ACCESSIBILITY AGENTS AND THE FUTURE OF INCLUSIVE DIGITAL DESIGN & ENGINEERING

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AR examples: Students of HAN B302: Sam Kleisterlee (animator); Vincent Brouwer (developer); Amy Yen.

AR art: Pan Vanitcharoenthum and Reinout Velleman
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AUGMENTED REALITY

Some of the pictures in this book have an extra layer that can be opened by using the camera of your mobile phone. In most cases, once you scan the QR code with your smartphone camera, it will lead you to a webpage that lets you place a 3D model on your table. You can walk around the 3D model and zoom in and out.

There also is an example of an 'art-card' that looks like a simple QR code. Once you open the website using the QR code, you can point your camera at the 'art-card' and it will show a 3D artwork made by Pan Vanitcharoenthum (www.panvanit.com).

There are also 3 video's and an animation that can be opened by using your smartphone and installing the app made by students of B302.

THIS IS FOR YOU

This book also contains something for you! A painting. Specially made for this inauguration by artists Pan Vanitcharoenthum and Reinout Velleman. You can put it on any wall and watch it with your smartphone.

Scan the QR code with your smartphone or tablet. Then choose the 'AR' button and point your phone to where you want to place the painting on the wall. Description of the virtual painting: This artwork is the result of an exchange between a painter (Reinout Velleman)

and an algorithm he developed. The algorithm was trained to locate the face of Frans Banninck Cocq in a low resolution image of Rembrandt's 'the Night Watch'. However, because the sensitivity had been set to low, the face seemed to appear everywhere according to the program. A monochrome portrait was left at each occurrence. The artist then transposed this image into an oil painting. The question that followed from this process was to whom the authorship of the work belonged, the painter or the algorithm. Is it possible to recognize a computer program as an autonomous artist?

Note: The Augmented Reality examples in this book are not yet made accessible. Some of the (currently non-accessible) AR layered images and videos in this book are made by students of HAN Bureau B-302 (creative media mob) in their search for requirements for people with disabilities.

Animation made by HAN 'B302' students about the HAN Research Group for Inclusive Digital Design & Engineering.cvcxassessments, best practices, technology roadmaps and codes of conduct. Inclusive, multidisciplinary teams will be set up to monitor, validate and benchmark AI systems.

As a research group, we would like to work on the inclusion aspects of these tools and study user needs, monitoring and reporting, data visualization, privacy and security aspects related to accessibility.

STAKEHOLDERS' INPUT

In preparation of this research group, we have spoken to many people to find out what they think should be the main questions regarding inclusive digital design and

ACCESS ALL AREAS

Interactions with technology depend heavily on what we can see, hear, say, touch, learn, and remember. Are we forced to adapt to technology, or is technology adapting to us (Microsoft, 2016)?

According to the UN, around 1 billion people in the world are – to some degree - affected by a disability (United Nations Enable, 2021). For example, in the Netherlands alone, more than 300.000 people have a visual disability (De Klerk et al., 2012). Population growth, a rise in chronic health conditions and the ageing process will further increase those numbers in the coming years (World Health Organization, 2021). If we want all these people to fully and equally participate in society, we need to ensure that our society is inclusive. This means that we have to design new media and technology applications to be accessible for everyone, including for persons with disabilities.

This seems obvious, but is not yet part of most curricula, it is not on the agenda of most organizations making new media and technology products and services and it is not part of most research projects. It is also not a requirement for most funding and tender calls. So there is obviously work to do.

How can we make sure that technology around us is designed and made in such a way that we can all use it. Companies like Microsoft, Apple, Google have taken up the challenge to include accessibility into their products and services from the start of the design and engineering process. This focus on inclusive design as opposed to exclusive design means that persons with disabilities do not need 'separate versions or entrances' to products and services but can use the same inclusive mainstream product as everyone else.

In 2006, the United Nations declared that accessibility is a fundamental aspect of the modern information and knowledge society. In their UN Convention on the Rights of People with Disabilities they recognized accessibility as a basic human right (United Nations, 2006). The UN Convention is supported by laws and regulations in most countries of the world. This includes all EU Member States, the US, Canada, etc.

More and more organizations and individuals freely and collectively adopt and implement accessibility, like in the case of websites and mobile applications. But in many cases,

accessibility is still far from an integral part of the (post-) design and engineering process. This is not hopeful for persons with (visual) disabilities, and many worry about the accessibility of the tech that is increasingly surrounding us (Broerse et al., 2015; Kappen et al., 2018). Can they still move around and control the world around them, their house, their health, their work?

As a results of the UN Convention, accessibility is a legal requirement in many countries. But we also conclude that the subject is still largely unknown to many students when they finish their studies. This includes students who will be developing the next generation technology.

Next, the current knowledge and legal requirements are mostly limited to accessibility of software, websites and electronic equipment. For many new technologies, there are no existing guidelines or even good practices to refer to. This means that in many cases, accessibility is added at a later stage of the lifecycle of new media and technology products and services, causing much higher costs (Boehm, 1984; Dawson et al., 2010).

There is an opportunity for education, research and industry to help find, document and share outcomes, design patterns and good practices and make sure that the next generation professionals will be more aware and their technology more accessible from the start.

Another aspect of accessibility that needs attention is the focus on compliance with guidelines. Even when there are guidelines, like for the web, and when organizations freely take up accessibility, they often seem unable to fully implement it or keep it implemented, even if the law requires them to and they are actively pursuing it (E. M. Velleman, 2018).

More policies and good practices are needed to support continuous implementation of accessibility during the full lifecycle of products and services. This includes developing awareness, policies, guidelines, maturity growth models, monitoring activities, datamodels and more.

Within the Research Group Inclusive Digital Design & Engineering, professionals from education, research and the workfield can work together with students to co-create and share knowledge and solutions for inclusive digital design and engineering challenges.

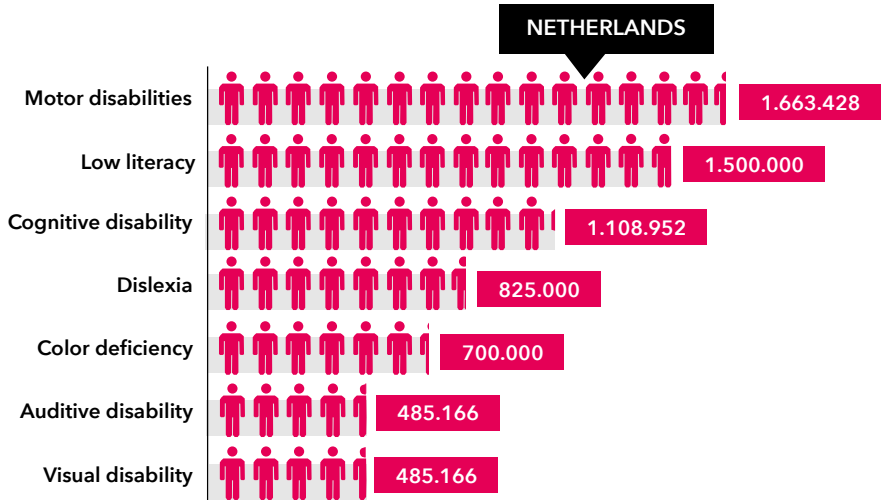
Challenges regarding monitoring, maturity of organizations and accessibility of new (innovative) media and technology (applications). Providing solutions for the multi-dimensional concept of disability, and in doing that, making the world more inclusive for everyone. HAN promotes this in the new course plans for 2022 - 2028: "every student and employee makes a difference on social issues".

