

## Universal Design of ICT: A Historical Journey from Specialized Adaptations towards Designing for Diversity

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**Abstract.** Over the last decades, the field of computer science has moved from specialized adaptations and add-on assistive technologies, toward universal solutions catering to a diverse set of user needs. Two paradigm shifts have arguably occurred on this journey: 1) a shift in disability perspective (from a medical model to a psychosocial and situated model) and 2) a shift from reactive accessibility efforts to proactive inclusive design efforts. In addition, we have changed our perception of the end-user (from ‘Mr. Average’ to situated individuals), have expanded our disciplinary epistemologies (from positivist objective knowledge to critical and empathic qualitative insights), and changed the way we build digital solutions (from plan-based with little user contact to iterative with high user contact). This article tells the story of this journey, and how these shifts have all influenced the way we think today. We argue that different ways of thinking about and arguing for universal design today are not necessary confrontations – but can be seen as evolvments over time to complement the different societal systems in which we are designing.

**Keywords:** Universal design, Disability model, Design for all best practice.

### 1 Introduction

Universal design (UD) of Information and Communication Technology (ICT) is today interdisciplinary and multifaceted, with different types of regulations, standards, principles, processes and disciplinary practices that have matured and changed over time. Given the interdisciplinarity, practitioners in the field of UD of ICT hold different schools-of-thoughts and disciplinary points-of-view. Further, we practice under heterogeneous national systems with different UD regulations, within different sectors and markets. As such, it can be hard for young researchers and practitioners struggle to identify the common guidelines for UD of ICT; agreed upon recommendations towards ‘good practice’. By highlighting key paradigm shifts from the past, the current rationale and values of the UD of ICT movement becomes clearer.

This historical outlook also provides a platform for discussing some of the apparent current confrontations in the field. When designing digital solutions, most agree the

ability to utilize a variety of design approaches is beneficial in order to match a diverse set of aims and constraints. However, diverging perspectives on an epistemological level is somewhat more confusing and polarizing. At the end of the paper, we therefore reflect on some of the challenges we face today when designing digital solutions to fit a diverse set of user needs. In relation to the different approaches and terminologies in use, we ask: Could these all be viewed as part of the Universal Design movements? And what important next contributions are needed on the continued journey towards designing for diversity?

## 2 Research Approach

The research approach applied in this paper, is an unstructured literature survey, qualitatively summarizing evidence on a topic to provide an overview [1]. In terms of extensiveness, the review was ended based on a feeling of literature command relative to its scope and length [2]. Chronologic and thematic structures are combined to tell a story of the theoretical history of a field; similar to that of a framework review [2]. From this ‘theoretical base’, we reflect and propose viewpoints for future discussions.

## 3 An Inclusive World: Universal Solutions for Diverse Users

### 3.1 Shifting Disability Perspectives

Modern parents are likely to stand in the principal’s office, demanding their special needs child get the best education possible. The idea that we should hide away our children with disabilities due to shame, is absurd. Whether it is acceptable or not to exclude persons with disabilities (PwD), is similarly argued to be a product of a cultural perception – for example that disability represents a divine punishment or that disability means less capable [3]. Different models for defining ‘disability’ co-exist in our culture (see Table 1) and though often reflected upon, the way we think about and understand disability and diversity, affect how we behave, the societal rules we accept and whether we recognize inclusion or exclusion.

**Disability as an Act of God, Illness or Victimhood.** *Moral (or religious) model*, under which a disability is viewed as a self-inflicted (or divine) punishment [4, 5] is an outdated view on disability. However, some may still think of a disability as a test of faith or a God-given opportunity for character development [6]. Another somewhat outdated way to thinking about disability, is of disability as a ‘disease’ or an individual abnormality. This understanding of disability as a person’s negative deviation from normal human bodily function is called the “medical model” [5]. In 1980, the World Health Organization (WHO) reflected this model: “*a disability is any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being*” [7].

