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Usability of public transportation centers

Are findings in human computer interaction research about usability applicable for pedestrians using a center of public transportation?

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Abstract

Human computer interaction (HCI) science offers a variety of guidelines and techniques for the design and evaluation of complex two-way communication between a human being and a machine – in most cases a computer. Whereas current research in this domain often focuses on interaction with graphical computer interfaces, the origin of the science included themes such as workplace ergonomics and tool specifications for safe use. When planning and constructing a center of public transportation, questions about technology and engineering dominate considerations about the usability of the building. The domain of signaletic tries to go beyond this technical view by importing human needs of orientation and gathering information into the conception of the facility. HCI science as well provides further insight in the intuitive use of a public transportation building. The aim of the current work is the comparison of the different approaches in respect to the usefulness of a facility and the extraction of applicable findings from HCI to the real-world usability of a center of public transportation.

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Contents

1 Topic specification

Ancient roman philosopher Vitruvius (27-23 BC) already pointed out three main principles of architecture: firmitas (strength), venustas (beauty) and utilitas (usefulness). All three should be considered when building or altering an edifice. The different functions (e.g. protection, admiration or habitableness) a building serves for favor one or another principle. The corresponding specialists in each functional section are engineers, designers and ergonomists whereas the architect himself incorporates all these aspects or brings them together at least.

The focus of this work is on a building with high usefulness requirements, mainly because psychological findings in usability research eventually may enhance or complete guidelines or best practice there. It is generally difficult to isolate and identify an interaction problem in the real world because of the impossibility to record and determine the interaction of all possible parameters. The selection of an appropriate site and setup is therefore crucial. The methods and concepts used in HCI on the other hand might be unsuitable or need extensive adaptations. The possible benefits integrating suitable ones nevertheless are worth the effort.

1.1 Site specification

A complete definition of the site in focus within this work is impossible. Instead, an outline of the main characteristics of the locus of attention may serve as an incomplete but satisfactory description of the place of actions. Combined with an outline of the user described later, a concise system will be given. The space wherein public transportation happens consists of static (e.g. buildings) and dynamic (e.g. trains) parts. The characteristics of interest of one of the former, a center of public transportation, referred to as “station”, are as follows.

As a model serves a pedestrian-only main train station in the public transportation network. This site is selected mainly because it features mixed individual aims and above average density of passengers as well as a complex combination of possible travel means and modalities. Efforts enhancing stations with shopping facilities and cultural activities lead to multiple purposes which conflicts at least partly with traditional transportation concepts. Given limited space and time of actual transportation "users" in combination with the entangling circumstances, the requests even increase the necessity of appropriate guiding assistance through the building.

1.2 User specification

Traveling per se begins when people plan, start and end the voyage usually outside of the train station. However, this work only covers the short but all the same important part of traveling inside of the station. Rather than beeing faded out, the former parts are mapped in the form of user aims and representations of an interaction pattern when changing between different modes of traveling (e.g. from tramway to train). These are important in the information processing taking place when transiting the station.

Even if legislation recently set the requirements enabling access for handicapped persons, those are not of main interest but represent one end of the range of users covered within this work. The term "user" in this work refers to a single person of adult age (20-60 years) without handicaps. Handicapped in public transportation here comprise the ample (e.g. toddlers, aged people, pregnant, luggage-loaden etc) and close (e.g. bodily, visually, auditorily or mentally impaired) definitions. It is also evident that inexperienced users like foreigners or first time users might encounter specific problems. Different aspects of the topic and their responsive specialists may however use more or less sophisticated differentiations of the user model.

2 Engineering

Whereas human aesthetics opens a broad field of whishes, visions and furthermore dreams, physical limits often set the boundaries of possible construction. Design ranges from functional, simple and sparely to visionary and literally twinkling objects. Ideally both are combined creating functional and beautiful buildings. Knowing physical measures therefore is essential when talking about sites and their usability or aesthetic value even if these may not share many features at first sight.

2.1 Classical movement – physical measures

Classical mechanics as one main department of physics provides profound knowledge of human motion and therefore of possible interactions with structural works. Weidmann (1993) offers an elementary work basically about classical mechanics of pedestrians in his comprehensive literature overview. He resumes the decisive characteristics of pedestrians and their responsive dependencies with external influences like inclination of a ramp or environmental temperature.

Pedestrian-inherent factor dependencies

Although gender is almost equally distributed in overall population, women tend to use public transport more often (Weidmann, 1993). There are also differences in daytime and weekdays distribution of gender. Weidmann reports an average 10.9 % faster walking speed of men in gender-split examinations. Regarding age patterns, the influence of the growing and increasingly mobile part of elderly people becomes an factor not to be underestimated in public transportation issues. Weidmann concludes an eminent slower walking speed of about 50 % compared with a reference pedestrian of age 40 causing relevant diminished average walking speeds when aged people become temporarily over-represented for example between rush hours.

