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The three dimensions of inclusive design: A design framework for a digitally transformed and complexly connected society

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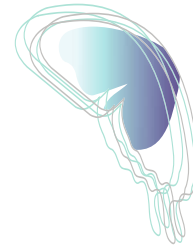
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UCD
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THE THREE DIMENSIONS OF INCLUSIVE DESIGN:

A Design Framework for a Digitally Transformed and

Complexly Connected Society

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Abstract

This thesis attempts to answer the following meta-design challenge: In this digitally transformed and increasingly connected society, how can we design in such a way that we include the full range of human diversity? How can we use design to both circumvent the new barriers that escalate exclusion and leverage the new affordances of emerging sociotechnical systems to reduce disparity?

This thesis documents the formulation, application and testing of a guiding framework for Inclusive Design, suitable for a digitally transformed and increasingly connected context. During the course of my doctoral studies I have iteratively formalised and refined this framework. As a doctoral student, Founder/Director of the Inclusive Design Research Centre of Canada (1993–), and co-Director of the sister European lab, the Inclusive Design Research Centre of Ireland (2008–), I have implemented the inclusive design framework in applied research with colleagues. I have also taught the framework in the graduate programme that I launched at OCAD University in Toronto in 2011. These framework applications have helped to develop tools and design methods that support the framework. The thesis conveys the formulation, implementation, and communication of the framework to several application domains.

The fields of knowledge are diverse and post-disciplinary. If a primary field must be chosen, then it would be the field of Design, not only in terms of Design Engineering but also in the broader scope of Design for Society: both are explored and developed in tandem. But the impact of the work in the 'real world' and within the industry sector that can support community change, is the most important aim and contribution of this research. The evolving framework is already being applied by a global collaborating community and has formed the basis of the corporate transformation of companies such as Microsoft. The applied research has delved into many cognate fields, including Systems Thinking, Deeper Learning, Economics, Machine Learning, Human Computer Interfaces, and Critical Disability Studies.

The thesis makes an original and substantial contribution to knowledge, articulating a guiding framework for Inclusive Design in a digitally transformed and complexly connected global society. The framework applies Systems Thinking to the area of digital inclusion for people experiencing disabilities and adds the consideration of the design process to inclusive or accessible Design. Examples taken from years of intensive practice that support the thesis are provided as use cases, to support future research and implementation.

The thesis also attempts to provide a bridge between scholarly study and community action, in part by using clear language to prevent or overcome any conceptual divide between scholars and the diverse individuals who must participate in co-designing a more inclusive society. The thesis includes translations of the concepts inherent in the proposed framework, expressed clearly and succinctly, for a variety of co-designers. The thesis posits that Diversity is Strength: a concept that can be applied in many cognate fields as well.

Statement of Original Authorship

I hereby certify that the submitted work is my own, and was completed while registered as a candidate for the degree stated on the Title Page. I also certify that I have not obtained a degree elsewhere on the basis of the research presented in this submitted work.

Signed:

Date: May 10, 2018

Dedication

This thesis is dedicated to: my team at the Inclusive Design Research Centre, and the amazing global community of practice in which it is embedded, along with my mentor the late Ursula Franklin, and my tremendously supportive family.

Acknowledgements

First and foremost, I would like to express my immense gratitude to my supervisor Professor Lizbeth Goodman. Her patient guidance, constructive critique, insightful introductions to her network, caring support and boundless energy, have made this doctoral journey possible. I would also like to thank the supportive, cohesive, worldwide SMARTlab community Lizbeth has knit together. I look forward to continuing this amazingly productive shared journey with them. I also want to thank my compassionate and motivating advisors Mick Donegan and Suzanne Guerin. They encouraged me to be bold and gave me the reassurance I needed to follow my judgement.

