, Winograd, & Stone, 2002]. PointRight is one more idea that includes the concept of ubiquitous computing by making interaction via several different devices possible. Newly coming up with this concept is the input device like a mouse or keyboard that is used by more than one graphical output device. One is able to control several independent devices with one input device, what in fact is strongly needed by teaching infrastructures. When working in teams and for example, one member of the group is standing in front of the room and explains the workflow or mentioned ideas, the group members are able to interact with the presenter's device, which makes it easier to communicate and to collaborate on the topic that is presented.

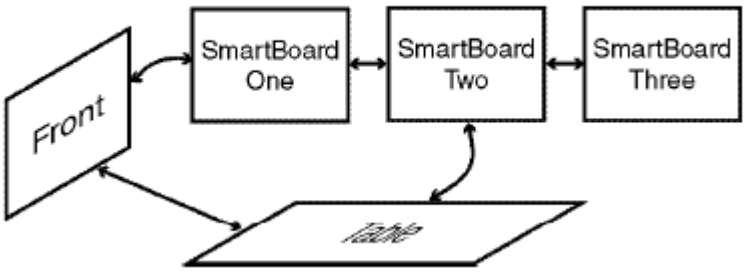

FIGURE 5: THE IROOM SCREEN TOPOLOGY SHOWING GRAPHICAL INTERFACES THAT CAN BE ADRESSED BY ONE INPUT DEVICE [JOHANSON, HUTCHINS, WINOGRAD, & STONE, 2002].

The strengths included in this system are the independency of operating systems. PointRight induces several virtual desktops to bridge the operating system dependent graphical interfaces what enables students or lecturers to use different devices, i.e. laptops or tablet PC. Despite all these opportunities, for different reasons it is not recommended to implement PointRight unchanged into the new WU's IT infrastructure. PointRight offers a background model that brings excellent ideas to the concept of the WU IT infrastructure, but concerning flexibility and compatibility, it is not a sufficient concept to overtake it without changes.

THE BEACH

The BEACH is a conceptual framework for synchronous applications on ubiquitous computing environments [Tandler, 2004]. "THE BEACH FRAMEWORK PROVIDES THE FUNCTIONALITY FOR SYNCHRONOUS COOPERATION AND INTERACTION WITH ROOMWARE COMPONENTS, I.E. ROOM ELEMENTS WITH INTEGRATED INFORMATION TECHNOLOGY. (...) 'ROOMWARE' IS A TERM WE COINED TO REFER TO ROOM ELEMENTS WITH INTEGRATED INFORMATION TECHNOLOGY SUCH AS INTERACTIVE TABLES, WALLS, OR CHAIRS" [Tandler, 2004]. The system mentioned above is a general framework that explains the term "ubiquitous computing" as it is used nowadays, and defines models how information technology components could interact with users' behaviors. One is the "The BEACH Conceptual Application Model" which can be used as an abstract explanation for developers, in order to help them understanding the design of a ubiquitous computing application [Tandler, 2004]. The Beach is mentioned as a concept in this thesis because it provides a theoretical background how to design ubiquitous computing applications and defines a concrete model with several layers in four levels of abstraction and describes how roomware components could be integrated into infrastructure. Nevertheless, The Beach gives an overview over ubiquitous computing and therefore is just an intention for developing further applications. For further reading about TheBEACH, the reader is welcome to read to the publication of Peter Tandler that describes this model in detail.

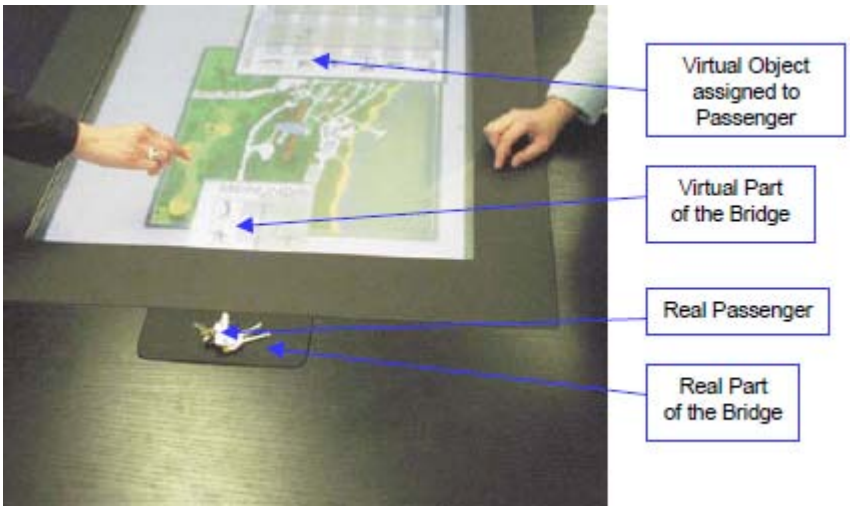

FIGURE 6: THE INTERACTABLE IS A COMPONENT WITH AN INTERFACE TO INTERACT WITH PHYSICAL OBJECTS, IN THIS CONTEXT NAMED "PASSENGERS". THE PASSAGE SYSTEM IS A SAMPLE APPLICATION OF THE BEACH FRAMWORK [TANDLER, 2004].

SIDESIGHT

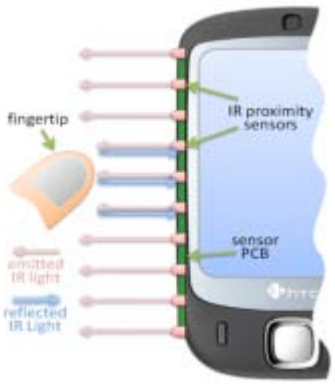

FIGURE 7: THE BASIC PRINCIPLE BEHIND SIDESIGHT. IR IS SHONE OUTWARDS FROM THE DEVICE VIA A SERIES OF IR LEDS; REFLECTIONS FROM NEARBY OBJECTS ARE SENSED USING A CORRESPONDING ARRAY OF IR PHOTODIODES [BUTLER, IZADI, & HODGES, 2008].

SideSight is a tool that focuses on interaction with mobile devices. Nowadays, we are used to slide on touch screens, use several fingers or even hand gestures to interact with mobile phones or other wearable devices. SideSight is a development that solves the problem of a too small touch sensitive surface. Equipped with infrared sensors, the mobile device can lie on a table, desk or any other flat surface and the user can use the whole space on the surface around as a big multi-touch interaction device. It is a new technique to support multi-touch on small mobile devices [Butler, Izadi, & Hodges, 2008].

SideSight is therefore a technology that can be implemented in small devices, such as smartphones or PDA's, which can be perfectly used by students and lecturers as wearable assistants that can be taken everywhere.

2.4. THE APPROACH: THE NEW WU

Now a broad overview should have been given to the reader by explaining a few of the recent developments that exist for supporting collaboration and building knowledge creating processes, especially within groups, more efficient. The new WU, as like as the actual building, has its main goal as a teaching infrastructure in producing or distributing knowledge on a preferably efficient way. Students are flexible people that use different kinds of devices. They are open for new developments and are likely to use and improve the newest applications. Students also develop new knowledge within their courses or projects and also improve the processes of gathering information and new knowledge.

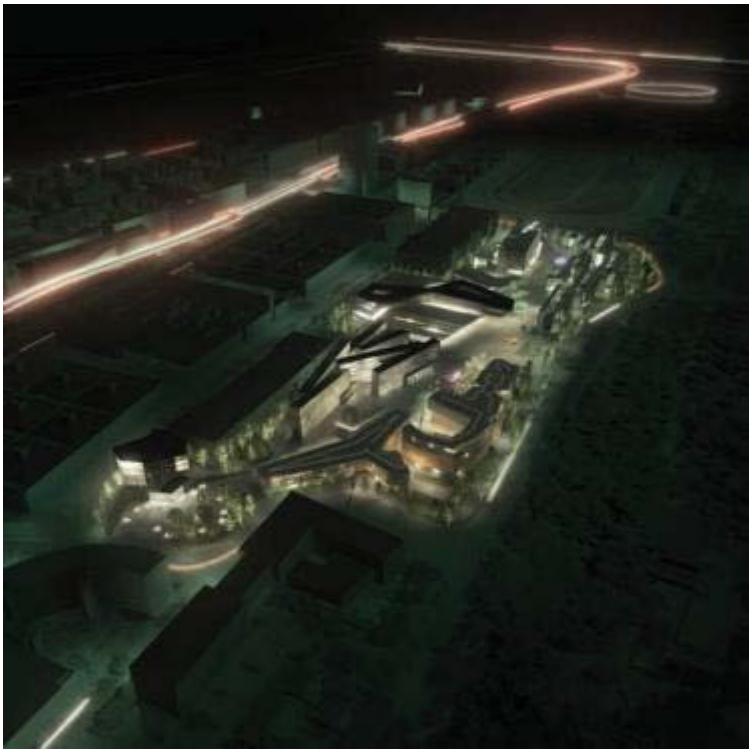

FIGURE 8: THE WU CAMPUS AT NIGHT [BOA, 2009]

"WHEN THE FOCUS HAS BEEN CHANGED FROM THE RESULTS OF TEACHING TO THE LEARNING PROCESS ITSELF THE GOALS OF EDUCATION WILL BE TO MAXIMIZE LEARNERS OWN EFFORTS IN THE LEARNING PROCESS" [Kirsti, 1991]. According to Kirsti, it is necessary to enable students to evolve their own process of gathering information and developing knowledge and at that point, the IT infrastructure comes into play, which should be a supporting surrounding, integrated all over the campus and making students' access to resources more comfortable.

As was found in a Swedish research study, information is defined as the following: "THE RESULT OF A TRANSFORMATION OF THE GENERATOR'S COGNITIVE STRUCTURES (BY INTENTIONALITY, MODEL OF THE RECIPIENTS' STATE OF KNOWLEDGE, AND IN THE FORM OF SIGNS), AND ON THE OTHER HAND, INFORMATION IS SOMETHING-A STRUCTURE- WHICH, WHEN PERCEIVED, MAY AFFECT AND TRANSFORM THE RECIPIENT'S STATE OF KNOWLEDGE" [Ingwersen, 1996, pp. 165, 98]. What, in other words means that students develop their knowledge depending on their prior background before gathering information. Students with different states of knowledge interpret information in different ways and so come to internalize this interpretation as specific knowledge. It is necessary to provide students with a transparent platform which they can use to interchange their information and specific knowledge. Especially when co-working, it is advantageous that all involved participants posses the same state of knowledge in order to understand each other and for there to arise consensus.

According to Dervin and Nilan, information is seen as "SOMETHING CONSTRUCTED BY HUMAN BEINGS" [Dervin & Nilan, 1986, p. 16], what enforces the speculation that information can be interpreted differently and therefore should be presented in a mostly transparent and neutral, understandable way.

The approach of the new WU is now to incorporate background ideas of recent developments, combine those existing ideas with upcoming technologies and build a new concept that brings new perspectives for students and lecturers to interact with each other and to use information technology components effectively and innovatively. "INFORMATION TECHNOLOGY WILL ALSO PLAY A MAJOR ROLE AS A MEDIUM AND MEDIATOR FOR SUPPORTING INFORMAL COMMUNICATION AND CONVEYING SOCIAL AWARENESS AND ATMOSPHERES IN ORGANIZATIONS" [Streitz, et al., 2003]. Information technology should change students' and lecturers' everyday life. In addition, such a concept must be based on applications that are easily usable for everyone who wishes to use them. The single applications should be intuitively controlled in order to require minimal prior knowledge.

2.5. DEMANDS ON STUDENTS

Naturally, whenever information technology is used, several requirements arise to the users. Users, in this case students and lecturers as well as research and administration personnel should be able and willing to use the applications.

Technology literacy is a term that can be used to explain the ability of users to interact with technology. A certain state of technology education should be brought in by the users to enable them to safely and efficiently control the applications in its entirety.

An American project for technology education called 'Technology for All Americans Project' (TAAP), introduced by the International Technology Education Association (ITEA) defined technological literacy simply as "THE ABILITY TO USE, MANAGE, AND UNDERSTAND TECHNOLOGY" [Boser, Palmer, & Daugherty, 1998, p. 6], whereas by the ITEA, technology education is used as a definition for general technology. In this context, it is necessary to understand technology education more specifically, linked to the term "information technology education", which requires the users not only to bring technology literacy with them but also specific IT knowledge.

However, the PATT study that was admitted by the ITEA later comes to the conclusion that students are thoroughly interested in technology [Bame, Dugger, De Vries, & McBee, 1993] and usually quickly get used to newly invented developments.

Summed up, the author came to the conclusion that a specific knowledge or awareness of technology, especially information technology should be brought by the users.
It is statistically proved that students bring a proper pre-knowledge with them and it is expected that those students have adequate interest and are willing and capable to handle those applications. Nevertheless, applications must be constructed in a way that makes it preferably easy for users to work with.

2.6. ACCEPTANCE OF PERSONNEL

One of the most important points when designing a new concept is of course the acceptance of users that will prospectively be the reason and furthermore justification for a new concept.

It was therefore a measure of necessity to imagine how the personnel that is employed at the university would react and accept all those new developments forcing users to learn new or even change their existing habitudes when interacting with lecturing infrastructure. The challenge while creating this concept was to think of different groups of users with different attitudes towards technology and innovation. While students and assistants working or studying at the university for a proportionally short time, employed professors who research and build up new institutes work there for more than ten or twenty years. Students usually like to learn how new inventions work and they quickly get used to new technology and innovations.

Lecturing personnel that give lectures for more than ten years have their well-established way how to hand knowledge to students and how to make information accessible in an efficient way. They often have justified doubts when new technology is being introduced. This more critical behavior primarily occurs when lecturers have

a lot of experience with using technical equipment, which definitely is related to the length of their employment.

However, no matter if assistants, professors or any other lecturing personnel, one should try to establish popularity among the users but should never force them to use newly established infrastructure without giving them the chance to get used to it. When lecturers do not feel comfortable with handling unknown technology, information should be provided to them in order to make sure they know how to use it. If lecturers would get forced to use unfamiliar equipment, their motivation and lecturing quality could decrease enormously. Nonetheless, it is necessary to increase interest in newly implemented infrastructure but also to provide classical, familiar equipment that could be used without specific prior knowledge. It is the relative advantage they should perceive and the observability of increasing productivity that makes users more likely to use a technology [Rogers, 1995, 2003]. "Do not presume too much" was a maxim sought to be respected constantly when designing this concept. Although this thesis is based on new developments and technology, the campus consists of conventional buildings that enable people to move in a familiar way within those buildings. Lecturing rooms are still equipped with well known infrastructure to ensure everyone feels comfortable in the new environment.

The ideal case would be a broad acceptance of both, students and lecturing personnel. For supporting the new concept in a constructive way, lecturers should bring the will to be retrained and also the willingness to communicate more intensively, especially with students. "Use flexibility by being more flexible" is a further maxim that should be kept in mind by all users. Because only when they are ready and willing as well as specifically educated for using the newly invented technology, benefits arise in a maximized way. The broad package of applications brings a so far unknown flexibility, supposing these applications are used correctly. Mobile devices always keep their users up to date and inform them of changes in real-time, but if users do not have the capacity to use such short term information and are not able to react flexible, all the applications would not help in their goal of a more flexible study landscape at the WU campus. At this point the reader should be aware that no matter what technologies come up, the market must be ready to accept it and to use it in a most efficient way, and this is certainly the case at the new WU.