Effectively required space for each individual is 0.15 m^2 or about 6.5 $persons/m^2$ without movement and luggage which increase required space and therefore reduce maximal passenger density (Weidmann, 1993). A person as a physical system has a natural frequency when moving which also represents the energetic minimum of motion. Because required power increases rapidly when walking at speeds over 1.9 m/s to 2.5 m/s Weidmann reports a cut-off where running at low speeds actually is power saving compared to fast walking but circumstances often force the choice of the latter.

External influences on Pedestrian factors

Apart from the characteristics of the human motion apparatus, external or situational influences cause a great deviation from resulting optimal speed of the former. The intended purpose of the motion results in categories of different walking speeds. Weidmann (1993) resumes the reference values of the common four categories with 1.49 m/s for commuter, 1.16 m/s for shopping, 1.61 m/s for work and 1.10 m/s for leisure pedestrian traffic. The assumed equally overall distribution of about one forth of every category however varies considerably regarding daytime and the categories differ also in age, gender and other factors which may account for the difference in speed. Peaks of walking speed are observed during rush hours in the morning and in the evening where the faster commuter and work traffic is overrepresented.

An interesting phenomenon is the negative correlation between environmental temperature and walking speed (Weidmann, 1993). This finding though has limited application because the walking speed plays a minor role on the platform itself and the temperature remains within borders inside the building but transit time might surpass an intended level in hot summer days. Passage length has en effect on transit time but not on walking speed. Exceptions are staircases, where the number of steps inflicts stepping speed negatively. The effect of the staircase itself is a 6.5 % loss upstairs and a 6.5 % gain downstairs. Weidmann additionally assumes a distinct loss of walking speed of around 5 % for ramps with a realistic inclination of about 5 % and a minor gain for the declinating ramps.

The pedestrian density has a considerable effect on walking speed. Because of the dynamic aspect of density and the interdependence of the two values, a clear interaction is difficult to draw but certain characteristic points can be made. First the speed decreases noticeably for densities between 0.5 and 2.0 $persons/m^2$. A second breakpoint is at 5 $persons/m^2$ where almost all motion disappears. For a density of 1.5 $persons/m^2$ the pedestrian speed is decreased by about 50 % (Weidmann, 1993). Comparable effects for staircases are observed but do not feature a broad database.

2.2 Advanced movement models – pedestrian behavior

Assuming the stereotypical lonesome cowboy and especially his free direction choice out of 360-degrees still exists. In spite of this dreamful vision reality for most of the increasingly mobile people looks different. When people travel more frequently and farther, limited space and choice of time are the downside of dependable, secure and fast dislocations. As traveling normally is no longer an adventurous project with unforeseeable duration, requirements for the offering services changed throughout.

As a consecution of these changed requirements the planning took an enhanced perspective and moved from individuals to modeling and integrating groups of people and their behavior in and as a group. This shift followed the development in natural science where observation at a macroscopic level fades out individual motion in support of the overall model but offers completely new insights thereby. But even classical mechanics offer some interaction models, which describe the performance of a site. Helbing, Molnar, Farkas, and Bolay (2001) even state some important facts that restrict the direct comparison with physical macroscopic models like gas-kinetics or magnetism. The human aversion to take detours or moving opposite the desired walking direction in combination with the general unawareness of behavioral strategies shows effects that can hardly be simulated by pure physical models. Examples of the issues caused thereby are the choice of the shortest instead of the fastest path or the obstruction of doors even though passengers from the inside are still trying to get off.

The level of service (LOS) concept

Physically optimized buildings provide high capacity at lower walking speeds combined with higher passenger densities but the result is a dramatically diminished comfort sensation on the other hand (Weidmann, 1993). The answer of engineers to this problem is the level of service concept which features nine qualitative levels of comfort, from free motion to massive crowd, basend on eight criteria like degree of freedom in choice of speed or possibility of crossing a stream of people. Crowded situations should be avoided and remain absolutely exceptional although this would be acceptable regarding physical ranges of possible densities of passengers.

The estimated passenger densities following the LOS concept are up to 0.6 $persons/m^2$ under normal conditions and range from 0.6 to 1.0 $persons/m^2$ for temporary rush-hour phenomena (Weidmann, 1993). The same levels can be reached on staircases with higher density loads. It is important all the same that the LOS concept is based on physical observation of walking speeds. Comfort sensation on the other hand is the result of individual and subjective processes of the pedestrian. Therefore it must be possible to affect comfort sensation through different means. Crowded sitations might become acceptable if the interpretive process of the pedestrian can be influenced successfully.

