The Activity Diamond - Modeling an Enhanced Accessibility

Hedvall, Per-Olof

2009

The Activity Diamond
Modeling an Enhanced Accessibility

Per-Olof Hedvall

Doctoral Thesis
Lund University
2009

The Activity Diamond

Modeling an Enhanced Accessibility

Per-Olof Hedvall

The Activity Diamond
Modeling an Enhanced Accessibility

Doctoral thesis

Certec
Department of Design Sciences, LTH
Lund University
Sweden

Cover: Per-Olof Hedvall
Diamonds on cover: © Edward Shtern — Fotolia.com

All illustrations by Per-Olof Hedvall, except for the ICF model in chapter 4 that is by the World Health Organization.

Photo:
Per-Olof Hedvall (Gamers' Lair)
Asta Schulerud (Gamers' Lair)
Göran Plato (The Pictorium)
Peggy Eklöf (Vig's Meadows)

ISBN: ENG: 978-91-976894-8-9
Certec, LTH, no. 2:2009
4 December, 2009

Certec
Department of Design Sciences, LTH,
Lund University
Sweden

Layout: Gunilla Persson, Media-Tryck
Printed by Media-Tryck, Lund University, Lund, Sweden

"We have never been modern."
Bruno Latour, 1991

"We have never been human."
Donna Haraway, 2008

"We have never been universal."
Per-Olof Hedvall, 2009

Acknowledgements

There are so many diamonds in my life. One of them is presented in this thesis. Many other "jewels" have contributed in different ways to the thesis efforts.

First of all, I would like to thank my supervisor, Professor Bodil Jönsson, for her close personal approach, dedicated commitment and thought provoking presence, always in the right amount and always with warmth. She has provided me with a good model of what an advisor should be. A big thanks as well to my second supervisor, Professor Eva Björck-Åkesson, School of Education and Communication, Jönköping University, whose constructive comments have contributed significantly to the thesis, and to Jörgen Lennartsson, former director of the Furuboda Association, who made it possible for me to start my Ph.D. studies.

I would like to thank my around-the-clock colleague Bitte Rydeman, Department of Philosophy, Linguistics and Theory of Science, University of Gothenburg, for all cooperation regarding our respective Ph.D. theses, for our paper that is part of my thesis, and for always being online.

A big thanks to the two experts with whom I have written papers: Professor Mats Granlund, School of Health Sciences, Jönköping University; and Dr. Peter Anderberg, Certec, Department of Design Sciences, Lund University. I am also very grateful to my colleagues at Certec for many good discussions and a warm, friendly atmosphere. A special thanks to Eileen Deaner for all her work with translation, proofreading and comments on the thesis text, and to Henrik Svarrer Larsen for his critical and insightful reading of the

thesis. Thanks also to Anna Persson for her assistance with the layout of the cover.

My sincerest thanks to the people and families that participated in the Gamers' Lair project.

Thanks to Asta Schulerud, Skien Kommune, Norway, Dr. Janna Ferreira, Linköping University, and Håkan Larsson and Jonas Paulsson, Furuboda Association, for our cooperation in the Gamers' Lair so far and in years to come.

Thank you Dr. Olav Bertelsen, Computer Science Department, Aarhus University, for our cooperations regarding NordiCHI 2008 and Interact 2009.

Thanks to Göran Plato, former manager of The Pictorium, for so willingly having shared with me the pictures and experiences that serve as basis for one of the examples in the thesis discussion.

The Furuboda Association has been very important in all of the phases before and during the thesis work. I would especially like to thank Kerstin Olofsson and Daniél Tejera for their strong commitment to my research.

The thesis research and the projects that have served as its basis has been supported by Lund University, the Furuboda Association, The Swedish Inheritance Fund and Region Skåne. Many thanks to all these organizations for making this thesis possible.

And finally, I want to thank my family and my wonderful wife, Elena, the largest diamond of them all.

Table of contents

Summary

The purpose of the research presented in this thesis is to enhance the field of accessibility to include a multitude of perspectives. Based on cultural-historical activity theory (CHAT), it analyzes how human, artifactual and natural factors impact an individual's possibilities to act in concrete situations that are part of a systemic whole.

The thesis presents two main results:

An enhanced accessibility encompassing:

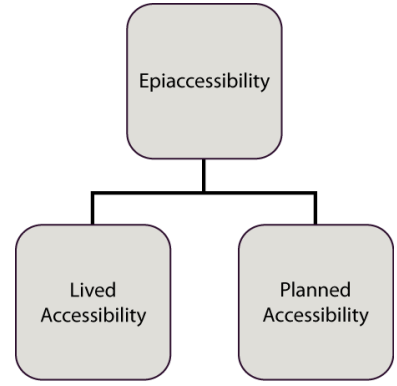
Epiaccessibility, accessibility's spirit of the times, stands for how experiences of activities alter accessibility capacities, learning, expectations, attitudes, trust, demands and denials of the individual and her human, artifactual and natural environments.

Lived accessibility, which includes the anticipations and the experienced conditions of a person to be able to do what she wants in a concrete situation.

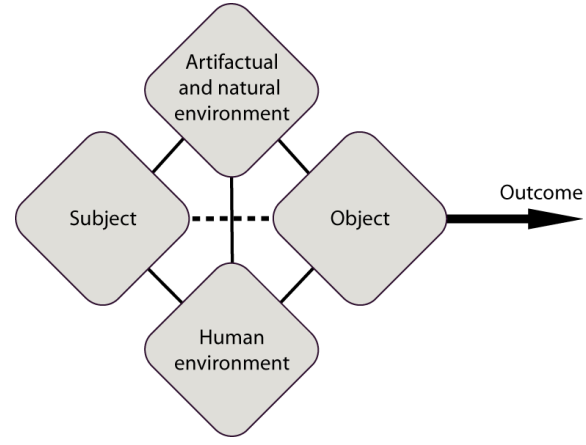
Planned accessibility, which consists of all the accessibility factors that can be created beforehand based on plans, guidelines and principles.

The Activity Diamond, a model for accessibility:

The Activity Diamond portrays a human activity system, where the subject-object relation is mediated and thus influenced by the human, artifactual and natural environments. The model is based on four interrelated sets of factors and is situated in time and place. Different actors with different activity systems may be involved. The model can be also used longitudinally in time.



An enhanced accessibility



The Activity Diamond

The thesis is based on a series of explorative studies in which the analysis unit is shifted from impairments and discriminatory factors in society to unique individual activity systems where humans, artifacts and nature together influence accessibility.

The thesis contains the following four papers:

I. The Activity Diamond: a model for multifaceted accessibility. Status: Submitted to *The Scandinavian Journal of Disability Research,* May 5, 2009.

II. An Activity Systemic Approach to Augmentative and Alternative Communication. Status: Submitted to the *AAC Journal,* July 24, 2009.

III. Towards the Era of Mixed Reality: Accessibility Meets Three Waves of HCI. Status: Full paper presented at USAB 2009 (Usability & HCI Learning from the Extreme), November 10, 2009, http://usab.icchp.org/. Submitted July 21, 2009. Accepted September 11, 2009.

IV. An activity theoretical approach to the International Classification of Functioning, Disability and Health. Status: Submitted to *Disability and Rehabilitation* October 30, 2009.

Sammanfattning på svenska

Syftet med forskningen som presenteras i denna avhandling är att vidareutveckla tillgänglighetsområdet i riktning mot en större perspektivrikedom. Avhandlingen baseras på kulturhistorisk aktivitetsteori (CHAT). Den analyserar en systemisk helhet utifrån sådana mänskliga, artefaktuella och naturliga faktorer som påverkar en individs handlingsmöjligheter i konkreta situationer.

Avhandlingen har två huvudresultat:

En vidareutvecklad tillgänglighet innehållande:

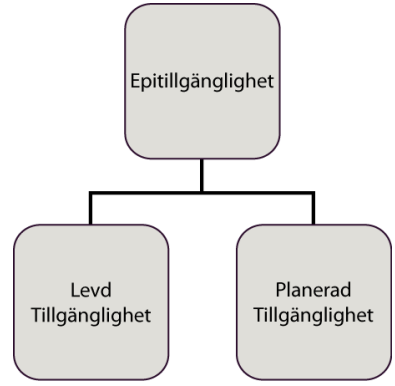
Epitillgänglighet, tillgänglighetens tidsanda, som innefattar hur erfarenheter av aktiviteter påverkar tillgänglighetsmöjligheter, lärande, förväntningar, attityder, tillit, krav och förnekanden hos individen och hennes mänskliga, artefaktuella och naturliga omvärld.

Levd tillgänglighet, som innefattar individens förväntningar och hur hon i den aktuella situationen upplever möjligheterna att kunna göra det hon vill.

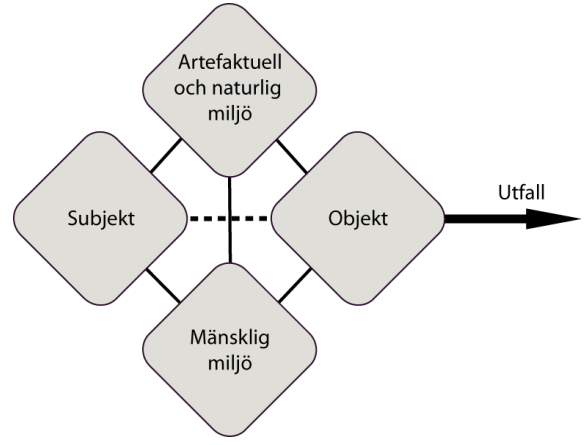
Planerad tillgänglighet, som består av alla förutbestämda tillgänglighetsfaktorer utifrån planer, riktlinjer och principer.

Aktivitetsdiamanten, en modell för tillgänglighet:

Aktivitetsdiamanten beskriver ett mänskligt aktivitetssystem där subjekt-objekt-kopplingen inte sker direkt utan via mänskliga, artefaktuella och naturliga inslag i miljön. Modellen bygger på samspelet mellan dessa fyra element (subjekt, objekt, omgivande natur/artefakter och människor) och är situerad i



En vidareutvecklad tillgänglighet



Aktivitetsdiamanten

tid och rum. Olika aktörer med olika aktivitetssystem kan vara inblandade. Modellen kan också användas longitudinellt över tid.

Avhandlingen är baserad på en serie explorativa studier av unika individers aktivitetssystem där människor, artefakter och natur tillsammans påverkar tillgängligheten. Handlingen står i centrum, inte funktionsnedsättningarna och inte heller de diskriminerande faktorerna i samhället.

Avhandlingen består av en avhandlingskappa och följande fyra publikationer:

I. The Activity Diamond: a model for multifaceted accessibility. Status: Insänd till *The Scandinavian Journal of Disability Research* 2009-05-05.

II. An Activity Systemic Approach to Augmentative and Alternative Communication. Status: Insänd till *AAC Journal* 2009-07-24.

III. Towards the Era of Mixed Reality: Accessibility Meets Three Waves of HCI. Status: Long paper presenterat vid USAB 2009 (Usability & HCI Learning from the Extreme) 2009-11-10, http://usab.icchp.org/. Status: Insänd 2009-07-21, accepterad 2009-09-11.

IV. An activity theoretical approach to the International Classification of Functioning, Disability and Health. Status: Insänd till *Disability and Rehabilitation* 2009-10-30.

1

Introduction

Introduction

This thesis concerns an enhancement of the *accessibility* concept and a new conceptual modeling of accessibility. The aim of the thesis is to contribute to a shift in the accessibility field so that it can better encompass an active and acting person with greater power over her own accessibility within a systemic whole and with that, over her life.

Personal background for this thesis

The theme of this thesis has been previously explored in my licentiate dissertation from 2007, "Situerad Design för Alla – Till Improvisationens Lov (Situated Design for All – In praise of improvisation)", where I emphasize how accessibility experienced in the moment is only partially coupled to that which is arranged in advance.

Other previous efforts have culminated in this thesis. One involved the many years I worked with the Gamers' Lair Project (Spelhålan), which dealt with how ordinary commercial computer games could be played using different types of adaptations. I worked at the Furuboda Competence Center in Sweden at the time (and still do), and there initiated the first (and still actively ongoing) Gamers' Lair in the framework of the Interagera (Interact) Project.

I cannot disregard my own lived perspective in this thesis on accessibility. As the result of an accident I incurred over twenty years ago, I have used a wheelchair since and thus have a rich corpus of experiences of different aspects of accessibility. The most longitudinal empirical data that I have consciously and unconsciously supplied to the research here presented stems from the experiences and knowledge I have gained through observations and different attempts in my own everyday life.

With accessibility in focus

The research proceeds from accessibilities and not from impairments and disabilities. The starting points for the thesis are:

1. *Activity* is central.
2. *Thinking of accessibility in terms of systems, synthesis and the combination of difficulties and possibilitie*s prevails over *analysis* of details. The research presented deals with the entire person's possibilities in a situated system where human, artifactual and natural factors together determine accessibility.
3. *The time perspective* is crucial: what is needed in the *present moment* and *simultaneously;* what is based on the before and after of the *longitudinal* (such as mutual learning and cultural and technological evolution); the significance of the *length of time* involved (if it takes too long to make

what the person desires accessible, it becomes inaccessible in practice); the dominance of the *everyday* (accessibility determined in around-the-clock everyday usage, not in the office of a therapist, in a lab or in decontextualized plans); and the role of *anticipation* (expectations of the future in the present). A person who learns that there are as a rule attainable possibilities at hand is imprinted by this in her daily life. This affects both her self-image and her attitudes towards all of the factors (human and non-human) in the surrounding world that can contribute to her accessibility.

4. *Observations* in the lived life are used as a source of empirical knowledge in parallel with research trials and empirical knowledge from specific projects.

Epiaccessibility, lived accessibility and planned ditto

In each action situation, a selection of the many possibilities that are at hand are either activated or inactivated on the individual or collective level. Every experience of an activity, and how accessible/inaccessible it proves to be in practice, leaves its mark on both the individual and the surrounding culture. In order to understand what accessibility is built up of beyond the instrumental and planned (such as the size of text fonts, sound levels, ramps and door openers), the concept

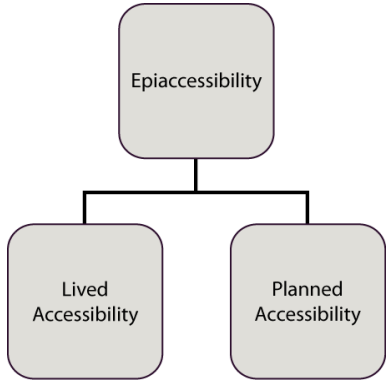


Figure 1. Accessibility on different levels.

formation of accessibility needs to be broadened to encompass a multitude of perspectives. It also needs to be modeled and further developed.

The thesis introduces and weaves together three complementary aspects of accessibility: lived, planned and epiaccessibility. *Epiaccessibility, accessibility's spirit of the times*, stands for how *experiences of activities* alter accessibility capacities, learning, expectations, attitudes, trust, demands and denials on the individual and societal levels. It is the sum of previous activity experiences while at the same time influencing the expectations one has for future accessibility. *Epi* is from Greek and means *on or above*. By launching *epiaccessibility* as a field and concept, I want to advance the idea that there is an accessibility over and above that which is individually lived and experienced and that which is societally planned and implemented (Figure 1).

In search of a theory

The research this thesis is based on strives to capture the perspective of the people directly affected in their important everyday life contexts and situations. I failed initially to find a relevant system theory that supported this. But when I came in contact with Kaptelinin and Nardi's *Acting with Technology* (2006) and Engeström's *Learning by Expanding* (1987), I realized that cultural-historical activity theory (CHAT) enabled such a systemic analysis (Engeström, 1987, 2001,

2008; Leontiev, 1978, 1981, 2009; Vygotsky, 1978, 1986, 1995). It contains the relevant prerequisites owing to its focus on capturing the effects of the following interplays based on actions and their outcomes: human-human, human-artifact (objects, technology, instruments), human-artifact-human, etc., in long chains of different human-artifact constellations. It also captures this development over time. *I saw the potential in CHAT for shifting the analysis unit in accessibility work from abstracted constructions of human types and discriminatory factors in society to unique individual activity systems where humans, artifacts and nature together influence the lived accessibility.*

For this purpose, I came up with and published the *Activity Diamond* (Figure 2)(Hedvall, 2008), strongly influenced by Engeström's research, and started to test it to this end in different accessibility contexts. The Activity Diamond is designed to be able to capture and maintain a constant focus on the entirety, but to also scrutinize it from different angles:

- the different actors
- the human conditions in the environment
- the artifactual and natural conditions in the environment
- the outcome: *Is it possible for the person affected to do what she wants to?*

With the Activity Diamond, I am able to describe accessibility in a world of empowerment in a way that differs from the prevailing one with its thought structures from the authoritarian era. This is significant because a change in the fundamental descriptions (i.e. theories and methods) of the field of accessibility also affects its balance of power.

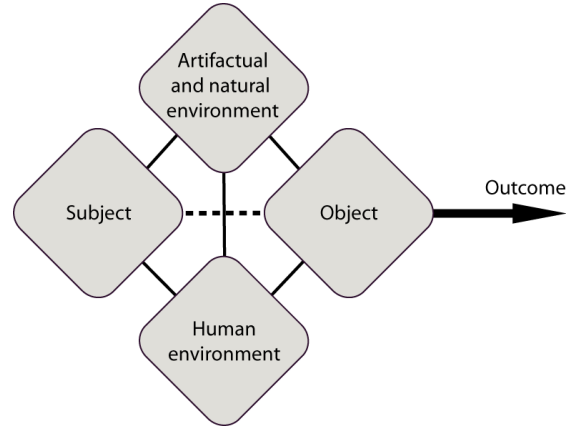


Figure 2. The Activity Diamond

The Activity Diamond's role in the thesis

The thesis concerns the Activity Diamond (Figure 2) and what themes that can be further developed when the Diamond is related to areas such as the ICF (WHO's International Classification of Functioning, Disability and Health) (WHO, 2001, 2007) and the complex field of AAC (Augmentative and Alternative Communication) (Beukelman & Mirenda, 2005), cf. the papers included in this thesis. It also concerns how the Activity Diamond can contribute to clarifying and laying the conceptual foundation for *epiaccessibility* at a comprehensive level and showing its effect on accessibility measures.

Approaching the mixed reality era

The Activity Diamond also has special importance in the era of *mixed reality* (Milgram, Takemura, Utsumi, & Kishino, 1994) we are entering. Accessibility in the material world has been characterized by a strong belief in that which is planned, predetermined and the same for all, while accessibility in virtual reality (computers, Internet, mobile phones) is based on being different for all: everyone does things their own way and most physical constraints can be altered. It is impossible for accessibility in a mixed reality world to be both the same

for all and different for all; it has to find its own conceptual background. This thesis is my contribution.

State-of-the-art in the field of accessibility

According to the preamble of the *UN Convention on the Rights of Persons with Disabilities*, accessibility is defined as the right to participate in "the physical, social, economic and cultural environment, to health and education and to information and communication, in enabling persons with disabilities to fully enjoy all human rights and fundamental freedoms" (United Nations, 2006). This umbrella definition does not take into account the different trends that exist in the field of accessibility, and that both research and practice contain a number of almost paradigmatic conflicts and/or parallel fields.

Some of the most significant accessibility trends of the 21st century are described in this section, primarily from a European perspective. The compilation is rather narrowly limited to accessibility lines of reasoning, which means, for example, that specific, detailed discussions of assistive technologies and occupational therapy with its focus on "occupation" are not included.

Accessibility unequivocally determined by the surroundings

Accessibility consists of both environmental and human components (Iwarsson & Ståhl, 2003; WHO, 2001, 2007). How these should be weighed has been much debated. Some think that accessibility consists of general measurements in the environment. An example is found in Sakkas and Perez (2006) who present a number of mathematical formulas for calculating the accessibility of buildings and activities, while the individual who interacts with the setting and her human surroundings is omitted. This type of accessibility has been criticized by interest group organizations in the disability area, among others. There is good reason to try and move away from accessibility as a causal response to environmental characteristics and the use of "normality" and "stigmatizing disability deviations" as foundational concepts (Goffman, 1990).

Accessibility for all

Another type of general accessibility is represented by the *Design for All* (European), *Universal Design* (American) and *Inclusive Design* (British) family of related approaches. They are strongly rooted in Ergonomics and Human Factors (Dong, 2007) and are based on general accessibility solutions in standard products and environments. The goal of Universal Design is to design "products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Story, Mueller, & Mace, 1998). This focus has strong political overtones and attempts to include the individual while striving for accessibility on a

broad level (Newell & Gregor, 2000). One way it does this is by accommodating diversity (Gregor & Newell, 2001; Gregor, Newell, & Zajicek, 2002).

In Sweden, the *Design for All* branch predominates, with its focus on conscious and systematic efforts for accessibility and inclusion in a society for all. In the original *Design for All* declaration, the tension between what is relative on the general level and on the individually level is hidden by making solutions *for all* into an ideal while still stating that one is striving for increased individual diversity. The target groups are different professional societal functions and actors, not the individual directly affected:

> Although today's world is a complex place, it is one of our own making, one in which we therefore have the possibility – and the responsibility – to base our designs on the principle of inclusion.
>
> Design for All is design for human diversity, social inclusion and equality. This holistic and innovative approach constitutes a creative and ethical challenge for all planners, designers, entrepreneurs, administrators and political leaders.
>
> Design for All aims to enable all people to have equal opportunities to participate in every aspect of society. To achieve this, the built environment, everyday objects, services, culture and information – in short, everything that is designed and made by people to be used by people – must be accessible, convenient for everyone in society to use and responsive to evolving human diversity. (The EIDD Stockholm Declaration, 2004).

In practice, *Design for All* has been of considerable significance in establishing systematic accessibility work as a part of society's mission. It has not, however, provided the field of accessibility with any theoretical foundation or methodological sensitivity for the perspective of the individuals directly affected. They are only depicted as

recipients to whom something will be "given", not as searchers who want to receive feedback for their accessibility attempts (Jönsson, 2007).

Accessibility along a continuous scale

As a rule, accessibility is not viewed as all or none, but as a continuum from inaccessible to accessible (Law, Yi, Choi, & Jacko, 2007). The assistive technology field with its focus on special equipment for people with disabilities thus continues to develop. Even if the accessibility and the diversity capacity in society improve in accordance with Universal Design in the future (Dong, 2007), the need for assistive technology will never disappear entirely.

Web accessibility

Even though all people tend to act differently in the world of computers, mobile phones and Internet, the work in the web accessibility field is, interestingly enough, both instrumental and stigmatizing (Goffman, 1990). At the end of 2008, a new version of the international guidelines for web content was released, *Web Content Accessibility Guidelines* (WCAG) 2.0, which is a part of the web accessibility initiative (WAI). The first paragraph of the introduction makes it clear that the guidelines are for people with disabilities:

> Web Content Accessibility Guidelines (WCAG) 2.0 defines how to make Web content more accessible to people with disabilities. Accessibility involves a wide range of disabilities, including visual, auditory, physical, speech, cognitive, language, learning, and neurological disabilities. Although these guidelines cover a wide

> range of issues, they are not able to address the needs of people with all types, degrees, and combinations of disability. These guidelines also make Web content more usable by older individuals with changing abilities due to aging and often improve usability for users in general (http://www.w3.org/TR/WCAG20/).

Accessibility and time geography

In recent years, sociological theories and methods have come to play an increasingly important role in the generation of spatial and temporal aspects such as location, space and the passage of time. These aspects have come to be more important for the understanding of accessibility, primarily emanating from the field of geography (Imrie & Edwards, 2007). In 2000, Gleeson introduced what he calls "enabling geography" with the following aim:

> This broad ideal seems to rest on two key normative aims. First, an enabling geography presumes a social model approach, requiring explorations of how social and spatial processes can be used to disable rather than enable people with physical impairments. Second, an enabling geography seeks to contribute something positive to disabled people: for example, knowledges that can be used to empower disabled people and disempower ableist structures, practices and institutions (Gleeson, 2000).

The new perspectives on disability are connected to the growth of the disability studies field over the last thirty years (Barnes, Barton, & Oliver, 2002; Oliver, 1990; Shakespeare, 2006; Swain, French, Barnes, & Thomas, 2004).

Accessibility and Disability studies

It is not sufficient to describe an individual's needs and abilities, in order to get at how the person in question will be able to manage in a given situation. The biomedical model has been criticized for trying to explain disabilities in terms of impairments described as diagnoses. According to the criticism, it is inadequate to state that someone has a developmental disability, a broken leg or a spinal cord injury in order to determine what obstacles the individual will encounter and the consequences those obstacles will have for the person in question.

Out of this criticism, the concept of an environmental-relative disability has evolved. Instead of looking for the explanation of the disability in the individual, the obstacles arise when a person encounters people and artifacts in the environment. According to the social model of disability, these obstacles have a social origin and are an expression of society's oppression of people with disabilities. Thus, disability is not a characteristic of the individual but rather the discriminating and situated (Suchman, 2007) response to an inaccessible, inflexible and unadapted environment and society (Albrecht, Seelman, & Bury, 2001; Barnes, Burton, & Oliver, 2002; Barnes & Mercer, 2003; Oliver, 1990). The relative (relational) model of disability connects to the social model, but frames disabling barriers relative to both individual impairments and situated, contextual settings (WHO, 2001, 2007). In order to problematize further the space between the individual and the environment, Anderberg (2006) introduced the dichotomy *Design for All* versus *Design for Me*. Accessibility and disability can to some extent be seen as two sides of the same coin, but accessibility does not have the tendency, as does disability, to be considered as an individual characteristic.

The social model is not sufficient to fully capture accessibility. It has a strong focus on discriminatory social processes and social factors in the surroundings, but is less sensitive to material aspects in the environment and how all of these – the individual, the people in his or her surroundings, the artifacts and nature – jointly and simultaneously interact, counteract, and change over time. For this, a methodological approach is required that enables systemic analyses and descriptions of all these factors viewed as a whole.

Accessibility research in the design context

Although accessibility is often discussed in ideological terms, its implementation has primarily been instrumental. In the context of design research, it has not been developed as close to the user as has the area of usability, which has come further than accessibility in taking individually experienced perspectives into consideration. This can be seen in the development of new standards for usability over the last ten years:

1. Originally, ISO 9241-11 (1998) defined usability as: "...the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use."
2. ISO FDIS 9241-171 (2008) defines accessibility as: "... usability of a product, service, environment or facility by people with the widest range of capabilities."
3. The new draft of the ISO standard ISO/IEC CD 25010.2 (2008), proposes a more comprehensive breakdown of *quality in use* into *usability in use* (covered by ISO 9241-

11), *flexibility in use* (which is a measure of the extent to which a product is usable in all potential contexts of use, including accessibility) and *safety* (which is concerned with minimizing undesirable consequences) (Bevan, 2008).

4. Since 2008, however, there has also been a *user experience (UX) standard*, ISO CD 9241-210 (2008), defining it as: "...all aspects of the user's experience when interacting with the product, service, environment and facility."

A corresponding development in the accessibility area towards elaborating *accessibility experience* (AX) could better accommodate a person with power over her life. This presupposes an accessibility that is not absolute and final, but activity-relative (Paper I).

In the next chapter, the appended thesis Papers I-IV are presented.

2

Papers

Papers

The thesis includes four papers (three journal articles and one conference paper), summarized in this section. This is followed by a summary of my licentiate dissertation.

Paper I: The Activity Diamond: a model for multifaceted accessibility

Status: Submitted to *The Scandinavian Journal of Disability Research* May 5, 2009.

Summary: This article introduces and exemplifies *The Activity Diamond*, an activity based conceptual model for accessibility. The model is inspired by cultural-historical activity theory and describes an activity system with the simultaneous influences of different factors in the human, artifactual and natural contexts. The system is imbedded in and dependent on cultural-historical factors, primarily learning and artifactual and social development. The article expands on a full paper presented at the ISCAR Conference (International Society for Cultural and Activity Research) in 2008 in San Diego, California (not included in the thesis).

The aim is to highlight accessibility as an individually experienced quality in the moment of action. The line of reasoning is based on a series of examples that show how established accessibility, largely built on plans and generalizations, can be complemented by individually unique, situated and activity-relative accessibility perspectives. The hope is that the Activity Diamond's system and factors can assist the accessibility field in progressing from its current focus on individual human factors and environmental situations to focusing on human actors with wills, motives and commitment of their own. Or, to utilize a phrase of Liam Bannon (1992): "From human factors to human actors."

Contribution to the thesis: Basic description of the Activity Diamond and it systems approach in the accessibility context. It introduces a new way of using activity theory in rehabilitation engineering research and design research.

Paper II:
An Activity Systemic Approach to Augmentative and Alternative Communication

Status: Submitted to the *AAC Journal* August 24, 2009.

Summary: The objective of this article is to discuss augmentative and alternative communication (AAC) by positioning it in the framework of cultural-historical activity theory (CHAT). The article is based on data from a three-year Swedish AAC project concerning activity-based vocabulary design of voice output communication aids. A CHAT model, the Activity Diamond, is applied. The CHAT approach is utilized to systemically capture and describe the interplay between humans and technology in AAC.

In a qualitative content analysis, twelve categories were derived from the Activity Diamond and applied to 476 video- and audio-taped excerpts of communicative interchanges concerning the shopping activities of four persons who use AAC. The analysis resulted in a multiplicity of related perspectives, in which six themes were identified: Attitude/Preference, Expectation/Trust, Goal/Power, Place/Space, Time/Learning, and Usability/Accessibility.

Contribution to the thesis: The article shows what a CHAT analysis of the outcome of an AAC project can contribute to the understanding of the project's primary results while exemplifying how it can generate hypotheses and inspire new project designs.

Paper III: Towards the Era of Mixed Reality: Accessibility Meets Three Waves of HCI

Status: Full paper presented at USAB 2009 (Usability & HCI Learning from the Extreme), http://usab.icchp.org/ and published in the conference proceeding (which will be part of Springer's "Lecture Notes in Computer Science, LNCS"-series). Status: Submitted July 21, 2009. Accepted September 11, 2009.

Summary: Today, the underlying theoretical and methodological foundations as well as implementations in the field of accessibility are largely based on plans, metrics and rules of thumb. There is an obvious tension between these norms and the attitudes in the overall spirit of the times, which lean heavily towards improvisations, diversity, and ever-changing affordances.

The parallel evolution of human computer interaction (HCI) has been characterized as three waves, each building on the previous one. Especially important for the corresponding development for accessibility is that between waves 1 and 2, where the concentration on *human factors* is exchanged for one on *human actors*. Not until then can we understand the simultaneous and interlacing interplay between human and non-humans (artifacts). With the advent of the mixed reality era, the accessibility field can greatly benefit from the collected knowledge in HCI and the fields of usability and interaction design.

Contribution to the thesis: The paper unites accessibility analyses based on the Activity Diamond with the usability, HCI and ANT (Active Network Theory) fields for confronting a future where real and virtual reality will be mixed.

Paper IV: An activity theoretical approach to the International Classification of Functioning, Disability and Health

Status: Submitted to *Disability and Rehabilitation* October 30, 2009.

Summary: In this article, an activity theoretical approach is applied to WHO's *International Classification of Functioning, Disability and Health*, ICF, in order to discuss and shed new light on the ICF as well as on the biomedical and social models of disability. Cultural-historical activity theory, CHAT, is used to portray the affected individual's perspective and capture both artifactual and human influences from the environment, all simultaneously present in several activity systems and thus enable or prevent what the individual wants to do. The paper deals with how CHAT can support further development of the ICF's model, categories and connections by adding the time perspective, direction of the outcome and the activity system.

Contribution to the thesis: The paper illustrates how thinking in terms of systems by means of the Activity Diamond can challenge the ICF's model and current categories and make visible important components that the ICF lacks so far.

Situerad Design för Alla — Till Improvisationens Lov (Situated Design for All — In praise of improvisation)

Licentiate dissertation. Presented October 17, 2007.

Summary: The aim of the research presented was to challenge and develop *Design for All* in order to shift the perspective towards the ability of the person who is individually and directly affected to act in the moment, rather than having a finished, predetermined "solution" bestowed upon her. It showed how the conventional approach involving well-planned static solutions can be enriched by design-for-all considerations, which includes those that are dynamic and situationally bound. This line of reasoning has its origins in the act of doing in the moment, which opens the door to new possibilities since the action potential and with that, accessibility are determined in the activity itself. Description and power are closely associated and a shift in description consequently involves a shift in power.

The dissertation is based primarily on research in computer game accessibility and interactive experience environments. It

progressed practically and theoretically from people as active, creative and meaning-seeking beings. "Person" is defined throughout as a system consisting of the person and her accessible technology, and where the design is focused not only on solutions for all but on the right potential for action too. With this altered outlook, accessibility is not primarily a predefined quality coming from without, but is personally experienced in the moment and coming from within: easily adaptable, flexible and able to adjust to the person and offer her improvisational opportunities and flow.

It can be easier in the non-physical world than in the physical one to build on individual action potential. A person who grows accustomed to the fact that it is in the moment that possibilities are in reach, alters her expectations when faced with a similar situation the next time. These expectations involve herself and the human and technical world around her. The transfer effects to the real world can also be considerable.

Contribution to the thesis: The licentiate dissertation forms the basis of the three cornerstones of the doctoral thesis:

1. Accessibility's situated and action-dependent nature – the impossibility of making something accessible for someone exclusively by means of predetermined measures.
2. Accessibility as simultaneously influenced by other people and artifacts, separately and based on reciprocal interaction.
3. The necessity to be aware of and open to longitudinal effects.

The dissertation and this thesis share in part the same theoretical foundations, which means that some formulations can be found in both.

3

Purpose

Purpose

The purpose of this thesis is to introduce and model *an enhanced accessibility* encompassing the planned, lived and systemic perspectives of accessibility. The thesis strives through a series of explorative studies to shift the analysis unit from impairments and discriminatory factors in society to unique individual activity systems where humans, artifacts and nature together influence accessibility.

4

Theory and method

Theory and method

The accessibility area is continuously influenced by new technologies, ideologies and changes in the times. Manuel Castells states that all technological development has to be understood in relation to the prevailing social context. The only technology that can be developed is that which the human world is open to (Castells, 1996). This means that the only advances that can be made in the accessibility area are the ones society allows through.