THE MULTI-DIMENSIONAL CONCEPT OF DISABILITY

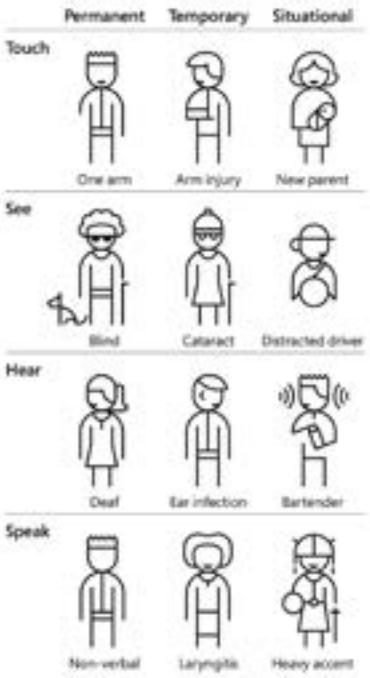
The United Nations have set the foundation for the implementation of accessibility standards in the UN Convention on the rights of persons with disabilities (UNCRPD) (United Nations, 2006).

In the UNCRPD, the UN defines persons with disabilities as "*persons who have long-term physical, mental, intellectual, or sensory impairments which in interaction with various barriers may hinder their full and effective participation in society on an equal basis with others.*" The Convention adds that disability is also an evolving, interactive and multi-dimensional concept, "not only an attribute of the person but a result of the interaction between persons with disabilities and attitudal and environmental barriers".

If we regard disability as an evolving, interactive and multi-dimensional concept, then social participation and inclusion of people with disabilities can be improved by addressing the specific barriers they encounter in their attempts to fully and equally participate in society. Further in this inaugural speech, I will argue that to address this, wider measures are necessary than just requiring conformance with standards or integrating it into your organizational processes. These measures include health and work related measures, schooling, changing policies, creating awareness, co-creating solutions, good practices and standards.



Persons with disabilities in the Netherlands (collected from multiple sources including: CBS, Volksgezondheidenzorg (.info), SCP, Gezondheidsmonitor GGD and RIVM). According to the UN, around 1 billion people in the world are – to some degree -- affected by a disability (United Nations Enable, 2021)



Microsoft's inclusive design toolkit addresses permanent, temporary and situational barriers.

Besides long term and temporary disabilities, there are also situational barriers. We rely more and more on technology for our daily activities, jobs, education and leisure. If this technology is not accessible in different contexts, these activities can become a challenge, even if you do not have a long term or temporary disability. For example, a natural circumstance like sun-glare might limit a person's abilities, making it difficult to read a screen. A loud environment can make it difficult to hear computer audio without a headphone or to speak to your conversational interface. If you are on a bumpy road, it may be difficult to push those small buttons on the screen. As driver of a car you could be distracted from the road for a moment, causing you to misjudge the traffic.

THE TERMINOLOGY-SOUP

So what is digital accessibility? ISO defines accessibility as the "extent to which products, systems, services, environments and facilities can be used by people from a population with the widest range of user needs, characteristics and capabilities to achieve identified goals in identified contexts of use" (ISO/IEC, 2014). For the web and web applications, the World Wide Web Consortium (W3C) defines it as "The world …. including websites, software, mobile applications and the internet (Web) of things is Perceivable, Operable, Understandable, and Robust (POUR) for all people, whatever their hardware, software, language, location, or ability." POUR is also used by the European Commission in their Directives requiring accessibility of websites and mobile applications.

Most design approaches like inclusive design embrace accessibility as an attribute of their methodology and put people in the center from the very start of the process. But the exact position or role of accessibility is diffuse when we read into the multitude of design approaches like Inclusive Design (ID), Universal Design (UD), Design for All (DfA), User eXperience (UX) and Universal Accessibility (UA) (Aizpurua et al., 2016; Zallio & Clarkson, 2021). And it does not stop there. In their top strategic technology trends for 2022 (Gartner, 2021), Gartner introduces Total Experience (TX). A business strategy that combines customer experience (CX), employee experience (EX), user experience (UX) and multiexperience (MX). The goal of TX is to drive greater customer and employee confidence, satisfaction, loyalty and advocacy. Organizations will increase revenue and profit by achieving adaptive and resilient TX business outcomes. They do describe accessibility as being a part of TX. But even if it is an attribute of the above methods and approaches, applying these methods and approaches does not automatically make products or services comply with accessibility guidelines. It has to be specifically

addressed to make experiences that are not only compliant with standards, but also usable for all (Microsoft, 2016).

More and more companies are taking up accessibility as part of Diversity, Equity and Inclusion (DEI)[1]. Boards of directors have long stayed away from politically or socially sensitive topics but according to Gartner's analyst Iyengar, an increasing number is aligning corporate goals with societal values. An important driver for this is external: as a result of societal developments like #metoo, BlackLivesMatter and the Covid pandemic, credit rating agencies and investors place increased emphasis on Diversity, Equity and Inclusion (DEI) when evaluating companies. The survey among boards of directors found that in 26% of the boardrooms that answered the survey, DEI was now discussed quarterly. In DEI, accessibility is a specific part of inclusion goals.

Sometimes, the lack of consensus on the place, the use and the definition of accessibility in all those approaches makes it difficult to know if people are talking about the same thing when they share research findings. This may confuse students and stakeholders and even hinder the actual adoption and implementation of digital accessibility, thus limiting the potential benefits for persons with disabilities (Arsel et al., 2021; Persson et al., 2015; E. Velleman & van der Geest, 2011). The benefits range over a wide area of levels including personal, business and society.