Adaptation of physical models to pedestrian behavior

In case of an emergency inconsiderable details like minor obstruction of the exit path can become an important threat to secure evacuation as phenomena caused by the evading people themselves can lead to horrible disasters. The obvious need to foresee and avoid such tragedies leads to the adaptation of gas-kinetic, magnetic and other physical models of integrated mass observation. The adaptation of a magnetic model by Okazaki and Matsushita (1993) offers the magnetic predictable direction of an individual pedestrian. This model is limited to evacuation or queue-building situations because the simulation ends when people simulated as particles reach the destination. Despite its ability to identify problematic situations and therefore to specify critical values for safety means, the relevance for normal situations remains minor.

Self-organization phenomena

Similarities with gas-fluid and granular media flow lead to the adaptation of the respective models for pedestrian simulation. These models feature explanations of self-organizational phenomena found both in pedestrian crowds and the respective physical media. The formation of uniform walking lanes is described by Helbing, Farkas, and Vicsek (2000) as an effect of optimization. When people move against a stream, frequent and strong interaction will occur causing unwanted decelerations or even impacts. In an attempt to reduce frequent and strong interactions while heading the desired direction, the formation of lanes is the optimized solution and furthermore supported by the preference of moving to one side by vehicular traffic and social norms (Helbing et al., 2001).

At narrow passages with the disposition of severe blockages oscillation phenomena can be observed instead. Helbing et al. (2001) explain this effect with pressure reduction when people move from one side to the other. People on the waiting side therefore have increased chance to occupy the passage and begin passing through themselves. Helbing et al. showed additionally in a simulation that spontaneous but unstable roundabout traffic at intersections can reduce disadvantages in motion like deceleration or avoidance movement. The loss of the little detour herein can be outweighted by the gain of attendance and speed when moving in an organized circular way.

3 Designing extends engineering

Apart from the physical interaction with a building there are also cognitive processes involved. In the best case, the possible interactions are clearly visible. Problems occur when the possible use of the environment is not visible or visibly equal alternatives do not show the different consequences they have. For instance, the passenger knows he has to open one of two possible doors but no information is visible which one leads to his destination. Therefore it is important to provide information where needed.

The decision where and when to provide information for the user is one problem but closely linked with the question what form this information should have. Both questions are optimization problems with an open answer space but no distinct solution. Furthermore, the pedestrian's need for information shows a broad deviation from experienced, fast and accurate processing to handicapped, slow and doubtful processing ones. The inhospitable premises make the field of signaletic hard to cultivate. Therefore literature is almost inexistent and even a basic work can't be found. But there are best practices used for years and decades by specialists in charge, which apparently cumulate rich knowledge of how-to that can hardly be put on paper. The growing influence of the highly networked information for our everyday living on the other hand may require adaptations of current signals and information paths.

3.1 Signaling best practice at Swiss Federal Railways

Signs at Swiss federal railway stations show coherence and diversity at the same time. Whereas the look seems to be the same no matter what station it decorates, the position, arrangement and size is individual for most sites. And even if parameters are set at a rather macroscopic level there are many formats that may provide information. Technical innovation brought completely new media and dynamic possibilities to compress data and focus on individual data tokens at the same time. The principle distinction therefore is between static and in time information through changeable signalization. An increasing part of information is dynamically accessed and personalized information displayed on private mobile technologies for example cellular phones and mobile computers.

The backbone that provides reliable and secure information even if everything else fails are the static signs of platform number, station name and other basic information. A second source that serves as fallback system in case of electronic or computer breakdown are the printout timetables hung out. While it may be sufficient to indicate directions at small stations featuring two platforms at most, timetables with platform indications at larger stations could be subject to change. Changeable signs show various kinds of information like destinations, departure time, platform and even the composition of the train. These signs are set up at points where the traveler needs brief and concrete information where to go. There are computer monitors and digital screens whose application is limited due to interaction problems concerning surrounding factors like daylight condition or viewing angles. The means mentioned above should not be regarded as a complete list of all actual forms providing information but serve as a quick overview.

Besides visual information that allows constant and manageable signaling, other channels are actually used. First, audible signals allow the presentation of important information in-time and at specific locations. When visual attention is needed for principal orientation or guidance through crowds this additional information channel offers appreciated opportunities. At last information of visually handicapped is regulated by federal law (Swiss Federal Legislation, 2002). Additionally, the tactile provision of basic, static information (e.g. platform number) allows the visually handicapped person to orientate and move more autonomously.

Swiss federal railways summarize the information about possible and actual information means in a collection of partly updated guidelines and technical sections called conventional FIS (Fahrgast Informationssystem; passenger information system). The impact of this capacious work remains relative altogether because of various possible exceptions and precedence cases. The actual embodiment of a station may therefore either follow the guideline closely or need profound changes and custom solutions for exceptional circumstances.