The medical model is also called the *illness model*, as it seeks to correct (treat, reduce or repair) any ‘abnormal’ bodily functions. It has two other key offshoots models. First, the *rehabilitation model* believes that with adequate effort on the part of the person with the disability, the disability itself can be overcome [8]. We see this view in arguments over e.g. diabetes reversion. WHO split disabilities into the categories: temporary or permanent, reversible or irreversible, and progressive or regressive. The model is however critiqued for not taking permanent disabilities into account. Second, the *expert (or professional) model* take the view is taken that a professional (typically a medical expert) should identify a disability and create a plan for treatment or assistance [9]. A disabled is assumed to benefit from any intervention to correct or minimize ‘deficiency’.

All three models originated in the 18<sup>th</sup> centuries [10]. They place the source of the problem within a single impaired person and as such solutions are found by focusing on the individual [5]. From this follows that if a design does not fit you due to a disability, it is your deviation from ‘normal’ that is wrong and must be corrected – not the design itself.

Finally, among the older models on disability, we find the (still widespread) *charity (or tragedy) model* [4]. This view arose in the 19<sup>th</sup> century, differentiating disabled people from other disadvantaged community groups and categorizing them as aged, sick, insane or defectives, and deserving of charity. Today, this model is critiqued for depicting disabled persons as victims, deserving of pity and aid [9].

**Disability as Multifaceted.** The above described individual models faced pushback from PwD [11] as well as from the nursing profession [8]. Disability movements state individuals themselves are fully capable of making decisions about their life. This is reflected in the *empowerment model*, which holds that disabled persons have the most insights into their own disabilities, and thusly the ones that should be in charge of any treatment plan (with professional expert as advisors or service providers). This viewpoint seeks to provide the individual with autonomy, power, choice and control; and opposes the expert and charity models.

We now view disability as something more complex and multifaceted [8]. The medical model is somewhat modified in the *spectrum model*, where disability is defined along a scale of ‘normal’ function. The label ‘disability’ and its seriousness are derived from functional ability threshold levels (we start to talk about mild, moderate or severe disabilities).

Other disability models are also taken up, for example related to social security schemes. The *legitimacy model* recognizes that disability can be defined in many ways, thus stipulates any individual rights should be based on personal needs for assistance and adaptations [9]. The *economic model* approaches disability from an economic analysis viewpoint, and defines a disability based on a person’s ability to work, and the degree to which economical and productive conditions are affected [6]. It is mostly used by policy makers to assess distribution of benefits [5]. The challenge is one of creating societal systems that support individuals in a cost-effective manner, promoting equity with incentives and subsidies while decreasing stigma [5].

**Disability as Contextual.** In the 70s and 80s, the *social model* is promoted by disability movements, as a response to the medical model. This is also called the *barrier model*. The social model was articulated in 1976 [10]. It argues that society creates disabilities through a lack of awareness and concern about those who may require some modifications to live full, productive lives [8]. In this model, disability is a complex collection of conditions, many of which are socially created [9]. Disability is now an exclusion experience and a socially constructed phenomenon – in contrast to previous models that place the responsibility of ‘overcoming the disability’ on the individual. From this view follows that if a design does not fit you, it is not *you* that is ‘wrong’, but the design.

If disabilities are mainly socially created, it is a societal responsibility to remove attitudes that exclude from participation – instead of placing the responsibility of “overcoming” the disability on the individual. If society has created physical and social barriers, it must take responsibility for tearing these down. The social model is as such linked to the (*human*) *right-based model*, which focuses on how disabilities should not affect a person’s opportunities for participating in the society, nor the access to products, goods and services [4]. This model gained traction in the 1980s, and political discourses led to a range of laws embracing the rights of PwD [9].

The critique of the social model is not acknowledging that the society cannot accommodate or adapt for *all* lacking abilities in *all* contexts [4]. However, ‘softer’ versions of the social model appear. The *social adapted model* acknowledges that individual disabilities may somewhat limit equal participation in a non-disabled community, but still upholds that disabilities are overall mainly socially created [4, 9].

A nurse with a disability is credited for developing the *interface model*, stating that a disability exists at the meeting point between a medical diagnosis and the environmental [8]. Under this model, the role of the nurse is altered to support the preferences of PwD, while offering treatment. This is in line with the views of the empowerment model and merges the social and medical models [4].