For many years, Bruno Latour has worked at describing the coexistence and social intercourse between humans and non-humans (Latour, 1991, 1999, 2005). All the relationships form networks that influence the contexts and larger networks of which they, in turn, are a part. New constellations and hybrids emerge (Haraway, 2008). Haraway describes this as "the world is a knot in motion" (2003, p. 6).

Viewing accessibility as embedded in and dependent on social processes is in sharp contrast to the technological determinism (Castells, 2004) that permeates large portions of the accessibility field today. Whenever a person wants to do something, it takes place in relation to her situated world (Suchman, 2007, 1987). That is why this thesis addresses everyday life and everyday situations, such as those described by cultural analysts, ethnologists and anthropologists including Pink (2004), Miller (2008, 2001) and Shove et al. (2007). In everyday life one is able to examine questions such as: What manifests and configures everyday practice and how do the configurations and re-configurations (Suchman, 2007) of people and objects take place? In what way is accessibility interwoven in everyday life?

Accessibility is not a laboratory product or something that can be generated on a drawing board (Hedvall, 2007). The accessibility field needs not only technical, medical, social and educational support, but also a thought climate derived from the lived dreams, wishes and needs of invidiuals. That is why the most important theoretical pillars that support this thesis are:

- Cultural-Historical Activity Theory
- Actor Network Theory
- Lifeworld phenomenology
- ICF
- Rehabilitation Engineering and Design
- Usability
- Mixed reality

At the end of the chapter, some methodological foundations for the thesis are presented.

Cultural-Historical Activity Theory

Cultural-historical activity theory (CHAT) (Engeström, 1987, 2001, 2008; Leontiev, 1978, 1981, 2009; Vygotsky, 1978, 1986, 1995) has its origins in Russia and the renowned

psychologist L. S. Vygotsky whose ideas are still influential today.

Activity theory is widespread in several fields, among them interaction design (Bertelsen, 1998; Bodker, 1990; Nardi, 1996), education (Roth, 2004) and organization theory (Engeström, 2008). This has resulted in there being a great number of different focuses and applications (Rogers, 2008). The following discussion is based primarily on Vygotsky's, Leontiev's and Engeström's work and I select portions from all three, even though there are minor differences between them (Kaptelinin, 2005).

Vygotsky studied and described human activity and human development of higher mental functions such as thinking, language and consciousness (Vygotsky, 1986), with cultural mediation as a central concept.

In this context the *object* is defined as what the subject's actions are directed at, such as tasks to be executed in order to reach a desired goal. When Vygotsky introduced cultural artifacts as a part of the subject-object relationship (Figure 3), he diverged from the prevailing tendency to regard human behaviors as separate with a direct stimulus-response based connection between subject and objects. Humans and their object-oriented actions could no longer be understood without their cultural tools; society, in turn, could not be understood without the individuals who act and make use of cultural artifacts (Engeström, 2001).

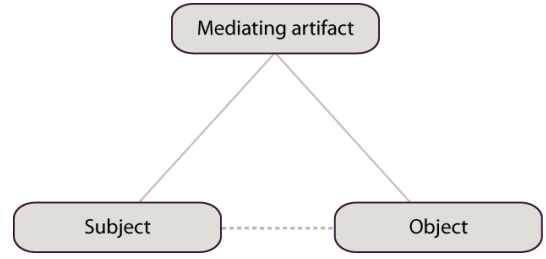


Figure 3. Vygotsky's model of mediated activity (Engeström, 2001, p. 134).

The priority of activity

One of Vygotsky's most fundamental suppositions was that all mental functions are internalized social relations. He formulated the general genetic law of cultural development. It states that each step of a person's cultural development occurs on two levels in which development first appears on the interpsychological social level to be later internalized by a person as an intrapsychological category (Wertsch & Tulviste, 1992). Thus, Vygotsky prioritizes the activity over the subject and object, and emphasizes not only what happens *intra* (within a human) but also what happens *inter* (between humans and their environments).

A. N. Leontiev carried on the work of Vygotsky but while Vygotsky primarily concentrated on concept development and higher mental functions, Leontiev continued working with the concept of activity and formulated what today constitutes some of the most central elements in activity theory. He chose "activity" as an analysis concept to gain insights into human life and, in particular, "the evolution of psyche" (Kaptelinin & Nardi, 2006). According to Leontiev, human activity generates people's relation to reality. There is always an object of an activity: "Any activity of an organism is directed at a certain object; an 'objectless' activity is impossible" (Leontiev, 1981). Leontiev puts forth three cultural factors that fundamentally affect human mental activity and interaction in the world: tools, language and division of labor. Kaptelinin and Nardi (2006) give an overview of CHAT's features, some of them being (author's italics):

- "Activity theory seeks to understand the unity of consciousness and activity" (pp. 7-8).

- "The individual-collective dimension: The dynamics of the social distribution of mind" (p. 46).
- "The idea of moving from supporting low-level tasks and applications to supporting higher-level *meaningful activities*" (p. 105).
- "That objects are constructed, initiated, and linked to one another through relations of *power and passion* among actors" (p. 155).
- A focus on "actions, within a horizon of possible actions, *responsive to actors' motives*, in varying relations of accord and discord to others' motives" (p. 171).

Some of the features of CHAT are described by Leontiev in his illustrious hunting example, which is described by Kaptelinin and Nardi:

> Let us consider Leontiev's canonical example of activity, the collective activity of hunting. Individuals participating in a collective hunt may be divided into two groups: one group (the beaters) beats the bushes in order to scare the animals and make them move in a certain direction, and another group hides, waiting to ambush the animals directed toward them by the beaters. Both groups are motivated by food. However, for members of the first group, the immediate goal is not to get closer to the animals and kill them but, on the contrary, to scare them away. These hunters are motivated by their share of the whole catch which they expect to receive as a reward for their contribution to the hunt. But taken out of the context of the collective activity, the actions of these hunters appear to have no meaning (Kaptelinin & Nardi, 2006, p. 58).

Activity theory has a fundamental insight about the primacy of activity over the subject and the object. Activity is considered the most basic category: analysis of activities opens up a possibility to properly understand both subjects and objects (Kaptelinin & Nardi, 2006, p.31).

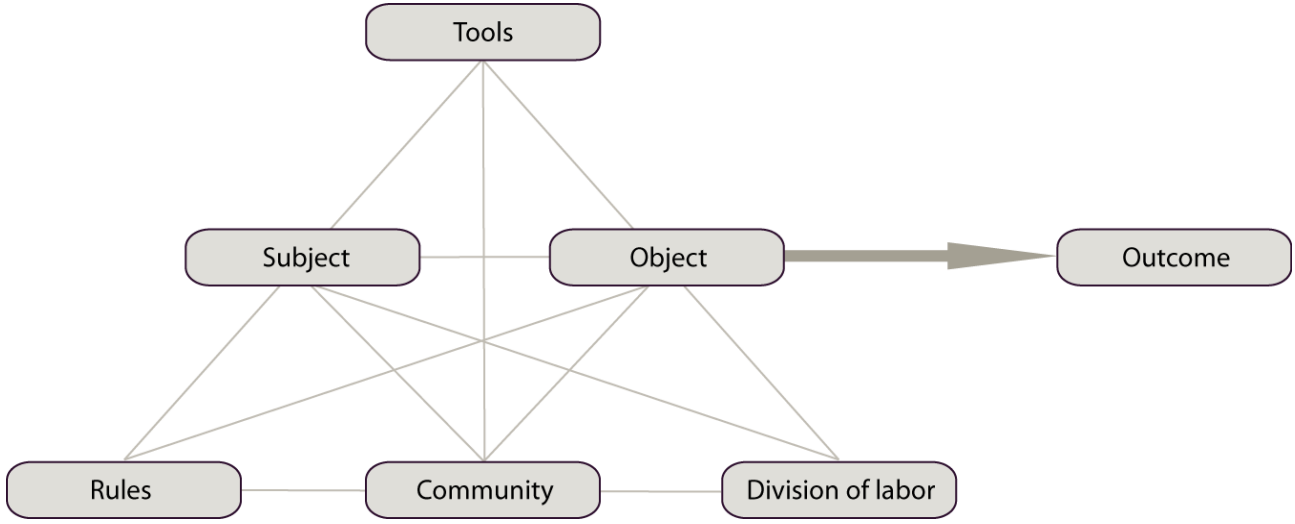


Figure 4. The structure of a human collective activity system based on Engeström (1987, p.78).

Activity systems

Leontiev expanded and further developed several of Vygotsky's activity arguments but he did not expand the graphic diagram presented in Figure 3. Engeström (1987) did, however, when he described collective *activity systems* (Figure 4).

Engeström (2001) summarizes activity systems according to five principles:

- The primary unit of analysis is a collective, artifact-mediated and object oriented activity system.
- Contradictions are a source of change and development. When an activity system accepts something new from the outside, such as a new technology, contradictions often arise between the new and the established.

- Activity systems develop over long periods of time (historicity).
- An activity system is always a community with several viewpoints, traditions and interests (multi-voicedness).
- Activity systems can go through changes and expand (transformations).

Engeström (ibid.) describes activity theory's growth over three generations, beginning with Vygotsky's (1978) work on individual activity and cultural mediation, followed by Leontiev's (1978) expansion from individual to collective activity and Engeström's (1987) description of activity systems. The next step for activity theory is to develop models that can include several activity systems. He writes: ". . .actions are always, explicitly or implicitly, characterized by ambiguity, surprise, interpretation, sense making, and potential for change. [...] The third generation of activity theory needs to develop conceptual tools to understand dialogue, multiple perspectives, and networks of interacting activity systems" (Engeström , 2001, pp. 134-135).

A focus on the lived perspectives

CHAT does not focus solely on the individual or the collective, but on the entire lived context. In this way, it can become a framework for studies of the lived perspectives, both those of the individual human being and of the collective society. Activity theory cannot do without these two perspectives, since the friction between them represents the core engine that drives the development of the activity systems.

Engeström (1987) expresses this as:

> The basic internal contradiction of human activity is its dual existence as the total societal production and as one specific production among many. [...] Within the structure of any specific productive activity, the contradiction is renewed as the clash between individual actions and the total activity system (Engeström, 1987, p.67).

The situatedness of human activity

According to activity theory, we cannot understand the human being outside of her context. This places human activities in time and space (c.f. Junefelt, 1993; Wertsch, 1991).

Paul Dourish (2004) focuses on activity and *embodied interaction,* and brings together phenomenology and embodiment as a way to understand the relation between action and meaning:

> By embodiment, I do not mean simply physical reality, although that is often one way in which it appears. Embodiment, instead, denotes a form of participative status. Embodiment is about the fact that things are embedded in the world, and the ways in which their reality depends on being embedded (Dourish, 2004, p. 18).

According to Dourish, the practice is always dynamic and arises from the mediation between actions and the situations where these are performed. Dourish defines embodied interaction as:

> Embodied interaction is the creation, manipulation, and sharing of meaning through engaged interaction with artifacts. [...] Embodied interaction turns action into meaning (ibid., pp. 126, 183).

Individuals have often thought out plans in their head that they intend to realize. But often they have to change the plans depending on what happens in the specific situation. According to the sociologist Lucy Suchman (2006), people trust their abilities and previous experiences in order to handle different situations in the here and now. She has introduced the term *situated action* as a way of understanding how people act and how they relate to their planning. Suchman gives an example from canoeing down rapids:

> In planning to run a series of rapids in a canoe, one is very likely to sit for a while above the falls and plan one's decent. The plan might go something like "I'll get as far over to the left as possible, try to make it between those two large rocks, then backferry hard to the right to make it around that next bunch." A great deal of deliberation, discussion, simulation, and reconstruction may go into such a plan. But, however detailed, the plan stops short of the actual business of getting your canoe through the falls. When it really comes down to the details of responding to currents and handling a canoe, you effectively abandon the plan and fall back on whatever embodied skills are available to you (Suchman, 2006, p. 72).

Situated action represents a view where every chain of events depends on the current material and social circumstances. Suchman explains that the term holds *all action* and *all planning* (Figure 5). She writes:

> Rather than attempting to abstract action away from its circumstances and represent it as a rational plan, the approach is to study how people use their circumstances to achieve intelligent action. Rather than build a theory of action out of a theory of plans, the aim is to investigate how people produce and find evidence for plans in the course of situated action. More generally, rather than subsume the details of action under the study of plans, plans are subsumed by the larger problem of situated action (Suchman, 2006, p.70).

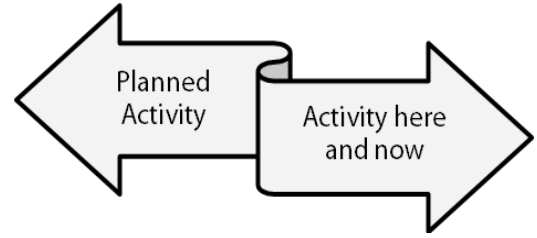


Figure 5. There is a tension between the plans beforehand and what the plans look like in action.

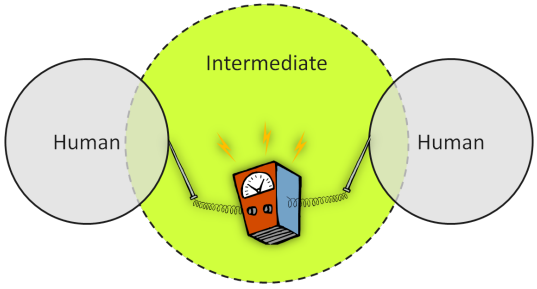


Figure 6. The actants, the "intermediates", actively shape our everyday lives, where the introduction of new technology opens up new opportunities for activity.

Thus, the design of new technology according to CHAT, and according to Suchman and Dourish, needs to consider that artifacts and actions are situated, both historically and in the current situation. The match between the potential of technology and what the person chooses to utilize in the moment cannot be made in advance. Planning might be ever so good but it is not until the realization of it that the design is tested. Freedom and self-responsibility are determined by the prospects of taking a resolute stand in the moment, and by not being locked into circumstances that someone (or something) else has decided in advance. When this happens, improvisation is part of the solution to some extent (Hedvall, 2007).

Actor Network Theory

The sociologist Bruno Latour has worked extensively with what has come to be referred to as Actor Network Theory (ANT) (Akrich, 1992; Latour, 1991, 1993, 1998, 1999, 2005). ANT focuses on social processes that involve both humans and non-humans and describes how action moves between agents that are related to one another in a way that is similar to how nodes make up a network. What distinguishes ANT is that these agents in themselves are active and can be human and non-human. Latour explains:

> "We are never faced with objects or social relations, we are faced with chains which are associations of human (H) and non-humans (NH). No one has ever seen a social relation by itself [...] nor a technical relation [...]. Instead we are always faced by chains which

> look like this: H-NH-H-NH-NH-NH-H-H-H-H-NH [...] Of course, an H-H-H assembly looks like social relations while a NH-NH-NH portion looks like a mechanism or a machine, but the point is that they are always integrated into longer chains" (Latour, 1998, p. 153).

The introduction of new technology has meant that people have new opportunities to act (c.f. Löwgren & Stolterman, 2004).

The agents (H, NH) are called "actants" because of their ability to act (Figure 6). According to ANT, we surround ourselves daily with not only chains but entire networks consisting of H-NH-. . . in which nodes constantly fall away, new connections arise and where the actants surprise one another. The chains are sustained by the activity that moves through them (according to Latour 2005, it would really be more correct to call the networks "worknets"). That non-humans are also active means that a reinterpretation and an act can take place in each actant node. In other words, it is not possible to determine what will come out based on what goes into a node (Latour, 1999). The illustration in Figure 7 shows how Agent 1 interupts the original meaning of the activity. The meaning is then taken over by Agent 2 but in connection with that, a translation takes place, which results in the meaning of the activity being reinterpreted and translated (From Latour, 1999, p.187).

According to Latour (2005), ANT is not intended to be a framework for the construction of actant networks but an analysis tool. He writes that ANT can be of assistance in generating better and more objective descriptions of different states of affairs.

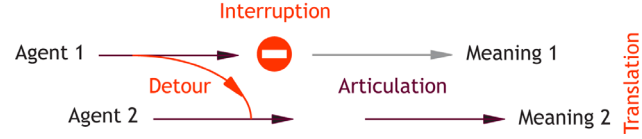


Figure 7. Interpretation and reinterpretation/ translation (From Latour, 1999, p.187).

Lifeworld Phenomenology

The situated action and its embodiment is central for this thesis, and I have earlier referred to Paul Dourish's *Where the Action Is: The Foundations of Embodied Interaction*. Let me elaborate further on some phenomenological aspects:

According to Maurice Merleau-Ponty, we are born of the world and into the world. By taking up room in the world, the body is a part of it. At the same time, it is with the body that we experience being-in-the-world (Merleau-Ponty, 2002). Merleau-Ponty and other phenomenologists express themselves in terms of phenomenon, "that which shows itself," the world's way of revealing itself to our senses. By interpreting the sensory impressions in streams of consciousness, we put together a comprehensive picture of existence, the lifeworld. Merleau-Ponty writes:

> The body is the vehicle of being in the world, and having a body is, for a living creature, to be intervolved in a definite environment [...] I am conscious of my body via the world [...] I know that objects have several facets because I could make tour inspection of them, and in that sense I am conscious of the world through the medium of my body (ibid., pp. 94-95).

Body and consciousness inhabit time and space under a parallelism that keeps them from delimiting one another. Consciousness's connection to existence is mediated by the body and it is through the body that we experience "participation in the world" (ibid., p. 459). The possibilities to make connections are multiple and they are far from mechanically predictable. We exist in the world through our body. The world spins around the experiencing person's body and all objects turn their faces to her (ibid., p. 94). To

understand how a person experiences his or her advances in the world requires a discussion that starts and ends in her actual situation, including her history and expectations. It is also the body's connection to the world that makes it so that we are always situated in the present without being able to set ourselves free from it.

"The body" is not limited to the dimensions of its own physical organism, but can be extended by incorporating an object so that it becomes part of the body's connection to the world. Merleau-Ponty describes the blind man's cane as an example: "...the stick is no longer an object perceived by the blind man, but an instrument with which he perceives. It is a bodily auxiliary, an extension of the bodily synthesis" (ibid., p.176). This synthesis has later been labeled "embodiment relation" by Don Idhe, who for the last twenty years has continued to work with technology, body and lifeworld in what is now referred to as *post-phenomenology* (Ihde, 1990, 2002; Ihde & Selinger, 2003).

ICF

The International Classification of Functioning, Disability and Health (ICF) was developed by the World Health Organization. It was completed in 2001. The ICF consists of a large number of parameters that are categorized into areas with associated sub-groups. This provides a standard language for health-components describing a persons functioning and

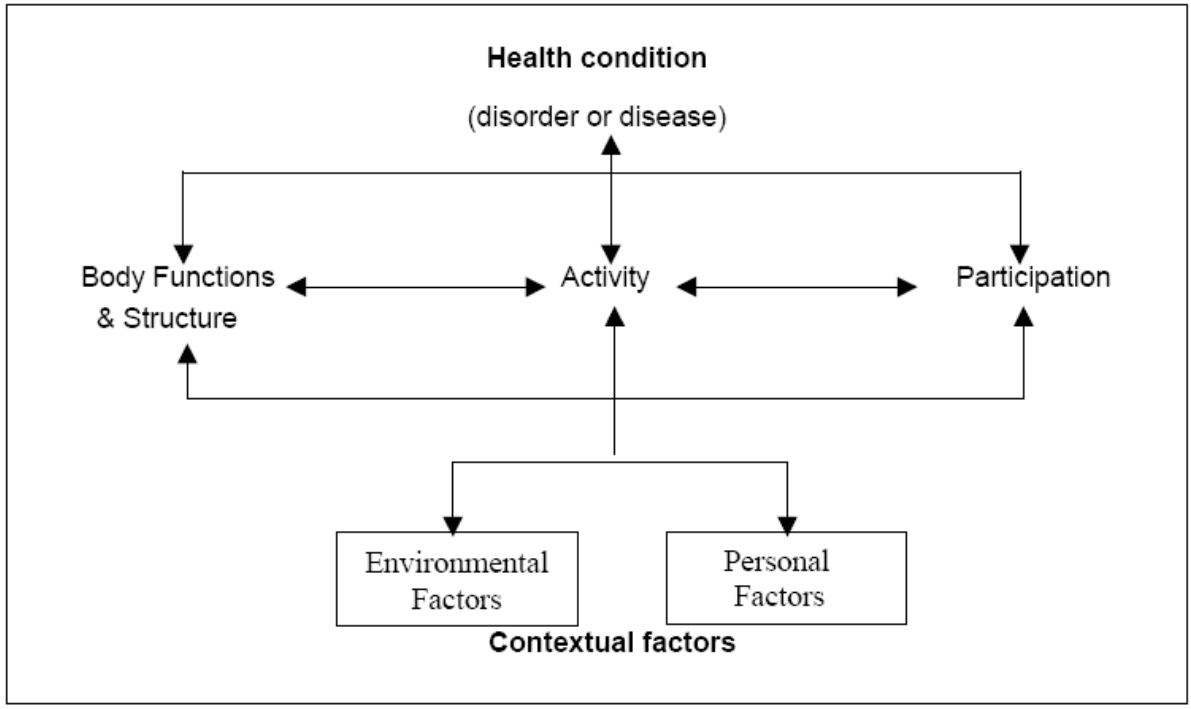


Figure 8. The ICF diagram (WHO, 2001, 2007).

abilities. An individual's functional condition is described by the following categories: body functions and structures, activity and participation. The ICF also includes contextual (environmental) factors that make it possible to describe facilitating as well as obstructive factors in the environment (WHO, 2001) (Figure 8).

The ICF's predecessor, the ICIDH from the early 1980s described shortcomings and inabilities, while the ICF describes what a person can do and perceives her functioning, health and involvement in everyday life activities. This has

at least two advantages. The first is that the ICF does not discriminate; it is applicable to all people, not only those who are sick or have disabilities. The second is that it is always much better from the human, pedagogical and technological perspectives to start from what a person can do than from what she cannot (Jönsson, 2006). The ICF is under continual development. In 2007, an edition was published for children and youth, the ICF-CY (WHO, 2007).

The ICF also includes an overall model, a system description, of how the domains are related. In Paper IV of this thesis, the ICF is compared and related to the Activity Diamond. The similarities are many: both regard the individual and the environment as parts of a systemic whole. ICF is, however, not a model for intervention. Among the differences is that the ICF is ahistoric. This means that it lacks both time and process perspectives, and with that, it also lacks defined outcomes (Paper IV).

Rehabilitation Engineering and Design

This thesis is methodologically grounded in rehabilitation engineering and design, described in *Design Side by Side* (Jönsson, 2006) and *Sowing Forth: 2007, Certec turns 20* (Jönsson, 2007). When it comes to research in the accessibility field, Certec (Division of Rehabilitation Engineering Research, Lund University, Sweden) has sought a third model for a

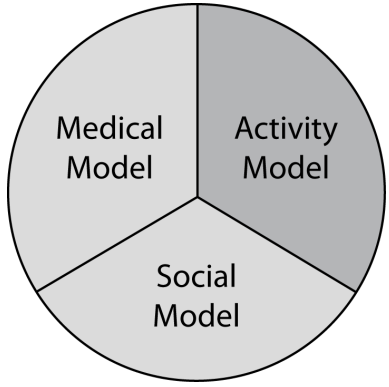


Figure 9. The Activity Model.

long time as a complement to the medical model (focus on diagnosis and treatment) and the social model (disabilities primarily defined and maintained by societal concepts of what is the norm).

The first approach to this third model was presented in Peter Anderberg's doctoral thesis *FACE* (Anderberg, 2006) and in *Design Side by Side* (Jönsson, 2006) as a "rehabilitation engineering model". It involves strong elements of action research and the methodical use of *useworthy technology* (Eftring, 1999) in iterative design processes (Rassmus-Grohn, 2008). It also involves the overarching desire to understand, to be able to do, and to do to be able to understand (Breidegard, 2006). In the research on which this thesis is based, this initial approach has evolved into an *activity model* with strong links to activity theory (Figure 9). It can provide activity theory with exemplars of "design of digital technologies that address the *needs and desires* of specific individuals and groups" (Kaptelinin & Nardi, 2006, p. 7). The staff at Certec has carried out research side by side with the individuals directly affected for more than 20 years. This has rendered a rich empirical base from the lived contexts, presented in a comprehensive website in Swedish, parts of which are also available in English: www.english.certec.lth.se/ .

Usability

The usability field (Gulliksen & Göransson, 2002; Lidwell, Holden, & Butler, 2003) is in a process of substantial change and development. Over the last ten years or so, new technologies have entered our daily lives. Internet, mobile phones and PCs are now commonplace for the vast majority of people in the West. Technology affects individuals and their lifestyles. The mobile phone, for example, has led to greater freedom, Internet to new ways to search for information and e-mail to other ways to keep in contact. The computer itself has become an everyday tool not only for written language but for lots of pictures, films and sound, including computer games and all the media. Overall, we now have many more relations with many more individuals and technologies in many more ways (Figure 10).

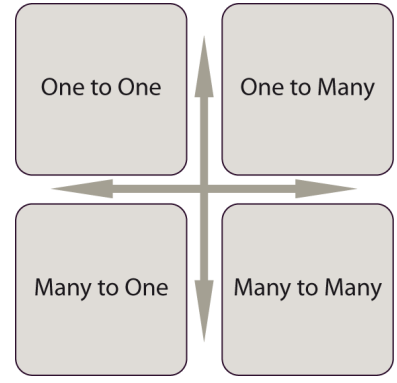


Figure 10. One-to-one, one-to-many and many-to-one relations (Jönsson, 2008, p. 43).

The combination of an active view of people and an active view of technology influences in many ways large and small — technology totally changes the conditions for humanity at the same time as individual products influence the individuals. Today, people are involved in many concurrent activity systems where dense networks with many individuals and considerable technology are present simultaneously. Consequently, the individual context holds a certain amount of ambiguity, which can offer extra value. Sengers and Gaver write that ". . . new domains such as domestic and public environments, new influences from the arts and humanities, and new techniques in HCI itself are converging to suggest that multiple, potentially competing interpretations can fruitfully co-exist" (Sengers & Gaver, 2006, p. 99).

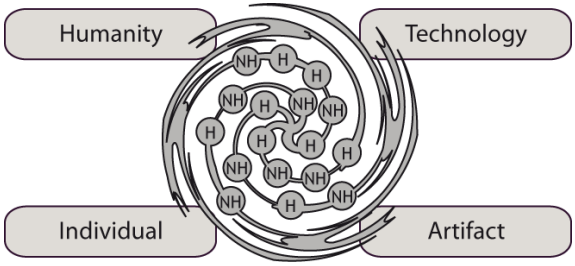


Figure 11. Human-technology evolution.

Seen through these eyes, it is not only the interactive technology that is "active". Instead, all technology is actively created, and that in turn exerts an active influence. This is what makes it natural to think of both humans and technology in terms of actants (like in ANT) and attempt to capture the chains of actants that lead forward (Figure 11).

On a comprehensive level, humanity and technology mutually influence one another (means of transportation, energy systems, mobile telephone technology, food technology). There is also a level of everyday life where the person chooses and influences her artifacts, which in turn influence her. Add to that the individual's interaction with humanity and artifacts, it is obvious how you cannot have one without the other.

Mixed reality

Twenty years ago, neither the technology nor the human habit of surrounding ourselves with the Internet, wireless units and other technology existed. It has only been in the last five years that the combination of technology and people has reached the level where many-to-many communication is a part of everyday life. We have just started to get used to the positive and negative aspects of these new possibilities.

HCI has shifted focus over the decades from the relationship between man and computer, such as the design of user interfaces, to an increasing concentration on the total

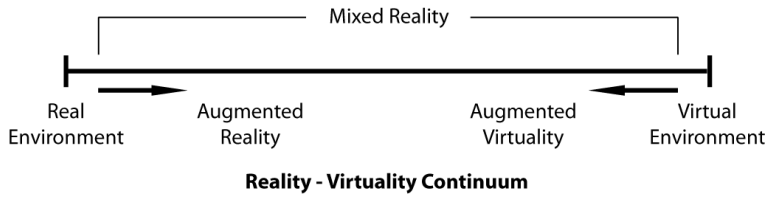


Figure 12. The Reality-Virtuality Continuum by Milgram et al. (1994).

experience, including aesthetics, ergonomics, narratives and other dimensions (Hochheiser & Lazar, 2007). Current interaction design (Löwgren, 2001; Sharp, Rogers, & Preece, 2007; Shedroff, 2001) includes knowledge from all the previous HCI areas. As humans and technology become more and more entangled so does the potential for their intertwined activity. This yields a mixture of the real and virtual elements, *mixed reality* (Figure 12) (Milgram et al., 1994).

In recent years, several related fields such as ubiquitous computing, tangible interaction, augmented reality, augmented virtuality, pervasive computing, enactive computing and so on, have emerged. Here, they are all squeezed in under mixed reality as an umbrella term, but each of them has traits that are important for a future elaboration of accessibility.

Gregor and Newell introduced the term "design for dynamic diversities" (Gregor & Newell, 2001; Gregor et al., 2002) as a way to view design of information technology for elderly individuals. They stated that the user is not an average static human being, but one that changes over time. As individuals grow older, they can lose physical and cognitive functions. Hence, the products that they rely on in their everyday lives must be able to meet them based on their current functional

level (ibid.; Heller & Guedj, 2001). There are new potentials for adaptivity and flexibility in the field of mixed reality, emerging for instance in the built environment: "While most current intelligent building technology is based around automated reactive systems, research is under way that uses technology to gather personal information from people and use this information to deliver personalized services to them" (Callaghan, Clarke, & Chin, 2009).

Methodological foundations for the thesis

This section presents the methological bases that have guided the thesis research.

Embedded values in artifacts

Artifacts are always parts of a context and need to be designed as such (Paper III). They are part of a whole, and dissociating them from that when evaluating or communicating them can seldom be done successfully. It is the effect on the whole that makes a difference, and it is in the whole that accessibility research can be conducted. When the artifacts are included in various contexts, they will affect the collective meaning of the context. The artifact's potential is defined in and by the current situation's horizon of possible actions. This means that

researchers, developers and others must be involved in people's everyday lives and in their activities, because this is where the artifact's further potential for the accessibility can be captured.

When looked upon as influential parts of a greater picture, artifacts are not neutral. Instead, they convey attitudes (Anderberg, 2006) and values because of the knowledge and meaning that are built into the artifact itself. However, they do not have any intentionality of their own. Over time, artifacts take on embedded values from the surrounding world and these in turn become part of the artifact's influence on meaning, and thus on accessibility. Instead of an end result, the artifactual influence is seen at every point in time as the expression of the implemented meaning, as far as this has come (Hedvall, 2007). Whenever the artifact is engaged in an activity, it becomes part of the different influences at play.

In recent years, the visual design of assistive technology and the like have developed from signaling "medical product" to increasingly fitting into everyday life and expressing individuality. But for the artifacts to better fit into a person's life, the individual's motive-driven activity system also needs to impact the design. An example: For young children with extensive impairments, feeding can take up a large number of their waking hours. Feeding aids need to be developed, not as stand-alone units but as items that can be included in play and other activities that are important in a small child's life.

Influence from the natural environment

Besides all man-made artifacts, brute natural factors must also be considered as influential parts of the whole. They constitute

integral parts of all human activity. When considering the accessibility of a given situation, natural factors such as the air temperature, a potential snowstorm or sunlight need to be weighed in. They are just as important as any personal or technical device at hand.

Motive, meaning and context

In CHAT, the object is closely associated with the motive of the activity, which Kaptelinin has described as follows:

> The object of activity has a dual status; it is both a projection of human mind onto the objective world and a projection of the world onto human mind. Employing the object of activity as a conceptual lens means anchoring and contextualizing subjective phenomena in the objective world, and changes one's perspective on both the mind and the world. Instead of being a collection of "mental processes," the human mind emerges as biased, striving for meaning and value, suffering and rejoicing, failing and hoping, alive, real. On the other hand, the world is no longer just a collection of physical bodies, organizational structures, and so forth, but a place full of meaning and value, a place that can be comfortable or dangerous, restricting or supporting, beautiful or ugly, or (as it is often the case) all of these at the same time (Kaptelinin, 2005, p. 5).

The motive is what drives the activity. This makes CHAT extra relevant for an accessibility that strives to follow the individual's creation of meaning (Arendt, 1988; Frankl, 2006) and coherence (Antonovsky, 2005). It also provides methodological insights regarding the individual and the context, and situations where more than one person are involved. There is a need for new methods within the field of design, since the ones invented within *participatory design* (PD) (Ehn, 1988a, 1988b) were targeted towards a workplace/

organizational context. Regarding accessibility, there are often inherent asymmetries between the involved actors. This makes it hard or impossible to use traditional PD activities such as organizational games that rely on breakdowns in the flow of action. Instead new methods such as diary studies, fictitious users, therapists as mediators, various forms of probing, and completely new forms of participation have to be invented in order to maintain PD as a realistic design approach (Bertelsen & Hedvall, 2009).

The centrality of the ongoing activity

The field of accessibility largely has its starting point in how products, services and environments can be designed to suit different types of people. The types are based primarily on medical diagnoses, human factors (Bannon, 1992) or corresponding abstractions. In other words, the unit of analysis is not living people of flesh and blood but the "blind type", the "cognitively limited type", the "wheelchair user type", and so on. In practice, efforts focus on metrics, guidelines, rules of thumb and solutions of a general nature. This means that something is regarded as being "accessible" when it fulfills the specifications of the model type. General accessibility such as this represents an approach in which top-down methods are seen as being sufficient for generating what the individual needs and wants, and in this way disregards the concrete activities in diverse individuals' lives.

Current trends are moving in the opposite direction towards greater individuality and diversity. In the 21st century, the tensions between general accessibility solutions and unique human ones have increased. This is hidden, however, in

rhetoric purporting that both the general "for all" and individual diversity are being offered at the same time, without taking time to problematize the conflicts (cf. EIDD, 2004).

Systemic versus analysis of parts

Accessibility is evasive by nature. It is like health – when it is there, you most often do not notice it. The opposite – strict, inflexible inaccessibility – is extremely evident and makes its presence known.