Without my team at the Inclusive Design Research Centre this entire endeavour would not have been possible. They are not only the ones that 'make it so,' but also the source of inspiration, insight, and hugely helpful suggestions. Their loyalty, brilliance in execution, and kind critique are beyond measure. Colin Clark, Michelle D'Souza and the skilled team of designers and developers have made it possible to test and refine the framework. Without the amazing talent and creativity of Sepideh Shahi, Lisa Liskovoi, and Caren Watkins, my graphics would be inchoate scribbles. Jan Richards' thorough technical precision and knowledge ensured that the standards and affidavits attributed to me were of the quality required. Iris Neher has ensured the whole experiment remains financially balanced. Vera Roberts is my hero. She rescued me from formatting and referencing nightmares that would have defeated me. Her editing and careful eye for misjudgements were essential to the production of the thesis.

I am ineffably blessed to find myself at the centre of a wonderful global community of practice. This includes inspiring fellow travellers and advisors such as Clayton Lewis, Eva DeLera and Catherine Frazee. It also includes the many graduates from the Masters Programme in Inclusive Design that I founded at OCAD University. The backbone of the community are the many partners in research that have accompanied us on the roller coaster ride of research in this domain. I've been very fortunate to partner with Gregg Vanderheiden in many of the grander adventures in Inclusive Design described in this thesis. He is a pioneer in the field who has leant me his broad shoulders to stand on and entertained my ideas with enthusiasm. I sorely miss the late, great Ursula Franklin who inspired and nurtured this work with her kind and patient wisdom. I am indebted to my colleagues at the World Wide Web Consortium and the Standards Council of Canada for the many years of collaboration; and the partners within

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The acknowledgement would not be complete without thanking the supportive colleagues and leaders at OCAD University. These include the brilliant President, Sara Diamond; V.P. for Research Robert Luke (who has risked working with me a second time); Dori Turnstull, who brings enormous resonance to my studies; Doreen Balabanoff, who has cheered me on, and many others too numerous to mention.

Lastly, and most importantly, I would not have survived this journey without the support of: my husband Charles who researched and pointed me to an ever-expanding set of current resources and kept the practical parts of our life moving whilst I wrote; my wonderful kids Kira and Theo; and, our cat Ripples - who kept me sane by jumping up on my keyboard to signal time for a break.

Foreword: The Long Road(s) to the Thesis

Many of the conventions of a traditional doctoral dissertation (in most disciplines, and in most cultural contexts and university settings worldwide) run counter to the philosophy of the proposed design framework described in this thesis. Indeed, for several decades of my career as a scholar, practitioner and professor, I—both consciously and unconsciously—resisted participating in the doctoral process, believing that the acculturation implicit in obtaining a PhD would be an unacceptable compromise of the very values that I address in all of my professional work. I also believed that a PhD would only be necessary as a stand-in for authentic and continuously renewed evidence of knowledge and understanding. I was convinced that the title of Doctor of Philosophy would serve as a mechanism for 'pulling rank' and as a shield from essential challenges that keep a notional domain current and dynamic.

When I decided to engage in this practice-based PhD after many years of work in the domain, I chose the programme carefully, determined to engage the scholarly thesis writing project with the integrity and respect for the values I embody in my practice. This has been possible, but has entailed a certain flow of engagement and resistance along the journey of the thesis.

Amongst the conventions that I continue to find problematic is the common use in thesis writing of the passive third person voice. This use of the passive voice rings false and feels burdened with associated pretensions of objectivity and neutrality: conceits that cloud the very goal of inquiry.

The contention that any new knowledge is ever arrived at independently, especially in our increasingly entangled world, is extremely problematic for me. It is my conviction that the pressure to assert this claim of independent thought throughout the lifecycle of formal education distracts the academy from the essential role of collaboration and robs the community of learners of the full power of scholarship. The individual who first articulates novel ideas, knowledge, or understanding does so with the support and implicit participation of innumerable unacknowledged contributors.

At the same time, the standard and sanctioned array of possible research methods prescribed for a doctoral dissertation all proved ill-suited to my research topic. More importantly, I remain convinced, even at the end of this thesis journey, that the general acceptance of a set of privileged methodologies, methods and forms of analysis has contributed

to the disparity of understanding at the margins of our society; a disparity that my proposed framework is intended to address.