3.2 Information supply and pedestrian information search strategies

The information gathering behavior of passengers changed along with the growing influence of highly networked dynamical information channels like the Internet. After social communicative actions on the internet (e-mail, digital messages), information retrieval is the common purpose of Internet usage. Timetable information requests share a major part of this information retrieval although the category is closely defined compared with others and only few suppliers share the market (Swiss Federal Statistical Office BfS, 2006).

The long-established information of passengers is the so-called information pushing which often neglects actual needs. The time and location of the presentation of such information depends on the decisions of the company only. With dynamical information available any time and increasingly accessible in a mobile way, the classical information push shifts to customers deciding the desired information pull. Hans Wanner and Beat Hürzeler (personal communication, June 26, 2006) confirmed a decrease in the publication of paper railway schedules of about a bisection in the last three years whereas the electronic internet version had an almost doubled hit rate in the same time (Schori, 2006), which proves this trend to be impressive. As a consequence, the passenger is increasingly already well informed when arriving at the station and thus mainly independent from the information provided there.

The more the customer already knows the more important becomes information of changes (e.g. delays, platform changes) taking part between the information retrieval (usually at home or on the way) and the actual transit trough the station. Otherwise, such ambiguous information can lead to severe interaction problems causing discomfort and a loss of confidence in the system of the customer. A way facing this problem are subscription services for personalized timetable information to mobile displaying units.

3.3 User representation at Swiss Federal Railways

Present consideration about revision and adaptation of the partly outdated conventional customer information system starts with the definition of relevant user characteristics. One method thereby is the use of personas as a carefully selected and virtually assembled representation of whole user segments in a fictitious single person. So-called personas are nevertheless more concrete than abstract conglomerates. The concept of personas and their use is widespread among information and computational specialists. Pruitt and Grudin (2003) give an example and description of the used processes thereby. The aggregation of personas may not only distribute widely due to public inherent factors but also vary depending on the aim of such a methodical drive. Marketing for example focuses on advertisements which might interfere with usability requirements. The user itself changes rapidly (e.g. the spreading of dragged instead of carried luggage) which makes the definition of appropriate personas a recurrent task.

The personas used by the Swiss Federal Railways are based on multidimensional interviews and cover a wide range of possible usages of the station and the respective requirements. The first is a so-called run-traveler who travels fast, repeatedly and mainly for business reason and who knows most stations he uses; the second is a fun-traveler with little traveling experience but more time at hand and the third a visitor who travels less and uses the train station not for traveling only but for shopping, meeting and more as well (Swiss Federal Railways, 2006). As for the run-traveler, an actual precise description might feature a precise (although fictional) name, age, job, social environment and even a representative journal (e.g. of one week) including all relevant activities.

4 Human Computer Interaction

The usability factor in the triad of Vitruvius (27-23 BC) requires a special viewpoint onto the topic of interest. Thinking of a center of public transportation as a system and of customers who act as users therein and -with provides a concise model to discuss and work upon usability considerations. For the way people learn how to "use" a station, make repeated errors, waste time and miss trains while searching and feel comfortable or show aversions using public transportation psychology and specially HCI science worked out frameworks to analyse, predict and ease these user interactions. Usability although is only one factor in overall system acceptability shown as a general draft layout in Figure 1 (Nielsen, 1993).

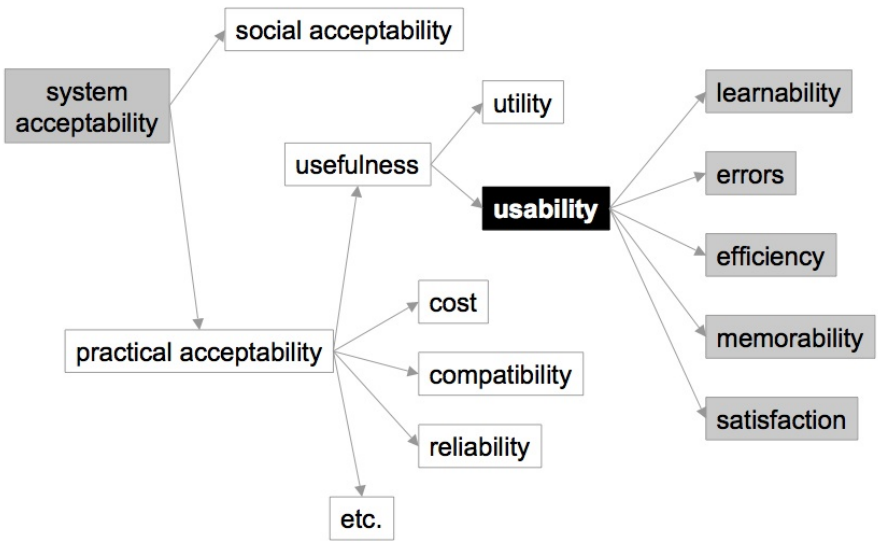

Figure 1. Composites of general system acceptability.