How discriminatory or satisfactory an individual person experiences a certain activity can be described neither in terms of figures nor of compliances with guideline goals. Instead, a simultaneous systemic analysis is required of all the related factors that in counteraction or collaboration prevent or enable what the person wants to do in a concrete situation. It is not sufficient to study individual environmental factors one at a time: an adequate font size does not automatically make the contents of a text accessible. Nor is it sufficient to focus on the particular abilities of the affected individual: an adequate ability to extend one's arm does not in itself mean that the person in question can grab the book on the top shelf.

Certain conditions for accessibility can be generated in advance, but it is not until a person is in a concrete situation, in a right-in-the-middle-of-life activity that it takes on its final form. It is then and there that the mutually dependent and influencing system elements exert their effect and can be analyzed. Hence, when describing such a system in its entirety, syntheses and combinatory considerations are more important than the analysis of separate factors.

Time perspectives and historical development

The established view of accessibility is largely atemporal, which (among others) is apparent in the fact that WHO's ICF classification system is entirely devoid of a time factor and with that, the ability to relate to the individual's learning and development over time (Wade & Halligan, 2003), to the dynamics of the system processes and to the longitudinal effects of epiaccessibility. Time aspects and opportunities for improvisation are discarded in favor of ones considered universally applicable and not bound by time.

To achieve an understanding of how time aspects come into play in the accessibility of the person directly affected, theories and methods are required that are also capable of capturing epiaccessibility:

1. How the current activity system is affected by its historical roots, by the combination of the system factors at the moment and the projected expectations of the future of the people involved.
2. How the activity system and accessibility conditions change and develop over time.
3. How the long-term time aspects of accessibility also affect the life of the individual. It is the longitudinal exertion and strain that often results in repetitive injuries, depression, etc., but it is also the little improvements over time that yield the greatest accessibility effects.

A personal example: It is often the frequent, repetitive elements in everyday life that over time wear out my shoulders. It is also these elements that cause those in the surrounding to expect that I can manage something like this time and time

again. A concrete example from my life is the new wheelchair I will be receiving in a few weeks. It is two kilos lighter than the one I have now, which is considerable given that I lift the chair in and out of the car 4-6 times most every day. This corresponds to 3-4 tons a year.

It is easy to calculate the total number of lifted kilos. It is more difficult to describe what it means to live in an environment that is well adapted across the boards. This affects one's view of what one can accomplish in a day or a year. Moreover, it exerts an influence on the confidence, attitudes and expectations that the people in the environment have on the person in question.

Everyday observations versus controlled studies

Individual accessibility is not a laboratory result but an integrated part of all the innumerable activity systems in everyday life. Some aspects of the general are parts of the specific – but the opposite is not applicable. The general and the specific co-exist in everyday activities, while the everyday is absent in the laboratories. Thus, the individual accessibility cannot be studied in usability labs (or similar setups) but requires everyday "living labs" (Thiesen Winthereik, Malmborg, & Andersen, 2009) in order to be viewed in the context of its system factors.

5

Results

Results

The publications that are included in the thesis describe and test CHAT's potential in different areas of accessibility. Examples of factors and relational aspects that are discussed in the papers are: attitudes, preferences, norms, expectations, trust, goals, power, time and learning.

Traditional double-blind intervention tests cannot be carried out in the study of an enhanced accessibility. These may be excellent for one or two factor analyses but are not suitable for studies of accessibility in which many interdependent factors act together and change over time. Instead, the system analysis that I have introduced draws its consistency from the Activity Diamond. The Diamond model remains the same over time and serves as a consistent provider of methodological perspective and structure where the results from different data collections can be tied in and provided with a context for interpretation.

Behind the totality of the experience there is a motive-driven system reality that does not solely consist of an individual experience, but that can be understood and influenced systemically, provided that one has the tools to make the systems visible. On the over-arching systemic level, the different accessibility perspectives can be related to each other and combined, and the whole – *Epiaccessibility* – is greater than the sum of the detailed parts. It represents an *accessibility in the spirit of the times* that sums up and corresponds to previous activity experiences, but without for that reason being directly derived from each of the individual underlying factors separately (Figure 13).

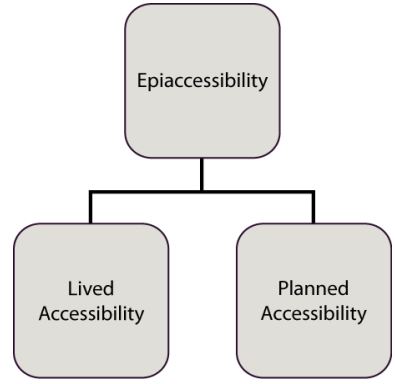


Figure 13. Accessibility on different levels.

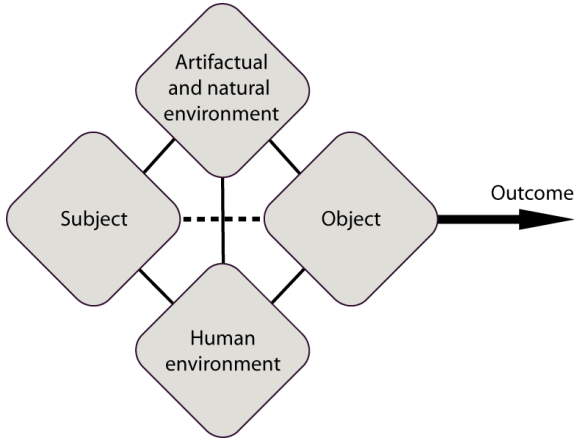


Figure 14. Activity Diamond

Epiaccessibility represents how the *experiences of activities* result in altered accessibility capacities, lessons, expectations, demands and denials, both on the individual and societal levels. In every action situation, the many different possibilities that present themselves are activated or inactivated, individually and/or collectively. The experience of each activity and of how accessible/inaccessible it proves to be in practice leaves its imprint, both on the individual and on the surrounding culture. Over time, the system adjusts itself and changes due to positive och negative outcomes and external influences on the system from other activity systems (cf. the example on concurrent activity systems on page 67). *In the action, epiaccessibility plays a considerable role for the forward direction and outcome*.

The Activity Diamond

The Activity Diamond (Figure 14) portrays a human activity system, where the subject-object relation is mediated and thus influenced by the human, artifactual and natural environments. The model is based on four interrelated sets of factors and is situated in time and place. Different actors with different activity systems may be involved. The model can also be used longitudinally over time.

The four sets of factors:

- *The subject* in the model is often an acting individual. On another level, it can also be a group of people, such as a family.

- *The object* of an activity is related to the will and needs of the subject, such as getting better grades, learning to read or producing a new car.
- *The artifactual and natural environment* consists of material and immaterial artifacts, and their respective affordances and resistances (Gibson, 1986; Norman, 1988). Some examples are computers, language, legislation, air temperature, snow storms and sunshine.
- *The human environment* is made up of the people or groups of people influencing the activity at hand. This can be the family, work colleagues or larger portions of society that are involved in or otherwise affect the activity regarding attitudes, norms and expectations.

A person's action possibilities depend not only on his or her own conditions, as in the biomedical model, and not only on discriminatory factors in the social setting, as in the social model. A more nuanced and multifaceted view of accessibility is needed. With CHAT as the theoretical basis, the following four facets are highlighted in Paper I:

- *Accessibility as an experienced quality*, partly through arrangements considered in advance, partly through improvisations in the moment of action.
- *The presence of different activity systems* in one and the same situation: one for the person with impairments; another for a relative; still another for a personal assistant, etc.
- *The simultaneous influences of the artifactual and human environments.*

- *The ever-ongoing mutual adaptation and development of the individuals and the human and technological contexts.*

In the Papers I-IV, accessibility is viewed as being activity bound (Hedvall, 2008) and experienced in action (Hedvall, 2007). The approach is that *accessibility achieves it final shape only in the activity itself*. This theoretical and methodological mind-set leads to an action focus, because if one does not understand the concrete activity, one will not be able to assess the accessibility.

The Activity Diamond has already been described in previous chapters. In the next chapter, *Discussion and conclusions for future research*, I discuss five concrete application examples of the Activity Diamond in use.

Methodological aspects of the Activity Diamond

What holds the Activity Diamond system together are the lines which represent the relationships between the boxes. When something is changed in one of the boxes, such as a new artifact being put into use, tensions arises in the system, which in turn results in development of the system over time. What follows is a elaboration of some of the lines/relationships in the systems. This constitutes a first set of methodological aspects and focuses for the use of the Activity Diamond.

The subject and the artifactual environment

A subject who does not want to rely solely on the human environment to achieve his or her goals has to recognize and utilize the artifactual and natural environment, and its material (and immaterial) possibilities and obstacles when trying to manage an object (Figure 15). A single one-to-one connection might do in order for the subject to be able to act according to his or her wishes. Multimodal and multivalent lines can offer redundancy and increased flexibility and freedom to improvise.

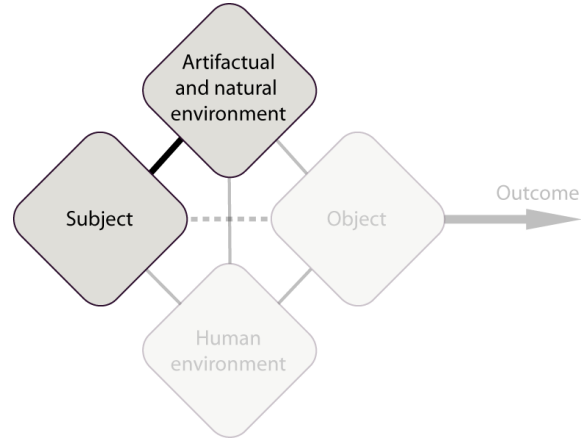


Figure 15. Relationship between the subject and the artifactual and natural environment.

The subject and the human environment

The human environment exists on many levels from the closest friends and family to official representatives, bureaucrats and politicians (Figure 16).

A positive attitude from the human environment can make a seemingly impossible action possible, while a negative attitude can have the reverse effect. Adults, for example, are normally free to smoke, drink or play video games if they want, but this is not always the case for people with disabilities. Out of the "best intentions" of the human environment, people with disabilities, are often hindered from engaging in what others have determined to be "less desirable" activities (Hedvall, 2007).

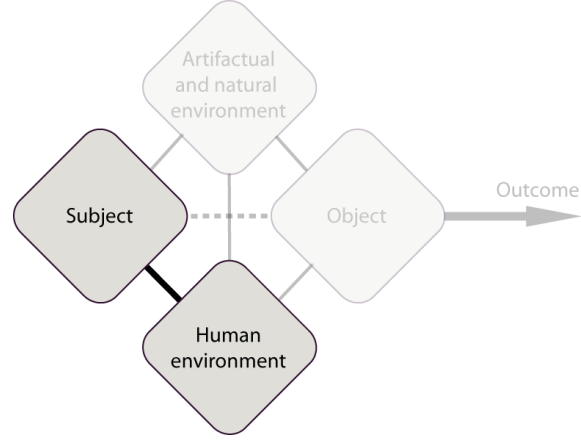


Figure 16. Relationship between the subject and the social environment.

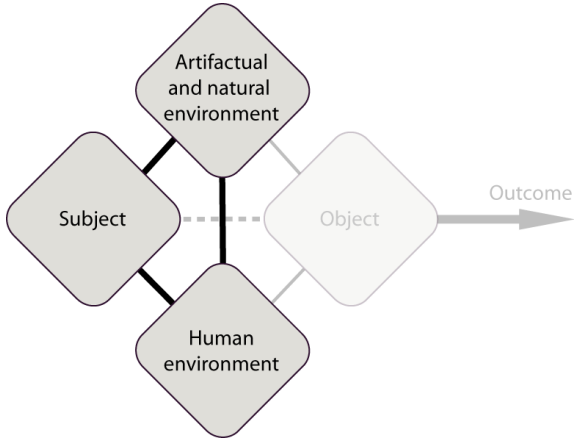


Figure 17. Relationship between the subject and the entire, combinatory environment.

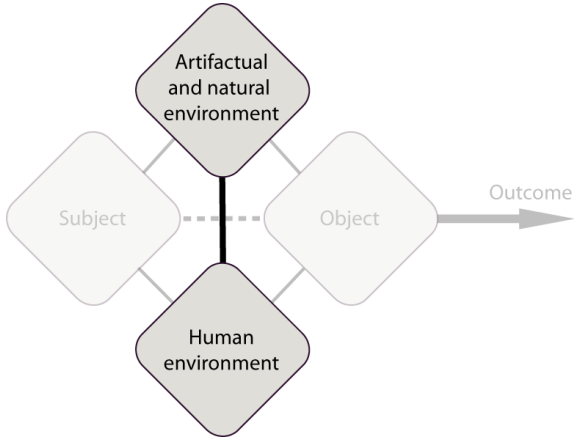


Figure 18. Relationship between the human and non-human elements in the environment.

The subject and the combined environments

It is the combined environments that the experiencing subject meets (Figure 17). Together, their impacts define the environmentally-relative accessibility. If there is no real or imagined activity, only the sets of factors by themselves can be analyzed. But when in a concrete motive-driven activity, these factors are tied together and interrelated in an activity system that provides direction and structure for the analysis.

Systemic analysis of artifactual and human assistance

The personal (human) and technical (artifactual) assistance have to work together; the Activity Diamond model can assist in discussing and improving the combinatoric sum of the two.

There are tensions between the human and artifactual environments, which develop the system over time (Figure 18). An imbalance between social norms and artifactual possibilities can sometimes lead to the implementation of social norms in artifacts, and sometimes to the reverse when an established technology results in differences in habits, attitudes, human relations and norms.

The relation between the human and the artifactual environments can be interesting to follow historically over lengthy periods. Social processes over time establish norms, which in turn may end up in, for instance, technical artifacts and laws (e.g. judicial artifacts, the study object in norm science and sociology of law). These crystallizations of attitudes and norms are exercised in their relation to the other parts of the system whenever involved in a activity.

Figure 19. The activity systems for two persons buying a birthday gift.

Concurrent activity systems

In many cases, two (or more) activity systems are at play simultaneously and need to be analyzed together. (Figure 19) The same activity seen from several subjects' perspectives, results in descriptions that are partly similar, partly different.

Although involved in one and the same activity, different people have different roles and are driven by different motives. Above is an example of a systemic description when two people, one with a disability and her personal assistant, are out in town to shop for a birthday present (Paper II).

Selection and application of theoretical perspectives

The combination of CHAT, lifeworld phenomenology and ANT constitutes a good and challenging basis for continued development and study in the accessibility field and could thus be considered a result per se. Phenomenology covers *what* and *how* from the individual perspective but cannot answer *why* questions, which CHAT can. ANT complements by including the interplay between humans and non-humans. This adds additional depth to the description.

The theoretical perspectives presented in chapter 4 can be applied in different combinations, depending on purpose and focus. There are both ontological and epistemological tensions, differences and incompatibilities between CHAT, ANT and phenomenology. Despite that, they were selected very carefully for their characteristics in relation to the enhanced accessibility presented here:

- CHAT has been the connecting thought and backbone of the entire thesis and is mandatory in any theoretical combination where the Activity Diamond is applied.
- ANT has contributed largely regarding the artifacts' many roles and influences in their co-relation with humans and other non-humans. ANT is the reason for the division of the environmental factors in the Activity Diamond into humans and non-humans (artifacts and nature). ANT is a resource for keeping track of all the humans and non-humans in our activity systems, and their mutual influence on human activity.

- Lifeworld phenomenology was brought in because of its abilities to portray the individual's experienced perspective and outlook on the lifeworlds (all the activity systems). Thus, this perspective is extra important in studies involving the lived accessibility.

6

Discussion and conclusions for future research

Discussion and conclusions for future research

A good deal of today's debate in handicap research and in practice, impairments and disabilities are built on the dualism of the individual and the environment. This has been polarized as our times grow increasingly individualized, while ideologically, disability is increasingly being attributed to discriminating human and artifactual factors in the environment. It is doubtful if this dualism is any longer meaningful, and this thesis suggests a system-based methodology in which both individual and environmental factors can be analyzed simultaneously, as one unit of analysis. Among the advantages in doing so, I especially want to stress the inclusion of personal factors such as motive, attitudes, expectations, experiences, personality, shifting form, etc. The ICF has yielded a first important step away from dualism by including fundamental components for both the environmental and personal factors but has still a long way to go for the classification and the model to agree (Paper IV).

Accessibility in the physical world has come a long ways thanks to *Design for all*. Online accessibility with WAI and WCAG, among others, has likewise matured. However, the standardization of accessibility aspects that are in between, in different forms of mixed reality, has not even started. Here, the close to 30-year-old universal design principles, "Flexibility in use," can have entirely new meanings and areas of application (Paper III).

The remaining discussion of the results is based on concrete examples.

The examples are:

1. The Pictorium, a day activity center for adults with developmental disabilities where the artifacts (digital pictures) establish favorable conditions and prerequisites for communication.
2. The Gamers' Lair (Spelhålan), an enterprise that works with accessibility in commercial computer games.
3. Vigs Ängar (Vig's Meadows), a Swedish home for the elderly designed to create a holistic environment for the residents.
4. The International Classification of Functioning, Disability and Health (ICF).
5. Myself — how 20 years' epiaccessibility and longitudinal effects have contributed to accessibility and anticipation.

Example 1: The Pictorium

The Pictorium is a day activity center in Lund, Sweden, for adults with developmental disabilities. It was managed from its inception until 2008 by Göran Plato, an artist both in practice (as a visual artist) and in his role as "mental companion". The fifteen-year-long close cooperation between The Pictorium and Certec has affected both organizations in their essence; first through the Isaac Project (www.english.certec.lth.se/isaac/) starting in 1993 and then through continual offshoots.

For The Pictorium this has resulted in all the participants being able to talk in pictures, not in words (www.tryckolera.certec.lth.se). The entire setting is dominated by artifacts (today their digital picture bank encompasses 130 000 pictures) which the participants are able to manage and use communicatively to express themselves (Figure 20).

Even before digital photos became so dominant in its environment and in the personal development of the participants, The Pictorium was characterized by the priority of the participants in all aspects: initiatives, plans, actions, story telling, wishes and dreams.

However, a human "mental companion" can never avoid imposing his or her own interpretations, expectations and preferences. So when personal digital photos were introduced in 1994 enabling the participants to start "talking with pictures," this resulted in considerable breakthroughs in the fundamental implementation of the existing thought climate.

Initially of course, Göran Plato put in much of his background knowledge, experiences and instincts into the digital photos. But when the introductory phase was over, thanks to the ever increasing bank of digital pictures the participants themselves could be in charge.

Since Göran Plato had access to a digital camera, he began taking photos continuously of different artifacts and humans, to document not only the indoor and outdoor environment of The Pictorium but also the history of the participants and their wishes for the future. This way, what started as an environment almost void of pictures developed towards an extremely picture based communicative community (Figure 21).

Figure 20. Göran Plato, manager at the Pictorium, an environment full of pictures

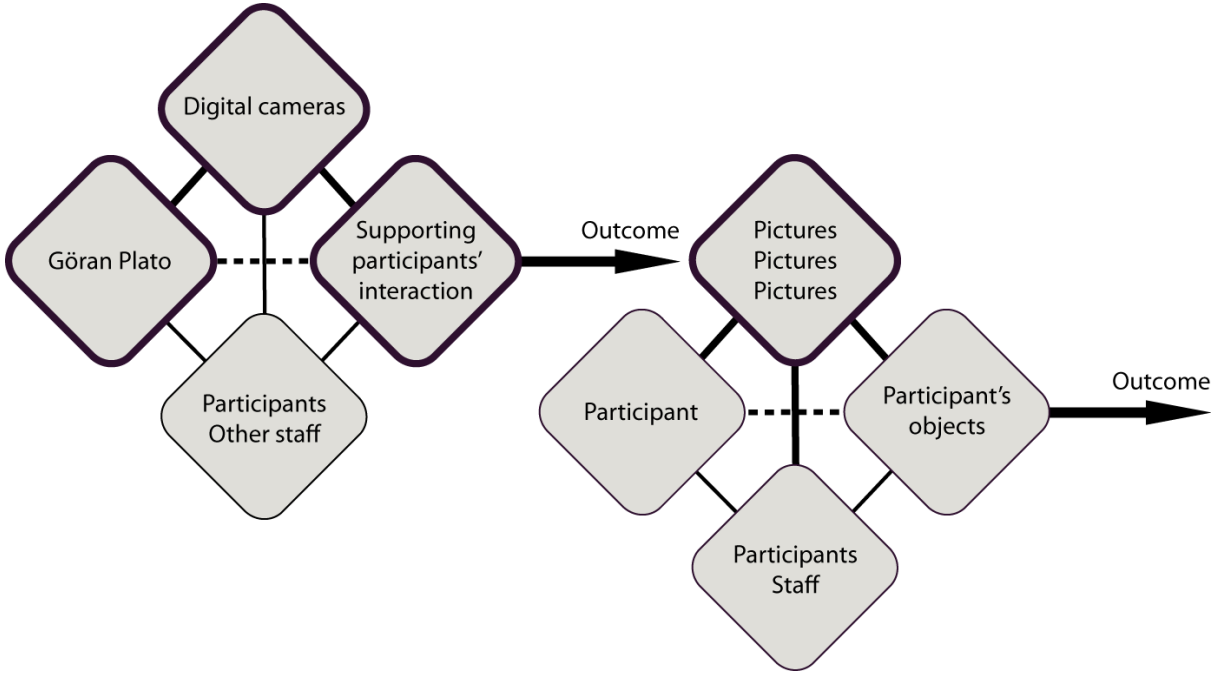


Figure 21. Over time, Göran Plato and his digital camera contributed with images to the participant's different activity systems.

Gradually, both the participants' and the staffs' activity systems changed. Below are six examples of how the pictures were used as part of the ongoing interaction, memory support and mental support at The Pictorium. The examples also highlight the epiaccessibility effects, where the pictures (and their related strategies) over time came to have a significant impact on both the participants' and the staffs' perceptions of themselves and each other.

1. Suddenly, Thomas, one of the participants, could show the other participants, the staff and the researchers involved how he thought. When he saw this picture (Figure 22) with no boat in sight, but just himself and Bodil, he said "The boat!" And he repeated it until Bodil remembered that there actually *had been* a boat out in Oresund, the ocean, and that they were looking at it when the picture was taken. He was the one who remembered the situation best, not the staff or the researcher. This is contrary to the prevailing assumption that people with significant cognitive limitations are unable to make associations with something that is outside of their immediate perception. Thomas's activity system changed when he became accustomed to being able to show others how he thought. The activity systems of others around him also changed when they understood how his conceptions of how things are related were much broader than they had previously supposed. This meant that they could give much more relevant feedback than what they had previously been able to.

2. When Alan Alda whirled into The Pictorium to document it in the popular TV series "Scientific American Frontiers", he could not possibly understand why Stig pointed to a picture of an elderly woman when Alan Alda himself tried to start a conversation about a picture of boiled potatoes (Jönsson, Philipson, & Svensk, 1998). But tears almost came to the eyes of the people who worked with Stig when they realized how he through his picture pointing tried and was able to relate that these potatoes were special. The participants had grown them themselves in that lady's garden (Figure 23).

Figure 22. Photo of Thomas, a Pictorium participant and Bodil Jönsson, researcher.

Figure 23. Alan Alda visiting The Pictorium, the potatoes, and the garden owner together with Stig.

Figure 24. Some of the participants interacting.

This is an impressive chain of thought for a person with a developmental disability, without spoken and written language and with very limited sign language. It was later followed up by many more dialogues including long and complex chains of reasoning, completely picture based. Once Stig had demonstrated that he could and wanted to discuss interrelations, not only separate occasions, a new communication and action base was grounded.

3. Gradually, every day at The Pictorium began with the participants talking to *one another* about what yesterday's pictures showed and (also based on the pictures) about what the day was going to bring (Figure 24). They simply had no need of expressly addressing the staff – they knew that they were the ones who were the principal actors and they had so much to say to each other that they were not dependent on a supervisor all the time.

4. "Picture Emergency Kit" – one day it was apparent that something was wrong with Stig, but since he had no words and because what had happened took place outside of the realm of the day activity center, he was unable to relate what it was. But he really wanted to – and that was how the Picture Emergency Kit came into existence (Figure 25). What Stig was able to relate the first time by showing his bruises led to the realization that he had been assaulted, which was in turn investigated. After that, Göran Plato instituted the Picture Emergency Kit, a dedicated set of pictures for emergencies and a special place where they were kept. Because of the pictures, Stig could communicate and was no longer defenseless. The Picture Emergency Kit was gradually developed for more general use – that was where the participants went when something was wrong.

5. A new participant came to The Pictorium, a man who wandered around restlessly. His constant agitated walking caused anxiety among the others. Göran Plato introduced special "picture islands" for him that became the stopping points along his path (Figure 26). After a while, the wandering gradually decreased to a reasonable level.

Figure 25. Stig showing his bruise.

Figure 26. Some of the "picture islands" at The Pictorium.

Figur 27. Anette on a trip to Denmark.

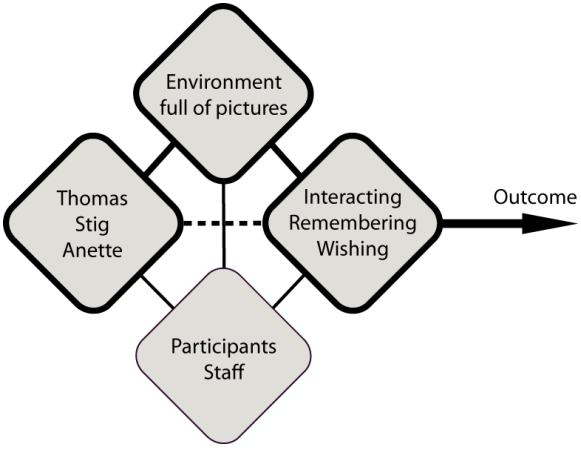


Figure 28. The participants' activity system when utilizing the pictures in order to interact, to remember or to wish.

6. The desire and ability to plan was drastically altered when the digital photos were domesticated. When it was time for the Denmark outing (Figure 27) and an employee at Certec asked what her responsibilities were, Göran Plato's response was:

> Good Lord! We aren't going to make any decision at all. Thomas has already done that. He has indicated what boat we are going to take over the Sound and will tell us where we are going once we are under way. "We are going to a hill in the woods," says Thomas. "And I want a red sausage and a beer," says Anette. So it is just for us to obey. We are in trouble when we are no longer allowed to decide.

To sum up this example on how the Activity Diamond can help distinguish new activity traits:

Fifteen years with the "digital pictures" artifact have led to several profound changes in the activity systems for both participants and personnel at The Pictorium. Even more important than these changes per se is the resulting epiaccessibility. More than a decennium of continous breakthroughs have changed the expectations and goals for the participants and opened up their imagination and knowledge about how to handle desired objects via the artifactual digital pictures. Doing so, they also strongly influence the activity systems of the personnel, families and friends.

Many visitors said that it must be disturbing to have that many pictures all over the place, even in the dining area. Thus, one day the staff removed the pictures there – but what was the result? Everyone grew quiet because without the external pictures that triggered the inner pictures there were nothing

to talk about, at least nothing that the participants themselves could initiate. For their part and their participation in the activites at The Pictorium, it was crucial that the activity "trail" (Figure 28) was available the whole time and everywhere.

Figure 29. Pictures from the Gamers' Lair.

Example 2: The Gamers' Lair

The Gamers' Lair is about how people with disabilities can use commercial computer games in their leisure time, at school and for training (Figure 29). As a rule, children and young people with impairments have more adults around them than other children, which makes them more dependent on the adults' attitudes and expectations. In the game context, these have often proven to be with the best of intentions but obstructive, since playing computer games often is not considered to be a "good" activity. The purpose of The Gamers' Lair is to change these kinds of attitudes by showing examples of how common commercial computer games can be played with ordinary controlling devices for computers (Figure 30)(Ferreira & Hedvall, 2006).

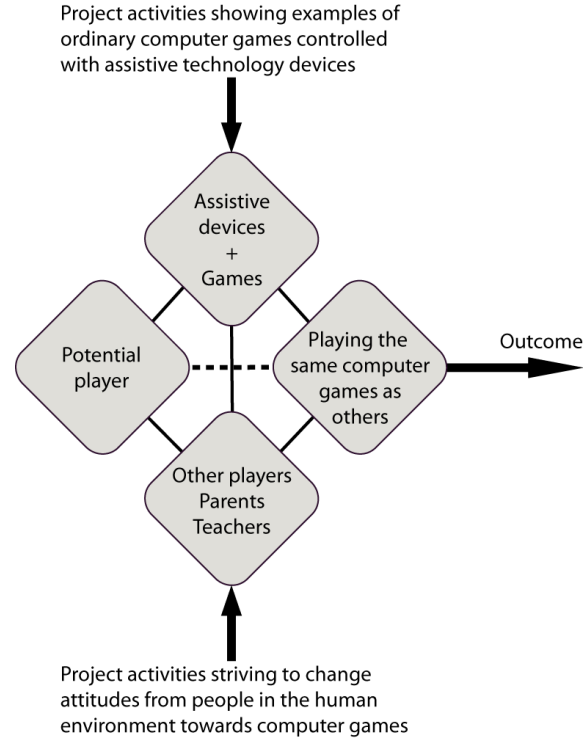


Figure 30. Project activities related to the Activity Diamond.

The Gamers' Lair's Activity Diamond

Subject: Children, youths and adults who want to play computer games.

Object: To play a computer game.

Human environment: Many adults in the surroundings, often with negative attitudes to games, which means that they are not interested in finding adaptations that enable this activity. Nor do many adults expect the child to be capable of playing a computer game, which often becomes a self-filling prophecy since they are not given the opportunity to prove the opposite.

Artifactual and natural environment: Many different kinds of artifacts, such as assistive technology in the home, mobility aids, communication aids, computer aids. Immaterial artifacts that come into play here are the regulations regarding assistive technology that in many cases do not support recreational activities. For someone to be able to play a computer game, they have to receive aids for communication, schoolwork or the like that may, in turn, also be utilized to play games.

Epiaccessibility in the Gamers' Lair

The long-term effects of not being a player like anybody else are palpable, not least of all in the home environment where the child ends up being the one watching, not participating. In the long run, this also means growing up without having trained and developed habits and skills in the computer game world, for example. In practice, it involves larger areas than that – one is excluded from the constantly increasing level of interactivity in society and in life in general. This results in

activity patterns that manifest themselves over time as well as in the action readiness, action affordances, expectations and attitudes in the artifactual and human environments to the degree that they often become self-filling.

An example: My experience is that the mothers of children with disabilities often experience that they are the ones fighting for their children and never stop believing in them. In my work with the Gamers' Lair, though, I have seen that children also surprise their mothers by being able to do more than what their mothers thought possible. The epiaccessibility change arises both from the child's altered self-concept and from altered ideas of what the child is capable of doing from the environment.

Figure 31. A day at Vigs Ängar (Vig's Meadows). © Peggy Eklöf

Example 3: Vigs Ängar (Vig's Meadows)

Vigs Ängar (Figure 31) is a home for the elderly in Köpingebro, Sweden, which is run by Äldreboendet Vigs Ängar AB under contract from the Municipality of Ystad. The buildings are owned by the Municipality, which also has referral rights to all the apartments. The residents have contracts for their apartments, which are furnished with their own furniture.

I take it up as an example for the applicability of the Activity Diamond because it demonstrates how at Vigs Ängar the staff have been able to make most of the Diamond's components work in harmony and without internal tensions (Figure 32). The human *and* artifactual environments have been central from the very beginning, based on the same founding ideas. Lillemor Husmark, an architect, designed the complex – but was also responsible for the entire organization. The buildings and the content, the actual processes, were interconnected not only during the initial phase but have remained so. Everything one does, sees, eats and experiences there (music, animals, nature, life-giving bath and massage treatments) contributes to development and well-being. All parts belong to the same whole. There are no obvious boundaries between the residents and the co-workers at Vigs Ängar; the personnel are expected to experience and contribute in the spirit of, "This is how I would like to have it when I grow old."

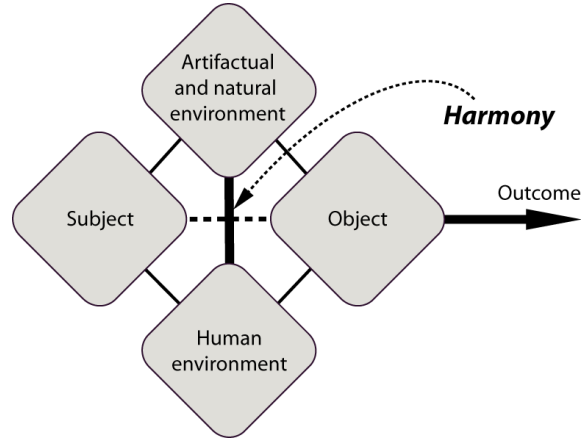


Figure 32. Activity system highligthing the harmony between the human and the artifactual and natural environments at Vigs Ängar (Vig's Meadows).