My critiques of the conventions associated with achieving a doctorate are not novel or unique. The unease with the entrenched hegemony that is reinforced by the indoctrination involved in the process of PhD studies is a vein that runs through feminist discourse and the discourses of other key movements that promote the transformation of formal education. These critiques are briefly mentioned here in the spirit of full disclosure, and in order to contextualise this work and to recognise that any doctoral thesis project is a social process. It has been my intention to acknowledge the utility of the ritualised conventions and role-playing inherent in this rite of passage, but with 'eyes wide open.' In deference to, and in deep appreciation of, the mentors and learning community members who have supported the culmination of this work, it is my conviction that honesty and candour are non-optional elements of engagement.

Constructive critique includes recognition of the positive, the negative, and the in-between. Indeed, in my mind, it is the constructive critique and positively interpreted aspects of 'rigour and discipline' that are integral to doctoral scholarship and that balance the current faults or risks of this complex process. Adding ineffable weight to the asset side of the ledger is the community of learners engaged in the academy—fellow travellers with a shared thirst for knowledge. This thesis journey was embarked upon with specific purpose: to take part in and in some small way to influence the direction and mode of travel of the collective sojourn into landscapes currently unfamiliar to human inquiry.

In completing this work, I have chosen a balance of compromises. Recognising that I am in a privileged position, having long ago achieved the senior academic status usually reserved for scholars with doctorates and not wishing to use that status to claim 'exceptionalism,' I have 'chosen my battles' judiciously. I understand that humility is an apt position when venturing into the vast wonder that is the unexplored terrain of human scholarship.

This thesis does not seek to make a contribution to a main field of knowledge, but rather, very ambitiously, seeks to define a new territory and field of knowledge: the emergent field of Inclusive Design for a digitally transformed and complexly connected society. Both academia and industry have recently embraced this field, in large part as a response to ideas outlined in this thesis, as shared at intervals throughout the thesis journey.

In this thesis I have tried to achieve a balance of generally sanctioned and less-recognised forms of evidence. Against sage advice, I have included active and informed collaboration throughout the thesis process and have marked this consistently for the sake of thesis examiners with a clear delineation of what ideas were first articulated by me. I have referenced non-scholarly publications when new ideas and practices have not yet been processed by the academy or when authors whose ideas and methods are vital to this thesis have chosen to bypass scholarly dissemination means. Rather than restrict my thesis to a specific discipline and a narrow niche of knowledge, I have also tried to keep my focus broad—grounding the theory with examples and borrowing from as many disciplines as possible—hopefully without missing detail in service of the necessity of seeing and sharing the big picture.

This thesis took me far longer to complete than either my community or I expected. A process which resists itself is hard to measure. Only in accepting my own precept in education—that is, the learning value of the imperfect, impermanent, and incomplete—was I able to finish and submit this work. It is already being enacted, and the learning journey continues as the field of Inclusive Design continues to emerge.

1 : Thesis Introduction and Overview

1.1 Design Challenge and Research Question

This dissertation attempts to answer the following meta-design challenge: in this digitally transformed and increasingly connected society, how can we design in such a way that we include the full range of human diversity? How can we use design to both circumvent the new barriers that escalate exclusion and leverage the new affordances of emerging sociotechnical systems to reduce disparity?

This dissertation documents the formulation, application, and testing of a guiding framework for Inclusive Design, suitable for a digitally transformed and increasingly connected context. I iteratively formalised and refined this framework during my doctoral studies. As Founder and Director of the Inclusive Design Research Centre (the original 'mothership' of which the UCD IDRC is its sister lab in Ireland), I have implemented the framework with my team's applied research. I have also taught the framework in the graduate programme I launched at OCAD University. These applications of the framework have helped to develop tools and design methods that support the framework. The dissertation conveys the formulation, implementation, and communication of the framework to several application domains.