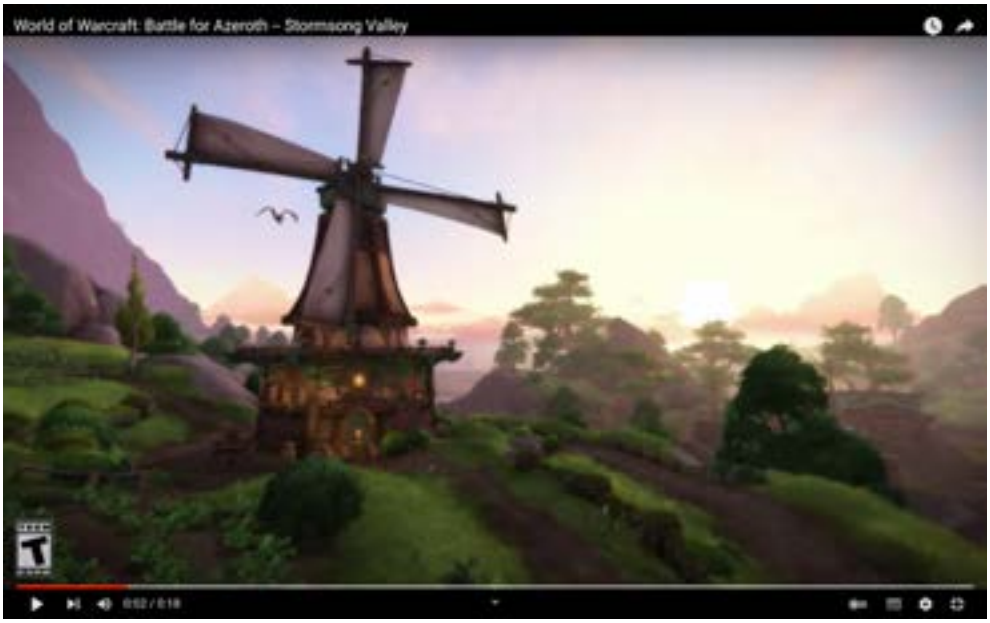
This 'terminology-soup' may be a reason why some authors specifically added accessibility to DEI to generate IDEA (Inclusion, Diversity, Equity and Accessibility) (Mullin et al., 2021; Zallio & Clarkson, 2021). In IDEA, accessibility not only has a more prominent position, it also makes what is now an attribute of methods and approaches more visible and therefore helps make it a more explicit and fundamental part of the agenda for new media and technology.

1 In his presentation at Gartner IT Symposium/Xpo 2021, Partha Iyengar, VP Analyst, Gartner, shared key takeaways from the Gartner Board of Directors Survey for 2022.
link: **https://www.gartner.com/en/articles/6-key-takeaways-from-the-gartner-board-of-directors-survey**

Some think humanity will soon spend time in the virtual world where we can spend our crypto money and show-off our NFT's. But is it accessible? What are the user needs and requirements for people with disabilities when using virtual reality or immersive environments, augmented or mixed reality and other related technologies (XR). We are challenging HAN students to work on XR and contribute to inclusive digital design and engineering of XR worlds and experiences.

EFFECTS OF INACCESSIBILITY

According to the World Health Organization, the economic, legislative, social and physical environment in a country may help resolve, create or maintain barriers to full participation of people with disabilities, influencing their economic, civic and social life (WHO, 2011). Examples of barriers are the inaccessibility of buildings, transport, information and communication technologies and of other products and services by public and private organizations and individuals. And important for research, the barriers also include a shortage of data and analysis for evidence-based, efficient and effective solutions.
The barriers also influence the risk of inadequate access to education, healthcare, culture, work, etc.



Screenshot from World of Warcraft. More and more game developers are adding accessibility options to their games like captions, color contrast settings, speech in- and output, etc. However, much more research and exploration is needed. Some developers see opportunities to combine existing games with Metaverse-like worlds.
When acquiring Activision Blizzard, Microsoft chairman and CEO, Satya Nadella said: "Gaming is the most dynamic and exciting category in entertainment across all platforms today and will play a key role in the development of metaverse platforms [..] We're investing deeply in world-class content, community and the cloud to usher in a new era of gaming that puts players and creators first and makes gaming safe, inclusive and accessible to all."

Imagine if more individuals with (visual) disabilities would be able to (keep their) jobs because workplaces are made accessible and companies include accessibility in their organizational processes. The accessibility solutions may not just be interesting for persons with disabilities, but also for companies to pursue a broader market and use for their products and services. It also helps companies with their ethical ideals, and actively pursuing accessibility even makes their existing non-disabled workforce more motivated to stay longer (Forrester, 2016). This benefits not only persons with disabilities and business, but also society as a whole.

Sadly, the current reality is that if you use assistive technology or even just a larger screen and your IT department decides to change the computers overnight to make workplaces more flexible, you are not able to work when you arrive in the morning. Then, instead of

concluding that the department has a low maturity level when it comes to accessibility, you get the feeling that they see you as a nuisance.

A study by the University of Amsterdam for Bartiméus Fonds shows that the number of visually impaired persons with a job in the Netherlands is consistently lower (29%) than that of people without a disability (84%) (Heppe et al., 2020). Also their income is lower. Looking at the total group of persons with disabilities, these figures are 51% versus 75%. The number of disabled persons with a degree is much lower than that of people without a disability (Braithwaite & Mont, 2009; Eurostat, 2015; Geiger et al., 2017; Hammersley, 2020; Tinson et al., 2016; van der Zwan & de Beer, 2021). Unemployment, the inaccessibility of education, low wages and increased cost of living do not only increase the risk of poverty for people with disabilities (Braithwaite & Mont, 2009; United Nations Enable, 2021), they also cause inequalities in health (Bussemaker et al., 2021). Fair health is one of the pillars of research at HAN University of Applied Sciences. Already, we have started projects with students and colleagues at HAN to create awareness and integrate inclusive digital design and engineering (specifically accessibility components) into the curriculum, including student research projects, semester projects and internships. We also have a HAN wide Learning Community involving other schools within HAN, a working group together with other UAS (with help of Bartiméus and Accessibility Foundation) and a working group that looks at all aspects of the organization and strategies of HAN for broad organizational adoption and implementation of the subject.

THE LEGAL FRAMEWORK

Accessibility is a fundamental aspect of the modern information and knowledge society that is recognized by the United Nations Convention on the Rights of People with Disabilities as a basic human right (UNCRPD) (United Nations, 2006). In the past, countries have already worked this into their national laws and regulations in many different ways, with different requirements, thresholds and exemptions. Mostly included into anti-discrimination laws. For organizations, specifically imagine large companies, working in more than one country, these local differences complicated accessibility implementation.

Using the same legal basis and standards helps to prevent fragmentation. This is why, in the past years, the EU has taken a large number of measures to support harmonized accessibility laws and regulations in the Member States. These measures range from

funding, to standards and legal measures (like EU Directives). European Member States have to transpose these EU Directives into their own national legislation. The use of Directives is therefore an efficient tool for harmonization. For the standards and guidelines, the EU points to the same sources as most of the world. This makes life easier for public and private sector organizations who are active in more than one country or Member State. So it happens that the guidelines for accessibility of websites and mobile applications used in the EU are harmonized with countries outside of the EU. For the web, most countries in the world now use the Web Content Accessibility Guidelines. For software and electronic equipment, the Section508 rules have been used as a basis for the European EN 301 549 standard.

Some examples of laws and regulations in Europe that apply to all Member States:

- directive (2016/2102) on the accessibility of the websites and mobile applications of public sector bodies (European Parliament and the Council, 2016). In short, this directive requires all Member States to ensure that public sector body websites and mobile applications work for all people 'regardless of disability'. It is supported by standard EN 301 549 that covers software, websites and electronic equipment. For the Web, this standard copies guidelines that are used throughout the world.