4.1 Origins of HCI science

The development of sophisticated technical equipment like modern personal computers or mobile phones opened a new field of possible traps and problems from the interaction. But interaction issues were observed as soon as the operation with machines or tools failed due to unclear handling affordances or invisible effects of manipulations already done. In the beginning of the modern technological society the emphasis was on user education that worked well with systems of modest complexity. After systematic persistent errors of highly trained users, human factors were taken into consideration when planning and designing new machines. Whereas this first paradigm change focused on accident prevention, soon the influence of productivity augmentation, learnability, and ease of execution became areas of interest.

The spreading of personal computers demanded a second paradigm change because the new users normally were novices and received little or no training. The groundbreaking success of personal computers was accompanied by new technologies and optimized systems that were direct results of usability research with mostly untrained users. The new systems were intended for laypeople and therefore completely new concepts and designs, different from those optimized for experts, had to be implemented. But often assumptions – done by experts - about the general knowledge of the new user segment were not accurate and research and methods began evolving accompanying the technical revolutions.

4.2 Main concepts and Models

When considering single system entities and functions, a far more general view should not be forgotten. The one of the triangle wherein every usability action is situated consisting of the user or subject, the machine or object the user tends to operate with and the surrounding or in a demotic term “the world”. Whereas interaction in general occurs between the subject and the object, the context modulates this process more or less. Psychological research provides some insights in user behaviour by models of human comprehension. Fundamental information processing models arose in the early days of information technology. The constraint and strict interaction patterns with the early computational machines raised fruitful concepts in cognitive psychology.

Another insight in user behaviour provides one of the fundaments of modern cognitive psychology: the discovery of the gestalt principles early in the last century. These principles were later adopted to various topics and at last to usability science too. Chang, Dooley, and Tuovinen (2001) offer an overview of this combination. The construction-integration model by Kintsch (1988) is an example of technically inspired insight – first limited to linguistics but soon expanded to a general human cognitive architecture. The core of this concept is the discrimination and at the same time integration of bottom-up (perception and integration of perceived tokens) and top-down (expectations and active search for discriminating cues) processes into a model of human comprehension.

Cultural conventions

The cultural background of the user sets some important but often neglected conventions (e.g. about the use of colors). According to Norman (1999), these conventions constrain the space of possible actions in a helpful way. Paying habits (e.g. by cash, bill, creditcard) for example depend mainly on social preference and cultural background and differs in distinct situations than it is a question of system techniques or marketing issues. Knowledge about cultural conventions can ease the use and raise familiarity and therefore comfort sensation when correctly applied.

Orientation processes

Spatial orientation is one of the key elements in real world interaction. Psychological research including ontogenetic development studies support the thesis of three core elements involved in mainly visual orientation, which are landmarks, route and map-like representations (Kallaia, Makanyb, Karadia, & Jacobs, 2005). Among landmarks are corners and edges of buildings; routes consist of chains of landmarks, but only at the map-like representation angles and distances combine to a relative and dimensional layout. Kallaia et al. (2005) found an interesting orientation strategy in humans that previously was only considered by animal pharmacological research to be a construct of fear: thigmotaxis, the tendency to keep close to walls or borders in unknown situations. This is a more schematic and automatised approach compared to visual scanning and cognitive processing of spatial information. The latter may apply more to human orientation and is considered the technique providing the most advantages.

Objects and their factors

Regarding the object or system to manipulate there are a variety of features that could possibly inflict interactive processes. HCI is concerned with graphical user interfaces (GUI) such as displays and spatial input devices. The organization for industrial standards provides an enclosing collection of guidelines about the usability of visual displays (ISO, 1998; Wikipedia, 2006b) which – apart from its initially narrow application – is now widely used in usability issues. ISO document 9241, part 10, lists seven principles in dialog design starting with task suitedness, self-descriptiveness, controllability of the process, conformity of anticipation, error tolerance, possibility of individualization and learnability. In part 11 the broader usefulness of a system is described by the three main features effectiveness, efficiency and user satisfaction with the system.

Whereas the ISO-principles mentioned above give an overview on the topic but no precise and checkable definitions, HCI experts developed a more experimental and ready-at-hand approach at usability issues. A field of major interest but also great dispute is the affordance of an object. Norman (1999) states that there are real and perceived affordances. The difference is the way an object communicates possible manipulations to the user. An upright window handle for example may be used – and therefore has the real affordance (among others) – as a hat stand (although it wasn't intended to). A vertical handle with four ergonomic spaces on the other hand literally evokes the urge to grab it when considering any action with this object.