1.1.1 Motivations

This work was motivated by the observation that our systems of research, education, markets and mechanisms of value exchange are structurally biased against diversity and complexity. This results in vicious cycles of disparity for anyone not represented by the average or majority, and results in dangerous blind spots as we navigate this increasingly unpredictable terrain. With the disruption of existing structures triggered by the ascendance of emerging technologies, the field of design has a heightened role to play in this pervasive pattern and represents a possible intervention in the complex adaptive system that is our quickly changing world. Hence the need for what I term *Inclusive Design*.

1.1.2 Origin of the Framework

The framework is the culmination of more than three decades of experience in leading initiatives to address digital inclusion. I chose the term *Inclusive Design* to denote the activities of the centre I established in 1993 at the University of Toronto.

The process of developing the framework was largely 'bottom-up,' meaning that the ethos and philosophy emerged and took shape by working closely with individuals and communities facing barriers to access. The framework was a formalisation and articulation of a largely unspoken multi-faceted cultural norm that had grown through practice within the Inclusive Design Research Centre. Connections to philosophical thought, categorisation, or typing with respect to pre-existing theories were secondary; an activity of seeking out like-minded thinkers and helpful tools, or an 'academic' language to express heuristic practice. Some of these allied theories were iteratively and informally considered through community processes, modified and potentially integrated based on their suitability or match with community practices. The primary guiding criteria was consistency with the collective experiential knowledge emerging from the practice of co-designing approaches to barriers experienced by individuals with disabilities. This process was assisted by an internal cultural norm, communicated both explicitly and implicitly, that the community welcomed and remained open to constructive critique.

As an inclusive designer, I am distressed by the rift that has been created between academic writing and writing for the general public. The 'insider' language used as disciplinary shorthand serves to divide the disciplines and sub-disciplines. This makes cross-disciplinary, trans-disciplinary, multi-disciplinary, or post-disciplinary pursuit of knowledge very difficult and robs the academy of the innovation and insight of diverse perspectives, contributing to what has been pejoratively called 'academic inbreeding.' The pursuit of precision frequently results in imprecise, lengthy, and convoluted narrative. The attempts to avoid all unsupported claims results in layers of provisos and hedge language (Pinker, 2014). I reject the claim by some of my colleagues that the chasm between communication necessary for advanced scholarship and communication needed to inform the general public is too great to cross and should not be attempted. I admit that this chasm can seem vast in some areas of inquiry, but I fear that the distancing can be used as a form of protective cushioning, to keep out anyone deemed not worthy of understanding.

My commitment to intellectual accessibility has always meant that in my work and in my writing, any integrated theoretical reference must be accompanied by translations and presentations that are easy to understand without an academic background. For this reason, citations within this work include references not only to scholarly peer-reviewed references but also to popular press books, blogs, and articles. This diversity and selection of source materials is

deliberate and rooted in the belief that communication of our ideas must be inclusively designed. Expressions of ideas, theories, and concepts in the popular press can bridge the gap between the intellectually complex use of academic shorthand or insider language, including the requirement to situate ideas in the scholarly domain, which provides a gift of accessibility to the general public. However, I do this 'bridging work' within a critical viewpoint, calling upon a diversity of expressions as supportive evidence.

Current academic regulations preclude a fully inclusively designed doctoral dissertation. I considered the prospect of a 'clear' or 'plain language' version of the doctoral thesis but concluded that this is too ambitious an aim at this point in time. I have tried to reach a compromise in this thesis, envisioning my audience as the members of the larger Inclusive Design community, where unfamiliar terms can be clarified and where a diverse group of members from multiple and indeterminate disciplinary backgrounds—all with a common interest in Inclusive Design—can assist each other in understanding relevant concepts.

An essential practice of Inclusive Design is co-design with individuals who cannot or who have difficulty using current designs. This means inviting the individuals who will use any designed tool, method, or object as equal partners in developing the design. To achieve this equitable role, it is imperative that the framework can be understood by the full diversity of potential co-designers. At minimum the structure must unfold in a way that will make sense to a reflective co-designer.