- the Accessibility Act (Directive 2019/882) covers accessibility requirements for products and services (European Parliament and the Council, 2019). It requires products and services of private sector organizations to be accessible. It points to the same standards and applies to a wide range of products and services like ecommerce, audiovisual media (including streaming services like Netflix, HBO, etc.), public transport, banking, computers, smartphones, tablets, e-readers, etc. Even advertisements should be accessible.

- the EU Digital Services Act and the EU Digital Markets Act cover anti-discrimination and point to the charter of fundamental rights for accessibility including for end users with disabilities to access online content and services including software applications.

Specific laws and regulations concerning accessibility in the Netherlands and relevant for HAN (and all UAS), students, education professionals, researchers and the workfield:

- the 'Tijdelijk besluit digitale toegankelijkheid overheid' is the Dutch transposition of the EU Directive (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2018).

- accessibility has been long covered in many other laws and regulations, e.g.: de Wet gelijke behandeling op grond van handicap of chronische ziekte (Wet *Gelijke Behandeling Op Grond van Handicap of Chronische Ziekte,* 2003), Aanbestedingswet (*Aanbestedingswet 2012*, 2012), artikel 429q WVS (*Wetboek van Strafrecht, Article 429q*, 1881), Wet elektronische publicaties (*Wet Elektronische Publicaties,* 2020), Wet generiek toezicht, and many others requiring products and services to be accessible (for public and private sector organizations).

- persons with disabilities are also explicitly referenced in the United Nations Sustainable Development Goals in SDG 4, SDG 8, SDG 10, SDG 11 and SDG 17. The SDG's are interconnected with the UNCRPD.

DISABLED AGENTS AND AI

(Ro)bots and software agents using Artificial Intelligence (AI) are already making decisions about who is fit for a job, who requires care, what music to listen to, what bubble you are in, who is a potential swindler, and in the case of your car, when to push the brake. Most online shops and streaming services can predict what you want to do next based on your trails and behavioral patterns. This means that AI is already reshaping employment, caregiving, automotive, security and other domains. Literature even mentions the reverse Turing test where machines require a person to prove he is not a robot instead of the other way round, by typing a Captcha or clicking on images of buses or traffic lights (Whittaker et al., 2019).

Searching the web or the way you move your cursor on the screen can be used by Machine Learning and AI to diagnose you. Research shows this could help diagnose Parkinson's disease, but this form of detection also raises fundamental ethical concerns around privacy, consent and disclosure.

The artificial intelligence community has long been working on (ro)bots that can think, feel and even live with us. Robots and software agents that can even have their own data-friends to exchange and build information and perform tasks. Until recently, these tasks were mostly limited to 'simple' things like playing a chess game, searching for cheap tickets, and answering one or two questions. Today, they can do more complex tasks like (adaptive) negotiations with multiple complex systems. But when trying to design more human-like agents or agents that have to do complex negotiations with other agents, issues arise like trust, emotion, adaptability, agility, resilience and other both basic and fundamental capabilities (Wiegel & van den Berg, 2009). Do we trust (ro)bots and software agents (using ML and AI) to land our airplane under difficult weather conditions?

Today, even the most simple technologies include software agents that communicate with other software agents. The possibilities of these agents, using Machine Learning and Artificial Intelligence (AI) and increasingly without any direct human interference seem countless. Especially if they can exchange data with other agents. These agents could make it possible to support or replace the more traditional accessibility solutions for persons with disabilities.

Special needs accessibility solutions used to be contained in separate products for reading, writing, control of devices, hearing, movement, mobility, etc. What if 'agents' would consider people with all needs in the mainstream design and engineering process. This would limit the need for separate and (often expensive) special needs solutions. For example, most blind persons in the Netherlands need assistive technology to use their computer at work. In many cases, this technology has to be installed locally. This requires the design of mainstream products and services that can collect, learn, exchange and adapt to user needs. This may involve learning the behavior and interactions of users with the products and services in different situations and contexts and the development of (ethical) standards for exchange of accessibility information between different agents.

The EU has recognized the ethical concerns around privacy, consent and disclosure and has addressed AI in the world's first ever legal framework proposal for excellence and trust in AI, laying down harmonized rules for artificial intelligence (Artificial Intelligence Act). By 2030, the EU requires high risk AI to be properly designed, tested and used to avoid bias and discriminatory impacts to disproportionally affect specific groups, including persons with disabilities, or by age, or by racial or ethnic origin in critical areas "such as education and training, employment, important services, law enforcement and the judiciary."

With the Act, the EU more or less forces companies from the US and China to conform to EU standards before their AI products and services can be used in Europe (more than 450 million consumers).

In the meantime, companies like Unilever and Sodexo are applying AI tools in the workplace to propose decisions about hiring, management, performance, etc. (Whittaker et al., 2019). The company providing the tooling also has a patent describing how their AI "can identify disabled people based on their speech, mannerisms, tone, and other physical markers" (Larsen et al., 2022). Do we know if this does not disregard the fact that disabled people are very diverse? Even if they identify as having the same physical disability, they can differ in motivation, intelligence, race, class, gender etc. A good solution would be to collect more accurate data information and patterns from disabled persons, but will that be enough, and how can we preserve their privacy? This information can have profound effects on persons lives. Disclosing a disability or an AI marking you as disabled may influence your chances of getting a job or insurance.

Screenshot of BBC website article about company stopping support of bionic eye implants (BBC, February 2022).

HAN researchers worked on the update, translation and redesign of the Web Content Accessibility Evaluation Methodology Report Tool (WCAG-EM Report Tool). Example of a result co-authored by the HAN Research Group for Inclusive Digital Design & Engineering in the past year:

THE WORLD IS REPORTING ACCESSIBILITY WITH A TOOL CO-AUTHORED BY HAN

We worked on the redesign of the WCAG-EM accessibility evaluation report tool. This tool provides worldwide support for web accessibility evaluation. It offers a step by step process to evaluate complete websites and share the results in a structured report.

The tool is internationally used by web accessibility auditing organizations. The steps in the tool and the resulting report are referenced by many countries in Europe and the world.

Evaluators can save/load their work at any moment and if they want send the file to others to see the results or to contribute. This way, persons with different roles in the evaluation process can contribute to the same evaluation. It is also possible to import data from tools that automatically check accessibility, thus combining manual and automated checking of accessibility.

The tool is available on the website of the World Wide Web Consortium (W3C). Currently the tool is available in English and Dutch.

Made possible by WAI-CooP
The tool was made in coordination with the W3C/WAI Education and Outreach Working Group within the WAI-CooP project. A Coordination and Support Action project, co-funded by the European Commission (EC) under the Horizon 2020 program (Grant Agreement 101004794).