4.3 HCI methods and evaluation

When defining and testing components of interaction processes, it is questionable whether these belong to the user or to the manipulated object. The first concern is whether the user – including the factors that inflict interaction – is known, or if unknown areas provide a basis for reasonable assumptions at least. After the more or less accurate prediction of user behavior, the conception or change of the intended interaction is the next step. After actual user testing (which is often omitted for different reasons) of the prototype, the planning steps ideally start again until a predefined goal for a certain interaction is achieved.

Limited resources of various kinds or so called expert-knowledge however often lead to cutting evaluation and profound user research. These seem expensive and slowing down productive process at first sight and therefore the longterm advantages are hard to point out. But the marginally higher investments are usually soon countervailed and even outmatched with substantially increased customer satisfaction, use and acceptance. Frequent, formative testing during production cycles is therefore the desirable state of the art but unfortunately, often involuntary summative "testing" by actual users occurs when the product is placed in its intended context.

Knowing the user

Without accurate knowledge about the factors of the users that inflict interaction, the conception of the object – which should match the user factors – is almost impossible or remains pure guessing. Methods describing and profiling the user are questionnaires, interviews and behavior observation by means of an existing comparable object. The IsoMetrics usability inventory by Gediga, Hamborg, and Duntsch (1999) is an example for a general applicable interview based on the implementation of the ISO-standards. An example for user behaviour observation is the federal statistical report mentioned above (Swiss Federal Statistical Office BfS, 2006). The problem with user observation is whether it allows correct and precise inferences because of the rough and weak operationalization. After identification of relevant user parameters it might be helpful for multiple reasons to define personas (Pruitt & Grudin, 2003) and fundamental user goals. First they allow user- instead of technical-centered design which adds more to usability. Predefined user goals then also enhance evaluation because tested subjects in probably abstract and new environments get concrete tasks and furthermore success parameters can precisely be defined.

Interaction design

Iterative conception should feature usability tests facilitating specific and accurate insight into changes made upon results from previous tests. Assumptions and results from a previous level should be term to reconsideration in every iterative cycle although the need for change often isn't apparent. Usability tests on the basis of an existing version or prototype of the object in question can be either empirical or analytical ones. The former includes somehow measuring actual user behaviour whereas the latter mainly features experts' assumptions based on underlying general knowledge about the user.

Subject testing and object evaluation

The methods to test subjects often include video-recording, log-file recordings and *thinking aloud* protocols (Gediga & Hamborg, 2002). These data usually gathered in an abstract laboratory context are afterwards analyzed by usability experts by means of the success criteria defined before. When experts try to predict user behaviour without actual subject testing they usually apply methods like the overall *heuristic evaluation* or the structured *cognitive walkthrough* (Gediga & Hamborg, 2002; Sears & Hess, 1999). The former is mainly a free exploration of the object whereas the latter follows predefined user tasks where experts answer structured questions at each step. An example for a combination of analytical and empirical methods is a structured user interview or walkthrough (an adopted example gives Appendix B). Tested subjects thereby follow more or less precisely formulated tasks and questions while the success and effectiveness of their registered actions provide further insights.

5 Site conception and usability evaluation

Engineering already investigated human motion and builds on hard evidence concerning physical measures. Signaletic experts follow rules based on settled knowledge and experience. And architects gather and assemble the different aspects into grand structure. Psychology on the other hand expanded knowledge and research about human mind to machines and systems with interfaces relative lately. The question arises whether the undoubtable impact of HCI science on the usability of computers can be carried on and adopted to main station buildings of public transportation. It is obvious that usability appears to be hardly measurable during planning, whereas physical entities are calculable and aesthetical questions merge into a public consensus even at conceptual levels. Experience from human computer interaction on the contrary show clear potential of early stage usability tests in reduced overall production costs and usually in an overwhelming final increase in user acceptability.

5.1 Architectural planning best practice overview

The designing and planning process of a public building, whether an entirely new one or a partly adapted one, features several typical cycles. Usually actual building planning starts calling in different design proposals for the given requirements and site constraints. The client (e.g. the government, the transport company) selects one proposition based upon expert opinion, political consideration, financial and technical reason. The actual user – the public – usually is consulted at a very late state (if queried at all). Alteration or adaptation of unusable features at this point is often already impossible — it is only question to accept or reject the sophisticated project in its unchangeable entireness.

As the introduction of graphical out- and input possibilities to computational technologies unclosed the adaptation to visual-based work sectors architecture partook in these mutations from the early beginnings. Whereas computer-based design renders fast design cycles and multi-user work on the same workpiece possible for the expert the digital output up today only plays a minor role as a “nice to have” playtoy for the actual user (when faced with digital output at all). Architects prefer small scale models or print-out plans as public exhibitions for reasons of realistic experience. A growing number of experienced users of abstract digital outputs and virtual environments in special (as featured e.g. in computer games) raise the question whether the public is able for the uptake of virtual models.