3. THE CONCEPT FOR THE NEW WU

3.1. THE NEW WU - DESCRIPTION AND SPECIFICATIONS

The new campus of the Vienna University of Business and Economics covers an area of 88.000 square meters. It consists of five complexes of buildings: The entrance building (NO.MAD Arquitectos, Madrid) which accommodates the Executive Academy, department buildings (Estudio Carme Pinós, Barcelona, & CRAB-Studio, London), the main square with Library & Learning Center(Zaha Hadid Architects, Hamburg), Auditorium Center (BUSarchitektur, Vienna), and a second block of department buildings (Hitoshi Abe, Sendai). [Projektgesellschaft Wirtschaftsuniversität Wien Neu GmbH, 2009].

FIGURE 9: THE NEW WU CAMPUS FROM SOUTH WITH A LENGTH OF 560M [BOA, 2009].

"WE DESIGNED AN URBAN CAMPUS, WHICH IS CHARACTERIZED BY A WALK-ALONG-PARK. THE WALKWAYS AND OPEN SPACES MAKE YOU BREATHE AND BRING A CREATIVE AMBIENCE. AN ACTIVE EDUCATION LANDSCAPE ARISES" [Spinadel]. The architect, Laura P. Spinadel, created the Master Plan and works for BUSarchitektur. The active education landscape is what is needed to create an atmosphere for students, which is supportive of their well-being in their life at university.

The structure of the new campus consists of six main plots, which are explained below in the following chapter.

3.1.1. Library & Learning Center (Zaha Hadid Architecture Berlin)

The Library & Learning Center (LLC) is planned to be physically and symbolically the center of the campus and consists of the following units:

- The main library, the center for studying and researching
- Subject specific libraries for Economics
- Learning Center including self-studying zones, project rooms, language learning laboratories and computing teaching rooms
- IT services
- Info-Center for IT services
- Study management
- Study- and exams departments, departments for legal affairs
- Career center
- International office
- Bookshop
- Copyshop
- Assembly Hall

[Projektgesellschaft Wirtschaftsuniversität Wien Neu GmbH, 2009]

In this thesis the covered units are mainly the library, Learning Center and Assembly Hall as these units require specific infrastructure components to meet their requirements brought by students and other guests who visit the campus.

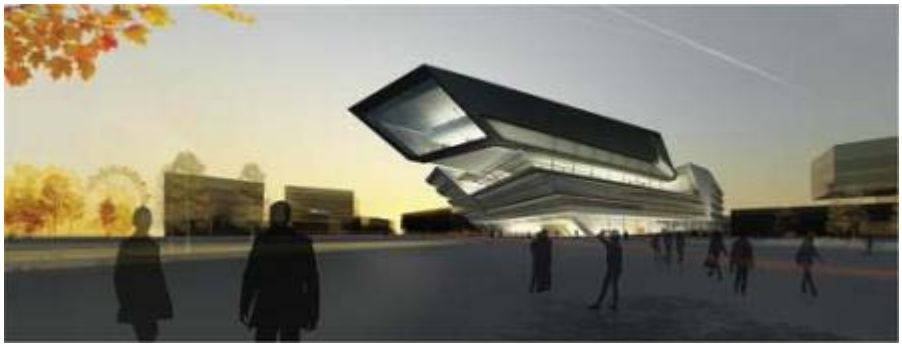

Figure 10: The Library & Learning Center is symbolically and physically the center of the new WU campus [Zaha Hadid Architects, 2009].

3.1.2. Plot O1 (BUSarchitektur ZT GmbH, Wien)

The Plot O1 is a construction field placed at the eastern side of the campus near the entrance. This plot accommodates the Auditorium Center and the Mensa, two institutions which are typically highly frequented. Further, the Department of Cross-Border Business and a garage and loading yard are located there [Projektgesellschaft Wirtschaftsuniversität Wien Neu GmbH, 2009]. In this context, only the Auditorium Center is concretely included.

Figure 11: Auditorium center and Department of Cross-Border Business [BOA, 2009].

3.1.3. Plot O2 (Atelier Hitoshi, Sendai)

Plot O2 is placed at the south-eastern end of the campus, forming the boundary to the green Prater. It mainly consists of departments and thereby the following units:

- Department of Information Processing and Process Management
- Department of Marketing
- Department of Management
- Department of Corporate Management and Innovation
- Department of Foreign Language Business Communication
- Foreign Languages Library
- Austrian University Student Association
- Sports Center
- Kindergarten
- Bookshop
- Supermarket

Plot O2 accommodates a library and several departments. As mentioned above, these institutions will be covered predominantly here. [Projektgesellschaft Wirtschaftsuniversität Wien Neu GmbH, 2009]

Figure 12: Plot O2, the head of the estate at the side of Krieau [Atelier Hitoshi Abe, 2009].

3.1.4. Plot W1 (NO.MAD, Madrid & Estudio Pinós, Barcelona)

The Plot W1 is split into two buildings, located at the western side of the campus. The Building W1E is accommodating the WU Executive Academy (NO.MAD Arquitectos, Madrid).

Figure 13: The Plot W1E is placed on the west side of the campus and accommodates primarily the Executive Academy [NO.MAD, 2009]

The Plot W1D (Estudio Pinós S.L., Barcelona) follows the Building W1E on the east and consists primarily of departments:

- Department of Finance
- Department of Statistics and Mathematics
- Department of Economics
- Department of Social Sciences
- Library for Social Sciences
- Cafeteria

[Projektgesellschaft Wirtschaftsuniversität Wien Neu GmbH, 2009]

In this context the Plot W1 is mainly represented by the library.

Figure 14: The Plot W1D accommodates departments and specific libraries [Carme Pinós, 2009]

3.1.5. Plot W2 (CRABstudio, London)

The Plot W2 forms the south-western corner of the campus. Several research institutes and primarily institutions that use to have less direct contact to students are located in this complex. But also the Library for Commercial Law and a Bakery are situated there.

[Projektgesellschaft Wirtschaftsuniversität Wien Neu GmbH, 2009]

Figure 15: The Plot W2 presents the south western end of the campus [CRABstudio, 2009]

3.1.6. Library

The main library, as well as the other libraries, is one of the institutions, where students may spend most of their day. A library's purpose is to provide a broad collection of books and other literal information. But without structure and collocation, the library cannot meet its requirements. Therefore it is necessary to implement a system that makes the vast amount of information accessible and manageable. It is also needed that the system provides a well established tool to administrate students' data and the library's services, for example how books are rented, for how long, and what to do when they are not returned on time. For all those reasons the application WU Library is developed.

Figure 16: Inside the Library & Learning Center [Zaha Hadid Architects, 2009].

3.1.7. Assembly Hall

The assembly hall is a room which is passed by most of the students, lecturers and other university personnel every day. The assembly hall is a place where lots of people meet, be it on purpose or by accident. The whole day long, people are present in the hall, thus it is a main place of information exchange. No matter what the people there are talking about, they are either on their way to or from any class, teamwork, research or studying. Students meeting in an assembly hall could be seen as a community of practice. "Communities of practice are groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" [Wenger E. , 2000]. Those communities should be supported by information technology to enforce their collective learning. "In brief, they're groups of people informally bound together by shared expertise and passion for a joint enterprise" [Wenger & Snyder, 2000]. In the assembly hall information systems should be implemented to guide people to rooms, squares or other buildings, to inform people about news, updates or changes in schedules. Moreover, the assembly hall is a place where lots of events take place during the semester, therefore a sound and visual system should by integrated in order to ensure clear communication.

3.2. IT INFRASTRUCTURE APPLICATIONS

The next step is to define what institutions need which specific IT infrastructure. As mentioned above, it does not make sense to implement special communication and collaboration infrastructure in every room or area. The most frequented units and units that stay in everyday-contact with students, lecturers or other guests should provide specific applications to improve interaction. Following places should be equipped with specific lecturing infrastructure:

- Library, including libraries for specific subjects or purposes
- Assembly hall
- Seminar/project/Break-Out Rooms
- Lecture rooms
- Learning Center, including sub-items

3.2.1. BRANDING AS AN IMPORTANT FACTOR

The concept of lecturing infrastructure consists of several applications:

- WU Library
- WU Organizer
- WU Navigator
- WU Messenger
- WU Portal
- WU Synchronization Assistant
- Room Adaptation
- Voting & hand Raising
- Throwing Docs

The reason for giving those applications meaningful names is the increased attention that those applications gain by their names. The applications exist as brands to publish them as products and raise people's attendance. The names will be remembered by people and hopefully propagated more intensively. Especially in the phase of establishing those applications, popularity helps to succeed and to settle those tools among users. Throwing Docs or Voting & Hand Raising remind people of simple words which they know from their time at school. People can easily understand what those terms mean and should feel familiar when using these applications.

3.2.2. COMPONENTS ON MOBILE DEVICES

As already mentioned in this thesis, the whole concept of lecturing infrastructure implemented in the new WU is based on a central database connected to devices installed in the buildings, which are so-called intelligent buildings or intelligent environments, and the users' mobile devices: smartphones, PDA's, laptops and some others. Observing the current market for smartphones and other mobile devices, one could assume that smartphones and laptops that become smaller and smaller - evolving to netbooks with screen sizes of ten inches- are replacing typical mobile phones and PDA's. When observed closely, one can see that all the functions of different devices are combined in one.

However, the applications implemented in the WU campus are designed to constantly interact with the users and small, handy devices to wear them everywhere should be used. In this thesis, it is considered that everyone preferably uses a smart-

phone to communicate with WU applications while moving, and eventually a more powerful device like a netbook when it comes to teamwork or video conferences. In July 2009, Samsung published a smartphone processor with a tact rate of 1 GHz [Klein, 2009], it can therefore be estimated that smartphones are becoming more and more powerful machines that will be able to fulfill even heavy-duty requirements and perhaps can be used as a multi talent device for doing all the tasks needed by users.

The applications running on the mobile devices are all browser based applications, which means that there is no additional installation needed to run them on a user's device. Brower based applications are less dependent on operating systems and platforms installed on the devices and so will prevent dependency on specific manufacturers.

Furthermore cooperation with OSGi Alliance [OSGi, 2010]and implementing OSGi as a platform on users' devices could be considered. This would be an approach to open source and manufacturer-independent operating systems, platforms and applications, which of course is a noteworthy topic. Preferably, all the infrastructure applications implemented in the WU should be designed to work with all of the different manufacturers' platforms and devices.

Unfortunately, in reality it is a matter of impossibility to offer systems for all platforms and devices. For writing this thesis, a few presumptions had to be made. One of those presumptions was the ability to implement the WU applications on different manufacturers' devices.

The reader is welcome to engross in this topic by visiting the website of OSGi Alliance. In this thesis, the topic is not covered more specifically as it would discharge in an overflow of information.

3.2.3. Requirements to mobile devices

For a proper usage of all the provided applications and especially for further understanding, a short mention of technical demands on user devices is offered. Users' mobile devices should include at least the following technologies:

- NFC (Near Field Communication) depending on RFID (Radio Frequency Identification
- GPS (Global Positioning System) transmitter and receiver
- Tactile graphical interface
- Built-in webcam
- Finger print sensor
- 3rd generation mobile telecommunications technology, short: 3G/UMTS (Universal Mobile Telecommunications System)

3.2.4. WU LIBRARY:

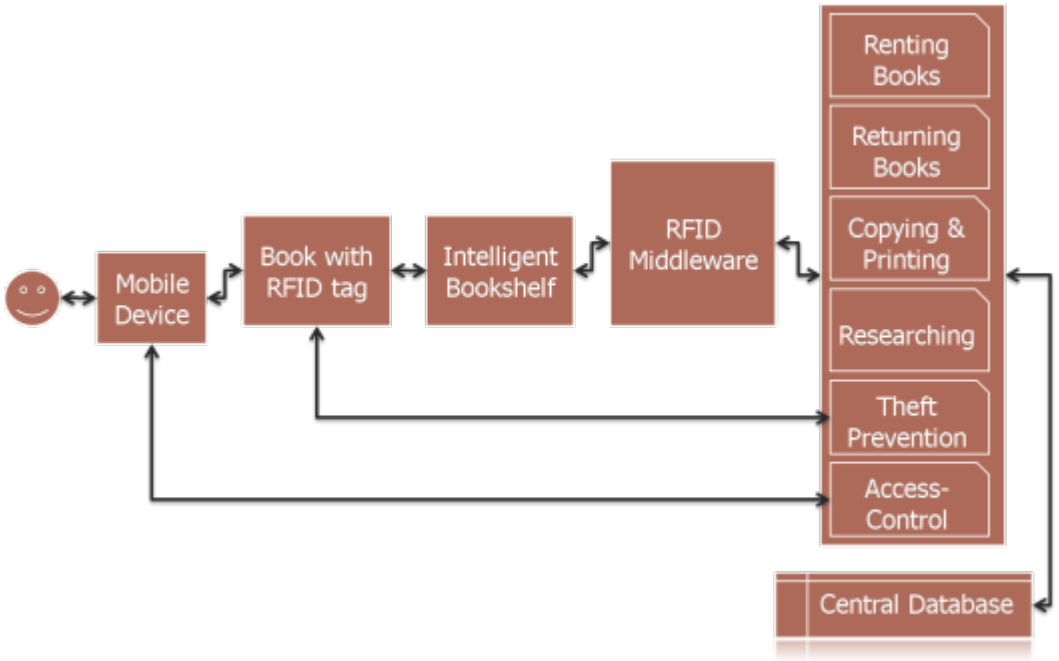

FIGURE 17: A CHART SHOWS HOW COMPONENTS OF THE WU LIBRARY INTERACT

3.2.4.1. INCLUDED COMPONENTS

- Info panels with integrated RFID component at bookshelves, entrances and exits
- Middleware to connect RFID components with database
- WU Library centralized database connected to the centralized database of WU Portal

3.2.4.2. IDENTIFICATION OF BOOKS

Each book that is in the library is marked and identified by an ID number. Here, the ISBN number is not used because each book should be concretely identified and the ISBN specifies an edition and not a single book. The ID number is also integrated in an RFID tag that is placed on the books.

3.2.4.3. HOW TO BORROW BOOKS

When a user wants to borrow a book they have to read the tag with an RFID reader. Preferably, the reader is built in the user's smartphone or laptop. The RFID writer, usually also included in a smartphone or laptop, now sends a signal to the library's RFID component. The message is a query to borrow a book that the user chooses which is looked up in the database. If the book's status is available and the user's status is registered, which is also stored in the database up to a specified length then the user can choose for how long to borrow the book by typing the period in the smartphone or laptop. If the book is not available, the user is told this when looking up the book at the online library and they get also told when it shall be returned. When the user takes out the book, its status is changed to "unavailable" and the period of time is registered. The library user can also ask for further information about a book when checking the RFID tag. The application has an interface which makes it

able to communicate with the other WU applications. For example the WU Organizer checks what books are on loan by a user and reminds them of giving the book back on time. The user can also search for a book. In this case they type a book's name in the smartphone, laptop or mounted info panels and the WU Navigator helps the user to find the searched book. The bookshelf and the line within the bookshelf where the book is located are signaled to the user and the way within the library how to reach the bookshelf is described. The WU Navigator works as a navigation system that guides the user through the library. The books can be reserved by the user using the smartphone or laptop, then the book's status is set to "reserved" for a specified period of time. When the user does not come to take the book its status is set back to "available". The advantage of this application is that there is no more need for a user's library card and no other devices are needed expect the ones that a student is used to carry with them.