The *biopsychosocial model* focuses explicitly on the interaction between a person and the contextual factors. As such, it draws on the interface model developed by the nurse profession but emphasizes the environment – not treatment. Disability is viewed as connected to both bodily functions (physical and mental) and social factors (possibilities for participation in a specific context and environment). In 2002, the WHO’s International Classification of Functioning, Disability and Health (ICF) was updated to reflect the biopsychosocial model instead of the medical [14]. This was a paradigm shift, impacting the role and responsibility of designers.




















The (*Nordic*) *gap (or relational) model* of disability is similar to the interface and social adapted models in promoting social inclusion for people with disability in the community by looking at people–environment interaction [12, 13]. It emerged in the early 2000s and overlaps with the biopsychosocial model in viewing disability as contextually created. The gap model states disabilities are appearing if there is a gap between a person’s abilities and the expectations of the social, digital, cognitive or physical environments or interactions. The role of the designer or developer under this model is to minimize and prevent gaps from occurring. This means the aims, needs, emotions, abilities, cultures etc. of the users must be identified and taken into account.

**Disability as Embodied Experience.** In rejecting the medical model view of disability as something ‘abnormal’ with the body (to be fixed), in favor of viewing disability as contextual (barriers being problems to be solved), disability is normalized. Looking at varying abilities as part of normal human traits leads to the conclusion that bodies (including brains) are of equal value regardless of being labeled as ‘disabled’ or not.

The *identity (or affirmative) model* shares the social model’s understanding of disability as socially constructed, but extends it with viewing disability as an aspect of who a person is [6]. This identity is viewed as positive; as a marker of membership in a minority identity, much like gender or race – and not as a tragedy for an individual [6]. Critical disability theorist is criticizing the “ableist understandings of disability” and not valuing atypical embodiments [15]. This is a direct reaction to the still common charity view, and is related to Disability Pride movements [9].

The identity model is extended in the *cultural model* [6]. While the medical model and the social model emphasize one factors each – body or context – the cultural model include a wider range of factors. The cultural approach focuses on how different notions of disability operate in the context of a specific culture.

**Table 1.** Overview of Disability Models

<b>Disability Models</b>	
	<b>Moral:</b> A disability is a self-inflicted or divine punishment.
	<b>Medical:</b> A disability is a negative deviation from normal human bodily function.
	<b>Rehabilitation:</b> Treatment to overcome the disability.
	<b>Expert:</b> An expert identifies the disability and plan treatment to correct deficiency.
	<b>Charity:</b> A disability is a personal, undeserved tragedy; deserving aid and sympathy.
	<b>Empowerment:</b> The disabled person should be in charge of treatment or assistance.
	<b>Spectrum:</b> A disability is defined along a range of seriousness based on ability.
	<b>Economic:</b> A disability is defined by (in)ability to work and productive conditions.
	<b>Legitimacy:</b> Disabilities can be defined in many ways; base rights on personal needs.
	<b>Social:</b> Disabilities are mainly socially created, thus societal responsibility to remove.
	<b>Right-based:</b> Disabilities should not affect opportunities for participation in society.
	<b>Social adapted:</b> Individual disability may limit, but societal responsibility to reduce.
	<b>Interface:</b> Support the preferences of persons with disability, while offering treatment
	<b>Gap:</b> Disability is contextually created; the gap between person and situated context.
	<b>Biopsychosocial:</b> Disability defined by interaction between person and context.
	<b>Identity:</b> Disability is a part of personal identity.
	<b>Marked:</b> Disabled and their families is a large and influential customer base.
	<b>Cultural:</b> Disability operate in the context of a specific culture.
	<b>Limit:</b> All humans are faced with limits.

The *marked model* combines a minority rights with a consumerist model, that looks at personal identity [9]. The marked model view PwD and their families and friends as a large and influential customer base with consumer power. In contrast, the *limit model* seeks to avoid categorizations such as ‘disabled’, ‘abled’ or ‘normal’. It emphasizes that all humans face individual limits (no humans can fly, not all can climb a mountain, some cannot walk) and focuses on embodied experiences and commonalities between people across typical categories. The limit model deviates from social and identity models by taking the stance that not all limits are ‘normal’ or ‘good’ – and recognizing that some people want to overcome certain of their limits [6].