Links:

- WCAG-EM Report Tool: https://www.w3.org/WAI/eval/report-tool/
- Web Accessibility Directive Monitoring Reports of which some are referencing WCAG-EM: https://digital-strategy.ec.europa.eu/en/library/web-accessibility-directive-monitoring-reports
- Structured report from the WCAG-EM report tool: **https://www.w3.org/WAI/eval/report-tool/evaluation/view-report**
- WAI-Coop project: **https://www.w3.org/WAI/about/projects/wai-coop/**

Another problem to look at is the fact that assistive technology, (ro)bots and software agents using AI and ML can break down during their lifetime. We are used to regular updates for our phones and computers, but imagine the 350 persons who have had bionic retinal implants in their eyes to help them see better. The company providing the implant stopped and so did all their updates and support. This happened in 2022.

Model-viewer example by Pan Vanitcharoenthum for this inauguration. Scan the QR code with your smartphone and place the object on the book to view. How can we make this accessible?

This realistically opens a broader question for research: what if (ro)bots, software agents or other AI's suddenly have a permanent, temporary or situational disability? Imagine if your robot loses a wheel, fights the cat and loses (or gets into another accident), or cannot see because the camera is blocked or the battery low. Or a part of the software could have a bug. Also, the lights in the room could be broken or the wifi connection lost. Studying this could on the one hand better help understand the accessibility requirements for users and on the other hand e.g. requirements for support and fallback mechanisms.

The enforcement of the EU Artificial Intelligence Act will require impact and conformity

assessments, best practices, technology roadmaps and codes of conduct. Inclusive, multidisciplinary teams will be set up to monitor, validate and benchmark AI systems.

As a research group, we would like to work on the inclusion aspects of these tools and study user needs, monitoring and reporting, data visualization, privacy and security aspects related to accessibility.

STAKEHOLDERS' INPUT

In preparation of this research group, we have spoken to many people to find out what they think should be the main questions regarding inclusive digital design and engineering that need urgent answering by the Research Group. During more than 24 preparatory interviews, stakeholders provided a rich list of priorities both for subjects to focus on in the next four years and for the priorities regarding the possible target audiences.

The 24 interviewed stakeholders include representatives from disability organizations and disabled persons themselves. We also interviewed researchers and education professionals from HAN, HvA and Tilburg University, experts from Bartiméus and Accessibility Foundation, other research groups (from Portugal and Austria), government officials (NL, Canada, US, Ireland), accessibility experts and audit organizations, a W3C project coordinator, funding organizations, and innovation experts.

First of all, the interviewed persons were all really enthusiastic about a Research Group specifically focused on Inclusive Digital Design & Engineering. They observe that both on a regional, national and international level, there is a:

- rapidly growing need to build, share and disseminate knowledge and information about inclusive digital design & engineering
- Strong demand for professionals who are knowledgeable about the subject and the related audiences

However, they also note that:

- although accessibility is a legal requirement in most countries, not many students learn about the subject during their study
- many studies are not accessible for students with disabilities because of the building infrastructure or the inaccessibility of study materials

The stakeholders applaud the initiative taken by HAN and Bartiméus and state that it is important that the Research Group not only contributes to HAN's expertise on this subject but also functions as a national and international pivot and driver of the subject, connecting HAN research with a large network of parties in the field, thus contributing to the development and transfer of information, knowledge and experiences on the subject.

When asked about the focus and audience for the Research Group, the stakeholders come up with a wide array of subjects and priorities ranging from an online list of links about the subject to ethical aspects of Artificial Intelligence and Machine Learning.

INVOLVEMENT

Asked for the main target audience to focus on, most of the 24 stakeholders identified persons with disabilities, as defined by the UN and WHO, some adding persons who experience situational barriers.

The goal being that in the end, all research and other output and results directly or indirectly benefits persons with disabilities, organizations and individuals developing products and services and adoption and implementation (this includes students, researchers and others).

To attain that goal, the interviewed stakeholders pointed to the importance of:

- involvement of persons with disabilities ('nothing about us without us')
- involvement with organizations and individuals who are directly or indirectly involved in the design, development, adoption and/or implementation of (new) media and technology
- involvement in legal and regulatory activities and standardization. The stakeholders point to the importance and impact of supporting policy and standardization with expertise, monitoring, tools and involvement of persons with disabilities
- involvement in innovation activities as an important opportunity to implement accessibility in the early stages of product and service design
- involvement in research regarding issues directly related to accessibility for persons with disabilities, like data-privacy and security

ROLAND GERBERS

"It is very important to me that I can participate well online and that I am independent. Online shopping is sometimes difficult for me as images appear too small or are not accurate."

IDD&E PRIORITIES

The priorities and subjects for study proposed by the 24 stakeholders rely strongly on their activities and are thus very diverse. The stakeholders came up with a long and wide list of 'necessary subjects'.

Based on the input by the stakeholders, the goals of HAN (in the course plans 2022 - 2028), the current projects and the actual links to education, we chose to focus on four overarching subjects and keep an open mind to other research priorities proposed by the stakeholders. All subjects are based on co-creation with users, students, education professionals, researchers and the professional field. The main subjects for the next four years are:

1. Maturity. The research group wants to contribute to the development of a growth model for organizational maturity to support the adoption and implementation of accessibility.

2. Monitoring and data visualization. To support accessibility. This includes research into effective and continuous monitoring of websites and mobile applications but also of other aspects relevant to improving accessibility.

3. Exploration and sharing. For many new technologies, there is not yet any information about how to make it accessible. We will co-create and share accessibility solutions. To skyrocket this, we are involved in 4 Next Generation Internet EU projects, and the WAI-CooP project.

4. Accessibility Network. We will continue to build and support an (inter)national community of stakeholders in education, research and workfield to help the subject evolve further and ensure that it is on every agenda.

Together with Bartiméus and Accessibility Foundation we already built up an extensive network that includes activities to make accessibility part of curricula.

Other subjects proposed by the stakeholders during the preparational interviews include:

- AI related projects to research user needs, data, privacy and security aspects specific to accessibility so AI's can provide assistance to people with all needs.
- personalization semantics, and related to this: data-privacy and security aspects for persons with disabilities
- environmental and attitudal solutions and barriers for advanced virtual assistants, robotics and accessibility support agents using sensor and other pattern generated data for smart living, health and mobility
- how to collect and use data (e.g. sensors, video and dark patterns) to prevent marginalizing of persons with disabilities
- guidelines/design patterns and good practices for smart spaces and immersive environments

Stakeholders also named: Internet of Things, Conversational Interfaces, Mixed Reality and Multi-modal interfaces,, digital twinning. Parts of these subjects may already be covered in the activities within the Next Generation Internet projects or in student projects (semester projects, internships, bachelor and master thesis).

Most stakeholders agree that inclusive digital design and engineering is a wicked problem, meaning that it looks simple, but the reality is more complex. The subjects provided by the stakeholders support this. One stakeholder describes it as a multi-dimensional puzzle, "with technical, organizational, financial, ethical, policy, harmonization and many other aspects" and wishes HAN and the Research Group good luck.