3.2.4.4. RETURNING OF BOOKS

When a user wants to return one or more lent books, they just have to go to the library. When a user passes the entrance, the WU Organizer reminds them of their borrowed books and the user can now choose to return their borrowed books. The device mounted at the entrance and the smartphone or laptop is used to remind the user. When they decide to return a book, the way to the returning center is shown on the device of the WU Organizer, placed at the entrance. When the book is returned its RFID tag is read and its status is set to "returned". The returning center is a machine in which the user inserts the returned book. The book now waits to be checked for any damages by the library staff. When the book has no damages, it is sorted into the bookshelf by the library staff. The library personnel are shown by the WU Library system where to put the book and the status is set to "available". Users can also return books on their own if they are near the required bookshelf and just skimmed a book. As it is always registered who last borrowed the book, it is possible to find out who damaged the book, if it is in a bad condition.

The history of each book is saved in the database, so it is possible to prepare statistical analysis and evaluation of books and for how long they are rented.

When the user enters the library the RFID component checks what books they have with them and the WU Organizer reminds them which books have to be returned and which are reserved and where they are placed.

3.2.4.5. SECURITY MEASURES

One of the most important things relating to a library is preventing theft and unauthorized access, leading to theft. Moreover, reliability is important to make sure that included information is actually present and at the right place. Order is needed to ensure information can be found where and when it is needed. At the entrances of the library rooms, an RFID component is located that checks whether the user is allowed to have access to the specified library. This implementation is named RFID Access Control. The entrances will open only when the user is checked and it is ensured that they have authorization to enter. If a user is denied to access the library, this is shown on the graphical interface at the entrance, and also steps to support the user are provided. These steps include error handling or information about who

is granted access. This measure ensures to prevent users from unauthorized access and also informs users how the information system interacts with them.

How can theft be prevented?

An RFID theft prevention system [United States Patent and Trademark Office (USPTO), 2009] is implemented that is usually used to prevent thefts in the commercial sector. The WU Library saves information about each book, which means, in the database of the WU Library it is well defined which books are available, unavailable because they are rented out, or reserved for renting. The RFID middleware that is implemented in the WU Library connects the RFID writers and readers to the centralized database. The RFID reader at the bookshelves of the library now reads the book's status in the database and also checks who has borrowed the book and if they are authorized to take the book. Physically, the user is always able to take any book out of the bookshelf, but their RFID tag is read and it is registered which book they took. That means that everyone who is allowed to access a specific library is also allowed to take any book out of the bookshelf, but if the user wants to rent the book, they must register it via their mobile device. Otherwise the user is not allowed to leave the library.

Moreover, it is needed to check whether the users who enter and leave the library have the right, and only the right books. The RFID device at the doors checks the history saved in the RFID tags of the books, it also checks the user's RFID tag, located on either their laptop or smartphone, and only allows to exit with a correctly borrowed book. In other terms, the WU Library application only allows users to exit the library with books that they have registered for and are authorized to take. If a user tries to leave the library with either a book they were not registered to borrow, or with a book that is registered as borrowed by another person, the system would deny the user to leave. These measures prevent books from being taken by unauthorized people but an important measure is to inform the user via a graphical interface about why they are denied to leave the library and what they should do to be granted to leave. For example, if the RFID component checks that a user wants to leave with a book for which they have not registered, the action would be: The door stays closed and denies the user to leave. A message on the information panel, mounted at the exit informs the user: "User: Wolfgang Zeitler, Matrikelnr.: 0653549. Rental denied, book is not registered for rental. Book: Hansen, Neumann, Wirtschaftsinformatik 2, ID No. 13456789. Please register or contact service personnel." That should heighten trustworthiness and prevents users from becoming suspicious of an intelligent information system.

Scanning and printing

Also in the future, students will still simply need to copy books or print out information. The library at the new WU will include a printer and scanning center where users can print out and scan in data. When a user uses a scanner, the device identifies their tag, and all the scanned-in data is automatically sent to their mobile device. When users print any data from their devices, the printer queues the order until the user arrives at the printer. Then, the user is identified and their documents are automatically printed. Copying of studying materials works in the same way to ensure that printed documents are only printed out when the right user is near the device.

3.2.4.6. IMPLEMENTATION IN DEVICES

"THERE ARE ALREADY HUNDREDS OF MILLIONS OF TAGS USED IN OUR EVERYDAY LIFE-FROM TAGS IN OUR CAR KEYS TO TAGS AROUND OUR LUGGAGE HANDLES. WE USE RFID TECHNOLOGY WHEN WE ENTER OUR OFFICE BUILDINGS (...) WE USE RFID IN OUR HOSPITALS AND IN MARATHON RACES. THE NEXT PHASE FOR RFID IS ADOPTION WITHIN THE SUPPLY CHAIN, THE SUPPLY CHAIN OF ANYTHING THAT ENDS UP IN A RETAIL STORE-BOTTLES OF COUGH SYRUP, BOXES OF CEREAL, CHILDREN'S TOYS, OFFICE EQUIPMENT, FURNITURE, AND SO ON.." [Bhuptani & Moradpour, 2005].

RFID is a technology that is becoming more and more established and therefore will be implemented in nearly all wearable electronic devices in the near future. "NOW IN A RAPID GROWTH PHASE, RFID TECHNOLOGY HOLDS SIMILAR PROMISE AND WILL BECOME AS UBIQUITOUS IN OUR EVERYDAY LIVES AS THE AUTOMOBILE OR THE WHEELS THAT MOVE IT" [Bhuptani & Moradpour, 2005]. One can understand that students in more than 2 years will either use smartphones or laptops with a built-in NFC. As RFID is predicted to become a technology that is included in our day-to-day life, like SMS or email are now, one can assume that students in the near future will be aware of how to use such components and will provide the essential consciousness to support the development of this application.

3.2.5. WU ORGANIZER

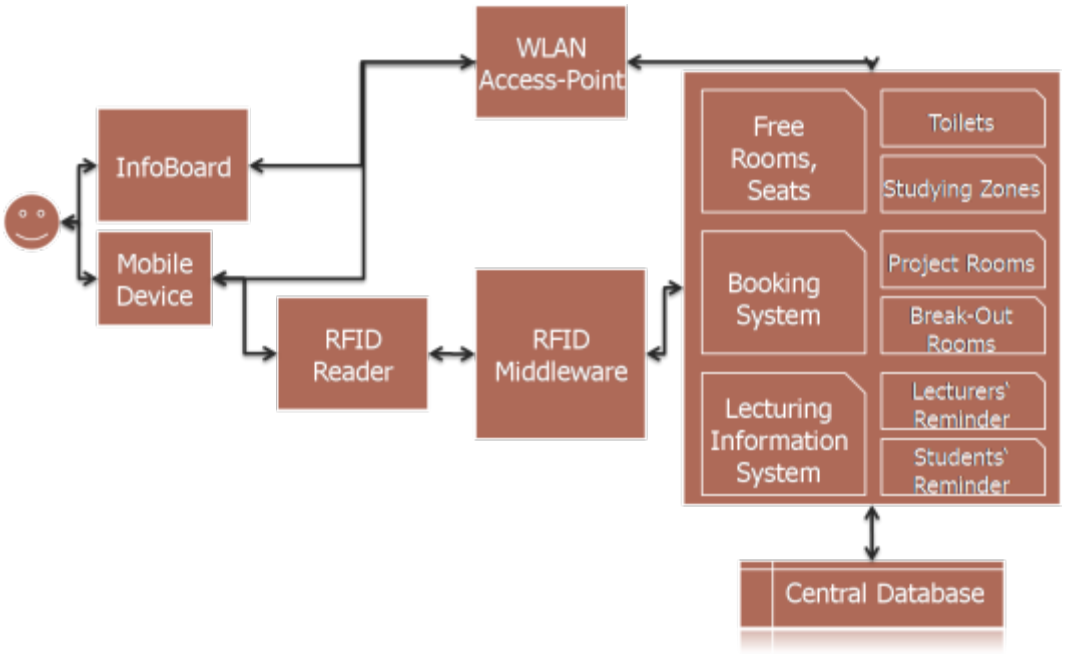

FIGURE 18: A CHART SHOWS HOW WU ORGANIZER COMPONENTS INTERACT

The WU Organizer is a tool that is implemented in the new WU lecturing infrastructure for supporting students and lecturers with organizational and administrative issues. The WU Organizer is implemented in the whole campus and it realizes the term ubiquitous computing as its components can be found in every lecture room, square, self-studying zone, even on the toilets, and in many more places. WU Organizer is an umbrella term for several applications as well as a name for software running on wearable devices. It connects the centralized database of the WU with a lot of applications and is an interface for interchanging data with mobile devices. The organizer always runs on its users' mobile devices and performs real-time actions and passes real-time information. It is an information system that uses different standards to interact with several devices.

3.2.5.1. INCLUDED COMPONENTS

- Movement sensors
- Interface to communicate with wearable devices
- Wireless access points
- RFID reader and writer
- Middleware to connect RFID components to information system and database
- Graphical interfaces (screens with 0.5, 2.5 and 5 meters diameter)
- Information system connected to a centralized database of WU Portal

3.2.5.2. FREE ROOMS, ZONES, SEATS, TOILETS

When students enter the WU campus, they are recognized by an RFID reader that checks their RFID tag which is built in a smartphone, laptop, PDA or any other portable device. The WU Organizer is an information system that connects users with a centralized database to help them organize their everyday life while studying. It has always been a substantial issue to know where to go for studying, practicing or team-working before searching the whole campus for a fitting place. The WU Organizer comes up with a solution for students as well as lecturers and secondly many more university personnel. It is an application that shows the user where to find free seats, toilets or rooms. As there are RFID readers placed at the entrances and exits of each room, it is easy to know who and how many people are inside that room. The LLC (Library & Learning Center) includes several self-studying zones that can be freely accessed by everyone. As these zones are freely available to not only people connected to the WU, one cannot be sure that every person who enters the campus has an RFID tag. It is therefore necessary to implement laser sensors. Laser sensors scan people moving in or out of a room, but they cannot recognize their identity. This means that it is only checked that someone entered the self-studying zone, but not whom. The information gathered by the sensors is now updated to the central database and it is registered how many people are present in a self-studying zone. Now a user can use their portable device to query how many free seats are available in a self-studying zone. When someone wants to meet a colleague to work on an assignment, they just have to use the WU Organizer, which is a browser based software that runs on a portable device to check where to go for getting the free seats they need.

A banal example for using WU Organizer are also the toilets. If one is looking for a free toilet, they just have to click the appropriate icon on the screen and the database is queried which toilet has a free seat. This tool also works with laser sensors integrated in the toilets' doors. When someone enters a toilet, its status in the database is updated to "occupied". Although the new WU Campus is far bigger than the actual one, it still could happen that the nearest toilet is occupied, it is therefore practical to know where to go.

When using elevators, one may know that waiting for the right elevator to come can take a long time. The WU Organizer checks which elevator is currently going up or down, communicates with the WU Navigator to get information about where the user needs to go, and so it is able to propose to the user which elevator they should take to get to their destination faster.

3.2.5.3. BOOKING SYSTEM

Another kind of self-studying zones are the so-called Break-Out Rooms and project rooms. These rooms are only accessible for WU-students, hence they have an RFID Access Control installed.

PROJECT ROOMS

By using WU Organizer, users are able to book project rooms for collaboration. A user can use the software to choose which room and a date and time when they want to reserve the room. The WU Organizer provides a virtual map of the LLC where free and occupied project rooms are shown on the screen. The user only has to touch which room they want to book. When the user types in when and for how many people, the room is now in the central database registered as "occupied". Only users that are part of a group that has booked a room are authorized to access the room, otherwise, the automatically locked door does not open. If a project room's status is occupied, it is shown on the map of rooms but marked as occupied. When the user chooses an occupied room, it is listed when it is available again.

BREAK-OUT ROOMS

Break-Out Rooms [officeMEDIA, 2009] are rooms for group-working during class. They cannot be booked by students but only by lecturers. The purpose of Break-Out Rooms is to allow teamwork during lectures, hence only lecturers are able to book those rooms during their lecture times. They can decide who joins the group that is occupying the Break-Out room. When such a room is booked by a lecturer, its status in the central database is set as "occupied". Then, it is disabled to be booked for that time. WU Organizer offers a tool to book those Break-Out Rooms. The software includes map of the Auditorium Center (located in Plot O1) with all the lecturing rooms and attached Break-Out Rooms. The user only has to touch the room that they want to book, which is - if free - shown in green, otherwise shown in red. The students who are registered for a specified room have authorization to access the room. The integrated RFID reader checks the entering user's identity and the door only opens when access is granted. This feature always provides a clear overview of whom and how many people are present in a Break-Out Room.

3.2.5.4. LECTURING INFORMATION SYSTEM

The WU Organizer furthermore provides an information system that helps students as well as lecturers to organize classes and exercises more efficiently. It includes tools to inform lecturers about who is coming to their class and if someone is arriving late. It also - if allowed by the student - informs the lecturer when the person will arrive.

LECTURER'S REMINDER

If a class is scheduled and a student knows that they cannot be there on time, they can update this information to the WU Organizer, which is synchronized with the central database. A message to the lecturer is sent, telling them that a specific student is coming delayed. This tool is necessary for lectures with only a few participants wherein the lecturer plans an intensive interaction or teamwork. The student can also type in when they will arrive or, if they authorize the software to access, can enable WU Organizer to communicate with WU Navigator. Then the Navigator interacts via an interface with WU Organizer and it is calculated how long it will take the student to come to a specific lecture. This application is implemented to provide lecturers a more flexible way to teach and make them aware of short-term changed circumstances in class. It enables them to temporarily react on changes.

If a student is unable to visit class and only recognizes that a short time before, they can update the WU Organizer and the database is immediately updated as well. Now the lecturer is aware of the actual number of students who will visit the lecture.

STUDENT'S REMINDER

The Student's Reminder is a tool that should help students to be perfectly prepared for a lesson. It is integrated in the WU Organizer software and messages the students if a lecturer delays, class is changed or dismissed, a team member delays or is prevented, or if special items for an exercise should be brought. If a lecturer knows that they cannot come to class on time, and consequentially the lesson starts later, they can update the WU Organizer, which sends a message to the participating students. The lecturer can also enable the organizer to access WU Navigator, then it is calculated when the lecturer will arrive in class. Moreover, if the lecturer dismisses the lecture, it is also updated in the database and the WU Organizer informs the students. Often, groups are formed during lectures. The organizer reminds students if one of their group members is not able to visit the lecture, so that they can prepare to work without the missing member. What is more, if the lecturer temporary decides to change the content of a lesson and therefore wants the students to bring an additional equipment, they can update the information via WU Organizer, and again, the students are informed on time and are able to arrive well prepared.

3.2.5.5. INFO BOARDS

The WU Organizer comes up with one more tool, the Info Board. This tool includes graphical interfaces, mounted at entrances and highly frequented places. Those screens are OLED (Organic Light Emitting Diode) [OLED.at, 2009] displays and differ in size from a diagonal of 0.5 meters over 2.5 meters up to 5 meters.