**Summary.** There is a paradigm shift in the 2000s, where we move from:

- An official WHO definition of disability as a ‘wrong’ within the individual.
- The default notion that PwD needs treatment and are less capable.
- Making individuals responsible for fixing their disability issues.

To:

- An official WHO definition of disability as ‘limitations’ in contextual interactions.
- The default notion that disabilities should not affect opportunities for participation.
- Making society responsible for creating inclusive contexts.

### 3.2 From Reactive to Proactive Accessibility Efforts

For coming generations, it may be hard to envision a world without phones, texts, e-books, remote controls or speech technologies. Early versions of all these innovations were created as technological adaptations for PwD. It appears PwD are not only inventors of groundbreaking technologies, but also early technology adopters. Many was designed by end-users themselves or for close acquaintances. For example, Captain Fraser lost his sight in WW1 and got tired of learning Braille, so he led the team that innovated LPs and released the first talking book in 1935 [16]. Chat rooms were developed by two deaf researchers as a long-distance phone alternative for deaf people in 1964, and text messaging was developed in 1972 by Cerf, who was hard-of-hearing and wanted easy communication with his wife and friends [17]. Pellegrino Turri invented the typewriter for his blind friend in 1808 [3].

Moving through 1970-1990, the personal computer is making its presence known. We get the mouse, keyboard, icons, windows, applications and dialogue boxes. As before, adaptations are created for persons with different needs. Assistive technologies (AT) are built, such as screen readers and screen magnifiers for users with visual impairments, key-guards and switch systems for persons with motor impairments. Stakeholders such as the National Federation of the Blind and the Trace Center collaborates with tech-giants such as IBM and Microsoft [17] to research and create specialized adaptations. For example, Thatcher was inspired by his blind professor to pioneer the screen reader – which was released by IBM in 1986 [18]. However, accessibility adaptations are lagging behind mainstream innovations, as Stephanidis [19]

expresses: “*Each generation of technology (...) caused a new ‘generation’ of accessibility problems to blind users*”. The accessibility efforts become increasingly reactive.

In 1990, the Americans with Disability Act is legislated and in 1998, Section 508 requires information technology is made accessible to people with disabilities. Stakeholders, including the Trace Center, now promotes a more proactive approach to accessibility – moving away from third-party add-ons to provide out-of-the-box accessibility at no extra cost to users [20]. We start thinking about accessibility as something to be designed from the start. Standards and guidelines to support technical accessibility are developed. The WCAG criteria is particularly impactful; WCAG 1.0 in 1999, evolving to version 2.0 in 2008, and 2.1 in 2018 [21]. The move from reactive accessibility efforts to proactive inclusive design efforts is also a paradigm shift. In embedding accessibility into mainstream solutions, we move towards UD.

**Summary.** There is a paradigm shift in the late 90s, where we move:

- From specialized design as ‘add-on’ in a reactive accessibility approach.
- To a proactive accessibility approach focused on technical standards.

### 3.3 From Mr. Average to Situated Individuals

The discipline Human Computer Interaction is born in the early 80s, merging engineering with psychology and human factors [22]. Focus is on creating interfaces that are easy to understand and use, and during the 80s guidelines such as Shneiderman’s direct manipulation of objects (1982) and golden rules of interface design (1986), Norman’s gulfs of execution and evaluation (also 1986) and Nielsen usability heuristics and heuristic evaluation (1990) was developed [23]. Initially, this development was focused on ‘Mr. Average’ – a user that is male, white, western, middle class, educated, English speaking, able-bodied, young, tech-savvy, healthy and cis [24].

With the increase in digital solutions, we start worry about novice users with low digital competence. With this realization, we start to broaden our user focus. Initial focus was on access to computer technology. On a global level we started to understand that poverty leads to disability, and that disability leads to poverty. On a societal level, public spaces were used to promote digital competence. However, research found it was not so easy to reach non-digital users. Digital divides are often more complex than simply physical access. Some influential factors on usage uptake was found to be culture, race and socio-economic background. We realize people with different cultures, ages and genders might have different preferences and desires.