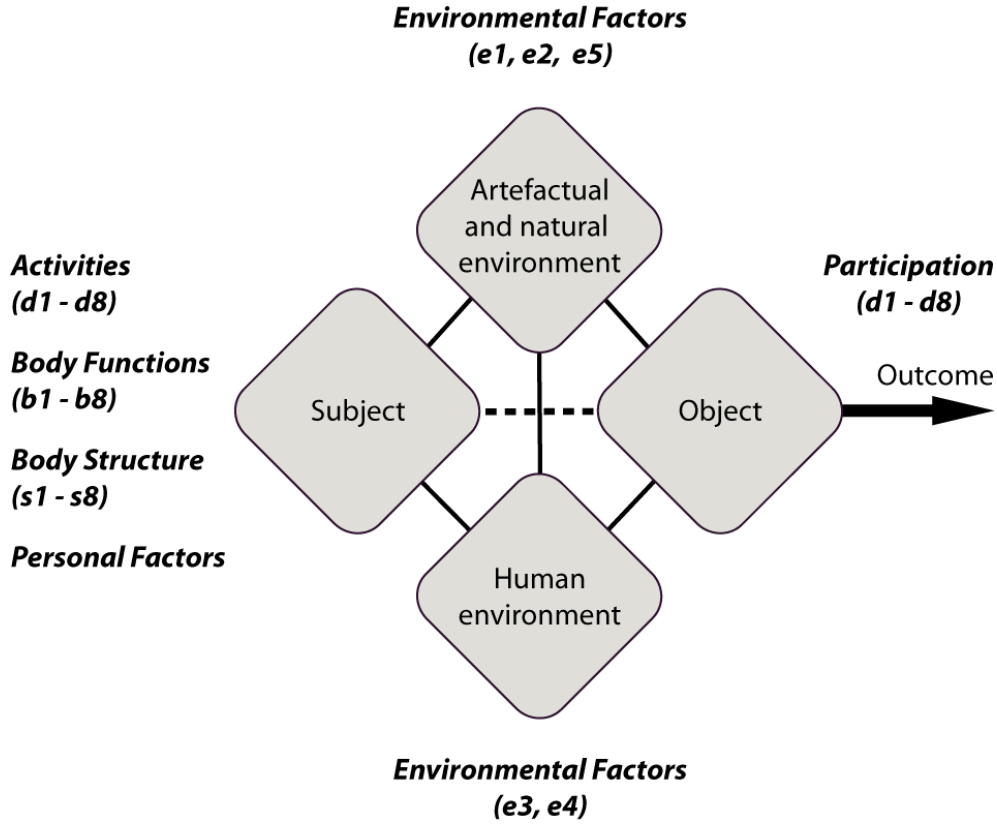


Figure 33. The Activity Diamond "dressed" with the ICF's different components.

Example 4: The International Classification of Functioning, Disability and Health (ICF)

One example of how the Activity Diamond has been used in the thesis work can be found in Paper IV, where it was used side-by-side with the ICF (WHO, 2001, 2007). The ICF has been criticized for being a political consensus model rather than a scientifically based model. The purpose of the article was to critically discuss the ICF by juxtaposing it with a theoretical framework: CHAT.

One of the discussions was about the ICF's Personal Factors (Figure 33). The application of these (along with the activity factors) to the Activity Diamond model can provide its subject component with more structure and detail in comparison to how it is today.

The conclusion in the article was that the ICF and CHAT have several similarities, such as having a multidimensional perspective on functioning and viewing functioning as dependent on many factors. By viewing the ICF as a systems model, the dichotomy between impairments and disability might be able to be bridged and brought together by depicting functioning as a systemic process in continuous change. There were differences between the two as well, which can serve as a basis for identifying aspects that may need to be changed when developing the next version of the ICF.

For more about this, see Article IV appended to the thesis.

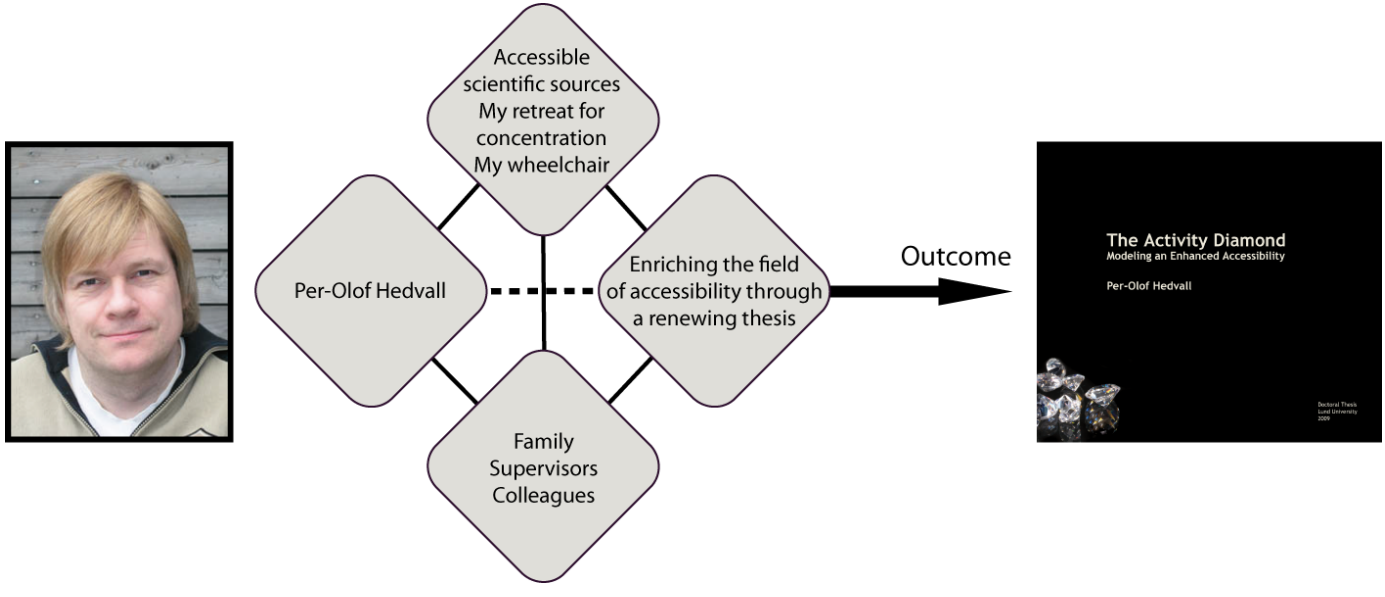


Figure 34. My Activity Diamond during the process of enriching the field of accessibility through a renewing thesis.

Example 5: Me — a doctoral candidate, a thesis author

In recent months, I have lived 24 hours a day with "the Diamond" and it is now internalized in me as a permanent thought assistant (Figure 34). When I read the newspaper, I often see how a line of argument in the articles falls into place in the respective squares of the model and how the tensions (the lines) between the squares are what is worth writing about. What follows are two ways to reflect upon my Ph.D. working life, with the assistance of the Activity Diamond and epiaccessibility.

"The Thesis Diamond"

Subject: Me.

Object: Enrich the field of accessibility through a renewing thesis.

Human environment: Family, supervisors, colleagues, former colleagues, etc., who all together and in different ways have influenced and continue to influence my road to getting my Ph.D., my research and the work on the thesis.

Artifactual and natural environment: There is much to be included here. Particularly important are the computer, the books, the Internet and the accessibility of all the databases for research papers, my wheelchair and that perfect place to sit and write as the deadline approaches. My wheelchair is included in most of my activity systems and is now pretty much a

part of "me", at least during the day. To use an expression of Donna Haraway's, "I have never been human" (2008). In other words, my individual accessibility in physical settings means accessibility for me *and* my wheelchair.

My experiences of well-adapted (artifactual and human) environments have no doubt affected my own view of what I can accomplish in a day or a year. It has also exerted an influence on the confidence, reliance, trust, attitudes and expectations from people around me. These longitudinal accessibility perspectives from twenty years are all involved in my recent activity system towards a Ph.D.

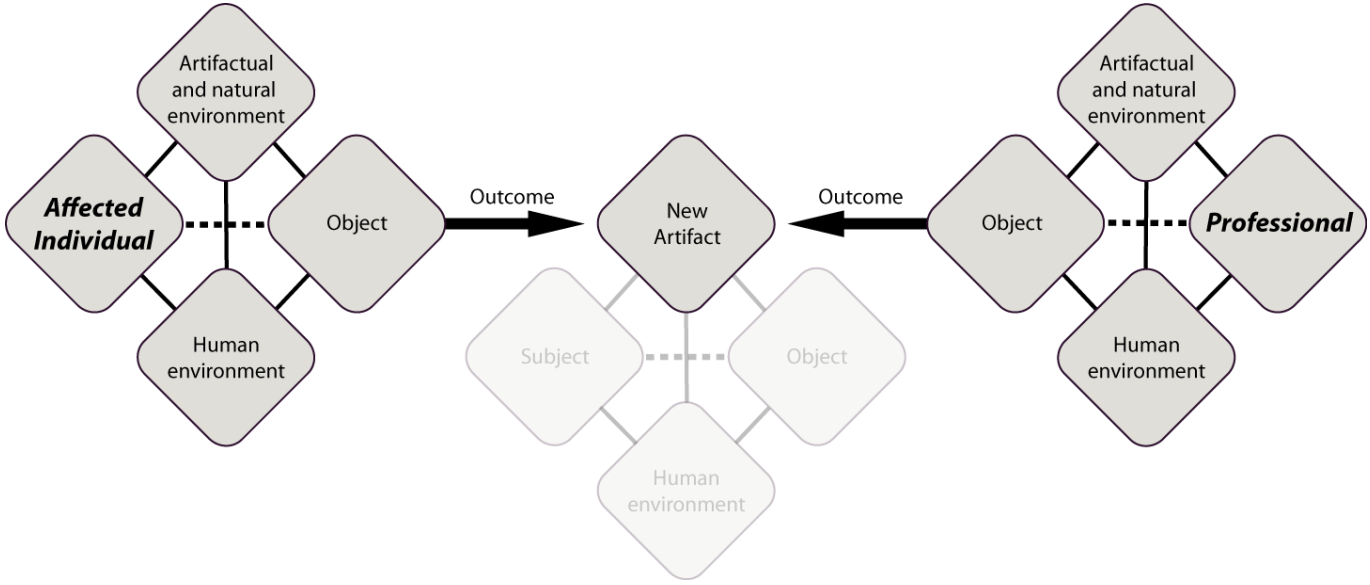


Figure 35. Two persons (i.e. two activity systems at play) designing a new artifact, and as part of the process co-constructing and negotiating the accessibility of it.

Future research

Description amounts to power, and a change in the description of accessibility consequently affects the power balance. An individual's accessibility is an integral part of all the countless activity systems of everyday life (Figure 35). This fundamental prerequisite can guide the field of accessibility towards an increased emphasis on research anchored in everyday life in the form of intervention-based action research.

Now when approacing the end of the thesis, I want to return to the *Convention on the Rights of Persons with Disabilities* that is introduced as follows:

> The Convention marks a "paradigm shift" in attitudes and approaches to persons with disabilities. It takes to a new height the movement from viewing persons with disabilities as "objects" of charity, medical treatment and social protection towards viewing persons with disabilities as "subjects" with rights, who are capable of claiming those rights and making decisions for their lives based on their free and informed consent as well as being active members of society (United Nations, 2006).

This thesis is my contribution and challenge to the field of accessibility. Much more is required before this pattern of thinking is consolidated. I plan to continue carrying out research in which I let the Activity Diamond provide structure the entire way from the design of a project, through the development and configuration of the data collection up to the finished results. I also hope that others in research and organizations will recognize and assimilate the Activity Diamond as a model for analysis of situations that are under simultaneous influences from people, nature and artifacts.

7

References

References

Akrich, M. (1992). The de-scription of technical objects. In: W. Bijker & J. Law (Eds.), *Shaping Technology* (pp. 205-224). Cambridge, MA, USA: MIT Press.

Albrecht, G.L., Seelman, K.D., & Bury, M. (2001). *Handbook of disability studies*. Thousand Oaks, CA, USA: Sage Publications.

Anderberg, P. (2006). *FACE: disabled people, technology and Internet*. Lund, Sweden: Certec, Lund University.

Antonovsky, A. (2005). *Hälsans mysterium* (2nd ed.). Stockholm, Sweden: Natur och kultur.

Arendt, H. (1988). M*änniskans villkor: vita activa.* Gothenburg, Sweden: Röda bokförl.

Bannon, L. (1992). From human factors to human actors: the role of psychology and human-computer interaction studies in system design. In: J. Greenbaum & M. Kyng (Eds.), *Design at work: cooperative design of computer systems (pp.* 25-44). Hillsdale, NJ, USA: L. Erlbaum Associates Inc.

Barnes, C., Barton, L., & Oliver, M. (2002). *Disability Studies Today.* Cambridge, UK: Polity Press.

Barnes, C., & Mercer, G. (2003). *Disability.* Cambridge, UK: Polity Press.

Bertelsen, O., & Hedvall, P.O. (2009). New Challenges for Participation in Participatory Design in Family, Clinical and Other Asymmetrical, Non-work Settings. In: T. Gross, J. Gulliksen & P. Kotze (Eds.), *Human-Computer Interaction – INTERACT 2009* (pp. 971-972).

Bertelsen, O.W. (1998). *Elements of a Theory of Design Artefacts: a contribution to critical systems development research.* Aarhus, Denmark: Computer Science Dept. Aarhus University.

Beukelman, D.R., & Mirenda, P. (2005). *Augmentative & alternative communication : supporting children & adults with complex communication needs* (3rd ed.). Baltimore, USA: Paul H. Brookes Pub. Co.

Bodker, S. (1990). *Through the Interface: Human Activity Approach to User Interface Design.* Hillsdale, NJ, USA: Lawrence Erlbaum Associates Inc.

Breidegard, B. (2006). *Att göra för att förstå: konstruktion för rehabilitering.* Lund, Sweden: Certec, Lund University.

Callaghan, V., Clarke, G., & Chin, J. (2009). Some socio-technical aspects of intelligent buildings and pervasive computing research. *Intelligent Buildings International, 1*, 56-74.

Castells, M. (1996). *The rise of the network society.* Malden MA, USA: Blackwell Publishers.

Castells, M. (Ed.) (2004). *The network society: a cross-cultural perspective.* Cheltenham, UK; Northampton, MA, USA: Edward Elgar Pub.

Dong, H. (2007). Shifting Paradigms in Universal Design. In: C. Stephanidis (Ed.), *Universal Access in Human Computer Interaction. Coping with Diversity* (pp. 66-74).

Dourish, P. (2004). *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge, MA, USA: MIT Press.

Eftring, H. (1999). *The useworthiness of robots for people with physical disabilities.* Lund, Sweden: Certec, Lund University.

Ehn, P. (1988a). *Playing the language-games of design and use-on skill and participation*. Palo Alto, California, USA: ACM. (pp. 142-157)

Ehn, P. (1988b). *Work-Oriented Design of Computer Artifacts.* Stockholm, Sweden: Arbetslivscentrum.

EIDD. (2004). *The EIDD Stockholm Declaration.* Downloaded 4 August, 2009, from http://www.designforalla.se/templates/Page____888.aspx.

Engeström, Y. (1987). *Learning by Expanding: An Activity-Theoretical Approach to Developmental Research.* Helsinki, Finland: Orienta-Konsultit Oy.

Engeström, Y. (2001). Expansive Learning at Work: toward an activity theoretical reconceptualization. *Journal of Education and Work, 14(*1*),* 133-156.

Engeström, Y. (2008). *From Teams to Knots: Activity-Theoretical Studies of Collaboration and Learning at Work*. Cambridge; New York, USA: Cambridge University Press.

Ferreira, J., & Hedvall, P. (2006). Computer games as life quality for disabled players. Presented at Young Researchers Consortium, *International Conference on Computers for*

Handicapped Persons (ICCHP 2006). Downloaded 4 August, 2009, from http://www.icchp.org/2006/content/view/54/87/.

Frankl, V. (2006). *Livet måste ha mening* (3rd ed.). Stockholm, Sweden: Natur och kultur.

Gibson, J. J. (1986). *The Ecological Approach to Visual Perception*. New York, USA: Psychology Press.

Gleeson, B. (2000). Disability, Geography and Ethics - Enabling geography: Exploring a new political-ethical ideal. *Philosophy & Geography (Now: Ethics, Place & Environment), 3*(1), 65-70.

Goffman, E. (1990). *Stigma: Notes on the Management of Spoiled Identity*. Harmondsworth, UK: Penguin.

Gregor, P., & Newell, A.F. (2001). Designing for dynamic diversity: making accessible interfaces for older people. In: *Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly (*pp. 90-92). Alcacer do Sal, Portugal: ACM.

Gregor, P., Newell, A.F., & Zajicek, M. (2002). Designing for dynamic diversity: interfaces for older people. In: *Proceedings of the fifth international ACM conference on Assistive technologies (*pp. 151-156). Edinburgh, Scotland: ACM.

Gulliksen, J., & Göransson, B. (2002). *Användarcentrerad systemdesign: en process med fokus på användare och användbarhet.* Lund, Sweden: Studentlitteratur.

Haraway, D.J. (2008). *When species meet.* MN, USA: University of Minnesota Press.

Haraway, D.J. (2003). *The Companion Species Manifesto: Dogs, People and Significant Otherness.* Chicago, USA: Prickly Paradigm Press.

Hedvall, P.O. (2008). *Xings for Augmented Family Communication.* Presented at ISCAR 2008, San Diego, USA.

Hedvall, P.O. (2007). *Situerad Design för alla - till improvisationen lov.* Lund, Sweden: Certec, Lund University.

Hochheiser, H., & Lazar, J. (2007). HCI - and Societal Issues: A Framework for Engagement. *International Journal of Human-Computer Interaction, 23*(3), 339-374.

Ihde, D. (1990). *Technology and the lifeworld: from garden to earth.* Bloomington, IN, USA: Indiana University Press.

Ihde, D. (2002). *Bodies in technology.* Minneapolis, MN, USA: University of Minnesota Press.

Ihde, D., & Selinger, E. (Eds.). (2003). *Chasing Technoscience: Matrix for Materiality.* Bloomington, IN, USA: Indiana University Press.

Imrie, R., & Edwards, C. (2007). The Geographies of Disability: Reflections on the Development of a Sub-Discipline. *Geography Compass, 1*(3), 623-640.

Iwarsson, S., & Ståhl, A. (2003). Accessibility, usability and universal design - positioning and definition of concepts describing person-environment relationships. *Disability & Rehabilitation, 25*(2), 57-66.

Junefelt, K. (1993). Introduction. In: *Proceeding of the XIVth Scandinavian Conference of Linguistics and The VIIIth*

Conference of Nordic and General Linguistics, Gothenburg Papers in Theoretical Linguistics. Gothenburg, Sweden: University of Gothenburg.

Jönsson, B. (2008). *Vi lär som vi lever*. Malmö, Sweden: Gleerups utbildning.

Jönsson, B. (2006). *Design side by side.* Lund, Sweden: Studentlitteratur.

Jönsson, B. (2007). *Sowing Forth: 2007, Certec turns 20* . Lund: Certec, LTH.

Jönsson, B., Philipson, L., & Svensk, A. (1998). *Vad vi lärt oss av Isaac ; What Isaac taught us.* Lund, Sweden: Certec, Lund University.

Kaptelinin, V. (2005). The Object of Activity: Making Sense of the Sense-Maker. *Mind, Culture, and Activity, 12*(1), 4-18.

Kaptelinin, V., & Nardi, B.A. (2006). *Acting with Technology: Activity Theory and Interaction Design.* Cambridge, MA, USA: MIT Press.

Latour, B. (1991). Technology is society made durable. In: J. Law (Ed.), *A Sociology of monsters : essays on power, technology, and domination* (pp. 103-131). London, UK; New York, USA: Routledge

Latour, B. (1993). *We have never been modern.* Cambridge MA, USA: Harvard University Press.

Latour, B. (1998). *Artefaktens återkomst : ett möte mellan organisationsteori och tingens sociologi.* Stockholm, Sweden: Nerenius & Santérus.

Latour, B. (1999). *Pandora's Hope: An Essay on the Reality of Science Studies.* Cambridge, MA, USA: Harvard University Press.

Latour, B. (2005). *Reassembling the Social: An Introduction to Actor-network-theory.* New York, USA: Oxford University Press.

Law, C.M., Yi, J.S., Choi, Y.S., & Jacko, J.A. (2007). Unresolved Problems in Accessibility and Universal Design Guidelines. Ergonomics in De*sign: The Quarterly of Human Factors Applications, 15,* 7-11.

Leontiev, A.N. (1978). *Activity, consciousness, and personality.* Englewood Cliffs, NJ, USA: Prentice-Hall.

Leontiev, A.N. (1981). *Problems of the development of the mind.* Moscow, Russia: Progress.

Leontiev, A.N. (2009). *The development of mind: selected works.* Pacifica, CA, USA: Marxists Internet Archive.

Lidwell, W., Holden, K., & Butler, J. (2003). *Universal principles of design.* Gloucester, MA, USA: Rockport.

Löwgren, J., & Stolterman, E. (2004). *Thoughtful interaction design: a design perspective on information technology.* Cambridge, MA, USA: MIT Press.

Löwgren, J. (2001). From HCI to interaction design. In: Q. Chen (ed.) *Human computer interaction: issues and challenges* (pp. 29-43). Hershey, PA, USA: Idea Group Pub.

Merleau-Ponty, M. (2002). *Phenomenology of perception.* London, UK; New York, USA: Routledge.

Milgram, P., Takemura, H., Utsumi, A., & Kishino, F. (1994). Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum. SPIE, 2351, *Telemanipulator and Telepresence Technologies,* (pp. 282-292).

Miller, D. (2008). *The Comfort of Things.* Cambridge, UK; Malden, MA, USA: Polity.

Miller, D. (2001). *Home Possessions: Material Culture Behind Closed Doors (Materializing Culture).* Oxford, UK; New York, NY, USA: Berg Publishers.

Nardi, B.A. (1996). *Context and Consciousness: Activity Theory and Human-computer Interaction.* Cambridge, MA, USA: MIT Press.

Newell, A.F., & Gregor, P. (2000). "User sensitive inclusive design" - in search of a new paradigm. In: *Proceedings on the 2000 conference on Universal Usability* (pp. 39-44). Arlington, Virginia, USA: ACM.

Norman, D.A. (1988). *The Psychology of Everyday Things.* New York, NY, USA: Basic Books.

Oliver, M. (1990). *The Politics of Disablement.* London, UK: Macmillan Education.

Pink, S. (2004). *Home Truths: Gender, Domestic Objects and Everyday Life.* Oxford, UK; New York, NY, USA: Berg Publishers.

Rassmus-Grohn, K. (2008). *User Centered Design of Non-Visual Audio-Haptics.* Lund, Sweden: Certec, Lund University.

Rogers, Y. (2008). 57 Varieties of Activity Theory. *Interacting with Computers, 20*(2), 247-250.

Roth, W.M. (2004). Activity Theory and Education: An Introduction. *Mind, Culture, and Activity, 11*(1), 1-8.

Sakkas, N., & Pérez, J. (2006). Elaborating metrics for the accessibility of buildings. *Computers, Environment and Urban Systems, 30*(5), 661-685.

Sengers, P., & Gaver, B. (2006). *Staying open to interpretation: engaging multiple meanings in design and evaluation* (pp. 99-108). University Park, PA, USA: ACM.

Shakespeare, T. (2006). *Disability Rights and Wrongs.* London, UK; New York, USA: Routledge.

Sharp, H., Rogers, Y., & Preece, J. (2007). *Interaction Design: Beyond Human-computer Interaction* (2nd ed.). Chichester; Hoboken, NJ, USA : John Wiley & Sons.

Shedroff, N. (2001). *Experience design 1.* Indianapolis, IN, USA: New Riders Pub.

Shove, E., Watson, M., Hand, M., & Ingram, J. (2007). *The Design of Everyday Life.* Oxford, UK; New York, NY, USA: Berg Publishers.

Story, M.F., Mueller, J.L., & Mace, R.L. (1998). *The Universal Design File: Designing for People of All Ages and Abilities.* (Revised ed.) NC, USA: Center for Universal Design, NC State University.

Suchman, L.A. (2007). *Human and Machine Reconfigurations: Plans and Situated Actions* (2nd ed.). Cambridge; New York, USA: Cambridge University Press.

Suchman, L.A. (1987). *Plans and Situated Actions: The Problem of Human-Machine Communication*. Cambridge; New York, USA: Cambridge University Press.

Swain, P. J., French, S., Barnes, C., & Thomas, D.C. (2004). *Disabling Barriers, Enabling Environments* (2nd Edition.). London, UK; Thousand Oaks, CA, USA: SAGE Publications

Thiesen Winthereik, J., Malmborg, L., & Andersen, T. (2009). Living Labs as a Methodological Approach to Universal Access in Senior Design. In: C. Stephanidis (Ed.) *Universal Access in Human-Computer Interaction. Addressing Diversity* (pp. 174-183).

United Nations. (2006). The United Nations Programme on Disabilities. Downloaded August 5, 2009, from http://www.un.org/disabilities/default.asp?navid=12&pid=150.

Wade, D.T., & Halligan, P. (2003). New wine in old bottles: the WHO ICF as an explanatory model of human behaviour. *Clinical Rehabilitation, 17*(4), 349-354.

Wertsch, J. V. (1991). *Voices of the mind : a sociocultural approach to mediated action.* Cambridge, MA, USA: Harvard University Press.

Wertsch, J. V., & Tulviste, P. (1992). L. S. Vygotsky and Contemporary Developmental Psychology. *Developmental Psychology, 28(4),* 548-57.

WHO. (2001). *International Classification of Functioning, Disability and Health: ICF*. Geneva, Switzerland: World Health Organization.

WHO. (2007). *International classification of functioning, disability and health: children & youth version: ICF-CY* . Geneva, Switzerland: World Health Organization.

Vygotsky, L. (1978). *Mind in Society: Development of Higher Psychological Processes*. Cambridge MA, USA: Harvard University Press.

Vygotsky, L. (1986). *Thought and Language*. Cambridge, MA, USA: MIT Press.

Vygotsky, L. (1995). *Fantasi och kreativitet i barndomen*. Gothenburg, Sweden: Daidalos.

8

Paper I

The Activity Diamond:
a model for multifaceted accessibility

The Activity Diamond: a model for multifaceted accessibility

(Submitted to *The Scandinavian Journal of Disability Research* 05 May, 2009)

Per-Olof Hedvall [a1] & Peter Anderberg [a]

[a] *Certec, Department of Design Sciences, Lund University*

P.O. Box 118
SE-221 00 LUND
Sweden

Email: per-olof.hedvall@certec.lth.se

Web: http://www.english.certec.lth.se

Phone: +46 739 88 46 76

Fax: +46 46 222 44 31

Keywords: accessibility; the activity diamond; cultural-historical activity theory; disability, usability

[1] Corresponding author. Email: per-olof.hedvall@certec.lth.se

Abstract

This article introduces and exemplifies *The Activity Diamond*, a new conceptual and activity-tied model for accessibility. The model is inspired by Cultural-Historical Activity Theory and covers the simultaneous influences of the social and the artefactual or natural contexts. It allows for the cultural-historical influence of time on the individual level as well as the collective one, primarily in the form of learning effects, development and artefactual and social evolution. The aim is to highlight accessibility as an experienced quality in the moment of action, most often involving different communities of practice and different activity systems. The hope is that a set of common concepts structured through their internal relationships will help the accessibility area to fully proceed from human factors to human actors.

Introduction

Accessibility manifests itself in human everyday activity where it appears as opportunities or, in its absence, as obstacles: a text font that is too small, a pavement kerb that is too high, or a door that is too narrow. Accessibility can never be completely anticipated via standards (cf. The EIDD Stockholm Declaration 2004) or guidelines based on measurements, abstractions and generalizations. It also depends on the situated social and artefactual circumstances and on the interference between them. Disability and accessibility, two sides of the same coin, are both relative to the human and artefactual environments – an increased accessibility in many cases corresponds to a decreased disability.

It takes years of initiating, norm confrontations, lobbying and realization before a certain level of accessibility is reached. The infrastructure that is subsequently implemented ends up playing a conservative role in and of itself. If the conceptualization of accessibility also lags behind, the accessibility area grows more and more dogmatic and separated from its situated material and social conditions and at the same time less and less vitalized and open to change.

This article argues for a view of accessibility as *activity-tied* (Hedvall 2008) and experienced *in the moment of action* (Hedvall 2007). Its purpose is to reconceptualize accessibility out of Cultural-Historical Activity Theory (CHAT) (Vygotsky 1978, 1986; Leontiev 1978, 1981; Engeström 1987) in order to open up for:

1. *Accessibility as an experienced quality*, partly through arrangements considered in advance, partly through improvisations in the moment of action.

2. *The presence of different activity systems* in one and the same situation: one for the person with impairments; another for a relative; still another for a personal assistant, etc.

3. The simultaneous influences of the artefactual and social environments.

4. The ever ongoing mutual adaptation and development for the individuals and the social and technological contexts.

These four fundamental facets of accessibility will be elaborated, one by one, while building up and exemplifying *The Activity Diamond*, a new conceptual and activity-tied model for accessibility. The hope is that a set of common concepts structured through their internal relationships can help the accessibility area proceed from human factors to human actors (Bannon 1992).

1. Accessibility as an experienced quality

Accessibility often refers to how people with impairments can access the physical world or content on the internet, mainly web pages.

In the UN *Convention of the Rights of Persons with Disabilities*, the concept of accessibility is defined as 'the

physical, social, economic and cultural environment, to health and education and to information and communication, in enabling persons with disabilities to fully enjoy all human rights and fundamental freedoms' (UN 2006). Web accessibility relies on several components, one of them being the *Web Content Accessibility Guidelines* (W3 2008).

The European initiative *Design for All* (EIDD 2004) aims at supporting architects and designers in their work with new buildings or the development of new products. It is based on strategies for equal access to society by using plans, guidelines and heuristics as well as two fundamental principles:

1. That which is good for people with impairments is often good for everyone else.
2. Accessibility can to a large extent be established by thinking ahead, which means that the preconditions for accessibility are already created on the drawing board.

This view of accessibility as a phenomenon that can be achieved by planning ahead refers more to thought models of individuals and contexts than to the affected individuals. In the moment of action, however, the only accessibility that really counts is that which is individually experienced and activity-tied.

According to the social model, disability is not a characteristic of the individual but rather the discriminating and situated response to an inaccessible, inflexible and unadapted environment and society (Oliver 1990; Barnes, Burton, and Oliver 2002; Barnes and Mercer 2003; Albrecht, Seelman, and Bury 2001). The relative (relational) model of disability connects to the social model, but frames disabling

barriers relative to both individual impairments and situated, contextual settings (WHO 2001, 2007). In order to further problematize the space between the individual and the environment, Anderberg (2006) introduces the dichotomy *Design for All* versus *Design for Me* where the situated disability is seen from both the perspective of impairment and disability in the social model definitions.

Activity-tied and experienced accessibility, AX

Suchman's (2006) work on *situated action* is highly relevant to the conceptualization of accessibility. It represents a view where every chain of events depends on the current material and social circumstances and that plans arise or are modified in the course of action.

Situated action (Suchman 2006) and participatory design (Ehn 1988) are now encountering an ever increasing penetration of technology, especially when it comes to computers, internet and mobile phones in everyday life, in workplaces, in society and at home (Bødker 2006). This yields an interwoven mixture of humans and nonhumans that is present in every activity (Latour and Woolgar 1986; Latour 1991, 1999, 2005; Akrich 1992). Miller (2008) pinpoints how material aspects of the environment influence and structure an everyday life, but artefacts are often neglected both conceptually and in actual studies, and there is a 'need for further theorization of the role of stuff in everyday life' (Shove et al. 2007, 3).

The current view of accessibility as a predefined characteristic represents a structuralistic approach to accessibility that turns

the individual into an un-situated passive robot without desires or idiosyncratic whims (Hedvall 2007). What determines if an individual can manage in a given situation can just as easily be a broomstick that happens to be available as compared to something specially designed and placed there to be accessible. Kaptelinin and Nardi point out that to a large extent we are not aware of our operations and do not plan them. They state: 'Operations may emerge as an "improvisation", as the result of a spontaneous adjustment of an action on the fly' (2006, 63). This view of improvisation is in agreement with the one put forward by Hedvall (2007) and Suchman (2006). An approach to accessibility as being tied to activity leads to an interest in situated practical activities, lived situations and everyday life as described by Pink (2004), Miller (2008) and Shove et al. (2007), among others. Although the environment is made up of all the man-made artefacts and the people involved (such as parents, teachers or personal assistants), accessibility has traditionally been studied by professions dedicated to either the artefactual environment (such as medical aids or assistive technology) or the social environment. In a concrete situation, though, it is these two facets of the environment taken as a whole that matter.

The accessibility field can seek inspiration and challenges from the related usability field. The latter has long since passed from human factors to human actors, taking into consideration the actor perspective of the users (Bannon 1992). In a disability context this is explored in the book *Design Side by Side* (Jönsson 2006).

Advancements in the usability field in the last ten years have progressed as follows:

1. Originally, ISO 9241-11 (1998) defined usability as: '... the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use'.

2. ISO FDIS 9241-171 (2008) defines accessibility as: '... usability of a product, service, environment or facility by people with the widest range of capabilities'.

3. The new draft ISO standard ISO/IEC CD 25010.2 (2008) proposes a more comprehensive breakdown of *quality in use* into *usability in use* (covered by ISO 9241-11), *flexibility in use* (which is a measure of the extent to which a product is usable in all potential contexts of use, including accessibility) and *safety* (which is concerned with minimizing undesirable consequences) (Bevan, 2008).

4. Since 2008, however, there has also been a *user experience (UX) standard*, ISO CD 9241-210 (2008), defining it as: '...all aspects of the user's experience when interacting with the product, service, environment and facility'.

This UX standard exposes the absence of a corresponding standard for *accessibility experience* (AX). The absence can be seen as a sign of the lag in development of the concept *accessibility* compared to that of *usability*, and a need for a renewal of the accessibility field to allow for both the empowered and experiencing user, as well as an activity-relative rather than an absolute accessibility.

Example 1: Wheelchairing at a conference cocktail party

Life in a wheelchair involves a multitude of everyday experiences of contradictions and tensions afforded by artefactual, natural and social factors in the environment.

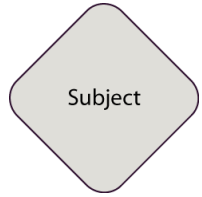
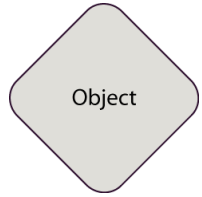
Their impacts on accessibility are simultaneously present and tied together in a concrete activity. In this example, an individual using a manual wheelchair is mingling at a conference cocktail party.

Mingling is a social activity where those attending are supposed to move around and talk to one another, affording them an opportunity to meet new people and chat with people they already know. It is often combined with appetizers and a drink. Attending such an event in a wheelchair can be quite a challenge, rolling around with a wine glass and a plate in each hand is hard. In addition to the logistics of having at best two hands, people are often standing up and walking around as this is the social norm. That makes it difficult for them to look you in the eye when you are in a wheelchair, and conversations can be difficult to hear due to the different heights.