The special professorship is only 2 days per week. So sadly we cannot do everything. Focus is therefore on:

MATURITY GROWTH MODEL

For the web, there should be no problem to implement accessibility. The author of the standards for the web, the World Wide Web Consortium (W3C) says everything is ready made for this purpose (Lawton-Henry & McGee, 2018):

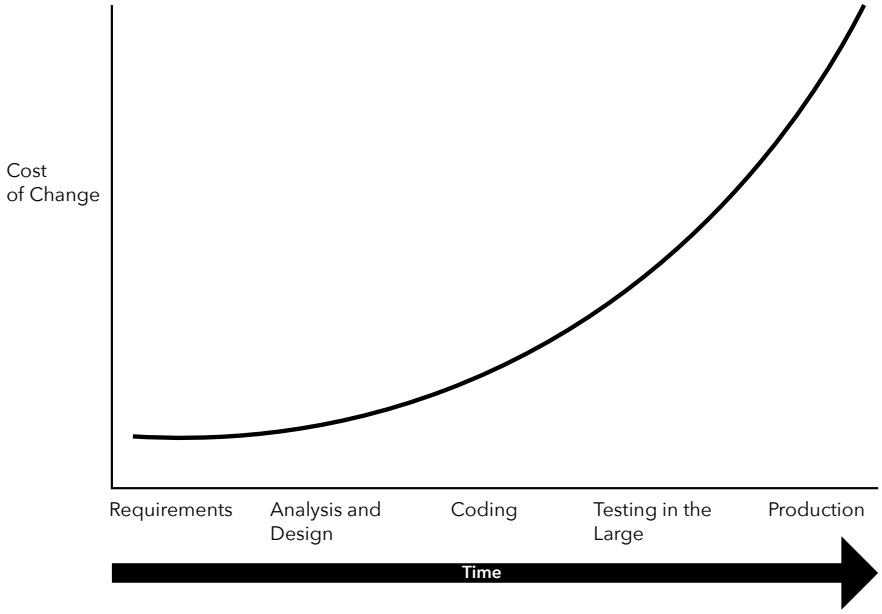
"The Web is fundamentally designed to work for all people, whatever their hardware,

software, language, culture, location, or physical or mental ability. When the Web meets this goal, it is accessible to people with a diverse range of hearing, movement, sight, and cognitive ability. Thus the impact of disability is radically changed on the Web because the Web removes barriers to communication and interaction that many people face in the physical world. However, when websites, web technologies, or web tools are badly designed, they can create barriers that exclude people from using the Web."

But, even though the web has accessibility built in, worldwide research shows that the actual implementation of accessibility is still behind all schedules and there are still substantial accessibility barriers to be found on most websites (Hanson & Richards, 2013; Level Access, 2019, 2020). As described earlier, this is serious, because according to the UN, these accessibility barriers may also increase the risk of inadequate access to education, healthcare, culture, etc.

However, the current level of implementation does not necessarily mean that nothing is being done. The accessibility barrier findings could be partly explained by the rigid approach to measuring accessibility standards implementation (Ebbers & van Dijk, 2007; E. M. Velleman & Wormeester, 2021). If we look at the vast amount of literature, for the web, the focus has long been on technical 'post mortem' compliance measurement. This means that website compliance is measured from a predominantly technical viewpoint and at the end of the process/development. The output is mostly provided including a description of the barriers to accessibility that were found (i.e. missing descriptions for images, bad use of headings etc.) (European Parliament and the Council, 2019; Gonçalves et al., 2012; Kuzma, 2010; Loiacono & Djamasbi, 2013; Rau et al., 2016).

Research into the reasons behind the barriers, shows that implementation is not just a technical issue, but also organizational (E. M. Velleman, 2018) and social. The importance of organizational factors to support the implementation of accessibility has long been underestimated. To view accessibility as a technical issue and to check for accessibility barriers at the end of the process will not do the job. Repairing barriers at the end of any development process is not just much more time consuming and expensive (Boehm, 1984; Dawson et al., 2010), in most cases it is also too late. For successful implementation, organizations should be in control and being in control involves much more than just testing for guideline compliance (providing there are guidelines for the new media or technology that you are implementing).



The Boehm curve shows that changes made later in the process lead to an increase in costs. Another important reason to apply inclusive digital design and engineering from the start of any process.

The Research Group will contribute to the development of a maturity growth model for organizational maturity to support the adoption and implementation of accessibility. A model that creates awareness and provides insight and solutions to organizations (and individuals) for the adoption and implementation of inclusive digital design & engineering in all phases and aspects of the lifecycle of products and services.

MONITORING AND DATA VISUALIZATION

Monitoring and reporting the actual status of accessibility is an important determinant of implementation success. In the case of websites, monitoring and reporting on technical compliance has long been the only way to address accessibility, but this does not necessarily show the measures organizations take to be in control. Accessibility statements could give more information about the actual implementation work as compared to the simple pass/fail information that we see in most reports.

We recently worked on the Monitor of the Dutch public sector body websites and mobile applications (E. M. Velleman & Wormeester, 2021). The project was commissioned to the Accessibility Foundation together with core expert and stakeholder organizations[1]. The reason for this monitor was the three yearly report the Dutch government has to send to the EU about the status of accessibility of websites and mobile applications (European Parliament and the Council, 2016). The report was very much focused on the technical results while aspects of the measures supporting implementation are available in the Accessibility Statements. Besides technical results (e.g. guidelines), monitoring and reporting should include the involvement of management, users (with and without disabilities, internal and external) and other relevant measures and processes in organizations.

Besides gathering information about adoption and implementation, we would also like to study the way all these data are visualized to stimulate the adoption and implementation of accessibility.

CO-CREATE AND SHARE

For many new technologies, there is not yet any information about how to make it accessible. The goal is to co-create and share accessibility solutions for an (inter)national audience.
For this reason, the Research Group is partner in multiple EU project. This includes the WAI-CooP project and the EU Next Generation Internet partnership.

1 Expert organizations involved in the Monitor: Accessibility (lead), Firm Ground and Cardan Technobility

WAI-CooP

For the Web, HAN is a partner in the EU funded WAI-CooP project[1]. The project is coordinated by the World Wide Web Consortium (W3C) and provides ample opportunities for co-creation and transfer of knowledge. Through W3C, the output of the Research Group will reach a large worldwide audience, thus generating a huge impact.

Together with students and researchers we have already worked on the revision of webpages on the W3C website and will continue this work in the coming years. The activities within WAI-CooP include:

- revision of the accessibility evaluation tools list: Establishing a vendor-neutral overview of available tools and resources with regard to web accessibility internationally. Multiple teams of HAN students have already worked on a draft design revision of the list. After the revision, the new tool will be built and then the tools list will be further filled and updated in the coming years. HAN will also help with the overview of accessibility courses and with a list of Frequently Asked Questions (together with the European Disability Forum)

- updating the policies pages on the W3C/WAI website: Gather and share information about policies regarding accessibility in all countries of the world. The information is published on the W3C websites.