PERSONAL INFOBOARD

The small sized Info Boards are mounted only at places where people can get close to them. Such small screens are located at the entrances of rooms, on toilets or in elevators. These screens come to use when the user's mobile device, preferably a smartphone do not work or are not synchronized with the WU network. As the built-in RFID tag gets its needed energy via induction, it does not need the mobile device to work for being used. If the mobile device is not able to build up a connection to the WU Organizer, the Organizer recognizes that and switches to show information on fixed mounted screens. The RFID middleware always updates the database and so feeds the WU Organizer with information about a user's position. When a user enters the campus, the RFID reader scans the tag, and then the student's ID is sent via middleware to the information system. The central database gets updated about a user's position and the information system returns information about lectures, messages, memories, updates and deadlines to the InfoBoard that is currently closest to the user. For privacy measures, only small screens are used that show information only when the user is near to them. In other terms, the distance to a user is scanned by long and short-range RFID reader. This allows different interactions between users and the InfoBoard. When a user is in the long-range reader's distance, only ambient information is shown on the InfoBoard. Personalized information and interaction with the InfoBoard is only possible when the user's tag is scanned by the short range RFID reader. Personal InfoBoard allows a user to use the WU applica-

tions the same way as on their mobile device. The applications interfaces are shown on the small tactile screens and users can use their hands for typing in data. For example, if someone enters the library with a turned off mobile device, the Personal InfoBoard runs the WU Organizer, which reminds the user which book they wanted to rent and where the searched books are. If the user moves inside the library and comes to another InfoBoard, the applications follow them, so the Organizer is again shown on the screen where the user actually is and reminds them where to go.

This application is leaned on the Hello.Wall and ViewPort development, which describes three zones of interaction with the user [Prante, et al., 2003]. An important point is: the huge amount of information about a user like their lectures, rented books, personal memories, meetings, etc. could never be saved on an RFID tag. The RFID tag is only used to identify the user, the data afterwards is taken from the database that holds detailed information about the user. The mounted InfoBoards should ensure reliable redundancy. Furthermore, users should not be solely dependent on their mobile devices, though InfoBoards provide availability of the information systems, even if the users' devices are not running.

PUBLIC INFOBOARD

As informal communication raises attendance in work environments, it is now designated to widely support this way of communication by information resources that are embedded in the daily life [Prante, et al., 2003].

The medium and large sized Info Board screens are mounted on public places where everyone can look at them. They are used for public viewing and show general, campus wide information. The medium and big screens are also connected to, and are part of the WU Organizer, but they do not show personalized information to single users as they are mounted on highly frequented places. Small and big-sized InfoBoards also support interaction and recognition of users' tags and wireless network signals. They are able to real-time process user statistics about present users.

Imagine a big InfoBoard, mounted in the Assembly Hall in an altitude of five meters. When people just pass the hall, it shows general information, for instance recent news or TV channels. If there are a specified percentage of students of a specific major or subject present in the Assembly Hall among others, the InfoBoard processes that there is a high contingent of specified students and therefore shows personalized information. For example, when 200 people are present in the Assembly Hall and 80 of them are students of the major Information Systems, the TV channel can be switched, or any news or updates about that major can be shown.

3.2.5.6. INTERACTION WITH MOBILE DEVICES

The whole concept of the WU Organizer is built up on a permanent connection between a user's mobile device and the information system that is connected to the database. Users can update their profile continuously with their mobile device. The concept of the communication can be considered as a two-component concept. On the one hand, RFID reader and middleware are used to enable communication between RFID tags in mobile devices and applications. On the other hand, wireless network is used to directly update the application data via a mobile device. Each user has their profile that is saved in the database. The application WU Organizer processes the data stored in the database to enable interactive communication with a user. For example, the database stores which books are rented by which user. The Organizer now checks where the user is and if present, reminds them when they should return the book.

Imagine a lecture, the lecture times are stored in the database, and the Organizer enables lecturers to change times or places of the lectures. When details of the lecture are changed, the Organizer also informs all the visiting users by sending them a message. The users are connected to the application either via the local wireless network, or when off campus, the communication works by using IP (Internet Protocol) [RFC 791, 1981].

UMTS (Universal Mobile Telecommunication System) would be the standard used mainly to connect mobile devices with the WU applications. According to the RTR Telekom Monitor, in the third quarter of 2008, 3,344.000 SIM cards with enabled UMTS where used in Austria [Rundfunk und Telekom Regulierungs-GmbH, 2009]. This fact enforces the speculation that users in at least two years will be ready to follow these requirements.

Moreover, a study has shown that the network coverage of UMTS allover Austria is more than 90 percent [Felser, 2008] [Theiss, 2009]. Although the WU is located in Vienna, where network coverage is ensured, a lot of users do not live in Vienna, work abroad or travel farther away from time to time. Thus, it is required to guarantee a reliable connection to the WU applications in order to keep users up to date.

3.2.6. WU NAVIGATOR

The WU Navigator is one of the core applications of the whole WU IT infrastructure. The Navigator should help the users to find any points of interest, which includes lecture rooms, self-studying zones, project rooms, departments, offices, cafeterias, shops, toilets, squares, elevators or other people. It cooperates closely with other applications and is operated by a sophisticated pack of tools.

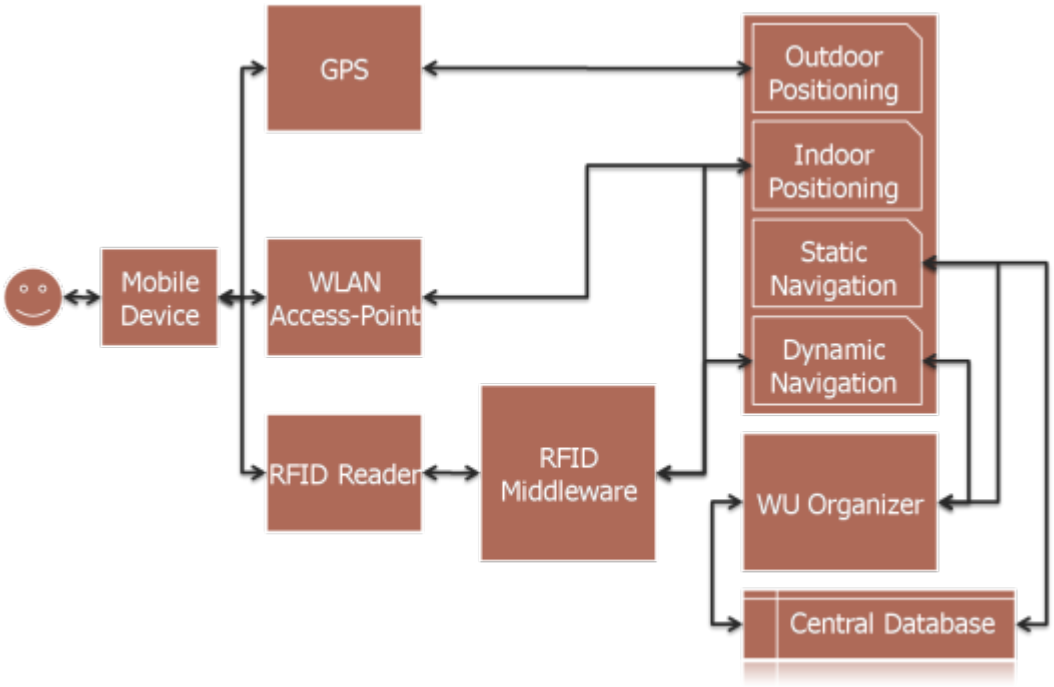

FIGURE 19: A CHART SHOWS HOW COMPONENTS OF WU NAVIGATOR INTERACT

3.2.6.1. INCLUDED COMPONENTS

- Cell tracking via Wi-Fi signal and RFID tags
- Indoor positioning system
- Global positioning system
- Google Maps [Google, 2009]
- Google Street View [Google, 2009]
- RFID reader
- RFID middleware
- WLAN access point
- Interface to connect to database and other applications
- Interface to connect to mobile devices

3.2.6.2. LOCATING TOOL

The Locating Tool is a part of the WU Navigator, it implements an allover positioning system that combines an indoor positioning system on basis of cell tracking via Wi-Fi signals and RFID and a global positioning system for moving under free sky. It is an adaptive positioning system based on Wi-Fi radio signals and GPS signals [Chiou, Wang, Yeh, & Su, 2009]. WLAN fingerprints could also be used to support redundant network positioning [Laoudias, Panayiotou, Desiniotis, Markoulidakis, Pajunen, & Nousiainen, 2008]. As long as a user uses a mobile device with integrated wireless network, they are connected to the WU wireless network. In April 2009, 44 percent

of sold smartphones had integrated Wi-Fi, a study shows that this trend is increasing and more and more users plan to buy Smartphones with a built-in wireless LAN module [Schütz, 2009] [Gallen, 2009].

"..THE WHOLE AVALANCHE OF UBIQUITOUS COMPUTING DEVICES OF MOST DIFFERENT KINDS THAT IS SET TO ARRIVE IN OUR FIVES CAN BE EXPLOITED FOR POSITIONING PURPOSES—EVEN IF NOT ORIGINALLY BUILT FOR THIS—AND SUPPORTED BY A NUMBER OF DEDICATED POSITIONING SYSTEMS" [Pfeifer, 2004].

Nowadays, different technologies exist to locate peoples' indoor position by either calculating their position by processing which cells of the wireless network are currently used, or by using active RFID. For indoor-use the WU Navigator combines the RFID middleware that feeds it with information about different locations of the users, and wireless network tracking that locates users by defining in which cells they are. This means that if a user has activated the WU Navigator, it is always located where they currently are. Privacy is a highly regarded individual right and locations of single users are never updated on the central database. The WU Navigator directly interacts with other applications and therefore sends users' information directly to other applications. For outdoor use, GPS (Global Positioning System) is used to locate users' position.

It is to highlight that Japan is one of the technically most established and a worldwide leader concerning the topic of information infrastructure. Thus, it is not coincidental that Japan is one of the countries that have already implemented audio navigation systems in railway stations that are based on RFID positioning and movement sensors [Railway Technical Research Institute, 2009]. In Austria, the locating of private individuals is a much discussed topic when considering the issue of privacy. There are no laws in place that would allow indoor positioning systems to be used in public places. Hence it is a topic that is up to legal authorities and it is impossible to know what the legal environment will look like in the future.

OUTDOOR POSITIONING

Today, GPS enabled smartphones are establishing on the mobile device market and still have a good outlook for the future [Gallen, 2009]. Though, it can be assumed that users of WU infrastructure applications are aware of that technology and will support the establishment. Google Maps can be used as a mobile based application to locate user's position and to navigate to searched places [Google, 2009]. It is required to build an interface to closely communicate with the WU Navigator to ensure navigation on the WU Campus. Google Maps is a tool that runs on a user's mobile device and it locates the user's position and supports navigating functions. WU Navigator is a tool that supports indoor positioning and that processes GPS signals. Google Maps sends information about the user's position to WU Navigator, which processes the information and returns the description of the right path to Google Maps. For providing a positioning and navigation system, it is required to integrate campus area data in Google Maps. So, Google Maps can work as a mobile navigation system that guides one through the campus. Additionally, there are few other usable mobile positioning software tools like CSR E5000 [CSR, 2008] or DIALOGS [DIALOGS Software GmbH, 2010], which use tracking by net provider cells.

INDOOR POSITIONING

Google Maps, as well as other mobile mapping and service applications, processes GPS signals, and it cannot use Wi-Fi cells or RFID to locate one's position, it is therefore necessary to feed the tool with exact positioning information as long as a user is moving in a building. As mentioned above, WU Navigator well supports indoor positioning, so it is used to pass data about a user's position to Google Maps, which is running on the user's mobile device. The navigation software for mobile devices gets data about campus via wireless network or if moving outside, via the internet. While indoor positioning, Google Maps only works as a graphical user interface that shows the user their position and shows them where to go. Actually, the positioning is processed by WU Navigator, which uses Google Maps to show data via an interface to the user.

USER MOVEMENT PROFILES (UMP)

Users' movements along the campus show specific repeated schemes throughout longer periods on the campus. When users enable WU navigator to track their position, user profiles could be created that recognize and process users' movements and typical places they visit regularly. User Movement Profiles then could create statistical data about students' behavior or differentiate between users habitudes of moving during their daily life. It could help them to remember their past habitudes and analyzing their own behavior. They so could plan their ways on campus to save time and unneeded effort and trouble.

Regarding profiles of users' positions and movements, privacy again is a very noteworthy topic that should be kept in mind and of course, users are free to choose whether they want to activate it.

3.2.6.3. CAMPUS NAVIGATION

When a user comes to the campus and the Organizer recognizes that this user has an upcoming lecture, information about lecture and lecture room is sent to WU Navigator to show the user the right way. The user gets a message on the graphical interface of their mobile device and can choose if they want to be navigated. The same method is applied to other rooms, for example if a user has booked a project room and arrives at the campus, it is proposed to them to be navigated to the right place.

A virtual campus is implemented on the mobile device, which should help the user to find the right way. The WU Navigator could use Google Street View for detailed guiding through the campus. Images that show the users the way are synchronized via wireless network or the internet. When a user goes through any building on the campus, looking for specified rooms, people or offices, their physical environment is shown virtually on their mobile device, according to their position. So, if a user moves a long a corridor in a plot, searching for a free self-studying zone, the Navigator virtually shows the same corridor, including arrows and messages proposing them where they should go.

ALERTING

The WU Navigator closely communicates with the WU Organizer as well as with other applications. As mentioned above, the Organizer is able to give estimated information about when people will arrive at specific places.

The WU Navigator closely communicates with the WU Organizer as well as with other applications. As mentioned above, the Organizer is able to give estimated information about when people will arrive at specific places.

Alerting is an interface that communicates positions processed by WU Navigator to the WU Organizer. The WU Navigator works as a route guidance system that can calculate students' arrival time to specified places. The Navigator then informs users if they will be delayed and if enabled, the information about delay is sent to the WU Organizer via Alerting and other participants of a lecture, project or team-exercise would be reminded about the delay. It can be designated as a kind of alerting system, which should improve lecturers' and students' flexibility and also teaching and studying methods.

Moreover, also lecturers use mobile devices and therefore are able to be guided through the campus. Usually, lecturers know their way to their lecture rooms. Nowadays and especially at the new campus, which in fact, is far bigger, lecturers detain their lectures rarely in the same rooms. Here, WU Navigator comes to turn by helping lecturers to plan their schedule more efficiently. It is exactly shown where they have to go and how long it would take them. As the Navigator also processes their position, the so called alerting system can also be used to inform students of a delaying lecturer by sending information via Alerting to the WU Organizer and communicate with the Students' Reminder.

This system helps all the participating users to create their everyday life on the campus more efficiently and helps them gain more of the most demanded good: time.

MEETING

Students often want to meet up for studying, working on exercises, completing teamwork or just having a cup of coffee. As the new WU campus comes up with more than four entries in different directions and the campus scales a length of more than 500 meters, meeting other people could state a substantial problem. Several cafeterias and other places that students prefer for meeting each other are spread widely all over the campus. It is now the exercise to meet students' requirements and come up with a solution that enables them to find specific people easily and that way save a lot of time.

WU Navigator always checks one's position when moving on the campus. It also includes a tool that helps users to find each other using their mobile device. Users can either create their list of preferred people, who they meet often, or they can send individual invites for meetings to other users. If two or more users arrange a meeting, it is typed in their Organizer and updated in the database. When a user enters the campus and other users wait for them, they are reminded by WU Organizer. The WU Navigator now synchronizes users' positions and tells them where the others are. If users have arranged fixed places for meetings, then they get informed when their colleague will arrive.

