

Think Accessibility

AI and Automation Make Enterprise Applications Accessible for PWDs with Higher Quality and Lower Cost

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IN BRIEF

Outlining our research motivation toward accessible design in terms of the need, the growing market, compliances, and the advantages of designing for accessibility, this article focuses on some recent advances in AI and automation that make accessible design easier for various products and services. The TCS Accessibility CoE has used these methods to advantage in creating some commercially and socially impactful offerings and services.

Sixty-plus, and you are going to be differently abled. As you age, your brain and nervous system go through natural changes, slowing responses. Your senses are likely to lose sharpness; peripheral vision

and visual acuity begin to decline. Hearing loss is also possible (one in three adults over 65-years of age suffers hearing loss.¹). Therefore, your interaction experience with a bank, a store, a utility—online and offline—will be quite different from before. For people with disabilities, such interactions have always been a challenge. For instance, how easy would it be for you to use a computer without a mouse, screen, or audio? That is the kind of challenge people with disability face in accessing computer-based applications.

Disability and accessibility

According to *Accessibility Ontario*², in simple terms, a disability is “a physical or mental condition that



1 Health facts from NIDCD

2 <https://accessontario.com/aoda/definitions>

Fact File

TCS Research: Accessibility

Outcomes: 34 assets created, including 17 Technology Assets to establish Accessibility practice including accessibility diagnostic, assessment and remediation of IT Solutions in TCS. 69-plus client have been supported to deliver accessibility services.

Principal Investigator: Charudatta Jadhav

Techniques used: W3C Standard: WCAG 2.0, ARIA

Core Science Areas: Machine Learning, Artificial Intelligence, Augmented Reality, Brain Computer Interface.

Environment: Web, Mobile devices, IoT

Industries benefited: BFS, Insurance, Retail, Healthcare, Life Sciences, Retail, Travel and Hospitality, Media

Patents: 8 filed, 3 granted

Papers: 16 Conference presentations

limits a person's movements, senses, or activities" and accessibility refers to "the design of products, devices, services, or environments for people who experience disabilities."

People with disability (PWD) are not just wheelchair users, braille readers, or sign language

practitioners. A majority of disabled have invisible disabilities such as learning or cognitive disability.

A growing market

Rich Donovan, an analyst with the Return on Disability (RoD) group estimates that the US disability

Chart 1. Population and income data for PWD and their friends and family.³

	Global	USA	Canada	EU ⁶	Asia ⁶
PWD Population	1.31B	56.7mm	6.2mm	91.0mm	748.0mm
PWD Income⁶	>\$1.97T	\$872.7B	\$113.3B	\$983.9B	NA
PWD Disposable⁶	>\$1.2T	\$645.3B	\$55.4B	\$482.1B	NA
Friends & Family Population	2.42B	105mm	11.5mm	168mm	1.38B
Friends & Family Disposable	>\$6.9T	\$3.9T	\$311.1B	\$2.7T	NA

Source: US Census, US Bureau of Labor Statistics, StatsCan, EuroStat, Return on Disability Group

³ Chart Data courtesy: 2016 Annual Report. The Global Economics of Disability. <http://www.rod-group.com/content/rod-research/edit-research-2016-annual-report-global-economics-disability>

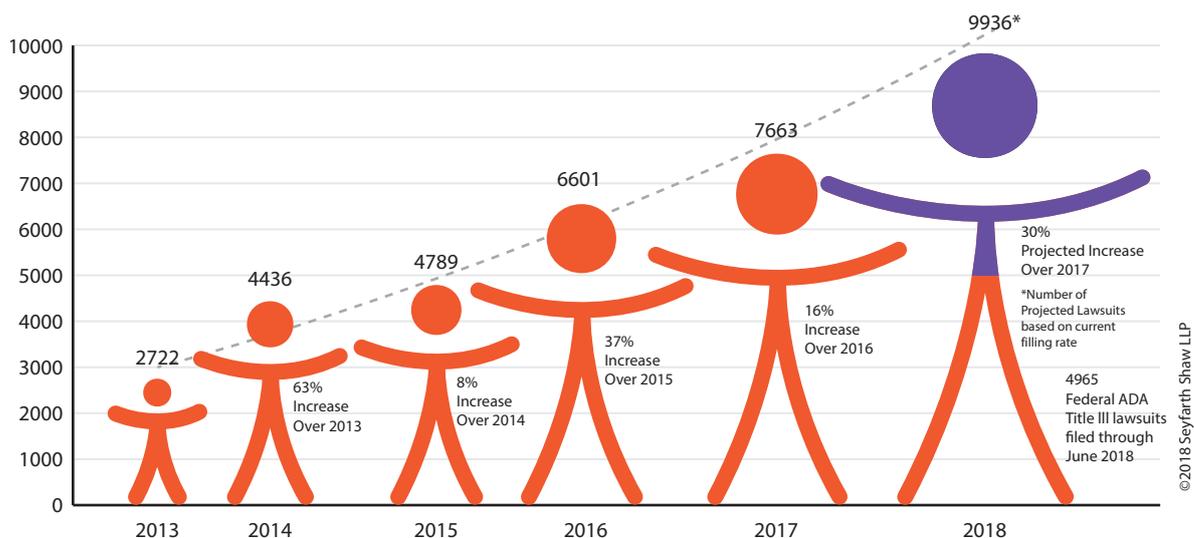
population is three times that of the US Hispanic population. He not only includes people with visible and invisible disabilities but also the friends and families of the disabled who are likely to spend on accessibility products or disability causes. RoD estimates of the disability market is provided in Chart 1.