- open Meetings: Providing opportunities for key stakeholders to share resources and to exchange best practices

In WAI-CooP, we build on the existing wealth of authoritative guidance available from the W3C Web Accessibility Initiative (WAI), to provide a one-stop shop for the broad spectrum of key stakeholders involved in the implementation of digital accessibility. This includes public bodies and private entities; organizations representing people with disabilities; product, service, and training providers; researchers; and policy makers.

1 This is project that is co-funded by the European Commission. Horizon 2020 Program (101004794).

Next Generation Internet

With our participation in the NGI0 projects, HAN has instant access to more than 300 innovative projects delivering products and services for the Next Generation Internet. The projects offer students, researchers and our network an exclusive insight into the technologies of tomorrow and possibilities to be involved in project opportunities.

The projects are related to searching on the internet (Discovery), to privacy enhanced technology (PET), to trust (ENTRUST) and to review (REVIEW). The overall mission of the Next Generation Internet initiative is "to re-imagine and re-engineer the internet for the third millennium and beyond to shape a value-centric, human and inclusive society for all".

The role of HAN is to contact the projects and build and exchange information about inclusive design and specifically on accessibility. If the technologies are new and there are no existing standards or solutions, HAN will try to help co-create and share accessibility solutions. Within NGI0, HAN is working together with organizations providing similar support in the field of security, packaging, privacy, etc.

The work involves organizing the contacts with the projects, providing them with information, asking them for questions, internships-, project- and research- possibilities and linking them with students, researchers and education professionals.

Some examples of the more than 300 awarded EU projects within the Next Generation Internet calls.

CRYPTPAD

Real-time collaboration with client-side encryption

Cryptpad is a secure and encrypted open source collaboration platform. The CryptPad teams project will fund the development of a number of group-focused features to Cryptpad. We'll improve our current implementation

of encrypted shared folders to display the permissions possessed by team members for different documents...

LIBRECELLULAR

Open hardware 4G Mobile Network

Free and open source solutions now exist for every component that is required to create a 4G cellular (LTE) network, all the way from the radio access network (RAN) and core, to services which are used for integrated voice (VoLTE). Creating a fully functional mobile network is the next logical step…

BETRUSTED STORAGE

Plausably deniable encrypted storage

Betrusted aims to be a secure communications device that is suitable for everyday use by non-technical users of diverse backgrounds. We believe users shouldn't have to be experts in supply chain or cryptography to gain access to our ultimate goal: privacy and security one can count on...

PERSONAL FOOD FACTS

Privacy protecting personalized information about food

Open Food Facts is a collaborative database containing data on 1 million food products from around the world, in open data. This project will allow users of our website, mobile app and our 100+ mobile apps ecosystem, to get personalized search results (food products that match their personal preferences and diet restrictions…

BONFIRE SEARCH & DISCOVERY

Improving search and discoverability in the Fediverse

Bonfire is a modular ecosystem for federated networks. The project creates interoperable toolkits that people can use to easily build their own apps to meet their specific needs. Users are then free to interact with multiple people and groups using these apps hosted on their own device, regardless of what federated software these other people use...

Within NGI, we continue to build an (inter)national network of education, research and professional field partners to co-create and transfer knowledge, information and good practices about different aspects of digital accessibility over a multitude of media and technologies (beyond web and mobile). These activities will be supported by a meetup platform and exchanges through weekly 'Tech Tinker Tuesday' events. The Research Group wants to contribute to the awareness and professionalization of students, lecturers, researchers and practitioners, together with all those involved, partners, projects and (inter)(national) network. This involves including the subject into different curricula and making students ambassadors for inclusive design & engineering.

By widening the group to include not only ICT students but a wider range of students and professionals from other studies, schools, Universities and UAS, we hope to broaden the scope of technology that is covered (like with studies related to health, automotive, ethics, etc.).

COMMUNITY OF STAKEHOLDERS

We will continue to build and support an (inter)national community of stakeholders in education, research and the professional field to help the subject evolve further and ensure that it is on every agenda. This means setting agenda's within HAN and Bartiméus, but also wider: local, regional, national and international. HAN has joined the W3C as a Member organization, an important step to work with the professional field on subjects regarding the future of the web. The Research Group plans to participate as expert in internal (Learning Communities) and external activities with regards to inclusive digital design and engineering.

For our network, and as part of the NGI Zero work, we plan to create a user testing group where stakeholders can request the help of actual users with disabilities to test products and services and other results of research and projects. The testing group will be available through the platform and during the Tech Tinker Tuesday Events. We will also organize round-tables with stakeholders in our network.

Screens in HAN Arnhem announce the weekly and open Tech Tinker Tuesday where students and all stakeholders can freely explore new technologies and help others find solutions. You are welcome to join!

HAN-WIDE ADOPTION

The website and the 2022-2028 Institutional Plan describe how HAN University of Applied Sciences wants to contribute to "a smart, green and social world of tomorrow" .
By the end of 2027, HAN wants students and employees to make "a difference on social issues and so deliver a meaningful contribution to the world of tomorrow". Key to this is good education and research "so we can train the professionals of the future in close connection with the region and the professional field". This may help to explain why HAN was enthusiastic about the idea to install a special Research Group on Inclusive Digital Design & Engineering. Inclusion (and accessibility) is an important factor in the 3 interconnected priorities smart, green and social. Recently, HAN started updating its curriculum for CMD. The new curriculum already specifically mentions inclusive design.

Together with other HAN colleagues, we started work on an update of the HAN strategic approach to accessibility. For example for the acquisition of new software, hardware and electronic equipment. This will not only improve accessibility of the website and apps, but may also influence the acquisition of new learning materials and the general accessibility of HAN for students with disabilities. HAN professionals should be knowledgeable of inclusive digital design and engineering methods but also in a practical sense produce accessible materials themselves, like websites, apps, research papers and other (pdf) documents. A special group has been created to formulate this new strategic approach.

Members of the Research Group already have the possibility to follow training about creating accessible documents (like pdf, Powerpoint etc.). Maybe we can include accessibility into the onboarding of all new employees.

TJARDA STRUIK

"Without inclusive education not everyone has equal access to the labor market. Good education is key to getting a job and gaining financial independence. So it is very important to ensure that everyone can follow the study of their choice."

FINALLY

Digital accessibility for all needs (including people with disabilities), is not only a matter of social responsibility, but also a legal requirement for products and services. There is extensive legislation and regulations in this area from, among others, the UN, Europe and the Netherlands that the professional field must (or will have to) comply with. Because the current design and engineering professionals need knowledge and experience with this, the professional field and professional practice are looking at courses and knowledge centers in the field of digital accessibility, or hope for expertise from recently graduated students.

Awareness and competences in the field of 'Inclusive (digital) Design & Engineering' should therefore belong to the luggage of all educational professionals and students in all programs, especially if they have a design or engineering character and if they produce products and/or services. Nevertheless, the subject of digital accessibility is still hardly to be found in Dutch education and new media and technology applications and innovations from education and the professional field are often inaccessible.