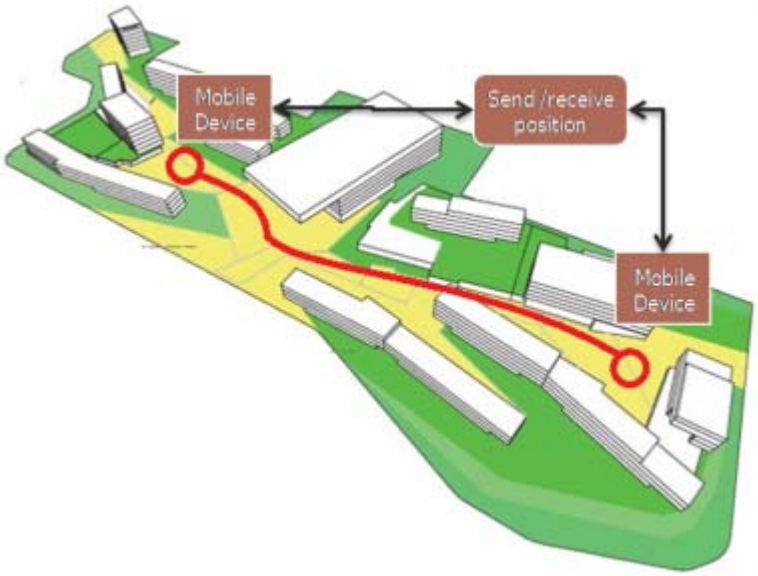

FIGURE 20: MEETING, FINDING COLLEAGUES QUICKLY ON CAMPUS[ARGE FLATZ_ARCHITECTS, ARCHITEKTURBÜRO ZEYTINOGLU, VIENNA, 2008]

Users can also arrange spontaneous meetings by calling each other or inviting other users to join a meeting. When a user submits to a meeting that was arranged by another user, both are informed of each other's position. They can now make up a meeting point and use WU Navigator to guide them to the agreed place. The Navigator also shows both participants when each of them will arrive, so one can use the time efficiently to get either studying materials or simply a coffee on the way.

3.2.6.4. DYNAMIC VERSUS STATIC POSITIONING

The positioning tool implemented in the WU Organizer should be able to handle more than 27.000 queries made by users constantly. Thus, it is necessarily needed to distinguish between dynamic and static positioning.

DYNAMIC POSITIONING

Meeting is a tool that is described above. Its purpose is to support users if they look for mates and arrange meetings with them. For instance, if 15.000 students are

present on the WU Campus, the positioning tool permanently locates users who have enabled WU Navigator. No matter how powerful the central database is, it would be a measure of limited performance not to handle all the users' positions centralized in the database. Users' positions should therefore directly be sent to querying applications and not be statically stored. When users look for mates, they should directly receive their position by communicating with other users' devices and not query their position from the central database.

STATIC POSITIONING

In contrast to dynamic positioning, static positioning works via communication with the central database. When students rent books that are property of any library, their position for instance would be stored in the central database. Kept in mind, that books could not be localized actively by wireless network signals, they can only by positioned when a person holding a book passes an RFID reader. As the books' position is not queried permanently, the database would be able to handle the amount of processed data. Of course lecturing or project rooms have also specified positions stored in the database. When a user is looking for a room, they get the position sent to their application by the information system directly, the rooms do not change their position often and therefore are stored and communicated on a static way. Positioning data that is stored in the database once and updated rarely or never and only queried often by users is included in the term static positioning.

3.2.6.5. PRIVACY ISSUES

"THE VAST AMOUNT OF INFORMATION BEING PROCESSED FOR THE REDUNDANT POSITIONING MIGHT BE ACCEPTABLE WITHIN AN ENVIRONMENT OF OPEN COMMUNICATION, I.E. WITHIN A DEPARTMENT, A SMALL COMPANY, A FAMILY, OR AMONG FRIENDS. FOR ANY EXTERNAL QUESTIONS, THIS INFORMATION NEEDS TO BE FILTERED, AND ONLY EXPLICITLY SPECIFIED DETAILS, OR HIGHLY AGGREGATED DATA WOULD BE PROVIDED" [Pfeifer, 2004]. The WU Navigator together with other applications collects a vast amount of personal information. In fact, a person can be followed everywhere they go. It is therefore necessary to strictly restrict access to this data and handle it carefully. Users have the right of privacy and they only accept information technology when they feel comfortable and trustworthy with it. To meet users' requirements and their wish for privacy, WU Navigator can be deactivated. That means that no information about their position - no matter if indoor or outdoor - is sent to the applications and they can move around the campus anonymously.

Nowadays, it is a legal issue that restricts positioning especially in indoor environments. It is therefore necessary to limit the stored positioning data of users to the needed level and only access it by applications explicitly enabled by users.

3.2.7. WU Synchronization Assistant

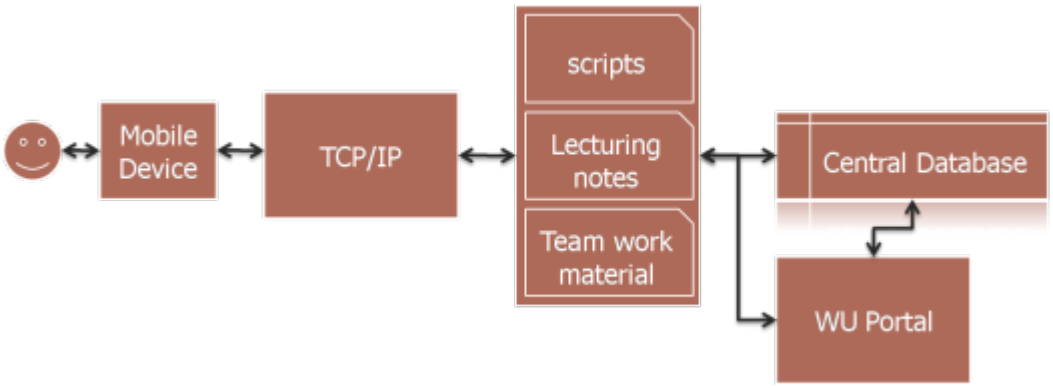

Figure 21: The scheme shows how WU Synchronization Assistant components interact

The WU Synchronization Assistant is a further tool that should help students to be up-to-date. The Synchronization Assistant is another application running on the mobile device that synchronizes user data with WU applications and databases. It communicates closely with the WU Organizer and other lecturing infrastructure.

Included components

- Interface to connect to database and other applications
- Interface to connect to mobile devices

The Synchronization Assistant is constantly running on the user's device. If a lecturer shares new material concerning a subject, it is immediately sent to the user's device. This happens either when students visit a lecture, or a lecturer publishes new material about a subject for which users are registered. Moreover, the Assistant watches information that is published by other participants of a lecture and if it is public content, it is sent to all the participants devices. This tool ensures that all students who participate in a lecture are up-to-date and have the same status of materials. If materials are renewed or changed, the Synchronization Assistant updates the data on the users' devices.

Imagine a lecture in an auditorium where more than 150 students are participating. The lecturer is physically present and - supported by other infrastructure applications – is giving a lecture. The students now make notes on the actual slide, the WU Synchronization Assistant now comes to play and ensures that all 150 devices or more store the same updated slide. This is only one example for the importance of keeping data synchronized. The Synchronization Assistant is included in every teamwork, group exercise and lecture that is held at the WU Campus, but moreover it supports distance learning groups by providing them with the same possibilities they would have when working together physically.

3.2.8. WU MESSENGER

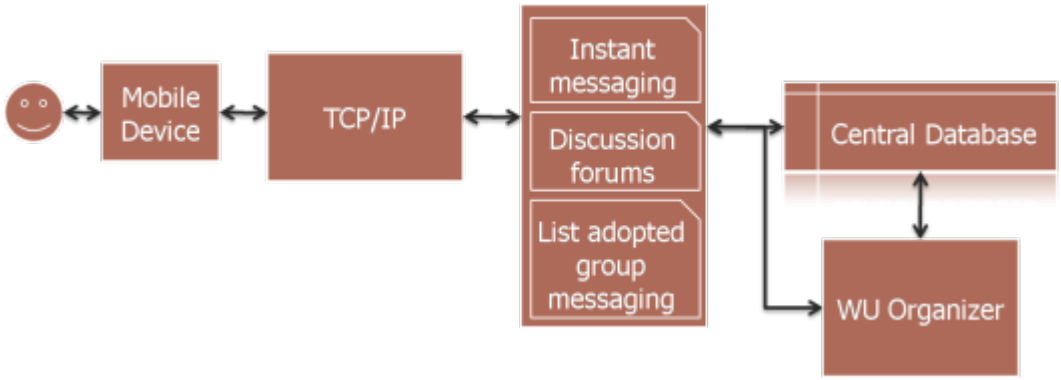

FIGURE 22: A CHART SHOWS HOW WU MESSENGER COMPONENTS INTERACT

INCLUDED COMPONENTS

- Interface to connect to database and other applications
- Interface to connect to mobile devices
- Software for messaging and discussion forums

The WU Messenger is a tool that is integrated into several WU applications. It supports users while communicating with each other. The Messenger is connected with the database, thus it is enabled to process information about which student or lecturer is part of which lectures. It provides intelligent lists of colleagues from different lectures and working groups as well as lecturers. The users can either send messages to a whole group or single users. Its purpose is to facilitate informal communication between users and improve contact to others. As mentioned above, groups of practice play a big role in the process of learning and motivation. WU Messenger enables people to make up groups of practice by giving them a basis for communication. If someone comes up with a question to a topic of a specific subject, they can easily send a message to their working group or even the whole participant list. Of course, the WU Messenger provides discussion forums to publish questions and postings by users. Users can choose what topics are of interest for them and so decide what they are reminded of. A user can follow a thread, which means, when another user posts a new message, the user is reminded by a message on their mobile device. The Messenger is a further application that makes the user's mobile device the center of communication. That furthermore improves students' and lecturers' flexibility and efficiency, as they are always in knowledge of the newest information and less questions and gaps in information come up.

3.2.9. WU PORTAL

The WU Portal is a web-based application that links the other applications together and so builds up a front-end for the users. These days, the WU Portal is a huge internet platform that includes a vast amount of information. The portal will also exist when a new lecturing infrastructure is established, but will communicate more closely with other applications. It will still be used to subscribe for lectures or exams, to search for information about offices or departments or to publish news for a broad majority.

3.2.10. ROOMADAPTATION

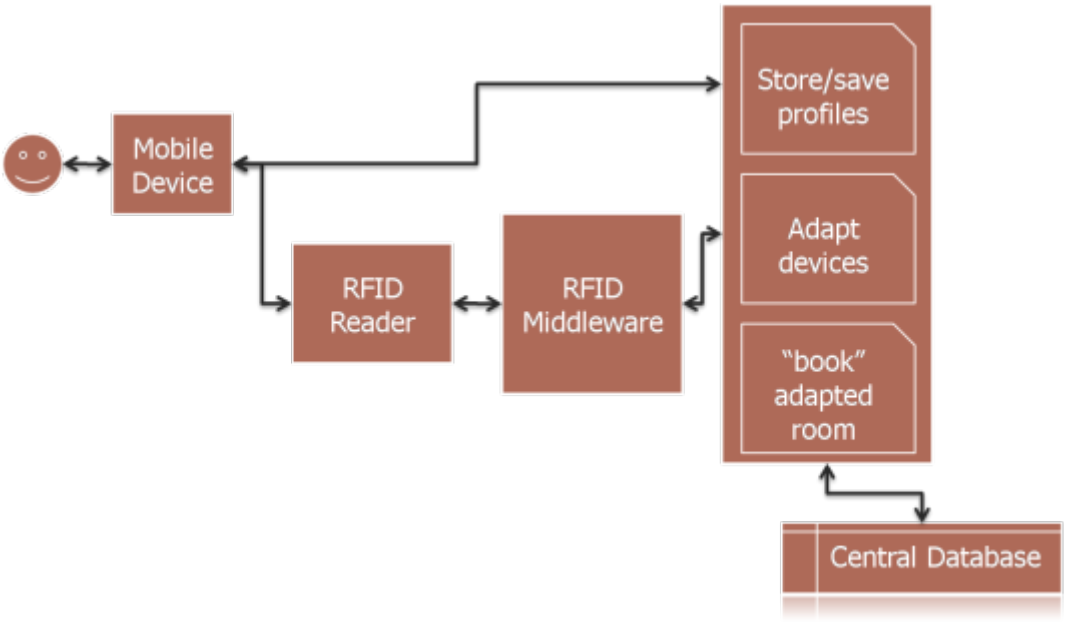

FIGURE 23: A CHART SHOWS HOW WU ROOMADAPTATION COMPONENTS INTERACT

INCLUDED COMPONENTS

- interface to connect to database and intelligent lecturing infrastructure
- interface to connect to mobile devices
- software on mobile device to implement virtual lecturing rooms

The RoomAdaptation is a tool that makes sure lecturers come to rooms that are perfectly adapted to their teaching methods.

Different lecturers have different demands to IT infrastructure, and not everyone uses the same applications, as not every lecture has the same requirements to the environment.

For this reasons, the RoomAdaptation is an implemented tool, which saves adaptations made during lectures as different profiles. So when a lecturer adapts a room for a specific lesson, the adjustments are stored to their profile and the next time this lecture starts, the room is automatically adjusted to the same requirements. Of course, lecturers can save different adaptations for different lectures and different rooms. For example, when different lectures take place in the same room, held by the same lecturer, each lecture is separately saved to their user profile. Moreover,

lecturers can adjust their lecturing rooms even before their first lecture starts. They can use the tool RoomAdaptation on their devices to see a virtual lecturing room with all the infrastructure as items. They can make adjustments to the rooms and save them. When the lecturer starts their first lesson, the room will be adapted according to their saved profile.

The RoomAdaptation is an information system that connects the lecturers' mobile devices to the central database and to the lecturing infrastructure. The profiles are saved in the database and the intelligent lecturing infrastructure reads the information from the database and adjusts its components.

3.3. LECTURING AND STUDYING INFRASTRUCTURE

3.3.1. ADAPTIVE LECTURING ROOM

"IN A RICH 'UBICOMP' ENVIRONMENT THERE WOULD BE HUNDREDS OF COMPUTATIONALLY DRIVEN GADGETS OR SMART APPLIANCES THROUGHOUT, EACH ONE PART OF A LARGER SYSTEM OF COORDINATED DEVICES. THESE OBJECTS TRANSMIT AND RECEIVE SIGNALS FROM NEIGHBORING OBJECTS AND OFTEN ACT ON THEM IN A CONTEXT SENSITIVE MANNER" [Kirsh, 1998].

An adaptive lecturing room should support the lecturer as well as the students in the best possible way as they have to get along with each other and should achieve a daily workload. In order to meet these requirements the adaptive lecturing room should be equipped with flexible, modular and reversible applications. It should also be ensured that the applications can be easily upgraded or exchanged for future developments.

Lecturing and seminar rooms should move on from so called 'frontal teaching'. They should provide an environment for interaction and collaboration instead of classical teaching.

In the new seminar and lecturing rooms, the only fixed objects should be the walls. That means that the rooms should be adaptive in various matters. The infrastructure implemented in these rooms should be flexible to provide different types of teaching as well as different compositions of seats and applications. Adaptive lecturing room means that the room can be completely changed within a short period of time.