In addition to this, the aged population can benefit from many accessibility features such as handrails and ramps in brick and mortar service areas, to bigger fonts or proper affordance in web interfaces. The world as we know is greying. In 2015, there were 901 million people aged 60 years or over across the world. This number is projected to grow to 1.4 billion in 2030.⁴ An Oxford-AARP publication brought forth surprising observations, especially in terms of spending: “Not only do those in the 50-plus cohort spend more overall

than their under-50 counterparts, the 50-plus cohort accounts for a majority of the spending in several categories of goods and services, including: healthcare, nondurable goods, durable goods, utilities, motor vehicles, and parts, financial services and household goods.”⁵ There are several estimates by academic and market researchers that peg the silver dollar economy’s value at trillions of dollars. Ageing population are growing more connected and are ready to consume a variety of digital services. The market for accessible products and services is indeed a large one.

Compliance

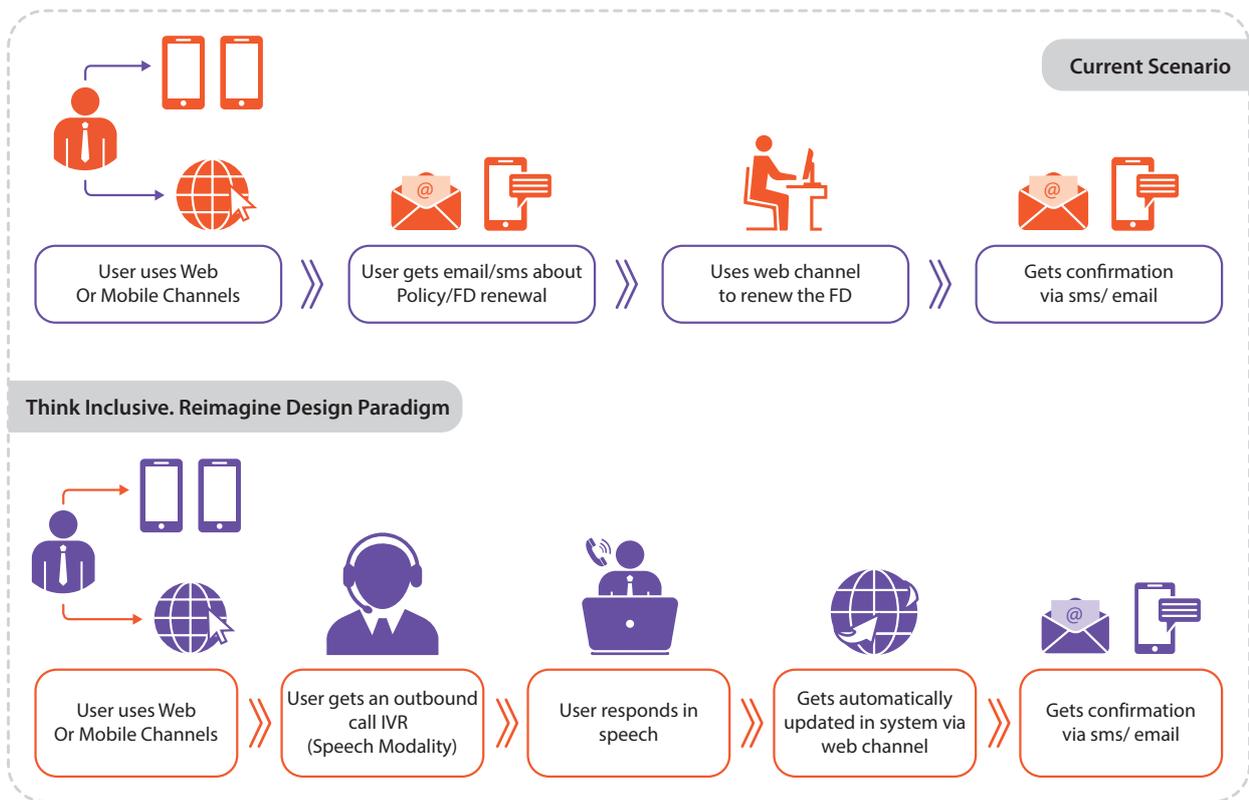
While market size is the “carrot,” regulations and compliance to them are the “stick.” The UN Convention on the Rights of Disabled People signed in 2006, currently committed to by 170 countries was an important