We discuss whether the system should automatically adapt to the user, or if the user should be able to adapt the system; we talk about multi-modality and the option to choose input and output devices according to your preferences. The aim to create use adaptations to cater to a diversity of needs is supported by the technological advancements. Through dialogue independence, the software system is separated from the user interface, enabling the flexibility to move towards catering to diverse users within one solution. With the new accessibility regulations, users with disabilities are

added to the expanded focus. Age, digital literacy, capabilities and culture perspectives are now thought of aspects of marginalized user groups in danger of exclusion.

Another major shift is when moving to the contextual disability models – such as the gap, the social and the biopsychosocial models. Now, we start thinking about contextual needs – expanding UD to cover non-disabled users. We slowly start to view our users as situated individuals, with their own unique experiences and needs that may put them at risk for exclusion in a particular contextual setting.

**Summary.** We move from thinking mostly about ‘Mr. Average’ (a white, western, young male) to thinking about different user groups (elderly, disabled, non-western) – and from this move towards thinking about our users as uniquely situated individuals in their particular contexts of use and with their subjective embodied experiences.

### 3.4 Increased User Contact and Changed Methodology

As digital solutions became more widespread, we needed a design approach that could provide early user feedback. There was a move from mainly doing late large-scale usability testing in plan-based development, to agile and iterative process models. Further, user (human) centered design (UCD) increases its uptake.

The developer and designer initially worked at a distance from the user, often with a task-based focus on user needs. The designer observed, designed, improved and acted as the expert. User needs specification could be expressed through use cases; and systems designed using UML models. Interfaces could be user tested in labs.

If viewing the professional designer or developer as the main expert within a typical (post-)positivist epistemology, it makes sense to get the expert to articulate objective, static, generalizable insights, and specify precise criteria to make sure the correct solution is built, in the correct way [25]. In such a frame of mind, the preferred methods would be quantitative – such as summative user testing and usability metrics benchmarking, eye tracking, surveys, marked research, statistical analysis, expert analysis, task analysis and so forth.

However, as the agile world opens up and cross-disciplinary negotiations start, it makes more sense to view the practitioner as an interpreter within both critical and constructivist paradigms; facilitating dialogue and reach a compromise between varying stakeholder. UCD is founded on user needs and focused on understanding the user in contexts of use, and advocates involving or testing with users early on. Identifying solutions that fit stakeholders’ needs within the defined constraints (which may change over time) fit well with the agile process of continuous updating the goal based on new insights and circumstances.

UCD emphasizes understanding users and their requirements, conducting iterative prototyping and evaluation, and are typically quite task focused. UCD approaches with minimal user contact are most common in agile projects [26]. Here, lean data collection makes sense; and using methods such as direct user feedback, guerilla testing, workshops, web analytics etc.



More political stances by the designer or developer – such as participatory design (PD) was introduced as early as in the 70s – but did not gain the same popularity as UCD. Viewing technology as non-neutral and co-constructive, PD seeks to empower the end-user, and focuses on power dynamics [27]. User involvement and ethical design is also important [28]. PD advocates viewing user input and practical experience as alternative expert interpretations and argues users and stakeholders should be equal partners. As design thinking approaches becomes popular, co-creation becomes more mainstream. Both PD and design thinking apply critical design perspectives. Design thinking does not seek to empower end users – but rather support divergent ideas. Still, both approaches promote methodological approaches that builds relationships with end-users.

When the accessibility regulations within ICT and the new way of defining disability changes the way we must think and work. UD is adopted in 2006 by the UN Convention on the right of PwD, and defined as: *“the design of services, products, environment and systems so that they may be used, accessed and understood by all people, to the greatest extent possible”* [29]. Note that the terms are no longer specifically focused on disabled users – but is rather “for all”. UD is cleverly branded as ‘good design’, hereby countering resistance from designers who feel accessible design would hamper creative processes and increase costs [15].