The accessibility of a conference cocktail party cannot be created by the affected individual him or herself, nor by the manufacturer of the wheelchair, the catering staff, the conference managers, or the other participants. Instead, it deserves a system description and analysis. The situation is not hopeless, though: some kind of mingling equipment could be added to the wheelchair, like a glass and plate holder; chairs could be added to the venue so that people could both sit and stand; new norms and attitudes exercised in the practice of mingling can be developed, etc. All of these partial approaches

may be important but are not the focus of this article which is about the multifaceted entirety, not about the parts. So, let us proceed to the four basic concepts of the model to be introduced (Table 1):

Table 1. The Activity Diamond's four concepts and their descriptions.

Concept	*Description*
	When it comes to accessibility, the subject in the model is often an affected individual. On another level it can also be a group of people, such as a family.
	The object of activity is related to the will and needs of the subject. This is determined by the purpose and aim of the activity, such as getting better grades, learning to read, producing a new car or mingling at a conference cocktail party.
	This concept consists of material and immaterial artefacts, and their respective affordances (Gibson 1986; Norman 1988) and resistances. Some examples are computers, language, divisions of labour and rules, such as legislation for medical aids provision. It also covers features of the natural environment (such as stones, air temperature), which are not the product of any human labour process.
	The social environment is made up of the people or groups of people influencing the activity at hand. This can be the family, work colleagues or larger portions of society that are involved in or otherwise affect the activity regarding attitudes, norms and expectations.

In reality, these four elements influence each other and the accessibility in the moment of action and are here arranged to form *The Activity Diamond* (Hedvall 2008) (Figure 1).

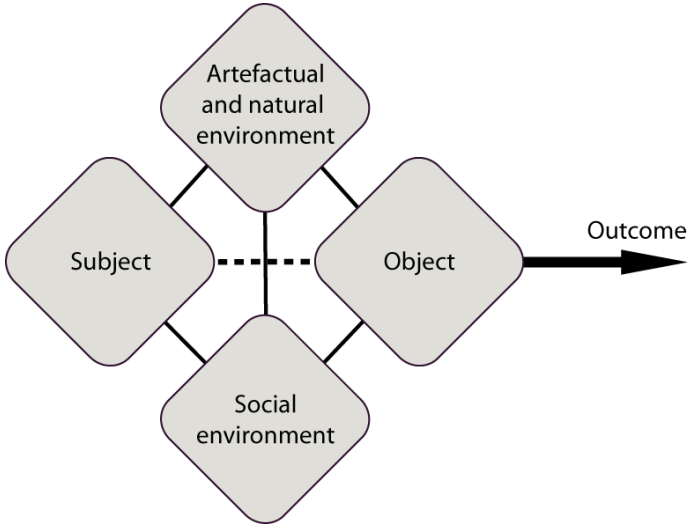


Figure 1. The Activity Diamond (Per-Olof Hedvall 2008). Illustration, Per-Olof Hedvall.

The Activity Diamond is a conceptual model aimed at capturing and describing a human activity system (Engeström 1987), where the subject-object relation is mediated and thus influenced by the artefactual, natural and social environments. It is situated in both time and place. This means that it can cover both historical development and instantaneous snapshots of the current activity system.

Even in the first example, the cocktail party, you may proceed along different lines from subject to object and outcome –

lines with different values for people with different aspirations and experiences. We will return to this model to elaborate its possibilities.

2. The presence of different activity systems

There are always several activity systems at work at the same time, 'the world is a knot in motion', as Haraway (2003, 6) states. Activity systems develop and change when contradictions arise within or between systems (Engeström 2008). Engeström also uses the knot metaphor: 'The notion of knot refers to rapidly pulsating, distributed, and partially improvised orchestration of collaborative performance between otherwise loosely connected actors and activity systems' (Engeström 2008, 194). Accessibility is entangled in all of these related systems, or knots. An example of this is that the artefacts in one activity system, such as a new screen reader for individuals with vision impairments, is the outcome of another activity system targeted at producing assistive technology. When introduced as a new artefact in another activity system, it changes the affected individual's possibilities, and hence the accessibility as well.

Next, the Activity Diamond is applied to an example concerning children with speech impairments and their families.

Example 2: Children's communication within their families

A family can be portrayed as involved in numerous different activity systems. When, for instance, a father and his daughter are involved in the same activity, they represent at least two activity systems driven by two different motives. They are two individuals, each with their roles in family life and with their corresponding activity systems.

This example is about a family that has a child with speech difficulties who uses a Voice Output Communication Aid (VOCA). The child's participation (Egilson and Traustadóttir 2009) within the family is in focus. The following application of the Activity Diamond describes the communication in a family from the viewpoint of the child with speech difficulties. Hence, the child is the subject of the described activity system (Table 2).

Table 2. A description of the activity system in example 2.

Concept	*Activity system*
Subject	The child with his or her expectations, needs, wishes and dreams.
Object	The communicative activity in itself but also communication as participation in family life and society.
Artefactual and natural environment	Environmental factors such as material and immaterial artefacts, which are important for the child's and the family's communication. This can be assistive communication devices (the child's VOCA in this case) but also mobile phones, language learning strategies, the house the family lives in, society's structure for medical provision and more.
Social environment	The child's relations and social networks (Blackstone, Hunt-Berg, and Berkley Study Group 2003) including other family members and their motives, attitudes and priorities, and society's attitudes towards children with disabilities, family life and normality.

Accessibility is never about just one person standing alone. Every individual is always situated materially, socially and in time. This example shows how the Activity Diamond can be used to describe situations where more than one person are involved, like in a family, and how they are all influenced by the artefactual environment. In this case, the VOCA might be considered to be the child's, but it is nevertheless entangled in all the family member's activity systems and hence affects all of them. Designing a VOCA for the child or for the family demands different design approaches.

Before we proceed to more accessibility aspects, it is time to introduce Cultural-Historical Activity Theory in greater depth, with an emphasis on the Vygotsky-Leontiev-Engeström line of development.

From Cultural-Historical Activity Theory to the Activity Diamond for Accessibility

Cultural-Historical Activity Theory (CHAT or activity theory) has its origins in Russia and the renowned psychologist L.S. Vygotsky whose ideas are still influential today. Vygotsky studied and described human activity and human development of higher mental functions such as thinking, language and consciousness (1986). He emphasized mediation in action and indicates not only what happens *intra* (within a human) but also what happens *inter* (between a human and her environment). He formulated CHAT with cultural mediation as a central concept.

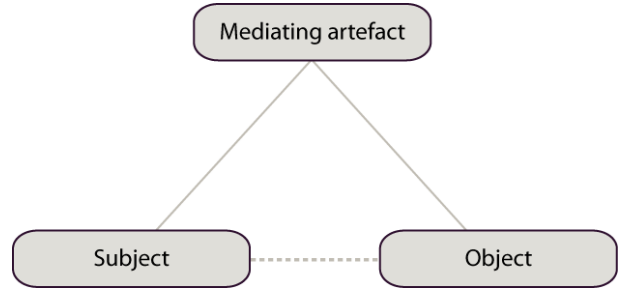


Figure 2. Vygotsky's model of a mediated act (Engeström 2001, 134). Illustration, Per-Olof Hedvall.

When Vygotsky introduced cultural artefacts as a part of the subject-object relationship (Figure 2), he diverged from the prevailing tendency in psychology to regard human behaviours as separate with a direct stimulus-response based connection between subject and objects. Humans and their object-oriented actions could no longer be understood without their cultural tools, and society in turn could not be understood without the individuals who act and make use of cultural artefacts (Engeström 2001).

Activity theory in Leontiev's and Engeström's work

Vygotsky's student and colleague, Leontiev (1978, 1981), chose activity as an analysis concept to gain insights into human life and, in particular, the evolution of the psyche (Kaptelinin and Nardi 2006). Human activity creates people's relation to reality. There is always an object of an activity: 'Any activity of an organism is directed at a certain object; an "objectless" activity is impossible' (Leontiev 1981).

According to Leontiev human activity is inherently and unavoidably social:

> Under whatever kind of conditions and forms human activity takes place, whatever kind of structure it assumes, it must not be considered as isolated from social relations, from the life of society. In all of its distinctness, the activity of the human individual represents a system included in the system of relationships of society. Outside these relationships human activity simply does not exist (Leontiev 1978, 51).

Leontiev expanded and further developed several of

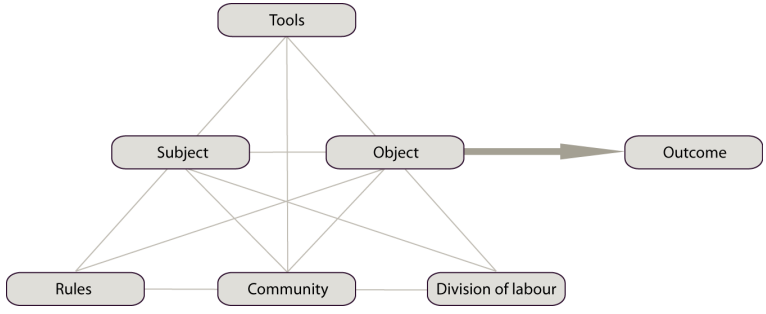


Figure 3. The structure of a human collective activity system based on Engeström (1987, 78), and Kaptelinin and Nardi (2006, 100). Illustration, Per-Olof Hedvall.

Considerable CHAT-based research over the last twenty years has used Engeström's model of activity systems to depict and study practice in school or work settings. For instance, it ties together the perspectives of an individual team member and his or her relations to the rest of the team, the artefacts, rules and division of labour involved in the activity at hand. Engeström's activity systems model enables analysis of the individual perspective and the collective perspective, and other factors vital for accessibility at the same time.

The Activity Diamond

Based on Engeström's works in conjunction with other CHAT theory and the body of knowledge in the fields of accessibility, usability and disability research, Hedvall (2008) has further elaborated the activity systems model into what he calls *The Activity Diamond* (Figure 1). The model is targeted at the accessibility field. It was first presented at ISCAR 2008 in San Diego and is further discussed and elaborated here.

As explained above, the Activity Diamond can be used to describe the presence of different activity systems (Engeström 2001, 2008), as seen in the next example.

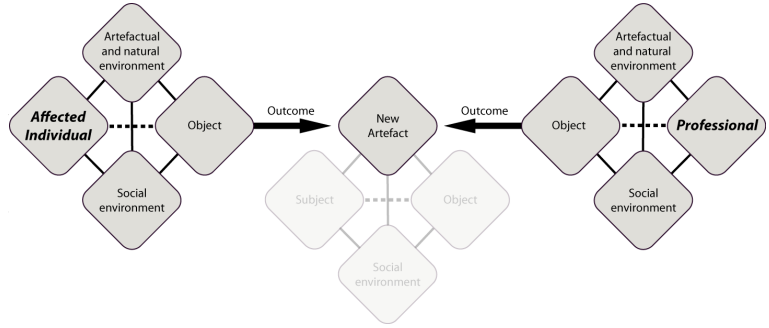


Figure 4. Two activity systems at play designing a new artefact. *Illustration, Per-Olof Hedvall.*

The person using a wheelchair (the affected individual) and the professional designer (the professional) each have their own activity system. Their motives for getting involved in the design activity differ, as does the role of the new wheelchair. While the wheelchair represents new business opportunities or

acknowledgement from other designers, it can hold new action potential and life quality for the affected individual.

When the artefactual corner of an Activity Diamond develops, such as when the affected individual starts to use the new wheelchair, it creates tensions and contradictions within the activity system. These contradictions influence the system and make it change and develop over time. The same reasoning goes for material artefacts, like the wheelchair, as well as immaterial artefacts such as society's wheelchair provision system and WHO's ICF (WHO 2001, 2007).

3. The simultaneous influences of the artefactual and social environments

The claim behind planned accessibility is often that when a building, a gadget or a website meets the standards or has the right measurements, then it *is* accessible. But if we turn to CHAT, such an argument is flawed: *accessibility is undecided and has no concrete meaning outside of activity.* Or as in the words of Leontiev: 'No properties of the subject and the object exist before and beyond activities' (Leontiev 1978, in Kaptelinin and Nardi 2006, 31), where 'processes of perception are included in the living, practical ties of man with the world, with material objects, and for this reason they are necessarily subjected, directly or indirectly, to the properties of the objects themselves' (Leontiev 1978, 35).

The subject and the artefactual environment

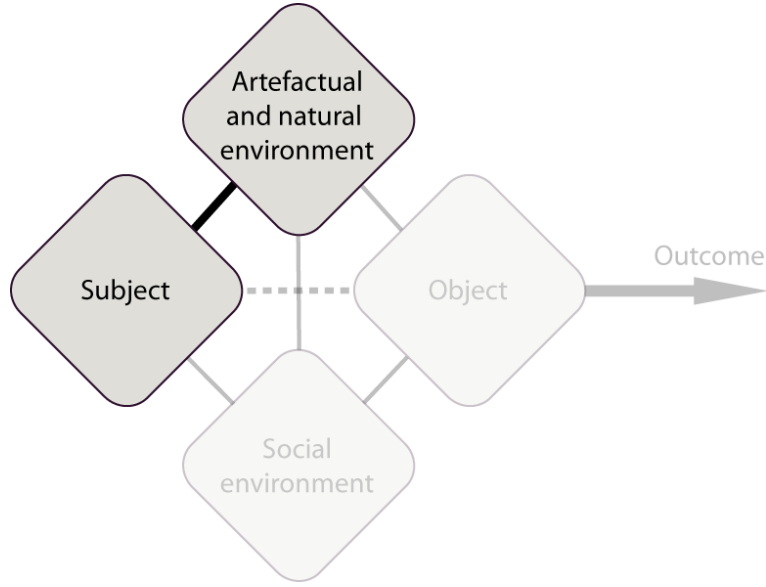


Figure 5. The subject and the artefactual environment. Illustration, Per-Olof Hedvall.

In CHAT, the subject is viewed with his or her artefacts: '...the agent of mediated action is seen as *the individual acting in conjunction with mediational means*' (Wertsch 1991, 33). A subject who does not want to rely solely on the social environment to achieve his or her goals has to recognize and utilize the artefactual and natural environment – it represents the material (and immaterial) possibilities and obstacles when trying to handle an object (Figure 5). A single one-to-one connection might do in order for the subject to be able to act according to his or her wishes, but multimodal and multivalent lines offer increased flexibility and freedom to improvise.

The subject and the social environment

The social environment exists on many levels from the closest friends and family to official representatives, bureaucrats and politicians (Figure 6).

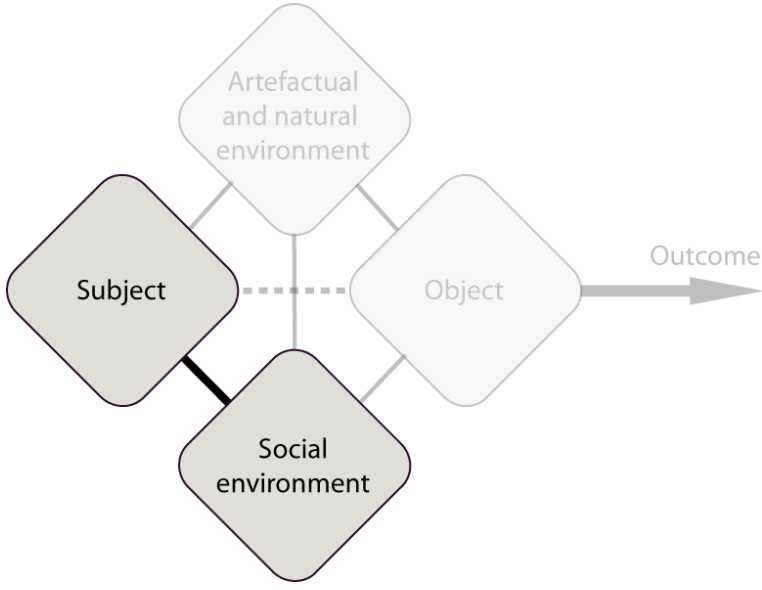


Figure 6. The subject and the social environment. Illustration, Per-Olof Hedvall.

The social environment has a huge impact on accessibility. A positive attitude from that part of the activity system can make a seemingly impossible action possible, while a negative attitude can have the reverse effect. Adults, for example, are free to smoke, drink or play video games if they want, but this is not always the case if they are disabled. People with disabilities are often hindered from engaging in what others have determined to be less desirable activities out of the 'best intentions' of the social environment (Hedvall 2007).

Both the concepts and the lines between them are needed in order to describe accessibility. It is the combined environments that the experiencing subject meets (Figure 7). Together, their impacts define the environmentally-relative accessibility.

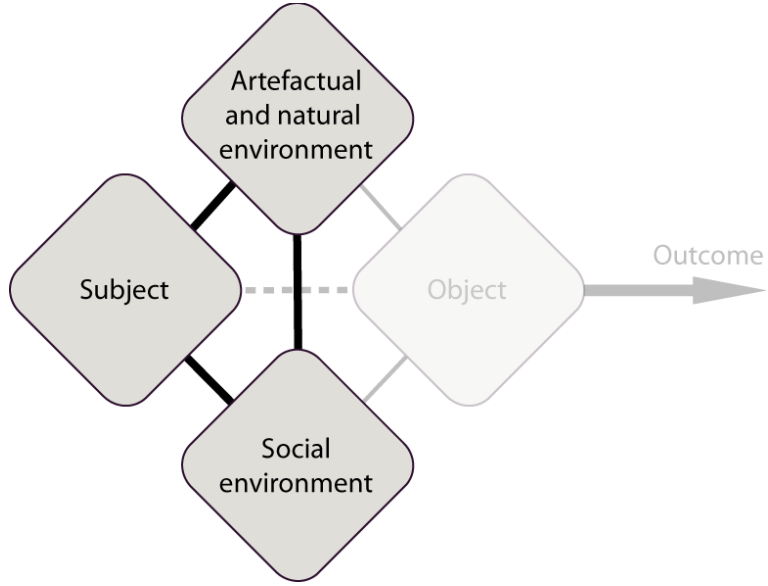


Figure 7. The subject and the combined environments. Illustration, Per-Olof Hedvall.

Example 4: Everyday life with personal assistance

The introduction of personal assistance has changed the possibilities for people with severe disabilities to manage their everyday lives and achieve their goals. The Activity Diamond of a system with and without a personal assistant looks different. This example is about an adult with cognitive impairments (due to a traffic accident) and her personal assistant (Table 3).

Table 3. A description of the two activity systems involved in the same activity in example 4.

Concept	Person 1	Person 2
Subject	Adult with disability	Personal assistant
Object	Going about her life according to her priorities.	Assisting person 1 in the role of professional personal assistant.
Artefactual and natural environment	All the 'stuff' (Shove 2007) involved in these everyday life activities.	Medical aids, the house, the car, regulations and legislation regarding personal assistance.
Social environment	The personal assistant, the family, colleagues and other people she is involved with in different parts of society.	Other personal assistants, employers and person 1's family. (N.B. Not person 1, who is the object of activity for the personal assistant.)

In this example, two (or more) activity systems (see also Engeström 2001, 2008) are at play simultaneously and the same activity is seen from several subjects' angles, resulting in descriptions that are partly similar, partly different. Although involved in one and the same activity, they have different roles and are driven by different motives.

4. The ever ongoing mutual adaptation and development

There is an ever ongoing process between the four concepts of the activity diamond, sometimes causing an imbalance between social norms and technological possibilities, sometimes leading to the implementation of social norms in artefacts and sometimes to the reverse influence when an established technology results in differences in habits, attitudes, human relations and norms.

Everything may be in constant flux, motion or change. The contradictory relation between planned and activity-tied accessibility, how it appears and how it is exercised, is helpfully elaborated through CHAT's capacity for the historically embedded processes, the here-and-now, and the different activity systems.

CHAT bears a strong heritage from Marxist dialectical thought where people are adapting to the world at the same time as they change it, and this connects it in many aspects to the social model of disability (Oliver 1990; Gleeson 1999; Thomas 2004). Confronting accessibility with CHAT is not merely a methodological issue dealing with focus and alignment: describing accessibility in CHAT terms has profound consequences for the elaboration of the concept.

CHAT's historicity and primacy of activity (Kaptelinin and Nardi 2006) both connect to planned (general) and experienced (specific) accessibility. CHAT embraces the entire lived context, both those of the individual human being and of the collective society. It cannot do without these two

perspectives, since the friction between them represents the core engine that drives the development of activity systems (Engeström 1987).

The tension between the social and the artefactual environments

The environmentally-relative concept of accessibility can be included in activity theory's concepts and models for interaction with the culture and the rest of the world; not just as it is seen by the individual but also as it is seen on a collective and common level; and not just how it is experienced in real time but also its historically rooted characteristics and conditions. An example of how this affects concrete activity systems is the way social processes over time establish norms, which in turn may end up in both technical artefacts and laws (i.e. juridical artefacts). These crystallizations of attitudes and norms are exercised in their relation to the subject, as well as to other parts of the system, whenever involved in a concrete activity.

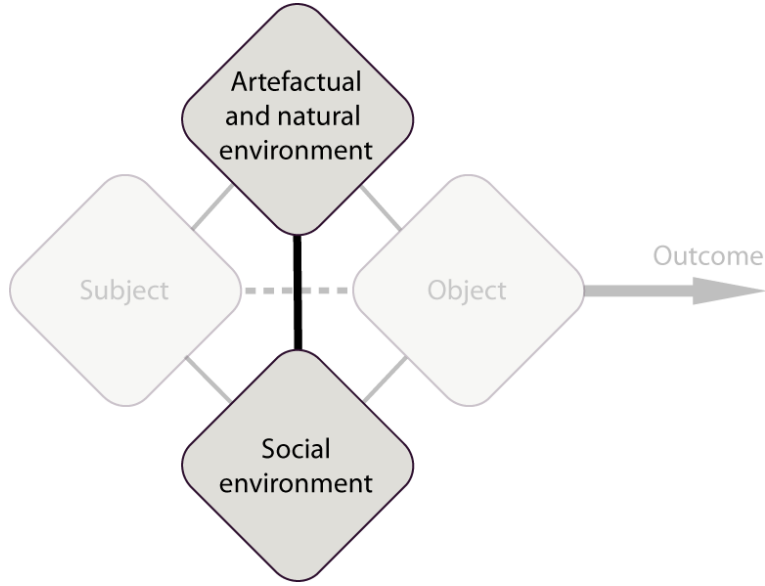


Figure 8. The social and the artefactual environments. Illustration, Per-Olof Hedvall.

There are tensions between the social and artefactual environments, tensions that reveal their relevance for accessibility and that along with contradictions are sources of development and change. The personal (social) and technical (artefactual) assistance have to work together, and the Activity Diamond model can be a help in discussing and improving the combinatoric sum of the two (Figure 8).

Example 5: The individual and the professional

Accessibility issues are distributed across societal systems that are heterogeneous and multilayered rather than uniform. The professionals involved have to conform to their roles in the

system, interpret and implement the general consensus and intentions embedded in the accessibility legislation. At the same time, the affected individual's primary interest is to go on with his or her idiosyncratic agenda (Table 4).

Table 4. A description of two different activity systems that are relevant for each other in example 5.

Concept	*Individual (person 1)*	*Professional (person 2)*
Subject	Subjected individual	Professional individual
Object	Trying to handle the current circumstances in order to achieve his or her goal.	Establishing and maintaining accessibility according to regulations and norms and one's own community of practice.
Artefactual and natural environment	Everything present at hand or ready at hand (Heidegger 1962), or something else that lends itself to the individual's purpose.	Accessibility legislation, guidelines and rules to conform to. Plus the professional work tools.
Social environment	Depending on age: family, relatives, friends and co-workers, doctors and care staff. On a much more peripheral level: the professionals working with accessibility.	Other professionals and their agendas, politicians and society at large. Organizations and individuals that are monitoring the progress and success of accessibility.

The affected individual and the professional portrayed in this example represent different communities of practice (Wenger 1999) and, contrary to example 4, rarely meet each other in everyday life. Yet their respective activities are of high relevance for one another. In a concrete situation, they are involved in the same activity system (the affected individual as subject and the professional as part of the social environment) but their purposes are quite different. In Anderberg's (2006) terms, the professional can be said to represent a top-down *Design for All* angle, while what really matters for the affected individual in a concrete activity is a bottom-up *Design for Me* perspective.

Work in progress

Planned accessibility has long since been visualized and is the overwhelmingly dominant accessibility concept due to its established political agendas, guidelines, and measures. Experienced accessibility, AX, requires a model as clear and as structured as that of planned accessibility if it is to contribute to the vitalization of the accessibility field. *The Activity Diamond* has been put forward as such a model: a common frame of references and a structure for elaborations. It has a pragmatic approach, as has experienced accessibility in itself: An individual is subjected to the current contextual circumstances and conditions and has to manage with the actual level of accessibility – however satisfying or discriminating this might be. When described dialectically,

the dichotomy accessible/inaccessible is rather pointless since accessibility is on a continuum that differs depending on whom the experiencing individual is and what activity he or she is involved in (i.e. what the present activity system looks like) or would like to get involved in.

This article introduces an early step. One of the next steps is to challenge and enrich ICF practice by means of the Activity Diamond. Another step will demonstrate how the diamond can be used for evaluating the results of an augmentative and alternative communication research project.

References

Akrich, M. 1992. The de-scription of technical objects. In *Shaping technology, building society: Studies in sociotechnical change,* eds. W. Bijker, and J. Law, 205–224. Cambridge, Mass.: MIT Press.

Albrecht, G.L., K.D. Seelman, and M. Bury, eds. 2001. *Handbook of disability studies*. Thousand Oaks, California, USA: SAGE Publications.

Anderberg, P. 2006. FACE – disabled people, technology and internet. PhD thesis, Certec, LTH, Lund University. http://www.english.certec.lth.se/doc/face/Anderberg_Peter_FACE-doctoral_thesis.pdf.

Bannon, L. 1992. From human factors to human actors: The role of psychology and human-computer interaction studies in system design. In *Design at work: cooperative design of computer systems*, 25–44. New Jersey: L. Erlbaum Associates.

Barnes, C., and G. Mercer, 2003. *Disability*. Cambridge, UK: Polity.

Barnes, C., L. Barton, and M. Oliver. 2002. Introduction. In *Disability studies today*, eds. C. Barnes, L. Barton, and M. Oliver, 1–17. Cambridge, UK: Polity.

Bevan, N. 2008. Classifying and Selecting UX and Usability Measures. In *Proceedings of the international workshop on meaningful measures: Valid useful user experience measurement (VUUM)*, eds. E.L.-C., Law, N. Bevan, G. Christou, M. Springett, and M. Lárusdóttir, 13–18. Toulouse, France: Institute of Research in Informatics of Toulouse.

Blackstone, S.W., M. Hunt-Berg, and Berkeley Study Group. 2003. *Social networks: a communication inventory for individuals with complex communication needs and their communication partners.* Manual. Monterey, CA.: Augmentative Communication, Inc.

Bødker, S. 2006. When second wave HCI meets third wave challenges. In *Proceedings of the 4th Nordic conference on human-computer interaction: Changing roles*, 1–8. Oslo, Norway: ACM.

Egilson, S.T., and R. Traustadóttir. 2009. Theoretical perspectives and childhood participation. *Scandinavian Journal of Disability Research* 11, no. 1: 51.

Ehn, P. 1988. *Work-oriented design of computer artefacts*. New Jersey: Lawrence Erlbaum Associates.

EIDD. 2004. The EIDD Stockholm Declaration. http://www.designforalleurope.org/Design-for-All/EIDD-Documents/Stockholm-Declaration.

Engeström, Y. 1987. *Learning by expanding: An activity-theoretical approach to developmental research.* Helsinki, Finland: Orienta-Konsultit Oy.

Engeström, Y. 2001. Expansive learning at work: toward an activity theoretical reconceptualization. *Journal of Education and Work* 14, no. 1: 133–156.

Engeström, Y. 2008. *From teams to knots: Activity-theoretical studies of collaboration and learning at work.* Cambridge, MA: Cambridge University Press.

Gibson, J.J. 1986. *The ecological approach to visual perception*. New Jersey: Lawrence Erlbaum Associates.

Gleeson, B.J. 1999. *Geographies of disability*. London: Routledge.

Haraway, D.J. 2003. *The companion species manifesto: Dogs, people and significant otherness.* Chicago: Prickly Paradigm Press.

Hedvall, P.O. 2007. Situerad Design för alla – till improvisationen lov. Licentiate thesis, Certec, LTH, Lund University.

Hedvall, P.O. 2008. Xings for augmented family communication. Full paper and poster presented at ISCAR 2008, San Diego.

Heidegger, M. 1962. *Being and time*. New York: Harper and Row.

ISO 9241-11. 1998. *Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability.* Geneva: International Organization for Standardization.

ISO CD 9241-210. 2008. *Ergonomics of human-system interaction – Part 210: Human-centred design process for interactive systems.* Geneva: International Organization for Standardization.

ISO FDIS 9241-171. 2008. *Ergonomics of human-system interaction – Part 171: Guidance on software accessibility.* Geneva: International Organization for Standardization.

ISO/IEC CD 25010.2. 2008. *Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Quality model.* Geneva: International Organization for Standardization.

Jönsson, B. ed. 2006. *Design side by side*. Lund, Sweden: Studentlitteratur.

Kaptelinin, V., and B.A. Nardi. 2006. *Acting with technology: Activity theory and interaction design.* Cambridge, Mass.: MIT Press.

Latour, B., and S. Woolgar. 1986. *Laboratory life: The construction of scientific facts.* Princeton, N.J.: Princeton University Press.

Latour, B. 1991. Technology is society made durable. In *A sociology of monsters: Essays on power, technology, and domination*, ed. J. Law, 103–131. London; New York: Routledge.

Latour, B. 1999. *Pandora's hope: Essays on the reality of science studies.* Cambridge, Mass.: Harvard University Press.

Latour, B. 2005. *Reassembling the social: An introduction to actor-network-theory.* Oxford; New York: Oxford University Press.

Leontiev, A. 1978. *Activity, consciousness, and personality.* Englewood Cliffs, N.J.: Prentice-Hall.

Leontiev, A.N. 1981. *Problems of the development of the mind.* Moscow: Progress Publishers.

Miller, D. 2008. *The comfort of things.* Cambridge, UK: Polity.

Norman, D.A. 1988. *The psychology of everyday things.* New York: Basic Books.

Oliver, M. 1990. *The politics of disablement*. Basingstoke: Macmillan.

Pink, S. 2004. *Home truths: Gender, domestic objects and everyday life.* New York: Berg Publishers.

Shove, E., M. Watson, M. Hand, and J. Ingram. 2007. *The design of everyday life.* New York: Berg Publishers.

Suchman, L. 2006. *Human and machine reconfigurations: Plans and situated actions,* 2nd ed. Cambridge, Mass.: Cambridge University Press.

Thomas, C. 2004. Disability and impairment. In *Disabling barriers, enabling environments*, 2nd ed., eds. J. Swain, S. French, C. Barnes, and C. Thomas. 21–27. London: Sage Publications Ltd.

UN. 2006. Convention on the Rights of Persons with Disabilities. http://www.un.org/disabilities/default.asp?navid=12&pid=150.

W3. 2008. Web Content Accessibility Guidelines 2.0. http://www.w3.org/WAI/intro/wcag.php.

Wenger, E. 1999. *Communities of practice: learning, meaning, and identity*. New edition. Cambridge, MA: Cambridge University Press.

Wertsch, J.V. 1991. *Voices of the mind: A sociocultural approach to mediated action.* Cambridge, Mass.: Harvard University Press.

WHO (World Health Organization). 2001. *International classification of functioning, disability and health: ICF.* Geneva: WHO.

WHO (World Health Organization). 2007. *International classification of functioning, disability and health: children & youth version: ICF-CY*. Geneva: WHO.

Vygotsky, L.S. 1978. *Mind in society: Development of higher psychological processes*. Cambridge, Mass.: Harvard University Press.

Vygotsky, L.S. 1986. *Thought and language.* Cambridge, Mass., MIT Press.

Acknowledgements

The authors gratefully acknowledge Eileen Deaner at the Department of Design Sciences, Lund University, Sweden for translation services and comments on the text.

We also would like to express our gratitude to Professor Bodil Jönsson at Certec, Department of Design Sciences, Lund University, Sweden for all the time we have spent together discussing the facets of accessibility found in this article.

Per-Olof Hedvall (per-olof.hedvall@certec.lth.se) is a doctoral student in Rehabilitation Engineering and Design at Certec, Department of Design Sciences, Lund University. He has worked in the fields of augmentative and alternative communication and assistive technology for 15 years.

Dr. Peter Anderberg (peter.anderberg@certec.lth.se) is a researcher in Rehabilitation Engineering and Design at Certec, Department of Design Sciences, Lund University, and leader of R&D at Blekinge Competence Centre. His research interests are the use and design of technology as functional support, especially ICT solutions. He is also interested in research in Independent Living and the cross section between rehabilitation engineering and disability studies.

9

Paper II

An Activity Systemic Approach to
Augmentative and Alternative Communication

An Activity Systemic Approach to Augmentative and Alternative Communication

(Submitted to *AAC Journal* 24 August, 2009)

Per-Olof Hedvall [a] and Bitte Rydeman [b]

[a] *Certec, Department of Design Sciences, Lund University, Sweden*

[b] *Department of Philosophy, Linguistics, and Theory of Science, University of Gothenburg, Sweden*

Keywords: Accessibility; Augmentative and Alternative Communication, Cultural-Historical Activity Theory, Design, Technology, Qualitative research

Correspondence
Per-Olof Hedvall
P.O. Box 118
SE-221 00 LUND,
Sweden
E-mail: per-olof.hedvall@certec.lth.se
Web: http://www.english.certec.lth.se
Phone: +46 739 88 46 76
Fax: +46 46 222 44 31

Acknowledgements

The authors gratefully acknowledge Bodil Jönsson, professor at Certec, Department of Design Sciences, Lund University, Sweden for her inspiration, critical questioning and constructive feedback, and Eileen Deaner, international coordinator at Certec, for translation services and comments on the text.

Author notes

Per-Olof Hedvall (per-olof.hedvall@certec.lth.se) has a licentiate degree in Rehabilitation Engineering and Design at Certec, Department of Design Sciences, Lund University. He has worked in the fields of augmentative and alternative communication and assistive technology for 15 years.