ADA Title III Lawsuits in Federal Court: 2013–2018

4 UN Report. World Population Ageing http://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Highlights.pdf

5 <https://www.aarp.org/content/dam/aarp/home-and-family/personal-technology/2016/09/2016-Longevity-Economy-AARP.pdf>



Accessible Thinking - Redefining design: Fixed Deposit Renewal

milestone. There are a number of standards and certifications (WCAG, ISO) that guide Accessible Design. Several countries have internal legislation that enforce the rights of people with disabilities. Lawsuits under The American Disabilities Act Title III which “prohibits discrimination on the basis of disability in the activities of places of public accommodations” have particularly burgeoned in the last couple of years (refer *ADA Title III Lawsuits in Federal Court: 2013–2018*).

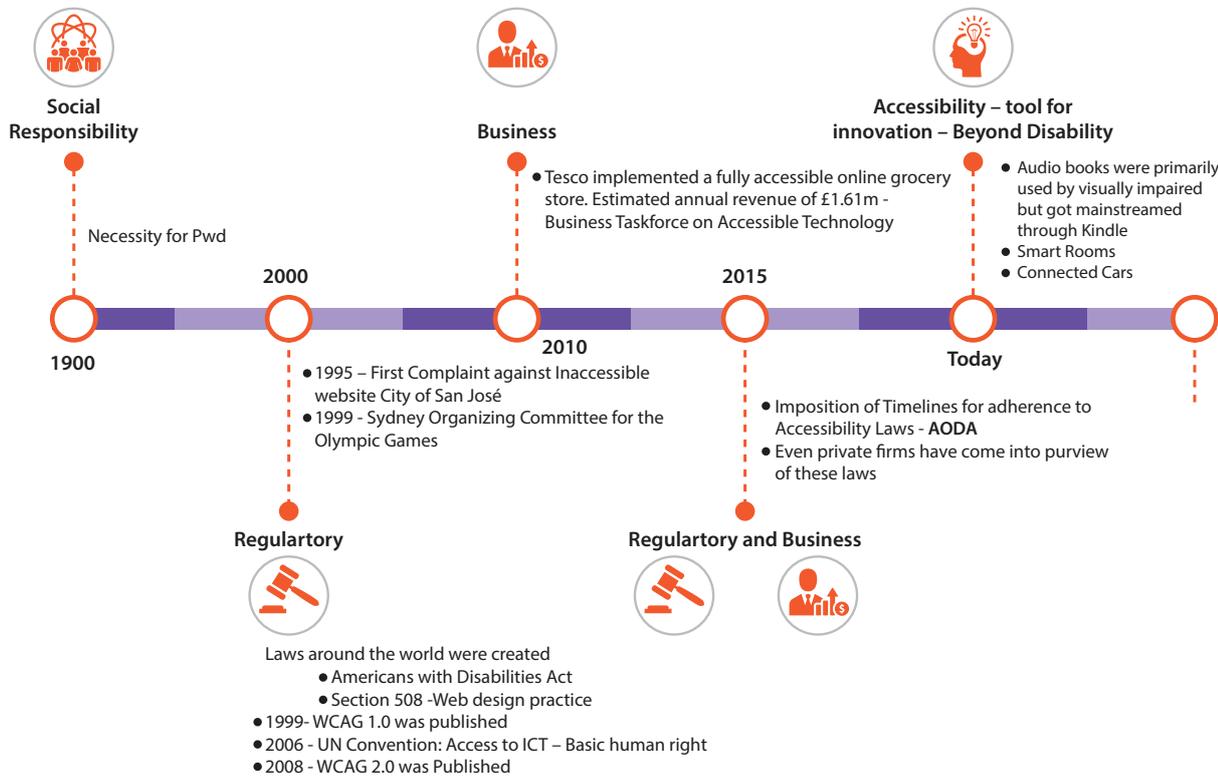
Designing for accessibility

A core tenet of the Business 4.0 world is that there is no “one size fits all.” Understanding every user enables business benefits. Even when businesses went by user “segments,” inclusive design principles recommended studying “points of exclusion” or users

normally not considered when designing, such as those with disabilities. Testing for extreme users, both the super savvy and the challenged, has been an important design consideration. Remote controls, audio books, and now voice-based ATMs are some examples of products designed for those with disabilities that are loved by all.