There is much work to do! Many hands are needed. To all of you who are here for the inaugural speech, or following the program online or reading this at a later stage, I hope you will join me and be a part of the network of stakeholders who want to join efforts to make new media and technology more inclusive, diverse, equitable and accessible!

Thank you.

FRED HISSINK

"Digital accessibility seems like an abstract notion, but really is as simple as being able to order a birthday present for my grandson online. I want to be able to do that myself, just like you, even if I can hardly see."

BARTIMÉUS, HAN AND BARTIMÉUS FONDS

Bartiméus is a center of expertise that has many years of experience in the field of accessibility for persons with visual and other disabilities. In 2001, together with Bartiméus Fonds, they set up the Accessibility Foundation to focus on accessibility for persons with a (visual) disability. The Foundation is involved in many national and international activities regarding standardization, policy development and implementation. For many years the Foundation was the only expert organization on the subject in the Netherlands. That is no longer the case. I see that as one of the many achievements of their work in the past 20 years. Bartiméus (Fonds) has always been a major supporter of the subject. Their main focus is on accessibility for persons with a visual disability, hence the subtitle of the Research Group: Inclusive Digital Design & Engineering, 'for persons with a (visual) disability'. The Research Group will work closely together on accessibility of new media and technology with the professionals of Bartiméus and Accessibility Foundation. Bartiméus offers HAN a unique opportunity to work with experts in all aspects of visual disabilities.

The HAN provides a stimulating environment for innovation, knowledge building and practice-oriented research in the field of inclusive digital design and engineering. In recent years, both partners have already worked closely together in a covenant. HAN offers more than 37 thousand explorers who can make a huge difference when it comes to making the world more social. Many of them have already worked on finding solutions for inclusive digital design and engineering.

Both parties wish to strengthen the existing collaboration and extend it to other schools and other Universities and Universities of Applied Sciences.

HAN endorsed the UN SDG 'Reducing inequalities' and acknowledges the laws and rules requiring accessibility. This means that many Research Groups, focal points, Professional Learning Communities and study programs in HAN have a need for expertise in the field of (digital) inclusion. This also applies to the professional field, both regionally, nationally and internationally. In its research and education, HAN focuses on 3 key areas:

- Smart Region
- Sustainable Energy & Environment
- Fair Health

The Research Group ultimately wants Inclusive Digital Design & Engineering to be an integral part of all education, research and activities in the professional field.

ACKNOWLEDGEMENTS

This special professorship is a lot of work and responsibility, but also great fun and therefore I must thank everyone who ever stimulated me to do this. Thank you!

First of all, thanks to Bartiméus, HAN and Bartiméus Fonds. My quest to make the digital world more accessible for persons with (visual) disabilities started at Bartiméus in 1987. Last year, we worked together to start Inclusive Digital Design & Engineering. Very special thanks to Thea van der Geest and Astrid Hoge (Director of HAN/School of IT and Media Design) for the fastest invitation mail ever! To Yvonne de Haan (CvB HAN) for the flexibility on the side of HAN and Jopie Nooren and Jan Naaktgeboren (RvB Bartiméus) on the side of Bartiméus. Many thanks to the members of the focus group: Paula van Woudenberg, Astrid Hoge, Thea van der Geest, René Bakker, Lyanne Feddema, Leonie Steggink. Thank you Ruud Tap and Marco Berndsen for helping find the right direction and strategy to combine the work of Bartiméus, HAN and Accessibility Foundation. Thanks to colleagues at Bartiméus who offered help and support (Jolyn van Vuuren, Dick Lunenborg, Hans Scholten, Melinda Choo, Inesz van Benten, and many others who deserve to be on this page). Thank you to Bartiméus Fonds for supporting and funding this lectorate, especially Joeke van der Mei and Frans van Nie.

A special warm thank you to the full team at CIM. I arrived in the middle of the Covid pandemic, everything was closed, everyone was working at home and still they organized meetings and events to make me feel extra at home and to get to know everyone by the titles of their books, Miro events etc. Thank you for the warm welcome! Special thanks to Boukje Postma who helps me and everyone at CIM understand 'how the hazen lopen' at HAN. Thanks to Leonie Hek and Ivo Schrijer for all their assistance with the EU projects. Since the start of the research group, we have so far added 5 EU projects to our portfolio and one is still waiting for a reply from the EU. Thanks to Wouter Nordsiek, we are giving the NGI projects a role in the Tech Tinker Tuesday events.

A special thanks to Thea van der Geest, with whom I have worked together for many years and with great joy. We wrote project plans and articles together and worked on the same subject 'accessibility of new media and technology applications'. Thea is now a 'pensionado' but I am sure we will stay in contact for many more years!

In preparation of this special professorship, many people helped a hand. Just to name a few: Shadi Abou-Zahra (W3C/Amazon), Ron Beenen (Deque), Jules Ernst (200ok), Stijn Hoppenbrouwers (HAN), Klaus Miesenberger (Uni Linz), Jan Engelen (Uni Leuven), Wilco Fiers (Deque), Jim Allen (TSBVI), Donal Rice (NDA), Claartje Sadee (Oogvereniging), Albert Klein, Frans van Hofwegen (HAN), Iacobien Riezebos (Firm Ground), Kristian Mul (Logius), Janny Brasker, Evert Verkade, Sasha van den Dries, Tessel Houdijk (MinVWS), Niels van Buren (Swink), Judith Jansen (ECIO), Elke van Doorn (ECIO), Marcel van Bockel , Wouter Bolier (Oogvereniging), Hannes Walrafen (Geluidinzicht), Vasilis van Gemert (HvA), Somaya Ben Allouch (Lector HvA), Dennis van Scherpenzeel (Consortium Visueel), Jan Wouter Dekker (Bol.com), Victor Zuydweg (Gebruiker Centraal), Maarten Verboom (Dedicon), Luuk Jan Boon (Oogvereniging).

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Eric Velleman (1960) is a passionate researcher and has built up a large international network in the field of inclusive digital design & engineering over the past 20 years. He obtained his doctorate in 2018 on research into the implementation of digital accessibility within Dutch municipalities and obtained his doctorate on this subject at the University of Twente. Velleman has conducted several studies into digital accessibility of, among others, the Dutch government, the business community and healthcare. In addition to his position as a professor, Eric Velleman is scientific advisor at the Accessibility Foundation and innovation expert at Bartiméus, a nationwide expertise organization that supports blind and partially sighted people.

INCLUSIVE DIGITAL DESIGN & ENGINEERING

With practice-oriented research, the research group wants to contribute to knowledge development and innovation in the field of digital accessibility, both nationally and internationally.
At the IDD&E Research Group, we are developing and sharing knowledge about accessibility of new media and technology applications. We do this together with lecturers, students, innovative partners (national and international) and with people with disabilities themselves. Our mission:

- Support public and private sector organizations.
- Reduce social inequality of people with disabilities.
- Strengthen self-management for people with a (visual) disability.

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