In this context it is distinguished between different types of adaptive lecturing rooms, sorted by ability to adaptation:

- Seminar/Project/ Break-Out Rooms
- Small lecturing rooms for up to 30 people
- Large lecturing rooms for 60 to 180 people
- Auditorium Maximum for 650 people

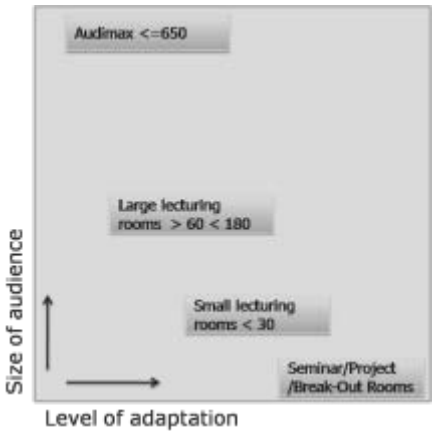

FIGURE 24: GRAPHIC SHOWS THE LEVEL OF ADAPTATION DEPENDENT ON THE SIZE OF AUDIENCE

Of course, one cannot design unlimited flexible rooms of all sizes when regarding the size of audience. Figure 24 shows the level of adaptation depending on the size of audience.

INTELLIGENT LECTURING ROOM

The intelligent lecturing room is a component to logically complement the tool RoomAdaptation. The intelligent lecturing room is connected to WU applications, and so knows what lectures are taking place in which lecturing rooms. Each room loads the used profile stored in the database and so adapts to the lecturer's needs. When there is no profile or adjustment stored in the database, the intelligent lecturing room scans lecturer's RFID tags when they enter the room. Any adjustments that

are made during a lecture are now saved to their profile and again made before the next unit of the same lecture starts. To understand, chairs and tables cannot be adjusted by the intelligent lecturing room, which would be physically impossible. But adjustments like which component of equipment is turned on, to which wall the video projectors are adjusted, how many TouchTables are turned on, etc.

3.3.2. Collaboration in rooms

"Typical lecture classes often fail to make students' thinking visible to both the students and the instructor. The professor lectures and the students take notes. Students are usually allowed to ask questions, but they often don't know they are misunderstanding [Bransford & Schwartz, 1998], are too confused to know the exact question to ask, or are too embarrassed to take class time on a point that, as far as they know, is problematic only to them. Professors can have trouble knowing how much time to spend on a student's question because the knowledge state of the person who asked it does not necessarily represent the class as a whole" [Bransford, Brophy, & Williams, 2000].

The classical image of teaching is frontal instruction but the modern approach supported by information technology is to create a new atmosphere, an atmosphere of familiarity and interactivity. For this reason, students should be able to collaborate with each other and to interact directly with the lecturer.

"For many people, the image of using educational tutoring programs involves students working alone at the computer, proceeding at their own pace, and becoming more technical and less social. And for some people, this image is accompanied by the thought that computer tutors can replace teachers" [Bransford, Brophy, & Williams, 2000].

IT infrastructure should neither make people less social, nor should it replace teachers. It should motivate both, lecturers and the audience to interact more closely and more consciously.

Presentation Mode

During a conventional presentation, one or more presenters stand in the front, the other participants sit, listen and watch them. With the new WU, there is an approach to change this situation. Like before, the presenters stand at the front, and the other participants sit, spread around the room. When presenting, the screen, video wall or any other media should only support the presenter but should not be the presentation on its own. While presentation mode, the presenter is able to use the environment, in fact they should use the IT applications installed for enforcing the message they want to send out to the audience.

The presenter can use either usual video projectors, remotely controlled by the presenter's mobile device, a TouchTable for editing a document and to show the audience how to do something, or they can use EtherTouch to edit a specific content, which is also synchronized with the audience's devices.

This approach only discusses IT infrastructure, of course. Traditional presentation instruments like flip charts are available in seminar and lecturing rooms.

FRONTAL INSTRUCTION

Frontal instruction is the classical way of teaching a large number of students. Like nowadays, there will also be lectures taught by frontal instruction in the future, so it is the exercise to support this way of lecturing to make it easier for both, lecturers and audience. Frontal instruction should be possible in rooms of all sizes. Thus, usual infrastructure for frontal instruction is available in all different types of rooms.

During frontal instruction, one or more lecturers or presenters stands at the front and the audience sits to obverse the presenters. The presenter is able to use either a video projector combined with a mobile device or one of the 3D-Displays combined with EtherTouch. Moreover, there are also classical teaching tools like moveable black- and whiteboards in order to provide space for noting instant announcements or messages.

GROUP-WORKING/PROJECT

While carrying out teamwork or working on a project, the lecturer engages in a supporting role. They therefore stay in the background and the focus is on the groups of students.

When working on a project, groups of up to six people can respectively use one TouchTable. They can also switch off the TouchTable and then assemble around usual tables and work either with their mobile devices that support SideSight and EtherTouch, or use the video projectors that project dynamic content to the walls.

The installed high definition cameras record the process and upload the high definition video to the database which can be synchronized to users' mobile devices via WU Synchronization Assistant.

3.3.3. CONCEPTS FOR LECTURE ROOMS

3.3.3.1. SEMINAR/PROJECT/ BREAK-OUT ROOMS

SEMINAR ROOM DESIGNED FOR UP TO 30 PEOPLE

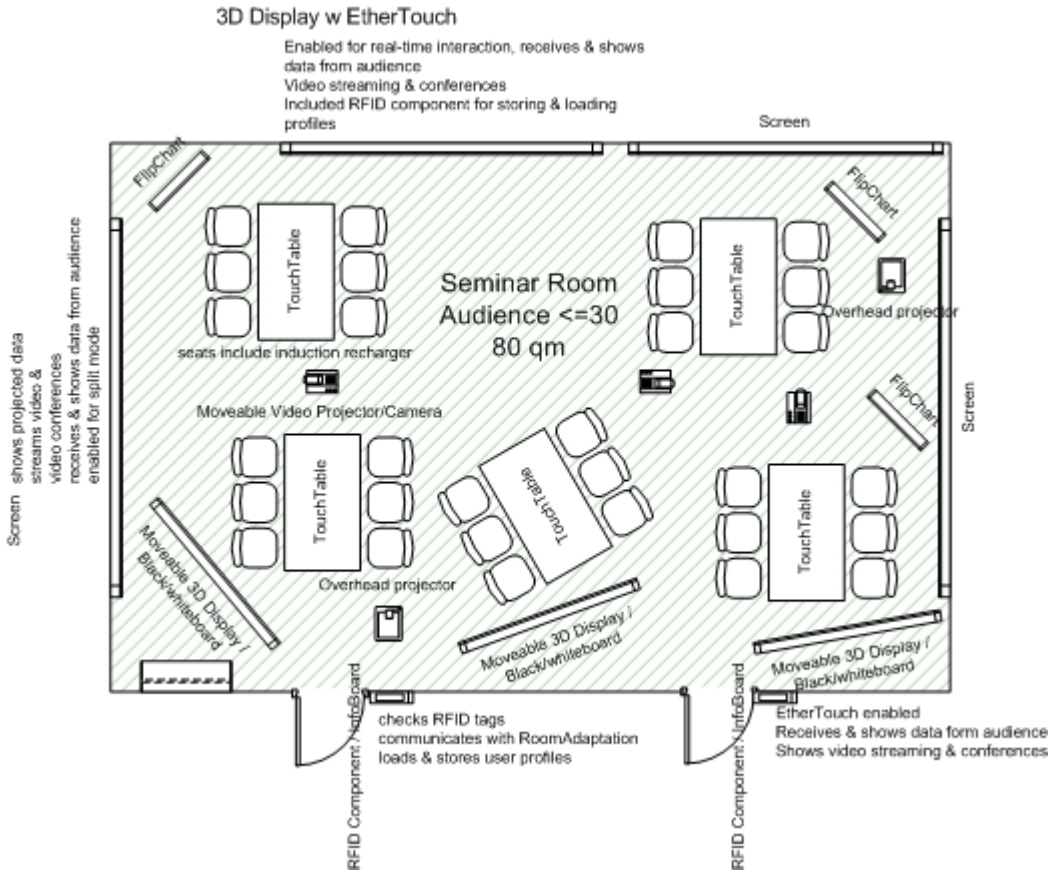

FIGURE 25: A DRAFT SHOWS HOW SEMINAR ROOMS COULD BE FURNISHED WHEN USED FOR PRESENTATIONS OR TEAMWORK

BREAK-OUT ROOM DESIGNED FOR UP TO 22 PEOPLE, SHOULD PROVIDE RELAXED SURROUNDINGS THAT DO NOT REMIND PEOPLE OF A STUDYING AREA.

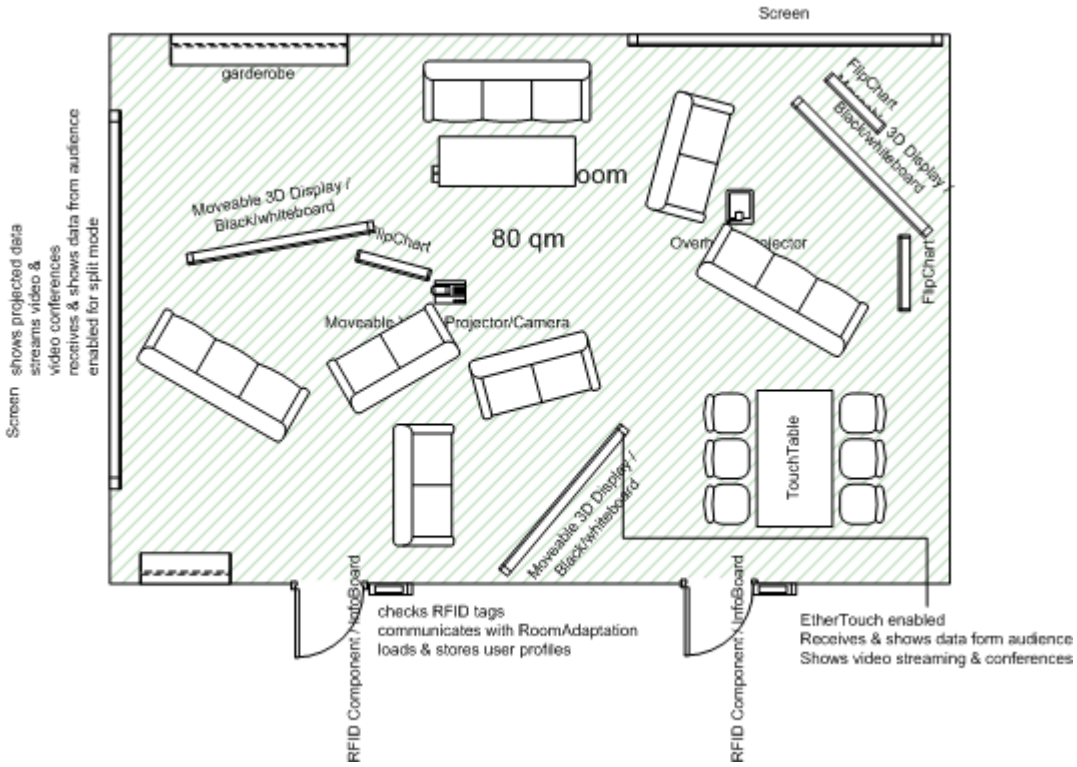

FIGURE 26:A DRAFT SHOWS HOW A BREAK-OUT ROOM COULD BE FURNISHED

For providing a flexible, motivating, quickly adaptive and relaxing working climate there are several infrastructure components installed in the seminar and project rooms.

- 3 video projectors, ceiling mounted, moveable on rails
- 3 high definition video cameras, ceiling mounted, moveable on rails
- 5 TouchTables, standing on the floor, wired, limited moveable
- one 3D-Display with EtherTouch option, 5 meters diameter, mounted on the front wall
- 3 3D-Displays with EtherTouch option, 2 meters diameter, wired, limited moveable
- Sound system, 8 speakers, ceiling mounted and 1 subwoofer integrated in the wall
- InductionChargers integrated in each seat
- InfoBoard at entrances/exits including an RFID component

3.3.3.2. SMALL LECTURE ROOMS

Small lecture rooms should come up with applications that support frontal teaching as well as interactive presentation mode for up to three presenters at the same time.

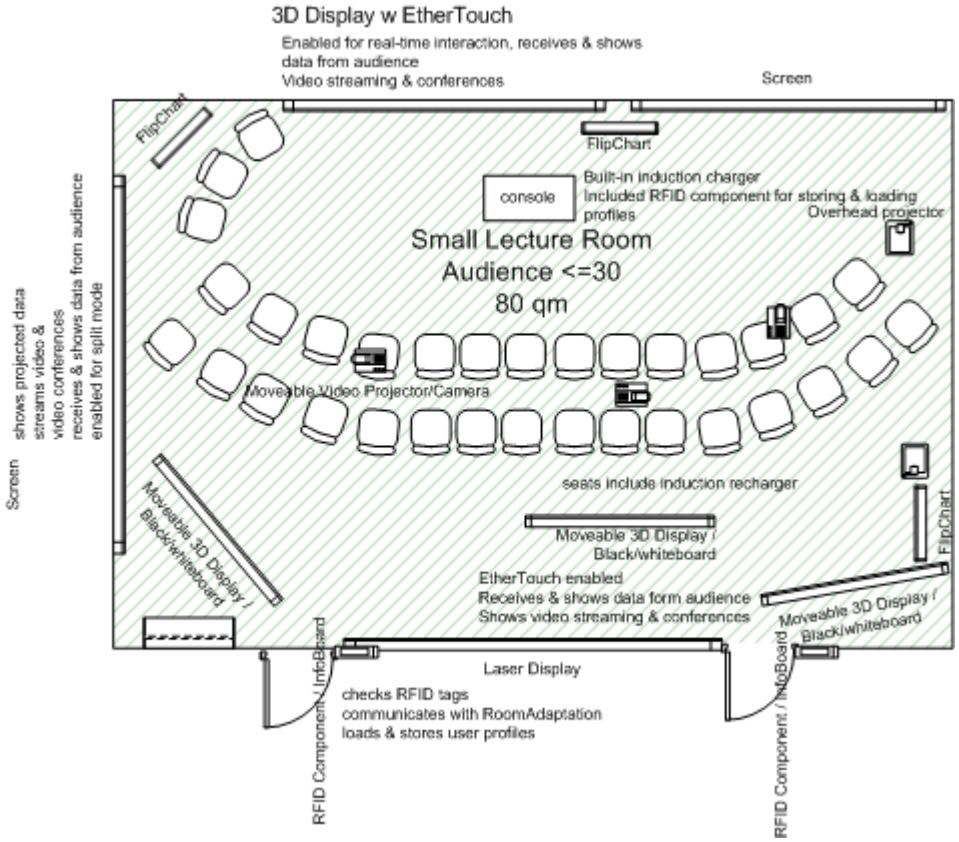

FIGURE 27: A DRAFT SHOWS HOW A SMALL LECTURE ROOM COULD BE FURNISHED

They should be highly adaptive and provide interactive, so as to be able to education methods, thus they integrate several infrastructure applications.