Virtual models and visualization used in architecture

The actual planning and drawing in architecture today normally takes place in complete virtuality. After the measuring of the surrounding or the already existing building and the respective input into an appropriate computational system, the virtually constructed status quo serves as a basis for the new planning. Besides from the team-work capabilities of digital planning it features easy stepping back if antecedent versions are needed again at a later state in the design process. Apart from specific but often voluntary input devices like graphic tablets, the software is the core component of the digital system used in architecture.

The program probably most established in architecture is an adopted version of the CAD (computer-aided design) software mainly used by engineers and industrial designers (Wikipedia, 2006a). The program archiCAD features a library with common architectural parametrized objects (e.g. walls, doors or windows). These objects can easily be set in place and adjusted for individual needs. Although archiCAD features different output options such as 2D print-out plans or surface structure layers to create visualizations, the capabilities for realistic virtual models are limited. But the raw wireframe output can be fed into sophisticated visualization programs. These are developed for different reasons but usually feature 3D models and animated fly-throughs. A popular example of such a program is Cinema 4D featuring realistic shadow projection, lighting effects and optimized video output rendering.

5.2 Usability of virtual environments

Whereas computation devices were used from the early beginning to solve geometric calculations in three and even more dimensional space the introduction of graphical out- and input devices raised questions about the transferableness of virtually construced space displayed on a flat screen to near real world experience. Classical usability research about graphical user interfaces already sports relevant interaction fundamentals. But in general these contribute little to the usability of virtual environments. Stanney, Mollaghasemi, Reeves, Breaux, and Graeber (2003) therefore state three main user inter-actions with the VE: travel (movement), selection (targeting objects or points in space) and manipulation of objects. These interactions form and support three main tasks: wayfinding, navigation and object selection and manipulation. Because the last task affects station transit little and appears to open an own class of interaction problems, it is omitted herein.

Wayfinding

The first process when people encounter a new environment is usually wayfinding. Figuring out one's location and orientation is important for all following actions. Except for VE displayed with 3D techniques (e.g. lenses) it is of great importance for new users to move their viewpoint within the VE because of insufficient information provided about the depth of the environment. Constructing the mental map of an VE requires the triangulation possibility usually provided by our eyes. Wayfinding is therefore closely associated with navigation.

Navigation

Human movement looks simple but it is in fact the result of relatively long training. The coordination of head, body, arm and leg motion is not only a reaction to the environment but in addition provides cues about the surrounding and therefore supports the construction of a mental map including information about the consistency and structure of the encompassing matter. There is no possibility to navigate naturally in VEs and virtual navigation techniques are usually hard to learn and drain cognitive ressources (Stanney et al., 2003). It is generally difficult to switch from the entanglement of head (body) movement and the consequent change of the visual field to a moving visual field with fixed head position.

5.3 Usability experiments in virtual and real buildings

As HCI methods are based on models of human cognition and information processing, the adaptation to different objects is possible and needs foreseeable editing. From the point of test subjects needed, HCI science often quests explorational data and responding numbers are small to a manageable level. Selecting the appropriate mix out of adapted HCI methods supplies the discussion about the usability of a station with powerful and ready-at-hand instruments. Comparative experiments can be implemented wherever profound knowledge about narrowly defined problems are needed but need further organisation. Whereas testing in the raw shell without actual users may be more convenient, it lacks the distracting flood of advertisements and disposition found in the final-use set-up. Tests in buildings already in use on the other hand feature severe problems for example not handicapping actual users.

Experiments in virtual environments

Actual usability research depends mainly on whether the site in focus exists in virtuality or reality. Whereas the former allows accurate experiments in a usability laboratory and parallel development of information and guiding means while planning a new building, the latter case is probably the ordinary one. Given the raw model of the planned building and an adequate usability testing system, different sets of signposts and figures can be compared quantitatively (e.g. transit time, number of errors etc.). The result of this comparison can provide profound insight into specific usability problems as well as precise predictions about user behavior performance upon experimental outcomes.

Eye-movement detection and user action recording are experimental systems used in HCI science. As eye-movement detection can be fed with practically every digitalized image, sketch or even movie, it is question to select the appropriate material to allow meaningful interpretation of the recorded data. Figure 2 points out the fundamental usability principle of closeness – the movement destination and passage in the left picture are almost out of the visual field which may contribute to discomfort. The use of escalators appeases the usability problem by rendering navigation and movement unnecessary for pedestrians. Appendix A comprises further pictures which suggest possible input for such an eye detection evaluation.