Focus is computer science is however on catering to people with different capacities. We move from specialized “add on” accessibility to accessibility compliance with specified standards. However, adhering to technical accessibility standards does not automatically ensure inclusive experiences and usability in real life [30, 31]. This is not typically reflected in regulations, which tend to refer to measurable standards – and not qualitative benchmarks. For example, though UD recognizes the necessity of ATs extending design, testing AT compatibility in real-life is not an emphasized procedure. Increasingly, we have started to talk about checking both ‘technical’ and ‘usable’ accessibility in order to emphasize this point.

As emphasizing accessibility compliance to technical standards becomes a popular strategy for meeting diverse user needs in computer science, we sense a troubling simplification of UD concept. Shneiderman [32] theorizes universal access is not sufficient to ensure universal usability due to the complexity of computing services. I believe the issue is also related to changed development process models. In a user-centered, innovative and experimental agile team, accessibility checklists does not work well as a one-time quality inspection step – particularly not when completed towards the end of a project [33].

In order to make sure more than the average user was considered, educational information on diverse needs are built to help the designer understand diverse user needs. Initially, personas and other mapping tools are used to aid the designer in doing UD by communicate the needs of user groups with disabilities. Using these tools, we move towards more specified guidelines on who and what should be considered. This helps key user groups and diversity needs to not be forgotten, however, does not guarantee that all important perspectives, are included.

As the developer and designer must focus on interactions in the contexts of use, checklists and guidelines become too limited to cater to these diverse and contextual

needs. Additionally, personas and other mapping tools are criticized for stereotyping the users. Several activists argue that basing UD standards on human statistics reinforced norms of race, gender, and ability [15]. There is now a tension between what is called ‘representative thinking’ versus involvement of real people in the process.

There is also discussions of costs, both of user centeredness and of UD. We start hearing the argument that one for all solution prove difficult in some cases, because requirements for one group could be exclusive to one another – just as the social model was critiqued [34]. However, the impossibility to really design for everyone could be viewed as inherent to design, rather than a characteristic of UD [35].

Perhaps to counter this argument, pro-UD arguments often fit a marked model on disability; framing disability as a part of consumers identities similarly to other personal aspects. In this model, one would argue for UD based on the economic benefits of a larger market. Tapping into edge-case needs to trigger innovation is also argued for based on economic opportunity. Looking back, we can see how specialized developments for disabled users has transformed mainstream use of technology. This supports the argument of the innovative power in edge-case approaches.

Edge-case design is also promoted within inclusive design. Inclusive design is both advocating for specialized design approach (designing for distinct users with specific needs), and for focusing on user diversity and (avoiding) design exclusion causes. It is a user-centered approach, advocating collaborative design and user involvement. With regards to specialized design, focus is on disabled users, in particular perceptual, cognitive and physical disabilities, but also on non-disabled users under suboptimal conditions of use. The idea of edge-case design as inclusive approach, is that if you design solutions that fit the edges of user needs, your solution will also fit the average.

We see that the UD principles on flexibility aligns well with tech trends such as need for responsive design with rapid development and heterogeneity of mobile devices. Context of use becomes increasingly important, as technology becomes pervasive. Generally, there seems to be a slow shift from relying on quantitative data and expert inspections, to appreciating situated insights and co-creation. By moving in this direction, we start valuing in-depth understanding as a tool for design – more than the idea of objectivity and generalizations of user needs.

**Summary.** Related to the way we approach the design and development of digital solutions, we have changed:

- From an emphasis on user facts, to an emphasis on user empathy.
- From late and elaborate user testing, to early and lean user feedback.
- From generalized and stereotyped needs, to diversity aspects and contextual needs.
- From low user contact, to workshops, co-creation and user involvement.
- From neutral views on technology, towards value-based and critical design.
- From accessibility and AT focus, towards lived experiences.

## 4 Discussion

Combined with the bio-psychosocial model, modern legislation on UD of ICT reflects socio-economic, democratic and ethical reasons for ensuring all citizens are able to use solutions. UD can be viewed as a concept and political strategy that has evolved from social and rights-based disability models; focusing on disabling barriers and enabling environments [12]. Establishment of legislation and guidelines is a significant step toward ensuring UD; however, this alone does not guarantee successful change and implementation. The story told in this article emphasizes cultural changes in our societies, which has broadened and changed the disciplinary field. A significant paradigm shift in the understanding of disabilities, from a medical model to a contextual model, was not the only one. There was a coinciding shift from add-on accessibility to UD. Together, these shifts introduced radical changes to the way we look at disability, and thus the role of the designer/developer in creating digital solutions.