Bitte Rydeman (bitte.rydeman@lthalland.se) is a doctoral student in linguistics at the University of Gothenburg. She initiated and directed the Words at the Right Time Project. Bitte has worked as a speech-language pathologist since 1980, the last 20 years mainly within the fields of AAC and assistive technology.

Abstract

The objective of this article is to discuss augmentative and alternative communication (AAC) by positioning it in the framework of cultural-historical activity theory (CHAT). The article is based on data from a three-year Swedish AAC project concerning activity-based vocabulary design of voice output communication aids. A CHAT model, the Activity Diamond, is applied. The CHAT approach is seen as one that can capture and describe systemic influences of both humans and technology in AAC. Twelve categories were derived from the Activity Diamond and applied to 476 video- and audio-taped excerpts of communicative interchanges involving the shopping activities of four persons who use AAC. The analysis resulted in a multiplicity of related perspectives, in which six themes were identified: Attitude/Preference, Expectation/Trust, Goal/Power, Place/Space, Time/Learning, and Usability/Accessibility.

Introduction

This article discusses augmentative and alternative communication (AAC) (Beukelman & Mirenda, 2005; Todman & Alm, 2003) by positioning it in a theoretical framework for activity: *cultural-historical activity theory* (CHAT) (Engeström, 1987, 2001, 2008; Kaptelinin & Nardi, 2006; Leontiev, 1978, 1981; Vygotsky, 1978, 1986). The Activity Diamond (Hedvall, 2008) is used throughout as a theoretically-based CHAT model by which important aspects of AAC can be captured, described and, most importantly, systematically related to each other (Figure 1).

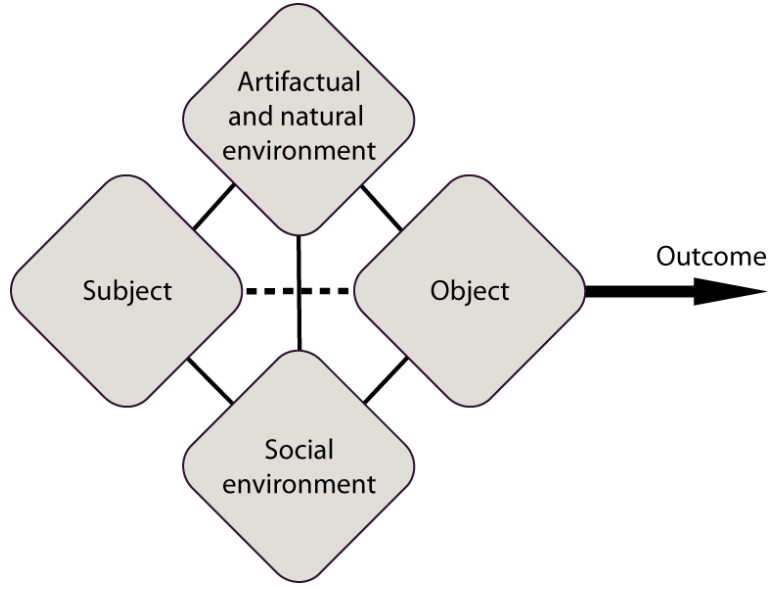


Figure 1. The Activity Diamond (Hedvall, 2008). Illustration by the first author.

The Activity Diamond is a conceptual model that portrays a human activity system (Engeström, 1987), where the subject-object relation is mediated and thus influenced by the artifactual, natural and social environments. The model is based on four inter-related sets of factors and is situated in time and place. The Activity Diamond conceptually captures an activity system that is constantly changing and developing over time. This means that it can cover both historical development and instantaneous snapshots of the current activity system.

The four sets of factors:

- The subject in the model is often an acting individual. On another level, it can also be a group of people, such as a family.
- The object of an activity is related to the will and needs of the subject. This is determined by the motive of the activity, such as getting better grades, learning to read or producing a new car.
- The artifactual and natural environment consists of material and immaterial artifacts, and their respective affordances (Gibson, 1986; Norman, 1988) and resistances. Some examples are computers, language, legislations, air temperature and sunshine.
- The social environment is made up of the people or groups of people influencing the activity at hand. This can be the family, work colleagues or larger portions of society that are involved in or otherwise affect the activity regarding attitudes, norms and expectations.

This is the first of two articles based on and informed by a three-year-long Swedish AAC project called “Ord i rättan

tid" (Words at the Right Time), that dealt with activity-based vocabulary design of voice output communication aids (VOCA). Four participants took part in the Words at the Right Time Project, in which a supplement consisting of pre-stored phrases was added to their existing communication aids. Most of these phrases were targeted at the activity of shopping, and during the project, they were to use their VOCAs in both real shopping activities and in role-play. In this article, data from the project is analyzed and thematically coded with the Activity Diamond as analytical construct. In the next article, the diamond model will be used to discuss AAC factors in the results from the project.

Participants

The participants in the project were four young adults for whom AAC is an important means of communication (Table 1). All of them had complex physical impairments, with limited mobility when not seated in their electric wheelchairs, and with significant difficulties in using their hands. Some of the participants used their voice to say *yes* and *no*; others used facial gestures for this or their AAC devices. All of them used combinations of low-tech and high-tech AAC and had been using VOCAs for many years. They were all motivated, communicative people with strong personalities and a great deal to say.

Table 1. Description of the four participants (Subjects) at the beginning of the project, their artifactual and natural environments (AN) and their social environments (SE).

Subject: *David*	34-year-old man with extensive cerebral palsy. He has no speech, but uses facial expressions and vocalizations. Writes long, grammatically correct sentences, but can only read single words. Uses his feet to access technology.
AN	Owns a car. Drives an electric wheelchair. Communicates through writing on a VOCA or, when not in his chair, by using a Bliss chart with partner-assisted scanning.
SE	Lives in an apartment in a small town with personal assistance 24 hours a day. His mother lives in another town nearby. Knows his neighbors. Attends a folk high school. Participates in sports activities with other people with impairments.

Subject: *Lisa*	18-year-old girl with extensive cerebral palsy. Her speech is limited to *yes*, *no*, and vocalizations with expressive intonation. Expresses herself through a combination of Blissymbols and written words to generate grammatically correct sentences. Uses her hands with some effort to access technology.
AN	Drives an electric wheelchair. Communicates through pointing to Blissymbols on a Bliss board and by selecting Blisssymbols on a VOCA, combined with writing letter by letter.
SE	Lives in a group home with staff nearby. Visits her family home in another town every other weekend where she stays with her parents. Speaks to her mother on the telephone every day. Personal assistance during summer vacation. Attends an upper-secondary school in a special class for students with disabilities.

Subject: *John*	19-year-old boy with extensive cerebral palsy. No speech and very limited vocalizations. Expresses himself by pointing at Blissymbols, by head movements and facial expressions. Uses his head to access technology.
AN	Drives an electric wheelchair, but not independently in all situations. Uses a head-mounted laser pointer attached to his glasses. Communicates by pointing at Blissymbols on a Bliss board and by selecting Blissymbols on a VOCA.
SE	Lives with his parents and siblings. Attends a folk high school with other students with disabilities. Has personal assistance during school hours and for leisure activities. Attends a discussion group for people who use Blissymbolics. Plays in an orchestra with other people with disabilities.

Subject: *Peter*	19-year-old boy with extensive cerebral palsy. No speech and limited vocalizations. Expresses himself by pointing at Blissymbols, by head movements and facial expressions. Uses his head to access technology, and his hand to drive his electric wheelchair.
AN	Drives an electric wheelchair. Uses a head-mounted laser pointer attached to his glasses. Communicates by pointing at Blissymbols on a Bliss board and by selecting Blissymbols on a VOCA.
SE	Lives with his parents and siblings. Attends an upper-secondary school in a special class for students with disabilities. Has personal assistance during school hours and for leisure activities. Attends a discussion group for people who use Blissymbolics. Participates in sports activities with other people with disabilities. Attends soccer and hockey games.

Capturing the Project Data

The focus of the Words at the Right Time Project was to develop a prototype vocabulary for VOCAs containing pre-stored phrases from natural conversations, while applying user-centered, iterative design (Gulliksen & Göransson, 2002). The activities of the project included analyzing conversations between typical speakers, specifically from shopping activities, building an activity-specific vocabulary including phrases from these conversations and testing the vocabulary in role-play, in an experiment and in real shopping activities.

The project was designed by the project leader, second author of this article, based on personal experiences of working as a speech-language pathologist with people who use AAC and from her knowledge of the state of AAC vocabularies in Sweden. They also stemmed from the scientific theories and models that were adopted as points of departure, such as speech act theory (Searle, 1976), Activity based Communication Analysis (Allwood, 2000a) and user-centered iterative design (Gulliksen & Göransson, 2002). The decision to build a vocabulary with pre-stored phrases was based on the fact that apart from word prediction software (Hunnicutt & Carlberger, 2001) and vocabularies from the core vocabulary of Blissymbolics, no ready-made vocabularies for VOCAs existed in Swedish. Studies carried out in Scotland (Dye, Alm, Arnott, Harper & Morrison, 1998; Lunn, Todman, File & Coles, 2004; Todman & Alm, 2003) and the U.S. (Bedrosian, Hoag & McCoy, 2003; Higginbotham, Moulton, Lesher, Wilkins & Cornish, 2000) regarding the use of phrases and targeting specific activities were promising, but simply translating a vocabulary from one language to another seemed

not to be a sound idea. Instead, it was decided to start from the beginning with one specific activity, shopping, and to use phrases from a language corpus of spoken Swedish (Allwood, 2000b).

To evaluate the usefulness of the pre-stored phrases, experienced persons who use AAC were invited to take part in the project, to collaborate with the second author and other members in the project group. The focus of the project was not to study the participants, but to evaluate the vocabulary and its use with their help, as is the practice in participatory design (Ehn, 1988).

The persons who use AAC were considered the primary informants and were interviewed on several occasions regarding their views about the vocabulary, the activities that they were taking part in and their interaction with other people. Their personal assistants (in one case a parent) were interviewed at the beginning and the end of the project. The participants were interviewed during different project activities and various aspects of their AAC systems were discussed. All the participants chose an activity other than shopping that could be video recorded and analyzed with the aim of learning what constitutes conversations when one of the participants is using a VOCA. These conversations and other project activities were video recorded on DV tape and imported into a Windows computer as mpeg files. These video files were imported into Transana 2.21 and transcribed. The interviews with the assistants and the activities that took place in the actual stores were audio recorded with a digital recorder, imported into Transana and transcribed.

Methods Used in the Article

As mentioned above, the project design was based on speech act theory, activity based communication analysis and user-centered iterative design. In this article, the project results are taken one step further through a methodological approach combining qualitative content analysis (Krippendorff, 2004; Neuendorf, 2002) with the Activity Diamond as a CHAT model (Hedvall, 2008). When using the Activity Diamond as a model for analysis, it is not only the four sets of factors (subject, object, social environment and artifactual and natural environment) that are of interest but also the inter-relations between them, in Figure 1 represented as the lines joining the four factor boxes. These include, for instance, attitudes towards the acting subject and the mutual expectations of the acting subject and the social environment. To capture these relationships, the subject, the social environment *and* the line connecting the two need to be analyzed.

47 transcribed files, 23 video (12h 47min) and 24 audio (8h 38min), from the project's different activities (interviews, informal conversations and some shopping episodes) were analyzed and annotated in NVivo8 (http://www.qsrinternational.com) and Microsoft Excel (http://www.microsoft.com). The analysis was divided into three steps. The authors worked together as a team and discussed and checked each other's codes during the process, except in the last step which was performed by the first author alone and then checked by the second author.

In total, this rendered 476 excerpts that were categorized and systematized in themes during this process. The transcriptions were analyzed as follows:

1. Interpretation and categorization of text excerpts according to the factors in the Activity Diamond. The categories were selected in advance by applying the Activity Diamond as analytical construct (Krippendorff, 2004, p. 171) holding three perspectives: the respective influence on the system from the Subject, the Artifactual and Natural Environment, and the Social Environment. This resulted in 12 categories, four for each of these three sets of factors in relation to the others, including Object, and to itself (i.e., Subject towards AN, Subject towards Object, Subject towards SE, Subject towards Subject, etc.) See Table 2. The transcriptions were read with one set of factors in mind at the time, and when the coder found a piece of the transcription that could be placed in one of the categories, a condensed description of that interpretation was also written. Example: The interpreted excerpt, *"John wants his assistant to interact with the staff in the stores"* was placed in the category, *Subject towards Social Environment*. The perspectives from the object of the activity to other parts of the system were not categorized. Analysis software: NVivo 8.

2. Extraction and coding of the meaning-bearing units from the categorized citations. Example: the meaning-bearing unit in the excerpt above was analyzed and coded as, *"Subject's attitude towards the Social Environment."* Analysis software: NVivo 8.

3. Annotation of the meaning-bearing units into pattern-based themes, which arose during this interactive-hermeneutic (Krippendorff, 2004, p. 303) process. In the analysis, each excerpt were searched for a statement, a most important meaning, and annotated into a theme. This was done by going back and forth in the material. If needed, the previous annotations were adjusted when a new theme occurred. To decrease the number of themes and since there were close relations between some of them, they were grouped two and two. Example: the excerpt above was placed in the theme *"Attitude/ Preferences."* The analysis process resulted in six themes presented in Table 2. Analysis Software: NVivo 8 and Microsoft Excel.

Results

In order to understand the results, it is important to take some aspects of the Activity Diamond into consideration: It is a model of an *activity system* (Engeström 1987, 2008), which means that the four factor boxes are inter-connected and inter-influencing; the system is always in change and develops over time; the tensions and contradictions between the boxes are sources of development. Hence, even though some of the results may be presented in tables, it is important to consider them as changing over time rather than fixed.

Table 2 presents an overview of the results from the study presented in this article, with the number of analyzed excerpts according to Activity Diamond categories in the horizontal rows, and the themes they fall under in the vertical columns. The category with the most excerpts, 118, was “Subject towards AN” and the one with the fewest, 2, was “AN towards Object”. In total, there were 287 codings regarding the subject, 114 regarding the social environment, and 75 regarding the artifactual and natural environment.

Table 2. Coding summary of the 12 categories and 6 themes for the 476 analyzed excerpts.

	Attitude/Preference	Expectation/Trust	Goal/Power	Place/Space	Time/Learning	Usability/ Accessibility	*Total*
Subject towards AN	29	8	3	7	7	64	118
Subject towards Object	45	6	32	1	0	8	92
Subject towards SE	39	6	21	0	1	4	71
Subject towards Subject	2	0	1	0	1	2	6
AN towards Object	0	0	1	0	0	1	2
AN towards SE	1	0	1	0	0	7	9
AN towards AN	0	3	3	0	0	3	9
AN towards Subject	7	2	14	11	2	19	55
SE towards Subject	15	5	8	0	3	0	31
SE towards AN	12	4	6	3	3	17	45
SE towards Object	5	0	5	1	1	2	14
SE towards SE	12	2	7	2	0	1	24
Total	***167***	***36***	***102***	***25***	***18***	***128***	***476***

Table 3 exemplifies the six themes found in the project data.

Table 3. The six themes identified, and sample excerpts that fall under the respective themes.

Theme	Interpreted excerpt
Attitude/Preference *(Attitude or preference towards something or someone.)*	"Peter doesn't want to talk about sports with his female assistant; he would rather talk about sports with her boyfriend."
Expectation/Trust *(Expectation or trust/ distrust towards something or someone.)*	"David's new electric wheelchair doesn't always stop when it is supposed to, so David finds that he can't rely on it."
Goal/Power *(Aspects pertaining to goals or power.)*	"Lisa thinks it is different when she is with her assistant than when she is with her mother. When she goes shopping with her mother, her mother decides."
Place/Space *(Aspects of place or space.)*	"John doesn't want to drive his electric wheelchair in stores with narrow aisles."
Time/Learning *(Time or learning aspects.)*	"Peter isn't sure about the items in his vocabulary, but thinks he will learn over time."
Usability/Accessibility *(Aspects regarding usability or accessibility.)*	"Lisa thinks it's much harder to use a bigger screen on the VOCA, because of her limited range of movement."

Some excerpts were coded into several categories. Tables 4, 5, and 6 present examples in which the excerpts have been interpreted from more than one perspective according to the different facets of the Activity Diamond. Each excerpt has been coded into several categories, showing how one and the same excerpt revealed different meanings depending on the analysis perspective in the analytical construct. The excerpts were translated from Swedish and transformed into standard orthography for reasons of readability. Naturally spoken elements are italicized. Words and sentences produced with digitized or synthesized speech are italicized and placed in quotation marks. I = interviewer, P = participant, A = assistant.

Table 4 . Excerpt 1, Interview with David.

I: *How do you think the communication works when you are out shopping?*
P: *"Sometimes it is difficult to make contact."*
I: *I didn't get the last part. Ah, contact. In what way was it difficult to make contact?*
P: *"They don't know that they should read."*
I: *Ah, they don't know that they should read. Don't they listen to the voice?*
P: *"Since it takes time for me to write."*

Category and *Theme*	Interpreted excerpt
Subject → SE	David sometimes has a hard time making contact with people in the mall.
Goal / Power	

Subject → AN *Usability / Accessibility*	It takes such a long time for David to write what he wants to say that sometimes people don't realize that he wants to say something.
AN → SE *Usability / Accessibility*	It is hard for David to make contact with people when shopping. It takes time for him to write and people don't know that they are supposed to read what is on his screen.

As can be seen in the examples above, the excerpts that were analyzed were coherent pieces of text from the transcribed material. Everything that David told the interviewer was related to her questions, and it is the whole excerpt that has been analyzed from the different perspectives of the Activity Diamond. Looking at what David is saying, each sentence relates to a different aspect of his communication experiences when shopping. That he sometimes finds it difficult to make contact has to do with him, the subject, and his relation to the social environment. It is inherent in his statement that making contact with others is his goal, a goal that it is not always in his power to reach. That people do not know that they are supposed to read the screen of the device on David's electric wheelchair has to do with the relationship between the social environment and this artifact. That it takes a long time for David to write on this device has to do with the relationship between David and the artifact. These two aspects are both related to usability and accessibility.

Table 5. Excerpt 2, Interview with John.

I*: Is there anything that doesn't work at all when you are out?*
P: *"Computer itself speaks."*
I: *OK, that the computer speaks.*
P: *"Yes."*
I: *You don't like it to start talking by itself, but just to speak when you want it to?*
P: *"Yes."*

Category and *Theme*	Interpreted excerpt.
Subject → AN *Expectation / Trust*	John doesn't want the computer to start talking by itself.
AN → AN *Expectation / Trust*	John would like to be able to rely on his VOCA not to start talking by itself (which it does when he accidently points to items on the screen with his head mouse).
Subject → Object *Expectation / Trust*	John would prefer that the VOCA did not start talking by itself.

The excerpt in table 5 can also be seen from three perspectives, but they are all part of the same theme: expectation/trust. What we have here is an artifact that does not behave the way John wants it to do. He does not want the computer to start talking by itself. His goal (Subject → Object) is to be able to control this artifact (Subject → AN). We also see that it is a feature of this artifact (AN → AN) that it behaves like this.

Table 6. Excerpt 3, Interview with John's assistant.

A: *And when people come up and most often he just wants to say a few sentences, well, it is better to turn it on then.*
I: *Yes.*
A: *And he is able to speak, you know.*
I: *But then he shows that he wants it turned on?*
A: *Yes.*

Category and *Theme*	Interpreted excerpt.
SE → Subject *Attitude / Preference*	Sometimes people come up to John and want to speak with him.
Subject → Object *Usability/Accessibility*	The subject shows his assistant when he wants his VOCA or laser pointer turned on.
Subject → AN *Goal / Power*	It is not possible for John to turn on and off his laser pointer by himself. He has to show his assistant that he wants it turned on.
SE → Object *Usability / Accessibility*	When people come up to John he wants to talk to them, and his assistant helps him to turn on his equipment

In the excerpt in Table 6, we can see four different perspectives and three different themes. That people want to talk to John has to do with the relationship between the social environment and its attitude towards the subject. That John wants his laser pointer turned on has to do with the relationship between a subject and his object and with accessibility. The fact that John is unable to turn it on by himself has to do with his (the subject's) relation to the artifact

and to the power he has to meet his goals. The last perspective has to do with the fact that John's assistant (SE) helps him to reach his goal (the object of this activity) and turn on the laser pointer. That he cannot do this without another person has to do with the artifact's usability and with accessibility.

Discussion

Treating AAC aspects as distributed over an activity system consisting of both the acting individual and his or her artifactual, natural and social environments is significantly different from looking at the person standing alone, without contextual factors and impact. Until now, there has been no way to systematically bring all these factors together into one multi-faceted account. Social Network analyses (Blackstone & Hunt Berg, 2004) come a long way, but are to some extent oblivious as to how combinations of humans (the social environment) and technology (the artifactual environment) together determine the conditions for the subject's activity and how these develop and change over time.

Using the four analysis perspectives of the Activity Diamond as a top-down approach forces together the artifactual/natural and social aspects of AAC. The social environment is usually considered in AAC research today, but this is not as often the case for the artifactual and natural environment. However, many of the important design aspects of AAC are found here, such as:

1. Minding embedded norms, attitudes and expectations, as in John's case when he cannot turn his laser pointer on or off by himself, leaving him dependent on other people.

2. Understanding the dependency of artifacts and the consequences of interruptions and breakdowns, such as the fear experienced by David because he cannot trust that his electric wheelchair will stop when he wants it to.

3. Control aspects, as in John's case when the VOCA sometimes starts to talk without his intention.

Like Social Networks (Blackstone & Hunt Berg, 2004), the use of the Activity Diamond places the affected individual at the center of the analysis. In the results from the study, this is demonstrated in the number of categorizations that referred to the subject's perspective (287 of 476).

The activity system is driven by a motive. Some of the excerpts in the analysis showed how the subject often negotiates the motive with personal assistants and parents in terms of power aspects. These aspects are found in the tensions and contradictions between the subject and the social environment, together forming some of the conditions for the subject's empowerment and self-determined independency.

In analyzing the data from all these different perspectives (with the help of the Activity Diamond), it becomes evident that the assistants are just as important a part of the VOCA users' activity systems as their assistive technology. A picture also emerges of how other modes and artifacts are more important for these specific individuals than their VOCAs are for their ability to communicate in a shopping activity. Much of the verbal communication with the shop assistants and

other people in the stores goes through the personal assistants, who are the ones who do the talking. To show the assistants their intentions, individuals use their electric wheelchairs to drive up to the items they are interested in. They also use their eye gaze, if possible their hands or laser pointers, to indicate items of interest. Some of them use their low-tech Bliss charts or their VOCAs to talk to the assistants but many times, they rely on the assistants asking them yes and no questions.

Even though this puts them in an answering position, the data analyzed here shows that they are in no way passive or indifferent. These individuals have very strong opinions about what they want and like. It is just that the shopping activity involves so many other things than talking and many obstacles in the artifactual and natural environment that have to be overcome, as well as attitudes from people in the social environment who often address the personal assistants instead of them. A number of functions of the artifactual and natural environment drive them towards dependence on their assistants rather than towards more independence. An unreliable AAC system in the form of a VOCA that starts speaking by itself draws John towards wanting to have it switched off in the stores, thus needing to ask his assistant to turn it on when he wants to use it. It is the same thing with the laser pointers which neither of the two users of these devices can turn on and off by themselves. There are examples of how the individuals actively delegate tasks to their assistants, but also of assistants automatically stepping in and talking for the participants who use AAC, without being explicitly asked to do so. Thus, it is the combinatoric sum of the artifactual, natural and social factors in the environment that together determine the conditions for the individual's activity, with AAC being one important part of that.

Conclusions

The direct objective of this article was to analyze the outcome of an AAC project by means of cultural-historical activity theory (CHAT) and thus systematically relate to each other all the humans and all the technology at play in the lives of the four AAC users. The procedure revealed a multi-perspective account of the video and audio recordings.

The results indicate that CHAT analyses might be a fruitful approach when it comes to focusing the acting subject and his or her will, attitudes, expectations, etcetera. In the article, this sensitivity was demonstrated by the large number of codes from the Subject's perspective.

The processing of the material has involved several steps. In the future, yet another step might be added by using CHAT's ability to portray more than one activity system in play simultaneously (Figure 2). This would typically involve collecting more data regarding the personal assistant's activity system.

Figure 2. Multi-system portrayal of a person using AAC and his or her personal assistant when out in the city shopping for a birthday gift. Illustration by the first author.

This project was not designed with the Activity Diamond in mind. The six themes that emerged in the analysis process might, however, be significant also outside the particular study presented here, and could deserve to form the basis for another AAC study all the way from guides for data collection to analysis and discussion of the results.

References

Allwood, J. (2000a). "An Activity Based Approach to Pragmatics". I Bunt, H., & Black, B. (Eds.) *Abduction, Belief and Context in Dialogue: Studies in Computational Pragmatics*. Amsterdam: John Benjamins, 47-80.

Allwood, J. (red.) (2000b). Talspråksfrekvenser. In *Gothenburg Papers in Theoretical Linguistics* GPTL S 21. Dept. of linguistics, University of Gothenburg.

Bedrosian, J., Hoag, L. & McCoy, K. (2003). Relevance and Speed of Message Delivery Trade-Offs in Augmentative and Alternative Communication. *Journal of Speech, Language, and Hearing Research, 46*, 800-817.

Beukelman, D.R. & Mirenda, P. (2005). *Augmentative & alternative communication: Supporting Children & Adults with Complex Communication Needs*, (3rd ed.). Baltimore: Paul H. Brookes Pub. Co.

Blackstone, S. W., Hunt-Berg, M., & Berkeley Study Group. (2003). *Social networks: a communication inventory for individuals with complex communication needs and their communication partners.* Manual. Monterey, CA: Augmentative Communication, Inc.

Dye, R., Alm, N., Arnott, J. L., Harper, G., Morrison, A. (1998). A script-based AAC system for transactional interaction. *Natural Language Engineering, 4*, 57–71.

Ehn, P. (1988). *Work-Oriented Design of Computer Artifacts.* Lawrence Erlbaum Associates, Inc.

Engeström, Y. (1987). *Learning by Expanding: An Activity - Theoretical Approach to Developmental Research*. Helsinki: Orienta-Konsultit Oy.

Engeström, Y. (2001). Expansive Learning at Work: toward an activity theoretical reconceptualization. *Journal of Education and Work*, *14*(1), 133.

Engeström, Y. (2008). *From Teams to Knots: Activity-Theoretical Studies of Collaboration and Learning at Work*. Cambridge; New York: Cambridge University Press.

Gibson, J. J. (1986). *The Ecological Approach to Visual Perception*. New York: Psychology Press.

Gulliksen, J., & Göransson, B. (2002). *Användarcentrerad systemdesign - en process med fokus på användare och användbarhet*. Lund: Studentlitteratur.

Hedvall, P.O. 2008. *Xings for augmented family communication.* Full paper and poster presented at ISCAR 2008, San Diego.

Higginbotham, J., Moulton, B., Lesher, G., Wilkins, D & Cornish, J. (2000). *Frametalker: Development of a frame-based communication system*. CSUN 2000, California State University, Northridge.

Hunnicutt, S. & Carlberger, J. (2001). Improving Word Prediction Using Markov Models and Heuristic Methods. In: *Augmentative and Alternative Communication, 17*, 255-264

Kaptelinin, V., & Nardi, B. A. (2006). *Acting with Technology: Activity Theory and Interaction Design* (s. 345). MIT Press.

Krippendorff, D. K. (2004). *Content Analysis: An Introduction to Its Methodology* (2nd ed.). Thousand Oaks, Calif.: Sage Publications, Inc.

Leontiev, A. (1978). *Activity, Consciousness, and Personality*. Englewood Cliffs, N.J.: Prentice-Hall.

Leontiev, A.N. (1981). *Problems of the development of the mind*. Moscow: Progress Publishers.

Lunn, J., Todman, J., File, P., & Coles, E. (2004). Making Contact in the workplace. *Communication Matters, 18*(1), 25-28.

Neuendorf, K. A. (2002). *The Content Analysis Guidebook*. Thousand Oaks, Calif.: Sage Publications, Inc.

Norman, D. A. (1988). *The Psychology of Everyday Things*. New York: Basic Books.

Searle, J. R. (1976). A classification of illocutionary acts. In: *Language and society, 5*, 1-23

Todman, J., Alm, N. (2003). Modelling conversational pragmatics in communication aids. *Journal of Pragmatics*, 35, 523 - 538.

Vygotsky. (1986). *Thought and Language*. Cambridge, Mass.: MIT Press.

Vygotsky, L. S. (1934/1978). *Mind in Society: Development of Higher Psychological Processes* (New Ed.). Cambridge, Mass.: Harvard University Press.

10

Paper III

Towards the Era of Mixed Reality:
Accessibility Meets Three Waves of HCI

Towards the Era of Mixed Reality: Accessibility Meets Three Waves of HCI

Per-Olof Hedvall

Certec, Dept. of Design Sciences
University of Lund
P.O. Box 118
SE-221 00 LUND
Sweden
+46 46 222 40 94
per-olof.hedvall@certec.lth.se

Abstract. Today, the underlying theoretical and methodological foundations as well as implementations in the field of accessibility are largely based on plans, metrics and heuristics. There is an obvious tension between these norms and those of the overall spirit of the times, which leans heavily towards improvisations, diversity, and ever-changing affordances. The parallel evolution of human computer interaction (HCI) has been characterized as three waves, each building on the previous one, resulting in an in-depth understanding of the interwoven activity of humans and non-humans (artifacts). Now when facing the era of mixed reality, accessibility can gain considerably from HCI's, usability's and interaction design's bodies of knowledge.

Keywords: Accessibility, Usability, HCI, Interaction design, Mixed Reality, Situated action, Activity theory, Norms.

1 Introduction

As Manuel Castells [1] has pointed out, only the technologies that the surrounding culture is open to can spread. There are, however, not only cultures but subcultures, one of which is accessibility with its own issues and development; HCI, on the other hand, is based on a different context and has a different development.

It is possible to distinguish three waves in the development of HCI [2]. The first was characterized by what is large-scaled, rule-based and pre-planned; the second focused on single individuals, who stand-alone with different conditions; and the third on different individuals in a state of many-to-many-communication. The accessibility field has not progressed through these three phases and is still based on the large-scale, predictability and rule management. This explorative paper deals with these differences and their background – and how the accessibility field can and should be inspired by HCI/usability development and benefit from it.

Despite the ever so distinguishing symbols (cf. Fig. 1) and diagnoses, people with disabilities are first and foremost human beings (cf. "people first" [4]) and increasingly integrated in their environment. They are, however, being challenged when the

A. Holzinger and K. Miesenberger (Eds.): USAB 2009, LNCS 5889, pp. 264–278, 2009.

Fig. 1. Rehabilitation International's well-known symbol of access, which was adopted in 1969 [3]

current norms in the accessibility field are not in phase with the norms in society. The field of disability studies, which is more focused on a social and ideological level, is doing better. But the experienced accessibility – as it is for the acting individual in her social context – is about actual implementations. It is currently based on a view of technology and of human beings that was more relevant 25 years ago than it is today. The accessibility area could gain considerably from a closer relationship to the HCI waves over the last decades, not least of all now when approaching the era of mixed reality.

2 Wave 1 of HCI and Its Relation to Accessibility

The starting point of HCI is often connected to Doug Engelbart's famous demonstration called *The Mother of All Demos* where, among other inventions, he showed the first computer mouse [5]. Another important breakthrough came in 1981 with the first what-you-see-is-what-you-get interface of the Xerox STAR computer. The first HCI wave was highly influenced by information processing psychology and ergonomic approaches such as human factors, with the design largely depending on rules, guidelines and other formal methods [2]. These later resulted in criticism that the human users and their real life were excluded instead of being an influential part of the process [6].

Accessibility usually refers to how people with activity limitations can access the physical world or content on the Internet, mainly web pages. The accessibility area started its expansion during the second part of the 20th century. For many reasons, the area has never been particularly variable or open to change: it has been collectively rooted and often tied to infrastructure, legislation and economic structures. Its experts have often had medical or social backgrounds. The target of the results has often been society at large rather than individuals. It may also have played a role that very few researchers with disabilities have been active and affected the accessibility area.

When a certain accessibility level has been negotiated all the way into political decisions and then implemented, this has been the result of such a great effort that it in

itself then becomes preservative. In that sense, the accessibility area interacted better with the continuous and relatively slow development during the authoritarian era than with the current one, which is characterized by empowerment, dynamic diversity and individual demands.

Value-wise, accessibility is related to the individual – as in the UN *Convention of the Rights of Persons with Disabilities*, where the concept of accessibility is defined as "the physical, social, economic and cultural environment, to health and education and to information and communication, in enabling persons with disabilities to fully enjoy all human rights and fundamental freedoms" [7]. But in reality, the individual's individuality and improvisational wishes have always been outside the main scope of the accessibility field, which is better suited to streamline how to respond to various human factors than different human actors. This is also reflected in how the field approaches the Internet. Web accessibility relies on several components, one of them being the *Web Content Accessibility Guidelines* [8].

The European initiative entitled *Design for All* [9], aims to support architects and designers in their work with new buildings or new products by doing the aftermath of accessibility issues beforehand. It is based on strategies for equal access to society by using plans, guidelines and heuristics. Among others, the work with *design for all* is based on the following two principles:

1. That which is good for people with impairments is often good for everyone else.
2. Accessibility can largely be established by thinking ahead, which means that the preconditions for accessibility can already be created on the drawing board.

The concept *design for all* has counterparts in other concepts such as the American *universal design* and the British *inclusive design* [10]. The work on accessible design is based on following principles and guidelines for how products should be designed to be used by as many as possible. See, for example, Connell et al. [11]. These are necessarily general, not situated in actions and not connected to an experienced accessibility, which more fully expresses environmentally-relative accessibility.

To some extent, it may be problematic to use concepts such as *universal* or *for all* and to see *design for all* as a desirable ideal. In his article, "Is There Design-for-All?", Harper argues that a *design for one* is needed as a counterweight to the impossible-to-achieve-practice perspective *for all* [12]. Anderberg [13] sees a need to nuance the term *design for all* and proposes the complementary concept *design for me* as a way to focus on the individual and the situated aspects of accessibility. Harper and Anderberg both discuss their individual design perspectives in relation to the field of computers and the Internet (Fig. 2).