- 3 video projectors, ceiling mounted, moveable on rails
- 3 high definition video cameras, ceiling mounted, moveable on rails
- one 3D-Display with EtherTouch option, 5 meters diameter, mounted on the front wall
- one Laser Display, 5 meters diameter, mounted on the back wall
- Sound system, 8 speakers, ceiling mounted and 1 subwoofer integrated in the wall
- 3 3D-Displays with EtherTouch option, 2 meters diameter, wired, limited moveable
- 3 high sensitive microphones, wireless, wearable
- InductionChargers integrated in each seat

3.3.3.3. LARGE LECTURE ROOMS

LECTURE ROOM DESIGNED FOR UP TO 60 PEOPLE

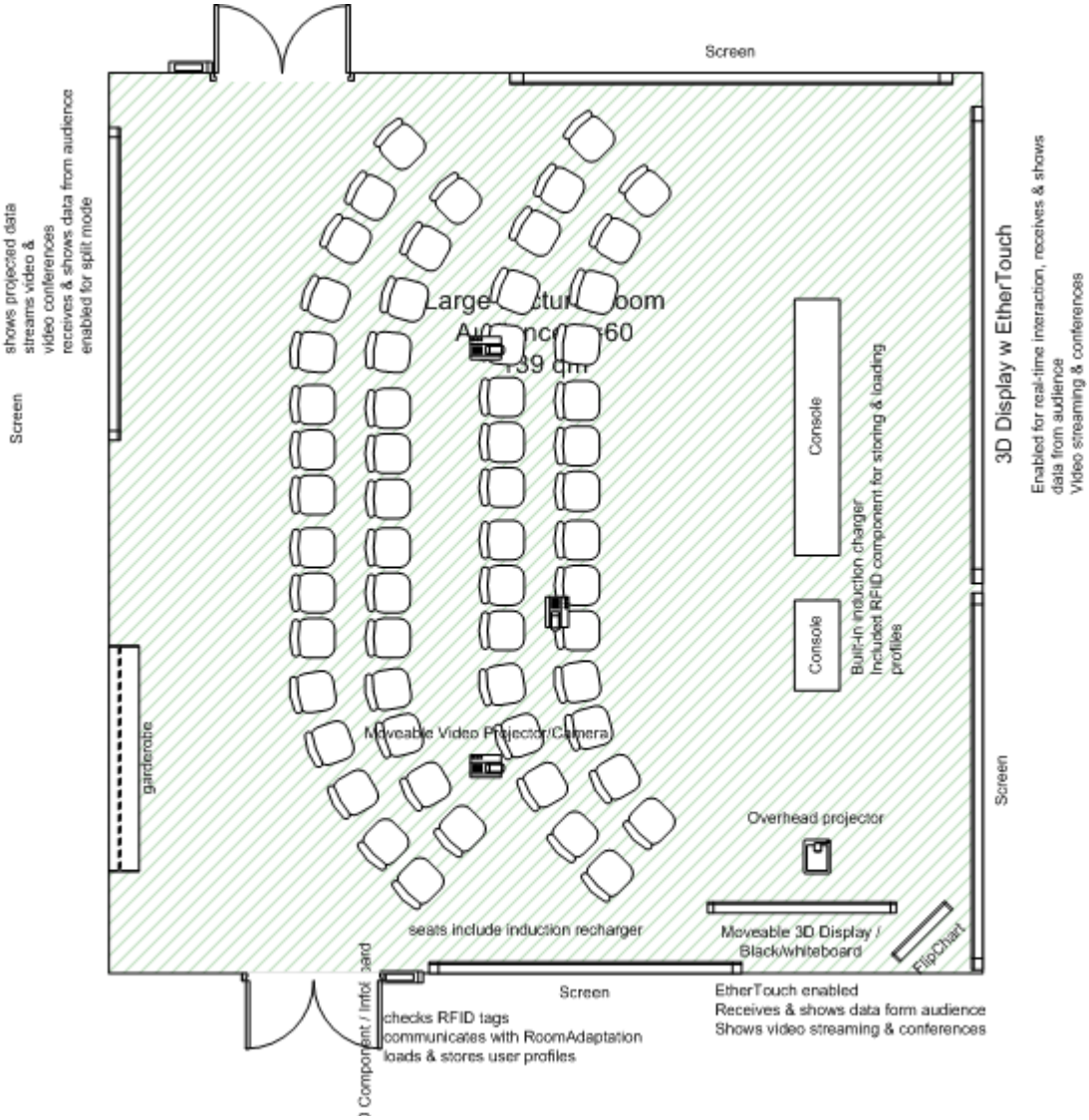

FIGURE 28: A DRAFT SHOWS A LARGE LECTURE ROOM FOR UP TO 60 PEOPLE AND HOW IT COULD BE FURNISHED

SPLIT LECTURE ROOM THAT CAN BE COMBINED AND ACCOMMODATE UP TO 120 PEOPLE.

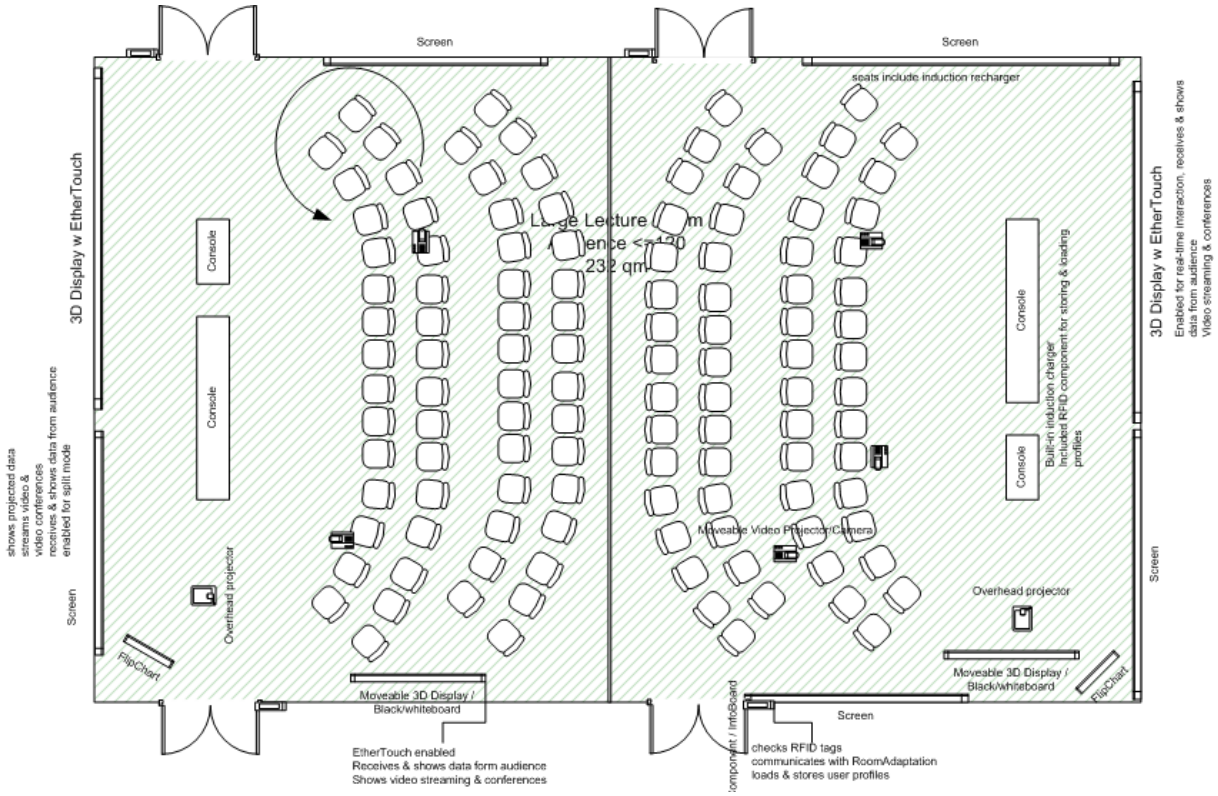

FIGURE 29: A DRAFT SHOWS TWO LARGE LECTURE ROOMS THAT CAN BE COMBINED TO ONE LECTURE ROOM FOR 120 PEOPLE, SEATS ARE MOVEABLE AND CAN BE SWIVELED

LECTURE ROOM DESIGNED FOR UP TO 180 PEOPLE

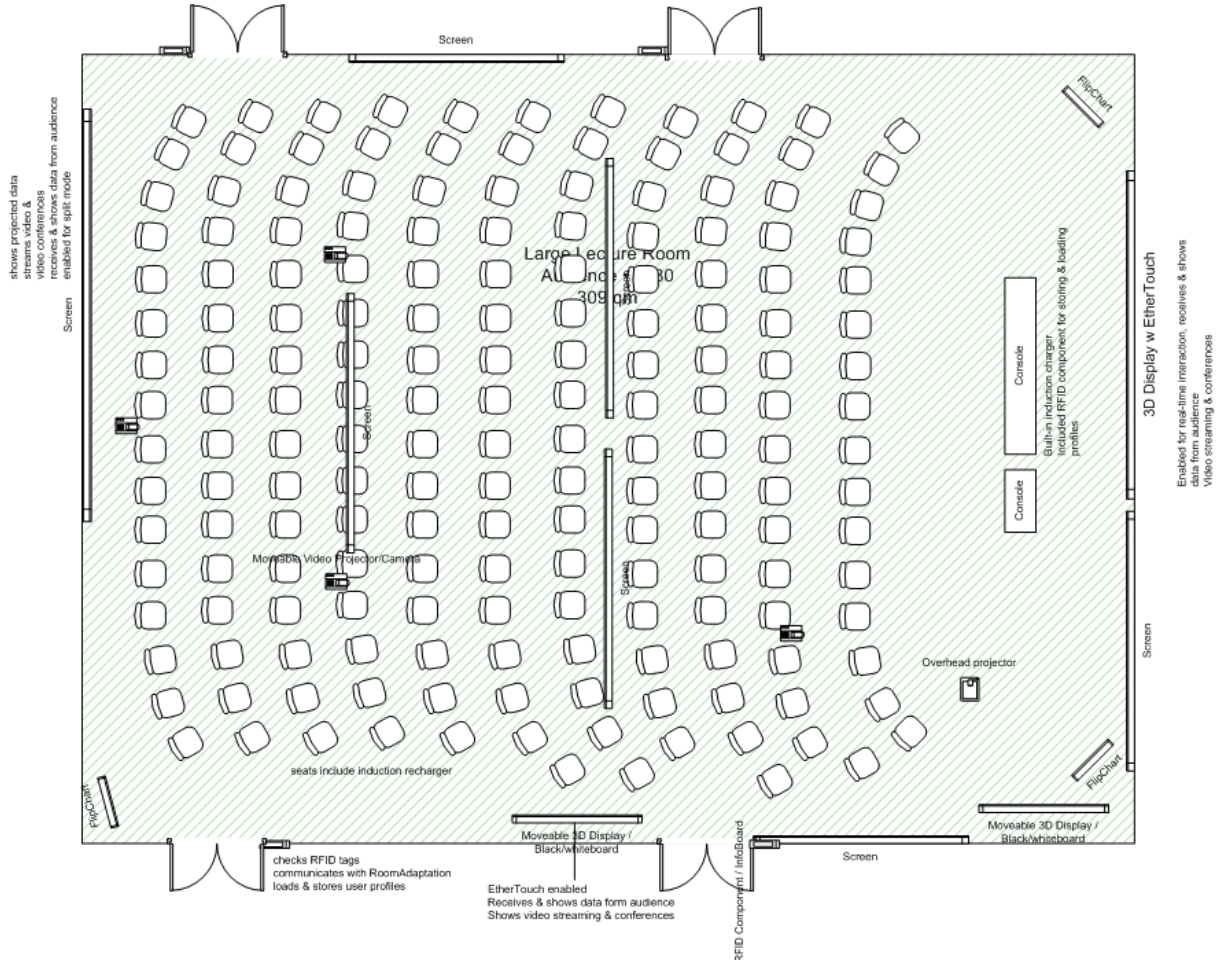

FIGURE 30: A DRAFT SHOWS A LECTURE ROOM FOR UP TO 180 PEOPLE AND HOW IT COULD BE FURNISHED

Large lecture rooms are proposed to serve for 60 to 180 people. They are adaptive in a limited way, as 180 people cannot move around a lot and 180 seats also need a lot of space. For a large lecturing room the following IT infrastructure is designated:

- one 3D-Display with EtherTouch option, 8 meters diameter, mounted on the front wall
- 3 high definition video cameras, ceiling mounted, moveable on rails
- 5 video projectors, ceiling mounted, moveable on rails
- Sound system, 8 speakers, ceiling mounted and 1 subwoofer integrated in the wall
- 3 high sensitive microphones, wireless, wearable
- InductionChargers integrated in each seat

3.3.3.4. AUDITORIUM MAXIMUM

The so called Audimax is the largest lecturing room on the campus. Its infrastructure is adaptive, but has very limited movability. The Auditorium Maximum is designated for either presentations or for frontal teaching. Interacting is only individually possible through each user's mobile device. Users' mobile devices therefore play the core role when interacting in the Audimax. Following applications are implemented:

- 3 high definition video cameras, ceiling mounted, moveable on rails
- 7 video projectors, ceiling mounted, moveable on rails
- Sound system, 8 speakers, ceiling mounted and 1 subwoofer integrated in the wall
- 3 high sensitive microphones, wireless, wearable
- InductionChargers integrated in each seat

3.3.4. IMPLEMENTED TECHNOLOGIES

VIDEO PROJECTOR

In the lecture and seminar rooms there are video projectors mounted on the ceiling, adjustable to project on each wall in the room. They are used for the classical way of presenting static or dynamic information to the audience. As video projectors are a well known and established technology and as they are also adaptive and movable, they should be installed in a lecturing room of the future. The video projectors can be moved along rails installed on the ceiling.

HIGH-DEFINITION VIDEO CAMERAS

Moreover, high definition video cameras are mounted to watch and follow human movements. They are installed on the ceiling and are moveable along rails. To make students more flexible and physically independent, high definition video cameras record every lecture. The record is updated to the WU database and made available for users via the WU Synchronization Assistant. The high definition videos can be watched as a streaming over the internet on WU Portal, and users are able to virtually visit lectures by using their mobile devices.

The cameras are also used for public video conferences during lectures, seminars or group exercises.

TouchTable

Figure 31: TouchTable [TouchTable Inc., 2009]

In each seminar room, there will be five TouchTables to complement the ability of collaboration and group working in the rooms. A TouchTable is a big screen disposed as a tactile table that allows real time modifying of shown documents simply by the users' hands. It is used for team working, group discussions or project management within the lectures and via the WU Synchronization Assistant, the edited documents are directly synchronized with the database and users' devices. In this context, the TouchTables have a diameter of three meters, what enables five to six people to collaborate on one TouchTable. Of course, it is also possible only to have the lecturer using a TouchTable and the screens in real time synchronized with the audience's devices. So they can see and also interact via their tactile interface with the lecturer, but do not need to assemble around the TouchTable. [TouchTable Inc., 2009] Yet, the power supply of TouchTable is still wired, so TouchTables are limitedly moveable.

EtherTouch

Figure 32: EtherTouch, allowing unknown ways of interacting with computers [EtherTouch, 2009]

EtherTouch is a technology that uses several 3D electromagnetic movement sensors to follow human movements. The newest development of EtherTouch allows users to interact with interfaces in a three-dimensional manner. To implement EtherTouch in the lecturing infrastructure, a 3D-Display, preferably with a diameter of at least two meters must be installed. The electromagnetic sensors are built into the display and usually these are small enough to enable an undisturbed learning atmosphere [EtherTouch, 2009]. Tracked hand gestures are now establishing on the market, they are accepted by the broad community of users, and finally will go mainstream in the near future [Vance, 2010].

There are several producers recently developing gesture recognizing technologies, also for usage in the private sector. TV sets, game consoles and other devices used day by day by millions of people will react to humans' gestures. It is therefore highly imaginable that there will be a broad acceptance among users and increasing maturity of technology will be a result [derStandard.at, 2010].