**Can the different approaches and terms in use be viewed as part of the UD movement?** The term ‘universal design’ is today used interchangeably with terms such as ‘universal access’, ‘design for all’ (DfA) and ‘inclusive design’. We find different practical design approaches applied. The question then is; do they represent the same movement and community? To this I would answer; Yes.

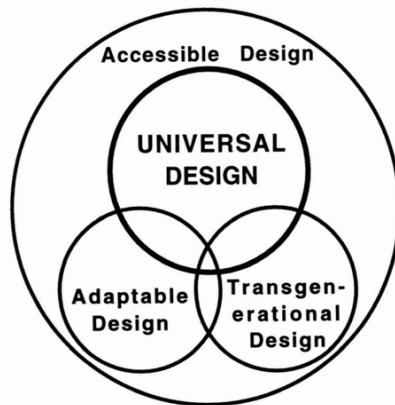
I hypothesize the co-existence of different terms is partly due to different legislation in different countries using different terms, more than regional differences in how we approach UD. However, if you study the approaches as reported in literature, you see differences. UD historically focused on the end result, and how to measure this. This may be why the 7 design principles for UD are quite similar to a checklist. The word ‘universal’ in UD may be interpreted as referring to a set of principles that are stable, timeless and value free. But UD is neither of these things,

UD as an approach is not contradicting the recognition of accessibility as “good design” for disabled users. Today, accessibility is usually regarded as a precondition for UD. However, the notion that UD is presented as an improved alternative to accessible design – where focus is on meeting prescribed requirements for use by people with disabilities – is a miscommunication. UD was supposed to extend accessible design (see Fig. 1) [36]. Nor is it correct that UD is contrasting adaptable design (enabling individual modifications to a standard design) [15]. AT compatibility and supporting the flexibility to personalize and adapt the system are highly relevant for ensuring technological variety. UD draws on flexibility – which is expressed in UD principle 2 “flexibility in use” [36-38].

Both these miscommunications are problematic, as a) accessibility versus UD has been blurred, and b) the room for flexible adaptation according to needs appeared too small to be practical. But as UD sought to extend accessibility and adaptivity, there is no inherent conflict between inclusive design and UD approaches.

Standards and guidelines are regarded as practical and fit requirements specification approaches, but not a replacement for direct user testing or user involvement. Looking at where we are today on UD in the computer science, I believe most would agree that a best practice approach for UD uses early direct user contact [39]. Further,

many agree with active involvement of end-users in co-creative workshops and the importance of user empathy [39]. As such, I believe we are collectively moving away from (only doing) a checklist-approach and towards adhering to the inclusive design approaches. However, we sense a gap between those that adhere to generalizable standards to reflect user needs (representing user groups through stereotyped checklists), and those that argue for active user involvement and empowerment.



**Fig. 1.** Relationship between accessible, adaptable, transgenerational, and universal design [36].

Design approaches within UD movements have been expanding [15]. I argue that newer approaches such as inclusive design could be regarded as more mature or updated versions of UD. Compared to the UD literature, inclusive design more explicitly focused on edge cases, exclusion cases, and apply more critical design perspectives – and turning away from the traditional values of objectivity. We see that the inclusive design dimensions (compared to the design principles in UD) read more like guidelines for the design practice; 1. Recognize diversity and uniqueness, 2. Inclusive process and tools, and 3. Consider the broader context and impact of the design.

It is argued that, UD as of yet not in harmony with critical disability theory and disability acceptance; for example, that UD holds hidden values [40]. To this I would respond; we are on our way. Though differences has evolved and maturity over time, design approaches increasingly holding up values from critical and participatory design. Still, this varies, likely depending on the resources at hand and the constraints we operate under [41, 42].