To sum up the first two sections, the current view of accessibility as a predefined characteristic represents a structuralistic approach to accessibility that turns the individual into an un-situated passive robot without desires or idiosyncratic whims [15]. However, what determines if an individual can manage in a given situation can just as easily be a broomstick that happens to be available, as well as something specially designed and placed there to be accessible. This in itself is not an argument against *design for all* – the pre-defined is necessary – but the scope needs to be expanded to also capture the dynamics affecting accessibility for empowered individuals.

Fig. 2. The perspectives *design for all* and *design for me* do not need to be contradictory. Instead, ME and WE can be seen as each other's reflections and preconditions. Illustration by Mattias Christenson [14] after a text by Bodil Jönsson.

3 Wave 2 and 3 for HCI – But Not for Accessibility

The growing criticism that the human users and their real lives were excluded instead of being an influential part of the process [6] led to the second wave of HCI. One of its obvious starting points was the groundbreaking paper, "From Human Factors to Human Actors", by Bannon [16]. Some examples of second wave HCI are *situated action* [17], *participatory design* [18] and increased interest in activity as described in *activity theory* [19].

In her keynote paper at NordiCHI 2006, Susanne Bødker [2] described the third wave of HCI as a consequence of the ever-increasing penetration of computers around us, at work, at home and following us from context to context. She writes: "Pervasive technologies, augmented reality, small interfaces, tangible interfaces, etc., seem to be

changing the nature of human-computer interaction in ways that we don't quite understand" [2:2]. Bødker argues for a Scandinavian approach where the user-sensitive theories and methods of the second wave of HCI are applied to gain understanding of the entangled and technology dense everyday lives in a third wave of HCI as well (Fig. 3).

Fig. 3. Today, high up in the mountains far north in Scandinavia, there is also excellent cell phone coverage. Photo by Bodil Jönsson.

The development that Bødker [2] describes also has consequences for accessibility, not only regarding computers and accessibility, but in an increasing extent to larger and larger domains of our lives, where combinations of humans and non-humans continuously influence the activity conditions. Although Jönsson et al., active in the disability/accessibility field for decades, have focused on the user's needs, wishes and dreams [20], there is no doubt that HCI, usability and interaction design as a whole have come further than the field of accessibility in describing and understanding the experienced consequences of the ever changing area of information technology.

The fields of HCI and usability are interwoven. Advancements in the usability field in the last ten years have progressed as follows:

1. Originally, ISO 9241-11 [21] defined usability as: "...the extent to which a product can be used by specified users to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use."
2. ISO FDIS 9241-171 [22] defines accessibility as: "...usability of a product, service, environment or facility by people with the widest range of capabilities."
3. The new draft ISO standard ISO/IEC CD 25010.2 [23] proposes a more comprehensive breakdown of *quality in use* into *usability in use* (covered by ISO 9241-11), *flexibility in use* (which is a measure of the extent to which a product is usable in all potential contexts of use, including accessibility) and *safety* (which is concerned with minimizing undesirable consequences) [24].

4. Since 2008, however, there has also been a *user experience (UX) standard*, ISO CD 9241-210 [25], defining user experience as: "...all aspects of the user's experience when interacting with the product, service, environment and facility."

This UX standard exposes the absence of a corresponding standard for *accessibility experience* (AX). The absence can be seen as a sign of the lag in development of the concept *accessibility* compared to that of *usability*, and a need for a renewal of the accessibility field to allow for the empowered and experiencing user, and an activity-relative accessibility rather than an absolute one.

4 A Complement: Activity–Tied and Experienced Accessibility

Categorizations are often followed by descriptions that can turn into assumed causal relations. Words control thought, thought controls words and we tend to realize our thoughts [26]. A well-established thought is that people with disabilities have "special needs" and that accessibility is meant to accommodate those needs with special solutions. But what really are these needs and how do they differ from the needs of non-disabled people [20]? In fact, it is not the needs that are different or special, but the human conditions that manifest themselves when the individual wants to do something.

In all of the existing accessibility standards, accessibility is viewed as a phenomenon that can be achieved by planning ahead, not for the affected individuals, but for thought models of individuals and contexts. In the moment of action, however, the only accessibility that matters is that which is individually experienced and activity-tied. Laboratory experiments, guidelines or blueprints can only partially predict this, and there are no contextually valid properties before or beyond participation in a specific activity. An individual is subjected to the current contextual circumstances and conditions and has to manage with the actual level of accessibility – however satisfying or discriminating this may be.

According to the sociologist Lucy Suchman [17], people rely on their abilities and experiences to handle different situations in the here and now. She has introduced the term *situated action* as a way of understanding how people act and how they relate to their planning. Situated action represents a view where every chain of events depends on the current material and social circumstances. According to Suchman, the term encompasses all action and all planning (Fig. 4).

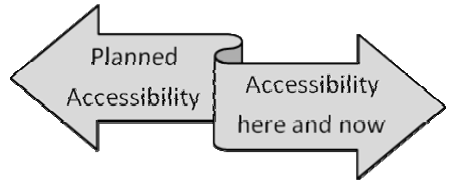


Fig. 4. There is a tension between the plans and how accessibility is actually experienced in the action. Illustration by the author.

Those who care about and depend on accessibility have good reasons to consider that actions are situated in the past, the present and the future. The planned accessibility covers only parts of the experienced accessibility in action. There is a need to broaden the understanding of accessibility to include not only what can be planned using guidelines, heuristics and logistics, but to increase the focus on situated and activity-tied accessibility. A previous plan may be ever so good, but it is not until the action in the here and now that accessibility is realized. In that sense, accessibility is tied to a specific activity in a particular situation, where both other humans and artifacts take part.

Accessibility today is under-theorized and lacks methodological sensitivity to the particular conditions for access and participation in concrete activities. The field has yet to account for several of the characteristics of and impacts on individually experienced and activity-tied accessibility.

5 Reframing Accessibility in the Era of Mixed Reality

The information technology (IT) area and its focus on non-physical materials [27] has stimulated those working with accessibility and IT to discuss the design of active and adaptive technologies that change for the user's varying conditions [28, 29]. What is desirable in the IT field is not that the possibilities are the same for all, but rather that they may be different for everyone. In the IT age, afforded uniqueness caters to equality.

In 2001, Gregor and Newell introduced the concept of *design for dynamic diversities* [30] as an approach for the design of information technology for older people. They pointed out that the user is not a static average person that does not change over time. As people age, they may lose physical and cognitive functions. The products they rely on in daily life must therefore be able to meet them based on their functional level here and now [30, 31].

HCI has shifted focus over the decades from the relationship between man and computer, such as the design of user interfaces, to an increasing concentration on the total experience, including aesthetic, ergonomic, narrative and other dimensions [32]. Current interaction design [33-35] includes knowledge from all the previous HCI areas. As humans and technology become more and more entangled so do the potential for their intertwined activity. This yields a mixture of the real and virtual elements that together form what is called *mixed reality* (Fig. 5) [36, 37]. In recent years, several related fields such as ubiquitous computing, tangible interaction, augmented reality, augmented virtuality, pervasive computing, enactive computing and so on, have emerged. In this article, they are all squeezed in under mixed reality as an umbrella term, but each of them has traits that are important for a future elaboration of accessibility.

Now with the mixed reality era well on its way, it is important that the accessibility field draws inspiration, theories and methodologies from HCI in its broadest sense, rather than from the physical world only. One of the many reasons is that it is more evident than ever that not only the interactive parts but all the artifacts in our surroundings exert an active influence on us. To design for many different opportunities and to be systematically open to the unexpected can be a way to avoid costly and

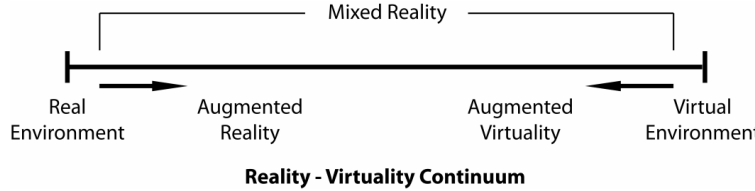


Fig. 5. The Reality-Virtuality Continuum by Milgram et al. [36]

stigmatizing special solutions for specific groups of people. Design for rich opportunities and redundancy increases people's degrees of freedom and allows for improvisation and whims while decreasing the likelihood that someone is suddenly caught standing there with no possibility at all. Donald Schön [38] is one of those who described the importance of having access to a repertoire of solutions, strategies and procedures. In meeting different situations, these provide opportunities to see the similarities and differences from previous experiences and can thus help to move forward.

On the whole, technology changes the conditions for humanity at the same time as individual products influence the individual person, and the accessibility as well. The combination of an active view of people and an active view of technology, like that in Actor Network Theory (ANT) [39-42], influences humanity and technology in many ways, large and small.

Over the last ten years or so, new technologies have taken their place in our daily lives. Internet, the cellular phone and the PC are now commonplace for the vast majority of people in the West. Technology affects individuals and their lifestyles. The cellular phone has led to greater freedom, Internet to new ways to search for information and e-mail to other ways to stay in touch, while the computer in itself is an everyday tool for not only written language but also for lots of pictures and sound, including computer games and all the media. Overall, it has meant that we now have many more contacts with many more individuals in many more ways, rendering a multitude of perspectives and possibilities (Fig. 6).

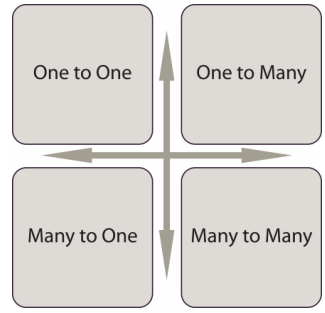


Fig. 6. The lower right corner has never before been available. Now it represents one of the most attractive possibilities of the information technology. Illustration by the author.

ANT focuses on the social processes involving both humans (H) and non-humans (NH) that are related to one another in similar ways, like nodes in a network. On a comprehensive level, humanity and technology mutually influence one another (means of transportation, energy systems, cellular telephone technology, food technology). There is also a level of everyday life where the person chooses and influences her artifacts, which in turn influence her (Fig. 7).

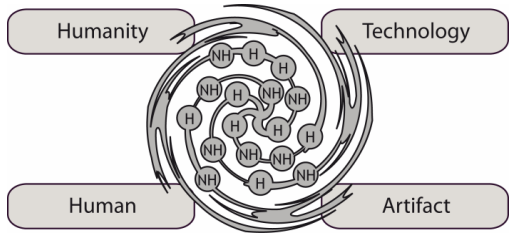


Fig. 7. Never before have humans been involved with so many people and so much technology at the same time [9]. Illustration by the author.

When a human utilizes an aid – an artifact – this activity does not occur in isolation. On the contrary, humans and artifacts are interwoven, together determining the terms for accessibility. Their activity interplays with both humanity and technology, both developing and changing in anticipation of the future. Being dependent on an artifact also means being dependent on this artifact's relation to everything else. Thus, the field of accessibility ought to be based on a view of the human being *together* with her technology, just as most of HCI, usability and interaction design are today.

Technology in itself boosts or poses challenges that can support, spur on, hinder or delay a given plan. Affordance [43, 44] can change dynamically in the moment and based on the current situation, alter the opportunities that the technology offers. Viewed through ANT eyes, the future challenges and opportunities are not static but depend on a dynamic environment where affordance changes.

6 Accessibility and the Situatedness of Artifacts

Another insight gained in HCI, which accessibility can profit from, is that artifacts always are parts of a context and need to be designed as such. Technology development and new prototypes are part of a whole, and dissociating them from that when evaluating or communicating them can seldom be done successfully. It is the effect on the whole that makes a difference, and it is in the whole that research can be conducted. When looked upon as influential parts of a greater picture, artifacts are not neutral. Instead, they convey attitudes [13] and values because of the knowledge and meaning that are built into the artifact itself. When the artifacts are included in various contexts, they will affect the collective meaning of the context. The artifact's potential is defined in and by the current situation's horizon of possible actions. This means that researchers, developers and others must be involved in

people's everyday lives and in their activities, because this is where the artifact's further potential can be captured.

Vygotsky's [45, 46] discussion of how knowledge and meaning are being co-created, for example during a normal conversation, can also be applied to technology. Series of mock-ups, user trials, small breakdowns and corrections have a different profile than a technology built on component refinements and a determinist linear approach (Fig. 8). Instead, technology is, at every point in time, seen as the resulting expression of the implemented meaning, as far as this has reached [15]. Most (in my opinion all) technology developments would benefit from being thought of and described as the non-linear processes they actually are.

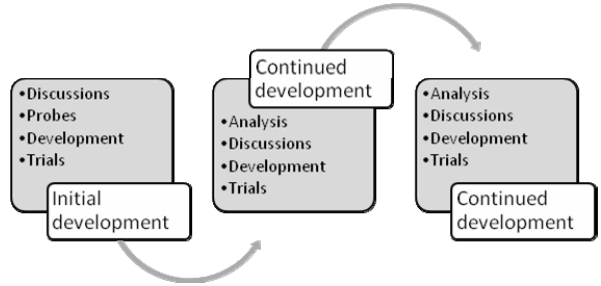


Fig. 8. An iterative design process can open the way up for richer initiative and participation, thus enhancing the shared implemented meaning. Illustration by the author.

In the initial development of a given technology, the designer and the users rarely share the same picture of the meaning the artifact should provide. Nor do they see the same meaning in the finished product. But the chances that the artifact actually can play a useworthy [47] and positive role increase considerably if the affected person's perspective is part of the knowledge and meaning that is built into the artifact.

A look at current participatory design (PD) methods reveals that they rely on text or speech to a large extent. This is not surprising at all, since PD arose in a workplace context [18]. Ong [48] describes technological aspects of written language. But how do you cater to a dialogue when written or spoken language is not an option? In situations with inherent asymmetries, due to disabilities or age differences for instance, the notion of technologies as intermediaries can facilitate communication that hardly could be achieved by relying on written or oral modalities [20, 49, 50].

7 Artifacts for Mutual Information and Inspiration

In the mixed reality era, the object of methodical inquiry becomes part of a mixture consisting of humans and non-humans entangled in a network (Fig. 7). This requires and offers new and complementary techniques other than today's. When information and actions are distributed across networks, it is not enough to focus solely on the

human actors; there is also a need to turn to the ever-increasing number of non-humans that are part of the studied context. With such an approach, the systematic introduction of new artifacts also can serve as a method for mutual information and inspiration.

Fig. 9. A mother and her son play with Pleo™. Photo by the author.

It is a matter of artifacts being physically here among us. We can gather around them and interact with them – they are an integral part of a situation in which the living communication between mother and son, here illustrated, can be afforded structure, direction and other significance for those involved. This is based on the simultaneous focus on the artifact as one in the context, such as the robot dinosaur Pleo™ in Fig. 9.

If spoken or written language is insufficient, technology can often offer other means of communication. It is possible both to ask and to receive answers via artifacts, as soon as the acting individual has a chance to do something with them. One quick way of getting started is to develop mock-ups at an early stage, models or sketches that definitely are not good enough to function as prototypes and that can lack much of the functionality, but that still have the weight, the size and some functions available that resemble those of the intended product [15].

By presenting these to the user, it is possible to get feedback in action at an early stage. The designer consciously or unconsciously has a strong inner image of the future results, and it is this early image that will be realized, unaffected by the surrounding world if the surrounding world is not given a chance to provide input. Trial implementations, in the form of mock-ups without any demands whatsoever on precision, can make a huge difference. It is only an advantage if the user does other things than those intended with the mock-ups, or even rejects them. Artifacts can be big and small, hard and soft, compliant and reluctant, meet expectations and act mischievously. Surprises like that spur on thoughts that contribute to the continued development process.

8 To Sum Up: Time for Accessibility 2.0?

While the framework and applications of HCI, usability and interaction design have developed continuously and long since reached their "2.0" level, the considerations, elaborations and applications of accessibility have proceeded noticeably slower. The relative delay of accessibility has its reasons as well as its consequences. It takes years of initiating, norm confrontations, lobbying and realization before a certain level of accessibility is reached. In itself, it then plays a conservative role – nothing steers a development as ruthlessly as an implemented infrastructure, and when HCI, usability and interaction design have reached their 2.0 level, accessibility is only in its 1.2.

As explored above, the era of mixed reality has several characteristics that can substantially add value to the field of accessibility, both in terms of new methodologies regarding inquiry and participation and in the form of a richer, warmer and more flexible accessibility that bends to fit the individual's dreams wishes, needs and even idiosyncratic whims and pure improvisation. This shift has dynamic effects, not only in technology (where an active network-embedded technology obtains a different and stronger position) but also on the human side. A person who becomes accustomed to opportunities being within reach, and being able to manage with the help of them, is influenced by her experience to have the expectation that she will manage the next time. These expectations concern both herself and her human and technical environment.

Let us return to *The Rise of the Network Society* [1] and Manuel Castells' clear statement that no new technology can be established unless the culture and its thought climate allow for it. There is, however, a follow up to this statement: when a technology is finally established, especially a technology in the societal sector, it can be very robust and almost aggressive in its efforts to block further development. The evolution of HCI and usability have not by themselves led to a comparative evolution of accessibility – the accessibility area is its own subculture and relies heavily on a slow development of rules and laws. This results in a tension regarding the ever-accelerating evolutions of attitudes and norms. There is an enhanced and challenging need for a thought climate that allows and urges design thinking on social concerns, that disclaims instrumentalistic disability attitudes and that strengthens improvisation (both individually and socially) to benefit the lived life.

These situated and individually oriented characteristics of our times can and will change the materiality of everyday life, with or without disabilities. A society that actually listens to its people necessitates an accessibility that can be adjusted to fit the individual. In the mixed reality era, it is the combinatoric sum of human and technological affordances that together determine the conditions for action in the here and now. If the combined environment wants the individual's success and adapts accordingly, it can offer an optimal potential in the moment of action. In the future, this also ought to be reflected in how metrics, heuristics and generalizations are utilized to facilitate access, and the ways it is designed.

It is about time to roll out the next wave of accessibility, version 2.0.

Acknowledgements

The author gratefully acknowledge Bodil Jönsson, professor at Certec, Department of Design Sciences, Lund University, Sweden, for her continuous inspiration, critical

questioning and constructive feedback, and Eileen Deaner, international coordinator at Certec, for translation services and comments on the text.

References

1. Castells, M.: The Rise of the Network Society. Blackwell, Malden (1996)
2. Bødker, S.: When second wave HCI meets third wave challenges. In: Proceedings of the 4th Nordic conference on Human-computer interaction: changing roles, pp. 1–8. ACM, Oslo (2006)
3. Rehabilitation International, http://www.riglobal.org/about/index.html
4. People First movement, http://www.people1.org/about_us_history.htm
5. Doug Engelbart's, Demo (1968), http://sloan.stanford.edu/MouseSite/1968Demo.html
6. Kuutti, K.: Activity theory as a potential framework for human-computer interaction research. In: Nardi, B. (ed.) Context and Consciousness: Activity Theory and Human Computer Interaction, pp. 17–44. MIT Press, Cambridge (1995)
7. UN.: Convention on the Rights of Persons with Disabilities, http://www.un.org/disabilities/default.asp?navid=12&pid=150
8. W3.: Web Content Accessibility Guidelines 2.0, http://www.w3.org/WAI/intro/wcag.php
9. EIDD.: The EIDD Stockholm Declaration, http://www.designforalleurope.org/Design-for-All/EIDD-Documents/Stockholm-Declaration
10. Klironomos, I., Antona, M., Basdekis, I., Stephanidis, C.: White Paper: promoting Design for All and e-Accessibility in Europe. Universal Access in the Information Society 5(1), 105–119 (2006)
11. Connell, B.R., Jones, M., Mace, R., Mueller, J., Mullick, A., Ostroff, E., Sanford, J., Steinfeld, E., Story, M., Vanderheiden, G.: The Principles of Universal Design (Version 2.0 -4/1/97) (1997), http://www.design.ncsu.edu/cud/about_ud/udprinciples.htm
12. Harper, S.: Is there design-for-all? Universal Access in the Information Society 6, 111–113 (2007)
13. Anderberg, P.: FACE – Disabled People, Technology and Internet. Certec, LTH, Lund (2006)
14. Christenson, M.: Bildrör, B4PRESS, Gothenburg (2008)
15. Hedvall, P.O.: Situerad Design för alla – till improvisationen lov (Situated Design for All – In Praise of Improvisation). Licentiate thesis. Certec, LTH, Lund (2007)
16. Bannon, L.: From human factors to human actors: the role of psychology and human-computer interaction studies in system design. In: Greenbaum, J., Kyng, M. (eds.) Design at work: cooperative design of computer systems table of contents, pp. 25–44. Lawrence Erlbaum Associates, New Jersey (1991)
17. Suchman, L.: Human and Machine Reconfigurations: Plans and Situated Actions, 2nd edn. Cambridge University Press, Cambridge (2006)
18. Ehn, P.: Work-Oriented Design of Computer Artifacts. Lawrence Erlbaum Associates, New Jersey (1988)
19. Kaptelinin, V., Nardi, B.A.: Acting with Technology: Activity Theory and Interaction Design. MIT Press, Cambridge (2006)
20. Jönsson, B. (ed.): Design Side by Side. Studentlitteratur, Lund (2006)

21. ISO 9241-11, Ergonomic requirements for office work with visual display terminals (VDTs) – Part 11: Guidance on usability. International Organization for Standardization, Geneva (1998)
22. ISO CD 9241-210, Ergonomics of human-system interaction – Part 210: Human-centred design process for interactive systems. International Organization for Standardization, Geneva (2008)
23. ISO FDIS 9241-171, Ergonomics of human-system interaction – Part 171: Guidance on software accessibility. International Organization for Standardization, Geneva (2008)
24. Bevan, N.: Classifying and Selecting UX and Usability Measures. In: Law, E.L.-C., Bevan, N., Christou, G., Springett, M., Lárusdóttir, M. (eds.) Proceedings of the international workshop on meaningful measures: Valid useful user experience measurement (VUUM), pp. 13–18. Institute of Research in Informatics of Toulouse, Toulouse (2008)
25. ISO/IEC CD 25010.2, Software engineering – Software product Quality Requirements and Evaluation (SQuaRE) – Quality model. International Organization for Standardization, Geneva (2008)
26. Jönsson, B., Rehman, K.: Den obändiga söklusten. Brombergs, Stockholm (2000)
27. Löwgren, J., Stolterman, E.: Thoughtful interaction design: a design perspective on information technology. MIT Press, Cambridge (2005)
28. Savidis, A., Antona, M., Stephanidis, C.: A decision-making specification language for verifiable user-interface adaptation logic. International Journal of Software Engineering and Knowledge Engineering 15(6), 1063–1094 (2005)
29. Darzentas, J.S., Miesenberger, K.: Design for All in Information Technology: A Universal Concern. In: Andersen, K.V., Debenham, J., Wagner, R. (eds.) DEXA 2005. LNCS, vol. 3588, pp. 406–420. Springer, Heidelberg (2005)
30. Gregor, P., Newell, A.F.: Other impairments and rehabilitation technologies: Designing for dynamic diversity: making accessible interfaces for older people. In: Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly WUAUC 2001, pp. 90–92 (2001)
31. Heller, R., Jorge, J., Guedj, R.: Workshop report: EC/NSF workshop on universal accessibility of ubiquitous computing: providing for the elderly event report. In: Proceedings of the 2001 EC/NSF workshop on Universal accessibility of ubiquitous computing: providing for the elderly WUAUC 2001, pp. 1–10 (2001)
32. Hochheiser, H., Lazar, J.: HCI - and Societal Issues: A Framework for Engagement. International Journal of Human-Computer Interaction 23(3), 339–374 (2007)
33. Löwgren, J.: From HCI to interaction design. In: Chen, Q. (ed.) Human-computer interaction: Issues and challenges, pp. 29–43. Idea Group Pub., Hershey (2001)
34. Shedroff, N.: Experience design 1. New Riders Pub., Indianapolis (2001)
35. Preece, J., Rogers, Y., Sharp, H.: Interaction Design: beyond human-computer interaction, 2nd edn. J. Wiley & Sons, New York (2007)
36. Milgram, P., Takemura, H., Utsumi, A., Kishino, F.: Augmented Reality: A Class of Displays on the Reality-Virtuality Continuum. In: SPIE. Telemanipulator and Telepresence Technologies, vol. 2351, pp. 282–292 (1994)
37. Behringer, R., Christian, J., Holzinger, A., Wilkinson, S.: Some Usability Issues of Augmented and Mixed Reality for e-Health Applications in the Medical Domain. In: Holzinger, A. (ed.) USAB 2007. LNCS, vol. 4799, pp. 255–266. Springer, Heidelberg (2007)
38. Schön, D.A.: The Reflective Practitioner – how professionals think in action. Ashgate Publishing, UK (1983/1991)

39. Latour, B.: Technology is society made durable. In: Law, J. (ed.) A Sociology of monsters: Essays on Power, Technology, and Domination. Sociological Review Monograph, vol. 38, pp. 103–131. Routledge, London (1991)
40. Latour, B.: Pandora's Hope: Essays on the Reality of Science Studies. Harvard University Press, Cambridge (1999)
41. Latour, B.: Reassembling the Social: An Introduction to Actor-Network-Theory. Oxford University Press, Oxford (2005)
42. Akrich, M.: The de-scription of technical objects. In: Bijker, W., Law, J. (eds.) Shaping technology, building society: Studies in sociotechnical change, pp. 205–224. MIT Press, Cambridge (1992)
43. Gibson, J.J.: The ecological approach to visual perception. Lawrence Erlbaum Associates, New Jersey (1986)
44. Norman, D.A.: The psychology of everyday things. Basic Books, New York (1988)
45. Vygotsky, L.S.: Mind in Society: Development of Higher Psychological Processes. Harvard University Press, Cambridge (1978)
46. Vygotsky, L.S.: Thought and Language. MIT Press, Cambridge (1986)
47. Eftring, H.: The useworthiness of robots for people with physical disabilities. Certec, LTH, Lund (1999)
48. Ong, W.J.: Orality and Literacy: The Technologizing of the Word. Methuen young books, London (1982)
49. Jönsson, B., Philipson, L., Svensk, A.: Certec.: Vad vi lärt oss av Isaac; What Isaac taught us. Certec, LTH, Lund (1998)
50. Jönsson, B.: Enabling communication: pictures as language. In: MacLachlan, M., Gallagher, P. (eds.) Enabling technologies: body image and body function. Churchill Livingstone, New York (2004)

11

Paper IV

An activity theoretical approach to the International Classification of Functioning, Disability and Health

An activity theoretical approach to the International Classification of Functioning, Disability and Health

(Submitted to *Disability and Rehabilitation* October 30, 2009)

Per-Olof Hedvall, Certec, Department of Design Sciences, Lund University, Lund, Sweden

Mats Granlund, School of Health Sciences, Jönköping, Sweden

Correspondence: Per-Olof Hedvall, Certec, Department of Design Sciences, Lund University, P.O. Box 118, SE-221 00 Lund, Sweden. Tel: +46 739 88 46 76. Fax: +46 46 222 44 31

E-mail: per-olof.hedvall@certec.lth.se

Abstract

Purpose The purpose of this explorative article is to juxtapose Cultural-Historical Activity Theory (CHAT) with the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF) in order to critically discuss the concepts of activity, participation and person-environment interaction as it is applied in the ICF framework.

Method Based on a literature review, CHAT is used to portray an activity system where a subject acts towards an object in an environment of artefactual, natural and human impacts. CHAT's perspective is compared and related to the ICF. By viewing the ICF as a systems model, the dichotomy between impairments and disability is bridged and brought together by depicting functioning as a systemic process in continuous change. A CHAT model, the Activity Diamond, is a vehicle for the discussion.

Results The analysis of the ICF from a CHAT perspective results in viewing the domains and components of the classification as parts of activity systems which change and develop over time.

Conclusions The ICF and CHAT have several similarities including a multidimensional perspective on functioning which is dependent on many factors. The differences can serve as a basis for identifying aspects that may need to be changed when developing the next version of the ICF.

Keywords

ICF, disability, Activity Diamond, activity systems, Cultural-Historical Activity Theory

Introduction

In the World Health Organization's (WHO) International Classification of Functioning, Disability and Health (ICF), *activity* has a central role in the interaction between an individual and his or her surrounding environment [1,2]. With the ICF's focus on the actual doing and what facilitates or hinders that activity, WHO brings together the biomedical model and the social model views of disability into one definition of disability that covers both of these perspectives, with activity being the common denominator. Body functioning is often deduced based on a person's actions and a group that is discriminated by society is identified based on its members actions or lack of actions. But activity per se is not elaborated on its own terms, which make the fundamental activity aspects less influential than they deserve to be.

The ICF has been criticized for being a political consensus model rather than a scientifically based model. Another critique is that the ICF is atemporal and cannot describe historical change over time [3]. The purpose of this article is to critically discuss the ICF by juxtaposing it with a theoretical framework for activity: Cultural-Historical Activity Theory (CHAT), mainly based on the development line Vygotsky-Leontiev-Engeström [4,5,6,7,8,9].

The principal focus of the discussion is on *activity, participation* and *the person-environment interaction* in the ICF. Some of the most important postulates in CHAT in relation to the ICF are:

- Human *activity* is central for development and learning [4,5,6,7].
- The subject is viewed together with his or her artefacts: '. . . the agent of mediated action is seen as *the individual acting in conjunction with mediational means*' [10].
- The individual is considered as historically situated [11] in *activity systems* [8] that are in constant change, both in real time and over time.
- The presence of several activity systems at the same time [12,13] urges *multiple perspectives* to be taken into account in understanding human actions.

CHAT

CHAT has its origins in Russia and the psychologist L.S. Vygotsky. He introduced cultural artefacts as a part of the subject-object relationship (figure 1) and formulated the foundations of what today is called Cultural-Historical Activity Theory with 'cultural mediation, as a central concept.

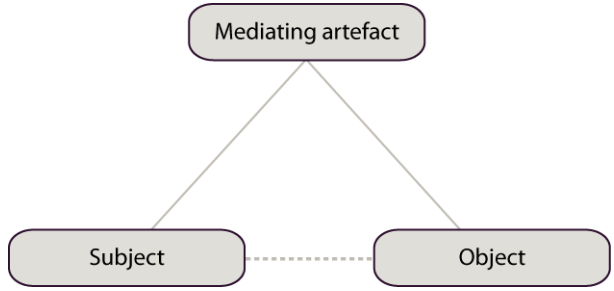


Figure 1. Vygotsky's model of a mediated act [12].

Vygotsky diverged from the prevailing tendency in psychology to regard human behaviours as separate with a direct stimulus-response based connection between subject and objects. Humans and their object-oriented actions could no longer be understood without their cultural tools, and society in turn could not be understood without the individuals who act and make use of cultural artefacts [12]. Culture mediates the relation between subjects and their objects.

In this context the 'object' is defined as what the subject's actions are directed at, such as task/s to be executed in order to reach a desired goal. According to Leontiev, a student and colleague to Vygotsky, 'human activity' is the foundation of people's relation to reality and there is always an object of an activity: 'Any activity of an organism is directed at a certain object; an "objectless" activity is impossible' [7]. Leontiev's works were extended by Engeström, whose activity systems model enables simultaneous analysis of the individual perspective and the collective perspective, portrayed as several simultaneously present activity systems [8]. In a disability context, Engeström's activity systems model has been further elaborated into the Activity Diamond [14] (figure 2).

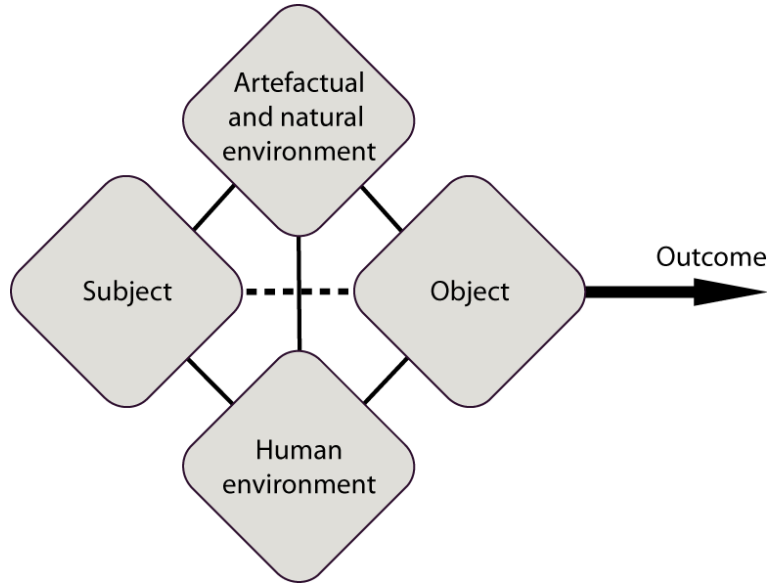


Figure 2. The Activity Diamond [14].

It is a conceptual model aimed at capturing and describing a motive-driven human activity system, where the subject-object relation is mediated and thus influenced by the artefactual, natural and human environments. The system is situated in both time and place.

Thus, it conceptually captures an activity system that is in constant change. The four concepts are:

- *The subject* in the model is often an acting individual. On another level, it can also be a group of people, such as a family.
- *The object* of an activity is related to the motives and needs of the subject, such as getting better grades, learning to read or producing a new car. Thus, the object

often consists of or is related to tasks to fulfil or goals to reach.

- *The artefactual and natural environment* consists of material and immaterial artefacts, and their respective affordances [15,16] and resistances. Some examples are computers, language, legislation, air temperature, snowstorms and sunshine.
- *The human environment* is made up of the people or groups of people influencing the activity at hand. This can be the family, work colleagues or larger portions of society that are involved in or otherwise affect the activity regarding attitudes, norms and expectations.

ICF

The ICF is WHO's classification of functioning, disability and health and was introduced in 2001 (figure 3). Its four domains deal with the 'body structures' and 'body functions' of an individual, and his or her 'activity and participation' in a given 'environment'. This places the ICF at the nodal point between impairments, limitations, restrictions and barriers on the deficit side and capacities and facilitators on the other, thus describing human functioning as the outcome of both person and environmental factors. The ICF is, however, notably more developed on the deficit side, and there is a need for further elaborations concerning how the person-environment interaction can be described in terms of accessibility and universality.