Heuristic user evaluation

Experience in HCI science shows on the other hand that an (even unstructured) quick user evaluation along a few predefined tasks already reveals the worst usability limitations. The results of such a short experiment often lead to profound testing of single usability issues. The challenge here (as with most usability experiments) is either to choose probably rare inexperienced test subjects or to train the tested

Figure 2. Basel main trainstation general timetable, viewpoint at the foot of the staircase, current state (left) and possible usability enhanced (right).

subjects not to use their heuristics and tricks acquired through the repeated exposure to the investigated problems during their periodical visits of the station. The heuristic evaluation as well as the structured cognitive walkthrough (Gediga & Hamborg, 2002; Sears & Hess, 1999) can both be edited for real world usability research means. The next paragraph gives a possible user task analysis consisting of the task as exposed to the test subject and the respective answer. Appendix B features further tasks as suggestions of a heuristic evaluation.

Task: You planned a trip to Geneva. You know the departure time from the internet. Find the track and optionally the position of a second class coach. You intend to work on the laptop during the trip. Can you optionally manage to find a quiet and/or power-supplied coach?

Possible test subject report: I found the train and respective track on the general timetable in the main hall but it took me some time because of the overwhelming number of trains and information displayed. I got confused later because there are additional print-out schedules which indicate another track. I followed the general timetable because it seemed more up-to-date. I found out the position of the second-class coach position on the track. There was no possibility to figure out in advance if there are power-supply equipped or quiet coaches on that train.

6 Conclusion

Even though there is a high acceptance of the public transportation system and the respective facilities in Switzerland, further usability considerations are worth the effort as pointed out in this work. Usability is just one factor among others concerning system acceptability (Nielsen, 1993) or building planning (Vitruvius, 27-23 BC). It is therefore important to keep the general picture and goal in mind and to work out the responsibilities clearly to profit from the co-operation of different specialists.

Several well-situated HCI methods displayed in this work bear the potential to become interpreted, adopted and used in the real-world usability discussion of public transportation centers. Further usability concerns in station planning and evaluation therefore may be headed towards inquiring specific questions about method adoption or aiming at a profound general insight in usability factors in construction science and signalling. The modulized structure of usability considerations allows serial and parallel processing and the development and implementation of an appropriate schedule is an interesting and fruitful task.

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Appendix A

The pictures show different versions of the placement of the general timetable in the hall of Basel train station. As the development of experimental pictures is not a topic of this work the suggested images are far from practicable and serve as outlook only. The viewpoint is from the main entrance to the staircases leading to the tracks. After the recent substantial modification including the change from under- to overpass, the timetable was first positioned in the left corner of the hall (Fig. 3).

Figure 3. The general timetable in the left corner, initial state.

In the course of several adaptations after the initial state, the timetable was moved to the middle of the hall (Fig. 4). From the aspect of closeness to the (sub)destination staircase this alteration is a major upgrade to usability. The proximity to the staircase provides the pedestrian to maintain attention to the passage while gathering information about train, time and track. Figure 5 shows a possible test picture for the comparison of a usability enhanced placement to the other positions.

Figure 4. The general timetable in the middle, current state.

Figure 5. The general timetable atop of the staircases, possible usability enhancement.

The usability problem concerning the space between the movement destination staircase and the timetable featuring important information becomes a significant issue when approaching the staircase. In Figures 3-5 the viewing distance limits reading. The approached viewpoint at the foot of the staircase shown in chapter 5 (Fig. 2) is more likely for most pedestrians.

Appendix B

The following task and report suggestions serve as a proposal for a possible heuristic evaluation. The tasks are generic and reach from simple to sophisticated whereas the report of possible usability problems remains pure fiction. Since the development of such an evaluation is not the topic of this work, the suggestion is far from practicable and serves as outlook only.

Task 1: You proposed to meet your friend at the station. You know the origin and the approximate arrival time. Search for the respective track and select a convenient meeting point (probably not the official one). Inform your friend by cellular phone where to meet and give directions if needed but do not exceed the number of 156 characters for your short message.

User report: There are several ways to get a departure time but the arrivals (no up-to-date information, only print-out timetables) are rarely spread around the whole station in a quite confusing scheme. Because the location of the official meeting point from the indicated track is not clear and no signs show the direction, I decided to meet atop of the staircases from the track. I figured out that there are two overpasses so I had to give exacte directions.
My short message would look like: "Await you on the overpass in front of the train."

Task 2: Your milk went out on sunday but you are addicted to cornflakes with milk. You know you can get some at the station but where? In your urge to get the milk you forgot to visit the toilet when you left home. Is there a toilet at the station? In case you can select from several options choose the most convenient (note the cues upon which you took your decision!).

User report: I found the appropriate mini-supermarket in the station but I had to transit half the station without an idea where to go until I accidentally ran into it. I could not figure out if there are multiple toilets in the station but the one I found after the same undirected search strategy as with the supermarket served my requirements.