While the benefits of Designing for Accessibility are compelling, businesses are tardy in doing so. The reasons are hesitation in taking on the initial cost; lack of planning in projects for accessible or inclusive design; investing effort in an area where skills are not easily available; worry over extra time required to complete projects. Accessible design must be a strategic move for a company, not a social cause, compliance procedure, or an operational irritant.

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Journey of Accessibility

AI for accessibility

A number of AI-based gadgets are already available in the market, creating a big difference in the lives of PWDs. Smart glasses with face recognition capability help the blind identify other people as well as their facial expressions. They also help in recognition of colors, and currency; read documents; navigate better, indoors and outdoors. In the digital space, AI enables automated image recognition and “alt-text” for visually impaired users; automated sign language provision; and captioning for hearing impaired users.

AI-based virtual assistants such as Siri, Alexa, and Cortana, and smart speakers such as Home and Echo have many accessibility features built into them. This advancement in speech technology and AI can be used to provide a new way of interaction—multi-modal—to interact with devices and appliances for home automation, indoor navigation, identifying products

in shopping malls, navigation, and controlling room temperature in a hotel environment.

Researchers are also exploring AI with a brain-computer interface (BCI) which will allow control of devices, computers without keyboard and mouse, changing of TV channels, and access of apps and data, all by our thoughts, which we believe will create a revolutionary impact on PWDs including people with motor disability (cerebral palsy or spinal cord injuries which affect body movement and muscle coordination).

In the area of IT applications, AI can eventually help in making websites accessible by increasing the automation in accessibility testing and thus extending it to test planning to development (across the value chain). From a digital applications perspective, machine learning and optimization methods can be used for assessment, test

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case generation, and website compliance checking. Manual methods of comprehensive accessibility assessment for an application of a hundred screens would take over 350 person-days to complete. An attribute-based AI sampling algorithm can ensure 100% coverage in one-fourth the time. In the most critical and time-consuming step of test planning, such as test strategy definition and dynamic checklist generation, mathematical optimization and a rule-based AI engine can generate the most effective test tool combinations and a list of applicable checkpoints. (To do this manually, accurately, and rapidly would require a battery of well-trained accessibility professionals.) Execution of test cases can be automated by identifying and assessing the corresponding widgets and checkpoints.

Automation in changing documents into multiple accessible formats is widely available as a cloud-based service. Advances in image recognition, optical character recognition (OCR), lip reading to text creation, natural language processing, and IoT are all enabling more accessible products and services.

TCS accessibility research

TCS' Accessibility Center of Excellence has, over the past 5 years, tested its thinking and practice not only within the organization but in over a hundred client engagements. We have research collaborations with leading design institutes. This keeps us innovating, building, and testing prototypes as proofs-of-concept both for TCS and customers.

TCS customers have a number of external- and internal-facing IT applications: product and

service offerings, ecommerce and information, email, multimedia systems and applications, intranets, desktop and back-office systems, and other IT-related elements. Their scale is vast. Making all these accessibility compliant is a huge challenge.

Even with some automation, making enterprise IT systems and applications accessible costs up to 30 percent of original development. On average, it takes an accessibility tester as much as one whole day to investigate, test, and remediate four webpages. Any manual process is very slow in today's technology speed. Accessibility testing requires niche competencies—a rare blend of technical skill and an empathic mindset because the tester, immersed in a fully abled world, must first visualize testing scenarios for the entire spectrum of disability and then create the test cases for those. These skills are rare. To develop the requisite accessibility testing competency, the learning cycle is long.

Through a wide range of proprietary process, people, and technology assets in accessibility, we offer well-defined accessibility services, delivering them through our enterprise-level Accessibility Suite, which comprises:

TCS accessibility testing platform

A novel one-click software-testing solution that helps enterprises achieve accessibility. It uses AI and optimization algorithms automating accessibility testing across the planning and validation phases. It offers full coverage in assessment based on 85% accuracy in test cases and checklist generation, and records lower percentage of false positives when validating website compliance. Since it automates

TCS Access Infinity is a countrywide web portal-based accessible print content ecosystem that equitably addresses the concerns and challenges of all stakeholders in the accessible content value chain.

processes, it maintains quality and creates up to 40% savings in cost and effort. Its AI features do away with the need for niche accessibility testing competencies.