It is true that the UD movement historically has not focused much on perspectives such as classism, sizeism, homophobia, transphobia and gender expressions. Now, we seem to move towards designing for as diverse a range of people as possible and merging of UD with diversity movements; regarding users as individuals; with unique and situated needs. In this move, there appears to be an increasing overlap between (dis)ability movements, feminism, anti-racism and other political movements. For example, the limit model of 2009 overlaps with intersectionality views.

Intersectionality suggests that people have unique experiences based on the combination of their identities, and that these can be oppressive multiple times (for example as a non-white, non-cis, disabled single mother) [43]. Further, that it is impossible to understand discrimination and oppression by considering one singular identity. I also see the identity model increasingly reflected in the way we speak, as we are moving away from labels as ‘an autistic person’, ‘a blind person’, ‘a poor person’. Instead, we now recognize that any challenges are a part of us, and say a person ‘with fatigue’, ‘with autism’, ‘who is blind’, ‘with low income’, and so forth.

It is argued that most of us are still on a journey – both in our personal and professional capacity [43]. As an international community, we are living or designing in quite different societal systems, with different cultures and politically correct stances, different regulations and legal mechanisms and different populations. D’souza [44] argues UD may come under functionalist paradigm (because it caters to utility), pragmatic (because it is instrumental in nature), positivistic (because it strives for universal principles), normative (because it prescribes certain rules) and critical theorist paradigms (because it gives voice to the oppressed). I argue this fluency provides an advantage to the UD community. Different arguments for UD, strategies for promoting UD and methodologies for implementing UD may be fitting based on the organizational or societal system we are living or designing within, and over time.

While our context changes, the technology changes, the political environment changes, and our process models and organizational structures changes, the UD of ICT movement have started to value building a deeper relationship with users, avoiding stereotyping or guessing their needs and seeking to understand real lived exclusion experiences and contextual needs. The ‘user sensitive inclusive design’ approach may thus be indicative of the direction of UD approaches today – merging ID with empathic design traditions and PD [45, 46]. Different approaches to UD of ICT are part of the same story towards the ultimate goal of solutions that fits as many as possible of their users, and that are experienced as inclusive.

**What are the next steps on the journey forward?** With an increasing recognition of the individual lived experiences of users, intersectionality perspectives may inspire critical design perspectives and participatory design approaches that focus on power dynamics [43, 47]. Intersectionality is focused on individuality, and though the notion of designing for all fits with designing for lived experiences (and e.g. the limit model on disabilities), it is arguably hard to design for individuals within a checklist-based approach to UD [48]. The latest model-based tools (from the inclusive design movement) merge the support of generalized specification based on statistics on user needs with the mapping of individual lived experiences [49]. Looking ahead, more tools facilitating collecting the insights of situated, embodied, individual experiences could be beneficial, to fit different situations and individual design preferences. It is also argued that more diversity guidelines are needed in the design of the design tools themselves, to fit the diversity of users and designers to be involved [50]. Further, including marginalized users and being sensitive to their needs means the design process and methods must also be inclusive. Here, we still face some challenges in making the UD process inclusive. For example, related to co-creative workshop-

techniques, these currently largely depend only on visual design methods and visual communications – and are as such excluding persons with visual impairments.

## 5 Conclusion

In this paper we have outlined some of the different stances related to universal design (UD) in the field of computer science. This is a story of a journey from specialized adaptations, via accessibility checklists and generalized summaries of marginalized users, towards designing for a diverse set of situated and individual user needs. We ask, related to the perceived diverging disability perspectives, terminologies and methodological approaches in use; Can all the different approaches and terms in use be viewed as part of the UD movement? And what important next contributions are needed on the continued journey towards designing for diversity? We argue that the article overviews how over time, culture and policies change, and new technologies emerge –potentially creating new barriers or possibilities for inclusion. Reflecting these changes, methodological approaches and tools are created and updated to advance the disciplinary practice. We further show how one set of guidelines seldom replace the old radically, rather, they usually update the original, extend the original, provide alternatives to the original or merge with the original. As such, I argue that different arguments and stances that have evolved over time, though diverging, belong to the same movement. Further, that the richness of views and approaches within the UD community could be viewed as a collective strength rather than as a divider.

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