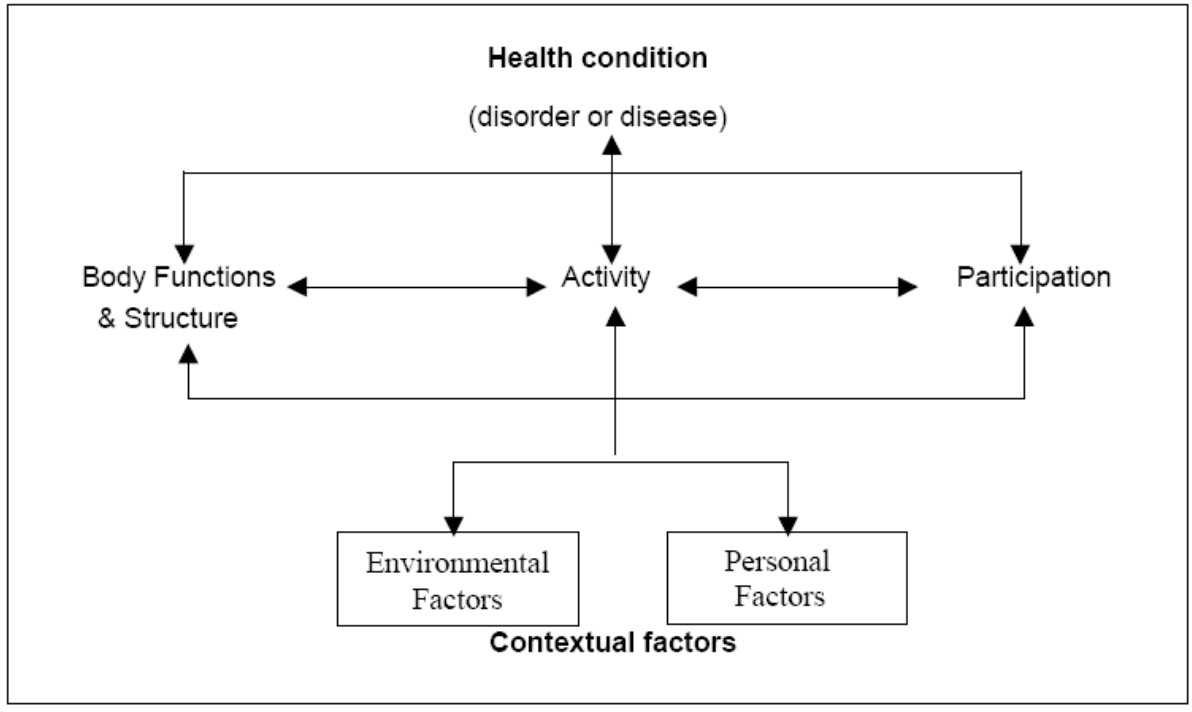


Figure 3. The ICF model [1,2].

This article draws on the ICF reasoning found in the ICF-CY [2] which can be seen as the first step toward the ICF-2. The Children & Youth version of the ICF (ICF-CY) was introduced to more comprehensively cover dimensions pertaining to the classification of children from birth to age 18 [17]. It contains all codes of the ICF plus the additional CY codes. We base our reasoning concerning how activity, participation and the person-environment interaction can be described on the following: the results from a search of the literature for articles discussing the activity and participation constructs in the ICF; our own research efforts; and a minor

survey of a selected sample of professionals working with assistive technology, people active in the disability movement and professionals working with design research and education in Sweden. They were asked whether they knew about the ICF, if they had ever utilized it, and if so how they perceived its utility. The ICF is meant to be used as a common language and reference for professionals in different disciplines [18]. The results from the survey, based on 64 answers, shows that the ICF to a large extent has been adopted and put to use in medically oriented assistive technology, while in design sciences (industrial design, ergonomics, human-computer interaction, etcetera), it was scarcely known at all. Most striking though, is that only a few of the people involved in the disability movement knew about it and that not one of them had used it. The results indicate that there needs to be more research and dissemination work carried out in order for the ICF to fill its role as a potential common reference between professionals and people with disabilities and their families, as well as facilitating empowerment and influence from the affected individuals.

The research available concerning the ICF has predominantly been conducted from a professional perspective, with a focus on health contexts [18]. Many articles on the ICF deal with theoretical and methodological reasoning and its conceptual model: how its categories should be understood [19], related to different instruments [20] or models [21].

The ICF components 'activity' and 'participation', and their interrelation to each other, have been a major source of discussion. Coster and Khetani [22] present three main questions regarding how activity and participation can be separated: What is the distinction between activity and

participation? Should measures of participation focus on objective indicators, subjective experience or both? Whose perspective should be measured? The answers to these questions differ depending on the underlying models and conceptualizations of disability.

Medical, social or functional model of disability?

The ambitions behind the ICF to bring together the social and biomedical models of disability in practice have not yet yielded a successful balance and integration. Literature searches clearly show a strong health science dominance in implementing the ICF [18]. The critique of the ICF from proponents of the social model of disability has been harsh. The ICF is considered to reinsert the causal relation between impairment and disability instead of describing disability as arising from external social discrimination:

> The 'bio-psychosocial' approach retains the individual as the starting point for the analysis of body function and activity. Its concept of 'participation' is underdeveloped and linked to individual circumstances rather than grounded in social and political inclusion [23].

The critique of the ICF from proponents of a medical model of disability is that it is a mixture of health factors, such as body function and capacity to perform activities, and health-related factors, such as participation and environment,

that do not belong in a health classification system. Partly as a consequence of this critique, the first field trial version of the ICIDH-2, which contained separate components for activity and participation, was changed in the revision work and 'activity' and 'participation' were collapsed into one component in the ICF classification. Thus, the ICF model and the ICF classification system are not completely compatible. The model suggests a distinction between activity and participation that is not visible in the taxonomy.

An alternative to the medical model and the social model is a functional model [17]. A problem both with categorical disability labels and diagnoses emanating from the biomedical model and the sole focus on the societal processes in the social model, is that they tend to collapse the individual's presenting problem into a single category or explanation. This makes it difficult to analyse the nature and severity of the problems an individual experiences in everyday life. The natural contexts of individuals, person characteristics as well as objects or tasks, partly define what necessary functions individuals must manage to have a good quality of life. Thus, all the components in the ICF model (body, activity, participation, environment and person factors) must be considered to understand functioning. This again brings up the important distinction between the ICF model and the ICF taxonomy. In the ICF taxonomy the influence of person characteristics are not assessed since the person factors depicted in the ICF model are left out and tasks have to be implicitly inferred from participation domains. In addition, no clear distinction is made in the taxonomy between activity and participation.

On the professional dominance of ICF usage

The norms at play regarding the ICF rest on the notion of normality and that it is possible to classify functioning, disability and health. These norms are embedded in the ICF's classificatory praxis [24]. According to the social model, norms are constructed by humans and normality is commonly defined statistically by professional experts. Thus, it is very important to consider who determines the norms: the professionals or the people with disability? So far, most research concerning the ICF is based on a professional perspective. One example is that the environment component according to the ICF [2] shall be described from the affected individual's perspective, but in several publications (e.g from the WHO research branch in Munich) it is primarily described based on professional reports [cf. 25]. These reports can, of course, be supported by client information but are then still based on professionally constructed items.

Another example is 'ICF core sets' [26]. A core set is a subset of ICF codes selected for a specific purpose. The rationale behind the core set idea is that the whole ICF classification system is too complex and contains too many codes to be feasible. By constructing a subset with the codes most useful for a certain purpose, the ICF will become easier to use. So far, it is primarily professionals in the health sector who have constructed core sets to facilitate their work. Thus, the core sets are primarily based on professional working tasks and diagnoses. This focus on professionals indicates that few individuals with disabilities or user organizations have been able to appreciate the usefulness

of core sets. The fact that most core sets are based on diagnosis can be seen as an expression of the dominance of the medical model. However, an opposing interpretation is also possible. In all diagnosis-based core sets, several codes from the activity/participation and environmental domains can be found. The inclusion of these will affect health professionals' perceptions of disability in the direction of the social model (i.e. core sets can also facilitate a move away from the medical model in health professionals). In theory, it is possible to construct core sets based on societal roles (e.g. the role of pupils in school or life tasks such as spending time with peers). So far few, if any core sets based on societal roles or life tasks have been reported in the literature.

The environment component was introduced in the ICF to facilitate a social model perspective. According to Whiteneck et al. [27] this component is one of the largest advancements from previous classifications of disability. However, the number of categories in the environment is remarkably few and lack detail compared to the other domains such as body structures and body functions. This fact might be a consequence of medical research having existed longer than social research. Another problem with the environmental component in the ICF is that the classification only concerns dimensions of environments that affect outcomes in terms of body functioning, activity and participation (i.e. products and technology, natural environments, support and relationships, attitudes and service systems). The scene setting qualities of the environment in relation to tasks, objects and functions are not classified. To 'understand' environmental aspects, both as scene setters for activities and tasks and as factors affecting the outcome of actions, environmental codes must be supplemented with activity/participation codes describing the task [28].

Interrelations between components and domains in the ICF

The ICF is constructed with the ambition of making room for the individual. When criticizing the ICF, it is important to make a distinction between the ICF model and the ICF taxonomy as well as between the ICF taxonomy as it appears in the classification and the current use of the classification. It is often the ICF taxonomy, rather than the ICF model, and the manner in which the taxonomy is used that the critique is or ought to be about.

Many ICF-focused articles deal with the 'boxes' in the taxonomy, what to put in them and how to do it. However, little has been written about the dynamics of the ICF model and the relation between the components and domains in the model. Two studies by Ibragimova et al. [29,30] indicate that the components of the ICF have empirical support in factor analyses of data from ICF-linked instruments, while domains in the activity/participation component have less support. A discussion is needed both of the lines between the boxes as well as about how the model is related to the taxonomy. This is where the ICF is not very clear. One problem is that the manual does not explain how to interpret the relations between the boxes in the model. The lines seem to imply that the domains are interconnected and the arrows on the lines seem to indicate that the flows within the system take place in specific directions.

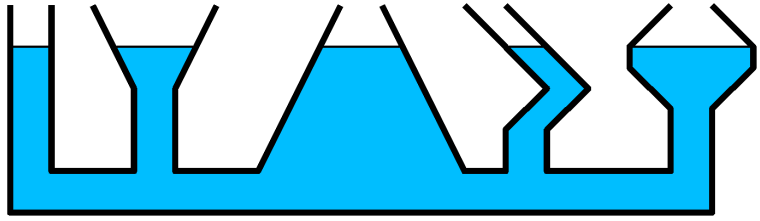


Figure 4. Communicating vessels, where a change in one of the vessels affects the rest of them. Illustration: Wikimedia commons.

But, if the different components of the ICF model are to be interpreted as 'communicating vessels' (figure 4), this raises many questions. When a change in one domain occurs, how is the rest of the system affected? If the ICF model portrays a system that is embedded in a context, are the contextual boxes to be interpreted as the systems' 'connectors' to its surrounding world, or are all aspects of the surrounding world depicted in the boxes? Here CHAT can assist the ICF with theoretical conceptions and understanding since it is based on similar activity systems, and thus needs to deal with the same issues as those raised in the questions above.

CHAT as a supplement to the ICF

According to Shakespeare [31] the social model of disability has come to a 'dead end' and needs to return to an interest in disability itself. He considers the ICF with its process focus and aim to understand how disability arises as promising. We share his interest in the use of the ICF to understand disability but do believe that the ICF needs to be vitalized regarding the definition and role given to activity in the model as well as the requirement of the object or task as a means to link the activity and participation concepts in the model. One means for achieving such links is CHAT.

The ICF and CHAT share activity as a central concept but their respective definitions of it differ:

- ICF: 'Activity is the execution of a task or action by an individual'. In the ICF, activity is closely related to participation which is defined as '. . .involvement in a life situation' [2, p. 129].
- CHAT: 'Activity of the human individual represents a system included in the system of relationships of society. Outside these relationships human activity simply does not exist' [6, p.51].

The ICF can be seen as a functional model [17], where the individual is supported, hindered or obstructed by different factors in the person or in the environment when trying to perform a task, a wished function. The functional model of disability has been criticized for being an individualistic model which maintains the individual or the individual-specific

environment as the main explanation for disabilities, while not sufficiently acknowledging and focusing on inclusive and discriminatory factors in society [32].

In CHAT the activity system (see figure 2) is driven by a motive to act towards an object. An activity system must be understood as a system within systems. The surrounding culture is to some extent present within each system, while the outcome from the systems creates contradictions and tensions which make both the system and the world around it change. The ICF model lacks an outcome and its relation to the surrounding world is a bit unclear. According to Leontiev, human activity is inherently and unavoidably social:

> Under whatever kind of conditions and forms human activity takes place, whatever kind of structure it assumes, it must not be considered as isolated from social relations, from the life of society. In all of its distinctness, *the activity of the human individual represents a system included in the system of relationships of society*. Outside these relationships human activity simply does not exist [6, p.51] (author's italics).

A problem with activity systems is that it may be difficult to conceptually and empirically discriminate different activity systems from other surrounding systems. In theory, what makes up a system is dependent on the object of the system. Thus, without knowing the object of the activity it is impossible to define the system.

The ICF's activity and participation are difficult to distinguish from each other [2, p.14]. In the ICF, activity is treated as a capacity, while participation is tied to performance. The causal relation between capacity and performance has been criticized by proponents of social model thinking, who mean that the ICF fails to disconnect conceptually from the previously hypothesized causal link between impairment and disability.

In a CHAT perspective, activity (capacity) and participation (performance) are not only relative in relation to the environment, but also in relation to activity (i.e. both capacity and performance are coloured by the environment in which they occur and by the actual activity). Viewed from a CHAT perspective, the connection between capacity and performance is materially mediated rather than direct and causal (as seen in figure 1). With this follows that activity and participation cannot be described without taking the environmental impacts into consideration, a view that is fully consistent with the ICF: 'Environmental factors make up the physical, social and attitudinal environment in which people live and conduct their lives' [2, p.189]. The ICF's definition of participation, 'involvement in a life situation' [2, p.129], is also compatible with that in CHAT, where involvement in a life situation is an outcome from the activity system.

In comparison to CHAT, the ICF seems to conceptualize the environment more narrowly and there is a need for further elaboration and expansions for the environmental categories in the taxonomy. The ICF treats artefactual and human aspects of the environment separately, with the effect that attitudes only can be exerted by humans and not by artefacts, such as medical aids provision and wheelchairs, even though these can be both hindering and facilitating. However, according to CHAT, artefacts are not neutral and transparent. They convey values, attitudes and meaning that are built into them, such as:

- The neglect of aesthetical preferences. If one does not want to have a 'state green' coloured wheelchair because of the signals it conveys, other options should be at hand.
- The unawareness of the stigmatic impacts of certain aids and procedures on users of technology. Examples: Being

forced to have a 'disabled' sign on your car. Having the best seat in a theatre dedicated to people in wheelchairs.

- The underlying assumption that you will not be able to manage by yourself and the consequent inclusion of activity factors that make you dependent on others. One example of this is voice output communications aids (VOCA), where the vocabularies often are managed in special parts of the programs which the user of the aid cannot access. The effect of this 'feature' is that people using VOCAs in many cases cannot change or add words to their vocabulary on their own.

In CHAT the relation in space and time between the artefactual and the human environment is an important component that impacts the conditions for activity. It is often the development over time of this relation that holds the most valuable properties of the environment. An example is how social norm processes over time are crystallised into artefacts such as rules, laws and legislation.

Relating the ICF and CHAT

A comparison and juxtaposition of the ICF with CHAT based the Activity Diamond reveal a clear overrepresentation of ICF categories on the subject side (figure 5). This can be seen as a sign of the relative dominance of the medical model, and urges researchers to redirect their focus to the environment and the object of activity in order to strive towards WHO's intentions

for the ICF. The Activity Diamond, on the other hand, is underrepresented concpetually in how the subject is depicted; it urges researchers to focus on how subject characteristics impact the activity system.

Combining the ICF and CHAT:

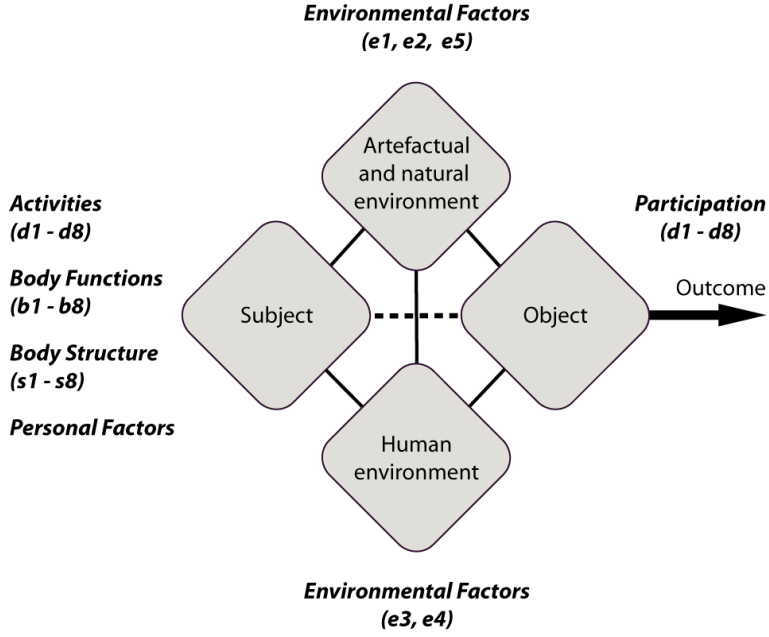


Figure 5. The Activity Diamond with ICF categories.

- The activity part of the ICF's Activity and Participation domain (d1-d8) is placed with the Subject, together with Body Functions (b1-b8), Body Structure (s1-s8), and Personal Factors (not classified at the moment).
- The participation part of the ICF's Activity and Participation domain (d1-d8) is placed with the Object/Outcome but is not equal to it. An object of an activity can be something other than participation, for instance, an individual's desire to experiment, to achieve independence and to learn something new.
- The Environmental Factors of the ICF are divided between the artefactual and natural environment (e1, e2, e5), and the human environment (e3, e4).

The Personal Factors are today part of the ICF's contextual domain but are not classified. According to a CHAT view, these factors (age, experiences, preferences, etcetera) ought to belong in the subject corner of the Activity Diamond, since they all are part of the individual's idiosyncratic agenda. The ICF's Personal Factors need to be classified and put to use, since the affected person becomes a passive robot when described without regard to his or her dreams, wishes and needs [33]. The application of the ICF's personal factors and activity factors to the Activity Diamond model can make the subject component more structured and detailed in comparison to how it is today.

A difference between the ICF and CHAT is that the latter, due to its roots in dialectical thought, deals with an activity system that is in constant change and development, while the former is a classification and as such atemporal. But, nothing in an activity system can be properly understood without taking

the cultural-historical influence of time into account, and here CHAT can contribute to the development of the ICF. The two of them can be used together to describe momentary ICF snapshots and the change over time. Below is an example of how the ICF and CHAT can be combined to facilitate descriptions of skills development by using ICF constructs together with the Activity Diamond (figure 6).

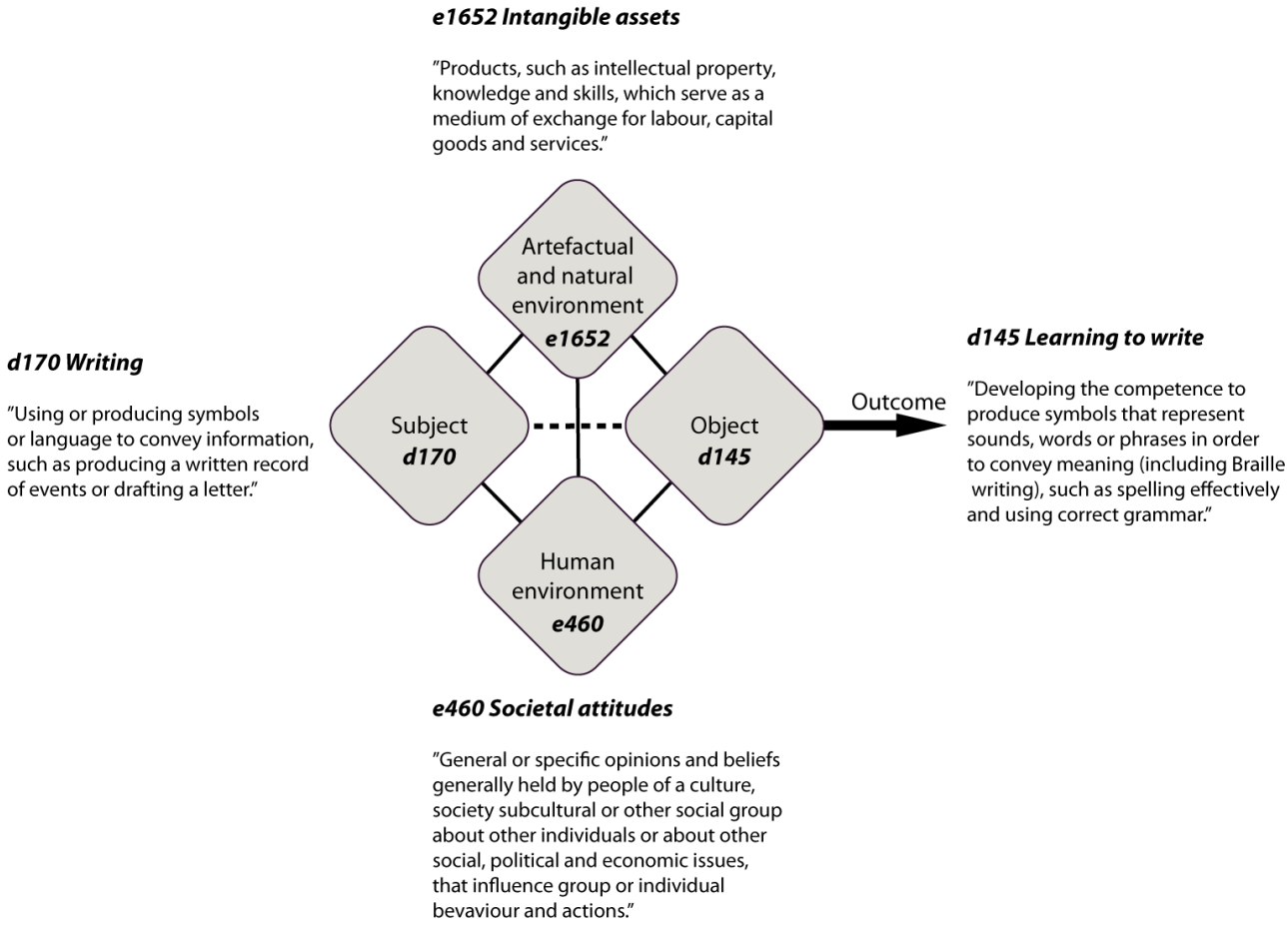


Figure 6. The Activity Diamond with an ICF example: Writing.

The example in figure 6 is about a person's development of writing skills, where 'd145 Learning to write' covers the earlier phases of the mature skill found in 'd170 Writing'. Both of these can be placed either on the subject (activity capacity) or the object (participation performance) side. Here they have been placed in order to portray the acquisition of writing skills. When the subject is learning to write, this is the object of his or her activity. Over time this activity matures into writing skills. When writing, the subject utilizes his or her writing skills (d170 activity part) and the cultural tools and other artefacts at hand, among them the written language (e1652), to participate (d170 participation part) in an activity involving writing. In the example, the 'e460 Societal attitudes' impact the person's learning process by facilitating or hindering it.

CHAT has an ability to portray when several activity systems are at play concurrently (figure 7).

Figure 7. An example of a system description when two persons, one with disabilities and her personal assistant, are out shopping for a birthday present.

In many cases, two (or more) activity systems are at play simultaneously and need to be analysed together [8,12,13]. The same activity seen from several subjects' angles results in descriptions that are partly similar, partly different. A typical application of this CHAT feature is when trying to gain understanding of a child and the other persons in her family, seen together as a whole. Although involved in one and the same activity, different persons have different roles and are driven by different motives. The ICF currently lacks the ability to encompass more than one person at a time.

Conclusions

This article is a first step in exploring the potential relations between the ICF and CHAT, here represented by the Activity Diamond as a vehicle for the discussion of activity, participation and the person-environment interaction. The ICF today, to some extent, covers all the central concepts of CHAT and vice versa (as seen in figure 5) and there are plenty of openings for further elaboration of combinations of the two:

- CHAT has an outcome where activity within the system produces participation in the surrounding world, while the ICF lacks a clear distinction between activity and participation and might gain from a CHAT understanding of these.

- The ICF's classification can enrich CHAT by providing snapshots of the current state of an activity system and by using the classification at recurring instances, a development over time can be followed.
- CHAT with its activity systems can help the ICF with an understanding of the dynamic and ever-influencing nature of the relation between the categories and the need to focus on the lines between the categories in the ICF diagram (figure 3) in the future development of it.
- The ICF is more developed than CHAT in how the subject is depicted, and it can enhance CHAT's conceptualization of the subject.
- CHAT holds the capacity to describe several activity systems at play simultaneously and historically. This feature can help the ICF in the classification of, for instance, a family where more than one person's activity system must be understood in order to understand the family dynamics. CHAT can in this way assist the ICF with a view of systems that are part of larger systems and thus place the ICF model (person) in a world full of other ICF models (persons).

In conclusion, the ICF and CHAT have several similarities, such as having a multidimensional perspective on functioning and viewing functioning as dependent on many factors. By viewing the ICF as a systems model, the dichotomy between impairments and disability are bridged and brought together by depicting functioning as a systemic process in continuous change. There are differences as well, which can serve as a basis for identifying aspects that may need to be changed when developing the next version of the ICF.

References

1. World Health Organization. International classification of functioning, disability and health. Geneva, Switzerland: WHO; 2001.
2. World Health Organization. International classification of functioning, disability and health: children & youth version. Geneva, Switzerland: WHO; 2007.
3. Wade DT, Halligan P. New wine in old bottles: the WHO ICF as an explanatory model of human behaviour. Clin Rehabil 2003;17:349-354.
4. Vygotsky LS. Mind in society: development of higher psychological processes (new ed). Cambridge (MA): Harvard University Press; 1934/1978.
5. Vygotsky LS. Thought and language (2nd ed). Cambridge (MA): MIT Press; 1986.
6. Leontiev AN. Activity, consciousness, and personality. Englewood Cliffs (NJ): Prentice-Hall; 1978.
7. Leontiev AN. Problems of the development of the mind. Moscow: Progress Publishers; 1981.
8. Engeström Y. Learning by expanding: an activity-theoretical approach to developmental research. Orienta-Konsultit Oy. 1987. Available: http://communication.ucsd.edu/MCA/Paper/Engestrom/expanding/toc.htm via the INTERNET. Accessed 2008 May 22.
9. Kaptelinin V, Nardi BA. Acting with technology: activity theory and interaction design. Cambridge (MA): MIT Press; 2006. p 345.

10. Wertsch JV. Voices of the mind: a sociocultural approach to mediated action. Cambridge (MA): Harvard University Press; 1991. p 33.

11. Suchman L. Human-machine reconfigurations: plans and situated actions (2nd ed.). Cambridge (MA): Cambridge University Press; 2007.

12. Engeström Y. Expansive learning at work: toward an activity theoretical reconceptualization. J Educ and Work 2001;14:133-156.

13. Engeström Y. From teams to knots: activity-theoretical studies of collaboration and learning at work. Cambridge (MA): Cambridge University Press; 2008.

14. Hedvall PO. Xings for augmented family communication. Full paper and poster presented at ISCAR 2008, San Diego, 2008.

15. Gibson JJ. The ecological approach to visual perception. Psychology Press; 1986.

16. Norman DA. The psychology of everyday things. New York: Basic Books; 1988.

17. Simeonsson RJ, Sauer-Lee A, Granlund M, Bjorck-Akesson E. Developmental and health assessment in habilitation with the International Classification of Functioning, Disability and Health for Children and Youth. In: Mpofu E, Oakland T, editors. Rehabilitation and health assessment: applying ICF Guidelines. New York: Springer Pub; 2009.

18. Bruyére SM, Van Looy SA, Peterson DB. The International Classification of Functioning, Disability and Health: contemporary literature overview. Rehabil Psychol 2005;50:113-121.

19. Coster W, Khetani MA. Measuring participation of children with disabilities: issues and challenges. Disabil Rehabil 2008:30:639-648.

20. McConachie H, Colver AF, Forsyth RJ, Jarvis SN, Parkinson KN. Participation of disabled children: how should it be characterised and measured? Disabil Rehab 2006;28:1157-1164.

21. Stamm TA, Cieza A, Machold K, Smolen JS, Stucki, G. Exploration of the link between conceptual occupational therapy models and the International Classification of Functioning, Disability and Health. Australian Occup Ther J 2006;53:9-17.

22. Coster W, Khetani MA. Measuring participation of children with disabilities: issues and challenges. Disabil Rehab 2008;30:639-648.

23. Barnes C, Mercer G. Theorising and researching disability from a social model perspective. In: Barnes C, Mercer G. Implementing the social model of disability: theory and research. Leeds: The Disability Press; 2004. p 1-17.

24. Whalley Hammell K. Deviating from the norm: a sceptical interrogation of the classificatory practices of the ICF. Brit J Occup Ther, 2004;67:408-411.

25. Stucki G, Ewert T, Cieza A. Value and application of the ICF in rehabilitation medicine. Disabil Rehab 2003;25:628-634.

26. Cieza A, Geyh S, Chatterji S, Kostanjsek N, Ustün B, Stucki G. ICF linking rules: an update based on lessons learned. J Rehab Med: Official Journal of the UEMS European Board of Physical and Rehabilitation Medicine 2005;37:212-218.

27. Whiteneck G, Meade MA, Dijkers M, Tate DG, Bushnik T, Forchheimer MB. Environmental factors and their role in participation and life satisfaction after spinal cord injury. Archives Physical Med Rehab 2004;85:1793-1803.

28. Badley EM. Enhancing the conceptual clarity of the activity and participation components of the International Classification of Functioning, Disability, and Health. Soc Sci Med 2008;66:2335-2345.

29. Ibragimova N, Pless M, Granlund M. The utility of ICF in mapping the communicative ability of non-speaking children in Russia. Disabil Rehab 2007;29:1689-1700.

30. Ibragimova N, Granlund M, Björck-Åkesson E. Field trial of the ICF version for children and youth (ICF-CY) in Sweden: Logical coherence, developmental issues and clinical use. Dev Neurorehab 2009;12:3-11.

31. Shakespeare T. Disability rights and wrongs. London: Routledge; 2006.

32. Swain PJ, French S, Barnes C, Thomas DC. Disabling barriers, enabling environments (2nd ed.). London: Sage Publications Ltd; 2004.

33. Hedvall PO. Situerad design för alla – till improvisationen lov (Situated design for all – In praise of improvisation) [licentiate thesis], Lund, Sweden: Certec, LTH, Lund University; 2007. 179 p. Available in Swedish with an English summary at: http://www.english.certec.lth.se/doc/situateddesignforall/index.html Accessed 2009 Oct. 22.

Acknowledgements

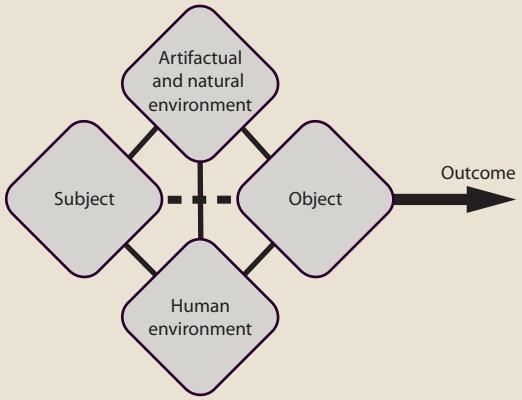
The authors gratefully acknowledge Bodil Jönsson, professor at Certec, Department of Design Sciences, Lund University, Sweden for her inspiration, critical questioning and constructive feedback, and Eileen Deaner, international coordinator at Certec, for translation services and comments on the text.

The purpose of the research presented in this thesis is to enhance the field of accessibility to include a multitude of perspectives. Based on cultural-historical activity theory (CHAT), it analyzes how human, artifactual and natural factors impact an individual's possibilities to act in concrete situations.

The thesis presents two main results:

An enhanced accessibility encompassing
- Epiaccessibility, accessibility's spirit of the times, stands for how experiences of activities alter accessibility capacities, learning, expectations, attitudes, trust, demands and denials of the individual and her human, artifactual and natural environments.
- Lived accessibility, which denotes the conditions for a person to be able to do what she wants in a concrete situation.
- Planned accessibility, which consists of all the accessibility factors that can be created beforehand based on plans, guidelines and principles.

The Activity Diamond, a model for accessibility



The Activity Diamond portrays a human activity system, where the subject-object relation is mediated and thus influenced by the human, artifactual and natural environments. The model is based on four interrelated sets of factors and is situated in time and place. Different actors with different activity systems may be involved. The model can also be used longitudinally.

LUNDS UNIVERSITET

The thesis can also be found at:
www.certec.lth.se/doc/theactivitydiamond

The explicit purpose of Certec's research and education is to achieve better opportunities for people with disabilities through useworthy technology, new design concepts and new individualized forms of learning and searching.

DOCTORAL THESIS
CERTEC, LTH NUMBER 2:2009
ISBN 978-91-976894-8-9
DECEMBER 2009

PER-OLOF HEDVALL
THE ACTIVITY DIAMOND
MODELING AN ENHANCED ACCESSIBILITY

Certec
Rehabilitation Engineering and Design Research
Department of Design Sciences
Faculty of Engineering
Lund University

Certec, LTH, Lund university
PO Box 118
SE-221 00 Lund

Sölvegatan 26
SE-223 62 Lund

+46 46 222 46 95

+46 46 222 44 31

per-olof.hedvall@certec.lth.se

http://www.certec.lth.se