TCS enterprise accessibility platform

This platform facilitates end-to-end (E2E) enterprise accessibility life-cycle management. It seamlessly integrates into an enterprise's delivery processes, offers enhanced compliance reporting, facilitates audits, simultaneously manages multi-modal projects (web, mobile, digital), and provides context-sensitive technical assistance and best practices. TCS' automated accessibility testing tool, which crawls through a customer's entire website and validates dynamic content through user-input simulation to automatically diagnose pages, report violations, and suggest remedies.

The automated accessibility assessment tool, which has an underlying patented engine with the industry's best automation capability (55%), also helps capture URLs from recorded scripts, using Selenium, and validate them. A playback feature plays over the scripts and validates the URLs navigated. The platform also exports report features for each test case and test scenario.

Accessible digital publishing

A conservative estimate says that over 1 million digital titles are published across the world each year. However, less than 5% of this content is available in accessible formats. In fact, in developing countries, that figure dips to a dismal 1%. TCS-developed platforms and tools for accessible digital publishing make a difference

to people with disabilities. TCS Accessible Content Publisher (TACP) and TCS Access Infinity are examples.

TACP enables one-click conversion of .txt, .doc, .rtf, .html, and .xml text to accessible formats—Braille; text-only, audio-only, and text-and-audio DAISY; and the revolutionary, secure EPUB3 which, given its digital watermarking and encryption features, is poised to have immense potential in the not-so-distant future. (TCS has built an E2E cloud-based solution for EPUB3 production, reading, and accessibility validation that retains complete source-file formatting.)

TCS access infinity

A further innovation that powerfully leverages our TACP technology is TCS Access Infinity. This is a social initiative that has already transformed accessible digital publishing across India and is ready to scale further.

Access Infinity is a countrywide web portal-based accessible print content ecosystem that equitably addresses the concerns and challenges of all stakeholders in the accessible content value chain. All content is converted in one click through TACP technology, which also addresses piracy. A single national catalog addresses duplication. The content is made available through a toll-free IVR line, via phone and web, on DAISY tablets and physically as CDs, DVDs, USBs, and audio cassettes. Urban and rural users are covered. Users can save their wish lists on the site.

The portal hosts over 450,000 books in 17 languages, including those provided by international publishers, and has been integrated into the World Intellectual Property Organization-led Accessible Books Consortium. Over 50 libraries feed

into the portal. TCS ensures real-time access to 7 newspapers and 8 magazines, textbooks from 13 state boards and 200,000 pages of study material from 3 universities.

The promise of immersive technologies

From a technology perspective, the future for accessible design is exciting. AR/VR, brain sensing, gestures, and air pressure signals are all enablers for more accessible design. The line between assistive technology and products for mainstream users is blurring. The possibility of smart homes and self-driving cars are big leaps for PWDs.

In terms of design, a lot can be achieved. Today, people prefer to use different modalities to interact with a system depending on context. The existing user interface systems are visual-based or audio-based, or combination of both, but with one modality preceding/ dominating the other. A design, even though made accessible, may

not be inclusive and may not offer great user experience. Impactful design needs to address functional, emotional, user experience, and inclusivity. To achieve this, we feel that inclusive design needs multimodal options based on various parameters such as scenario, situation, service, environment, and persona. We at TCS Research are exploring interaction design patterns from the angle of different disabilities and aging persons, their challenges and design. We hope to come up with new design considerations and concepts for creating real-time dynamic interfaces provided with multimodal interactions.

We are also working on exploring core science technologies such as augmented reality, virtual reality, BCIs with IoT to create products and experiences such as controlling home devices with a virtual gesture or with just a thought. We relentlessly aspire to bring independence in the lives of people with disabilities.



Charudatta Jadhav

Charudatta Jadhav leads the Accessibility and Inclusive Design at TCS Research and Innovation. He has 28 plus years of extensive experience and has been a key architect and lead consultant in establishing the accessibility practice within TCS. He has also filed eight patents, three of which have been granted. Charu has represented India six times at the World Chess Championships and Olympiads for the Blind. Among the many awards he has received is the National Award for Best Disabled Employee that was conferred on him in 2006. He has also been three-times winner of TCS Innovista and two-times winner of TATA Innovista.



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