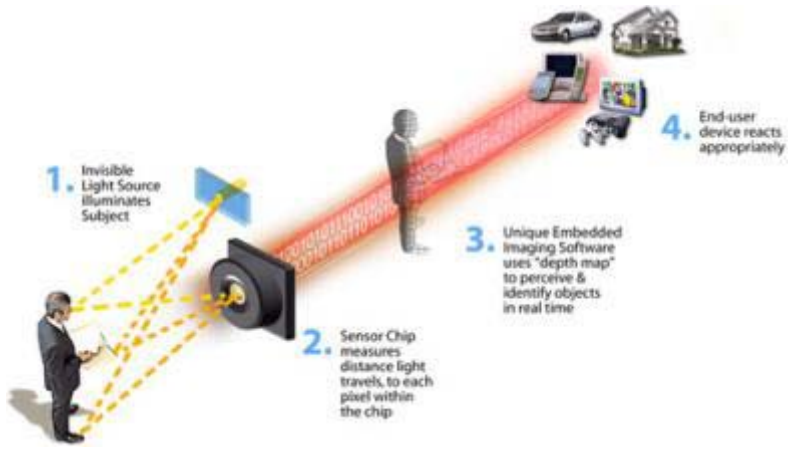

FIGURE 33: CANESTA - ELECTRONIC PERCEPTION TECHNOLOGY [CANESTA INC., 2009]

By tracking the lecturers' movements a so far unknown way of interaction and interactivity is possible, but moreover, it is necessary to enable the audience to interact with them.

Canesta, GestureTek and PrimeSense are further manufacturers of similar technologies that will enable people to interact with computers via gestures.

ETHERTOUCH FOR MOBILE DEVICES

According to Eikos and EtherTouch, the application EtherTouch will be integrated in mobile devices. By developing a transparent conductive coating to cell phone lenses, EtherTouch and Eikos will introduce this new development. This enables users to interact with their mobile device without any pointing devices. They would have to touch the device with one hand to enable the sensors, and then the other hand can be used to gesture and thereby interact with the device. EtherTouch is therefore the missing link in order for mobile devices to enable the audience to perfectly interact with the lecturer or presenter. It provides a far greater flexibility than any solution currently available [EtherTouch, 2009] [Eikos Inc., 2009]. One can assume that Either Touch for mobile devices places the missing link between limited screen sizes of mobile devices and intuitive interacting with them. This development would enable every user who sits in a lecture, no matter how large or how many listeners are present, to interact with the lecturer or the rest of the audience as if they were standing at the front and present. It would replace annoying attempts to hit the right keys on too small a screen when users quickly interact with a tactile interface.

SIDESIGHT

SideSight is a development, integrated in mobile devices, such as Smartphones or PDA's that supports virtual multi-touch interactions around the body of the device itself. Several sensors placed at the sides of the device allow fingers to be sensed as they move around the device from the sides [Butler, Izadi, & Hodges, 2008]. For detailed description of this technology, go to chapter 2.2.

SOUND SYSTEM

A sound system is integrated for bringing media as real as possible to the participants. Depending on the size of the room, in a lecturing or seminar room, there are six to eight speakers mounted on the ceiling and one subwoofer is integrated in the wall. The sound system amplifies the lecturer's, presenter's or student's voice should they have questions or points to make. It is also used for supporting public video conferences in lecturing or project rooms.

InductionCharger

Figure 34: WildCharge inductively recharges a mobile device [WildCharge, 2008]

To complement the range of applications used as lecturing infrastructures, the induction charger should be implemented in every room where users' mobile devices are needed. InductionCharger is an already developed technology that enables devices to be recharged inductively, without wires over a distance of up to 50 centimeters. In lecturing as well as in project or seminar rooms, InductionCharger must be installed to ensure users can use their core application: their mobile devices [Cell Phone Hits!, 2009]. WildCharge and PowerMat are products that are nowadays established on the market and it is estimated that recharging times and distances will improve.

ThrowingDocs

Based on Drag-and-Pop and Drag-and-Pick, ThrowingDocs is a technique that allows users to use drag-and-drop among several devices. With ThrowingDocs, a user can pick a document or parts of a document that they want to send and then drag the picked icon to a device that is indicated by an icon on their graphical interface and then release the icon. So the document is immediately sent to the chosen device and is opened by that device by showing a pop up window. If only a part of a document is chosen to drag to a device, the opened document is updated with the received information. Picking an icon can be done either by finger (when using a tactile interface), movement gesture, or any other input device, for example a mouse or touchpad.

Figure 35: Drag and drop across multiple devices [Baudisch, et al., 2003]. Throwing Docs is leaned on this technology

ThrowingDocs is an idea to improve collaboration and interaction by keeping several used devices synchronized. Imagine a lecture room with an audience of 100 students or more. The lecturer works on an exercise together with the audience. When the lecturer addresses the students with a question, they can ask the audience to throw the right answer to their document, instead of manually writing or typing in information. If a student mentions an idea or indication, they can make it visible to all others by showing it on a video projector or display.

ThrowingDocs saves time and coordinates interaction among a large number of users.

VOTING & HAND RAISING

Primarily used for lectures in front of a large audience these tools ensure ordered actions during a lecture. Voting is an application running on students' and lecturers' mobile devices. When lecturers have question to students or want them to vote or evaluate topics, they might use the tool to process the vast amount of answers given to them. A lecturer can give alternative statements or proposals and enable students to vote which they prefer. The alternatives are shown on the registered student's

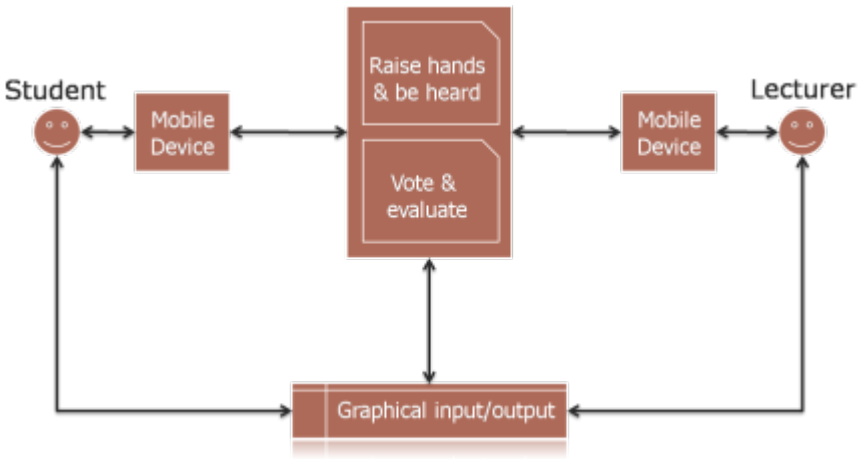

FIGURE 36: A CHART SHOWS THE TOOL VOTING & HAND RAISING AND HOW COMPONENTS AND USERS INTERACT

mobile devices and they can choose one or more alternatives using their graphical interface. The lecturer then immediately gets information about students' opinions and can quickly react, according to the given feedback.

When lecturing in front of 650 people in the Auditorium Maximum, it may be difficult for students at the back of the room to make themselves heard. Hand raising is a tool that enables students to announce individual messages. They can simply type on an icon, implemented on their mobile device, or type in a specified gesture that is recognized by the interface and the lecturer is immediately notified that a specific student has an announcement to make. If the lecturer enables the student to make their announcement, they can use the built-in webcam and microphone to be shown publicly on the video wall to visually support their announcement. That ensures that no one who actually wants to collaborate is ignored by the lecturer or presenter and can clearly publish their opinion to the audience.

VIDEO COLLABORATION

Video collaboration is nowadays widely established and often used when physically separated teams or groups are working on a project. The new WU will also take advantage of this development as the needed infrastructure for such a system is already provided. Users' mobile devices have built in cameras and microphones and every lecture or seminar room has mounted cameras and video walls. This tool is implemented to provide video conferences and instant web meetings among students and lecturers. Users can simply call their colleagues via the WU Messenger or Organizer and then start a video conference. Their camera films them and the in-

formation is sent in real time to the dialog partner and the other way around. In lecturing rooms, the application can view the stream either on one or more of the displays or on the video walls used by the projectors. Thus, a big audience can directly speak to not physically present people and is able to directly interact with them. Additionally, the application must properly communicate with other applications, for instance documents can be thrown to the dialog partner and the users' gestures that are tracked can directly be processed by the dialog partners' device and then the application can react. For example, an external professional is part of a lecture and interacts with the audience via the video conference tool. The external dialog partner is able to directly interact with the lecture room's EtherTouch because their signal is tracked and sent in real time to the application in the lecture room. That makes external people virtually present and enables them to show more complex contents and interact faster than using a usual input device.

3.3.5. Maintenance and sustainment

The new WU will consist of a large amount of technological interfaces and electronic devices. As mentioned above, reliability is a topic of high priority when it comes to information systems integrated in the daily life. When users are to be satisfied, it is an act of necessity to provide infrastructure that works properly and is reliable. Lecturers and students should also support maintenance in the most efficient way. In fact, maintenance often starts with the right handling of equipment. At the devices mounted in lecturing rooms, libraries, studying zones and other places connected to the information system, they can automatically send information of operating hours to the service personnel and so guarantee that expendable parts are replaced on time and services are made punctually. The lecturing infrastructure also sends messages to the users if anything is not running correctly or needs to be replaced or repaired.

Usually the information system should handle maintenance without requiring users to act, by directly communicating with the service personnel. When it comes to incidents in lecture rooms or other environments, the users are given information via their devices in order to ensure that they are reacting correctly.

3.3.6. Access for handicapped

The new WU should be free of barriers of any kind. It should also provide overall access to every place for handicapped people.

The applications implemented in the new WU support the handicapped to find their way round campus and propose to them specific barrier-free routes to directly go to specific places. When Navigator, Organizer and some other applications communicate, this would enormously facilitate the life on campus for disabled people as they would be enabled to work on most of the exercises without physical presence and are made aware of defined routes that lead them around campus quickly and barrier-free.

3.3.7. Further intentions

Social Network

To improve the informal exchange of information primarily among students, a social network implemented in an internet platform would be a helpful tool. Like social networks used nowadays, such as Facebook [Facebook, 2010] and StudiVZ [VZnet Netzwerke Ltd., 2010], they are integrated in the modern societies' daily life and users count them to their daily main activities. For example the WU Network could be created in order to enable a broad online community -in fact more than 25000 students- to interact virtually via their own network. The purpose of such a network would be the communication besides usual WU information system applications that are primarily used for studying and daily life on campus. While WU Organizer, Navigator and Messenger connect students and lecturers concerning professional topics, a WU Network would focus on private communication among students and lecturers. Students could create events like parties or balls, share their spare time activities like sports or hobbies with other students and also create groups of interest, either for literature, technology or board games. The WU Network would constitute a further idea to improve informal communication and sharing of interests which in effect leads to a better relationship among students and results in higher motivation and better coordinated teamwork.

Digital Library

A huge step towards local independency would be a completely digitalized library that holds all the books placed in any library of the WU. This would enable access from everywhere to the huge amount of information that is stored in the libraries and provide users local independency. There are several existing projects of digitalizing libraries [Greis, 2007], but the costs would exceed imaginable sums. To stay realistic, a complete digitalization of the library will not occur within the next three years, but this is a project worth considering in the near future.

3.3.8. Upcoming threads of an intelligent information system

The industrialization of the 19th century was not the first period which saw humans use previously unknown technologies and inventions. Modernity is confronted with revolutionary and accelerated changes in science and technology that challenge basic implicit and explicit moral assumptions and legal norms. This makes many people feel uneasy with technology; they wonder if it is safe, and they have trouble coping with constant change [Mordini, 2007]. With new inventions fears and doubts often arise. People are wary of handling things they do not know and they are afraid of because they are not familiar with them.

In this context, when one is talking about a lecturing infrastructure that is of a completely new design, this can be compared to technological inventions of the 19th century. In our time, fortunately, peoples' acceptance is becoming bigger and bigger and today there is a high level of technical literacy and background knowledge about information technologies. Nevertheless, people still remain critical and doubtful when they are introduced to new technologies, especially if they are forced to change their habitudes.

When thinking of an intelligent information system that does nearly everything of the daily work concerning organization and administration, one could be afraid that people are on the way to retire of mental activity. When combining all the applications mentioned above, users would have to use their devices permanently in order to maximize the benefit they gain from it. The question arising now is what happens if we stop thinking about banal daily stuff and concentrate on given exercises, research or learning. Of course high reliability and high availability are possible measures that help us to rely on information systems nowadays. Moreover fingerprints are used in order to ensure authenticity and preventing of abuse. Nevertheless, even when all the devices are actually mounted and all the applications are imagined as running properly, what if devices or applications would not work? What if the users' devices are lost and used by people not authorized?

Is an overall intelligent information system replacing our comprehension when it comes to daily life challenges? Yet, technology mostly facilitated our lives during the historical cycle. Technology is integrated into everyone's life more than ever, and devices such as TV sets, microwaves, personal computers and fridges have raised living standards by a substantial amount. As new inventions concerning technology require users to get used to them, society still faces a challenge. Even outside of daily life, there are lots of things to learn, for instance handling of more and more sophisticated systems and machines, it is therefore not the case that mankind is becoming stupid because of intelligent computers.

EPILOG

This concept should have given an overview to the reader of how infrastructure components could work together in the near future for making our daily lives easier and better organized. ´

Of course, for technically detailed descriptions of how the devices and applications would work, this framework is not enough, but it should create a picture of how the new campus could look like. There are still lots of lacks and gaps to fix before such a concept could be implemented. Moreover a few assumptions must have been made in order to imagine a proper implementation. For more detailed information the reader is kindly invited to do further reading about this topic as not every item can be discussed in detail in this framework. While writing this thesis, I tried to substantiate my imaginations and pass them onto the reader. Hopefully my visions have created a picture in the reader's mind and that my thoughts have been laid out clearly and understood well.

Lessons learned while doing research and writing on this paper where definitely a rising creativity and ability of abstraction. It was necessary not to combine technologies and describe them as a concept, but to create an infrastructure from A to Z. Before I was able to start writing and describing applications, I had to design a virtual picture of how the campus would look like and how the daily life would look like if all the applications are implemented. Establishing ideas by mind mapping and brain storming played a big role in this thesis and it was an exercise I had underestimated.

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CANESTA	HTTP://CANESTA.COM
CRABSTUDIO	HTTP://WWW.CRABSTUDIO.CO.UK
CSR - BETTER CONNECTED	HTTP://WWW.CSR.COM/HOME.PHP
ESTUDIO CARME PINÓS	HTTP://WWW.CPINOS.COM
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GESTURETEK - WORLD LEADER IN COMPUTER VISION CONTROL	HTTP://WWW.GESTURETEK.COM
NO.MAD ARQUITECTOS	HTTP://WWW.NOMAD.AS
OLED.AT	HTTP://WWW.OLED.AT
OSGI ALLIANCE	HTTP://WWW.OSGI.ORG
PRIMESENSE - NATURAL INTERACTION	HTTP://WWW.PRIMESENSE.COM
RTRI - RAILWAY TECHNICAL RESERACH INSTITUTE, JAPAN	HTTP://WWW.RTRI.OR.JP
THE ZEITGEIST MOVEMENT	HTTP://WWW.THEZEITGEISTMOVEMENT.COM
VENUS PROJECT	HTTP://WWW.THEVENUSPROJECT.COM
WILDCHARGE	HTTP://WWW.UK.WILDCHARGE.COM
WU HOMEPAGE WITH INFORMATION ABOUT THE NEW WU	HTTP://WWW.WU.AC.AT/WUW/OTHER/WUNEUBAU
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