Over the years of this thesis journey, many co-designers have engaged with these ideas and contributed to discussions about the process. This group is large, diverse, and active in the Inclusive Design community, which has grown online and in many gatherings. In many cases the Inclusive Design community has acted as a reviewer of portions of this dissertation, as part of the process of working with ideas from the ground up, and 'keeping it real.'

1.2   Communicating the Framework

I have explored the process of communicating essential concepts of the framework in publicly accessible language. I have experimented in publishing some of the pivotal ideas, including the *Three Dimensions of Inclusive Design* framework in public blogs. I have written 'op-eds' in national newspapers. I have also tried to encapsulate essential ideas on Twitter (see Appendix A: Testing the Framework on Twitter for the thesis-related tweets). These public engagements of

the emergent ideas have helped to gauge whether the ideas resonate and are understood by the Inclusive Design community. The thesis includes reference to these diverse sources where they help to demonstrate both the idea and the method in practice. I consider this framework expression across disciplinary and non-academic/academic boundaries as part of my practice, which is a necessary part of this thesis.

This exercise has also helped me to distil a much larger body of writing into a more manageable and consumable work. Inclusive Design can be an all-consuming topic with very 'fuzzy' and extensible margins. Because Inclusive Design, as it is conceived within the IDRC, encompasses design, research methods, learning theory, emancipatory/critical discourse, and even economics, this thesis can only provide a nod to the complex myriad of related works. Each body of knowledge would provide rich material for critical analysis to fill a lengthy dissertation.

One of the exercises we engage in as inclusive designers is to step back from the current conception of 'the problem' in order to gain a broader perspective. This process is assisted by referencing the role of the toddler who repeatedly asks, 'Why?' Academia has traditionally nudged scholars into smaller and smaller niches of inquiry, demanding deeper expertise in smaller and smaller domains. I fear that we have abandoned broader, more comprehensive, generalist inquiry as a result. The critical role of scanning the terrain as a whole seems to be missing, and this post is short-staffed. Scholars in domains such as Philosophy may explore the abstract, but do not often also practice applied scholarship. Professions connected to practice have tended to tilt toward more of a self-preserving 'business mindset.' This risks leaving a fragmented knowledge gestalt, with schisms between the theoretical and the applied and between advanced academic knowledge and public application. Scholarship that ties all the 'small bits' of knowledge together is rare and often frowned upon by 'serious' academics. Innovations are then often passed from specialist scholars to specialist businesses without knowledgeable oversight or attention to and consideration of 'externalities' by the public commons. This makes it difficult for our democracies to make informed decisions.

Several scholars have pointed to the alienation of the realm of value from the realm of knowledge or science. Terrence Deacon argues that the separation of value and science has led to the "existential crisis of the age"(Deacon, 2012). Brian Cantwell Smith has asserted that this vacuum of what should be in the exploration of facts also contributes to the rise of fundamentalism and extreme religions (Smith, 1998). Mikhal Csikszentmihalyi makes a similar

argument: "Science in general, and the science of evolution in particular, deals with what *is*, not with what *ought to be*. Faiths and beliefs, on the other hand, are not limited by actuality; they deal with what is right and desirable. But one of the consequences of an evolutionary faith might be precisely a closer integration between the *is* and the *ought*" (Csikszentmihalyi, 1990). The thesis explores the tension between the 'is' and the 'ought.' It proposes a framework that might support a multiplicity of 'oughts.'

This thesis is unapologetically generalist and grounded in lived experience. Our co-designers live in a whole world. Many do not have the luxury of quibbling over the minute specifics of design nuances. People at the edge of society are the most vulnerable to the impacts of large phenomena. Like the round spinning platforms in playgrounds, the children that hold on to the centre are displaced very little while those clinging to the edge cover large distances. If you are working with the edge, you need to keep a vigilant eye on the big topics and how they collide. Given the complex entanglement of the myriad of domains at play in the broad field of Inclusive Design, things can go seriously wrong very quickly.

At times my attempt to achieve greater accessibility in my writing and critique of the assumptions and practices of the Academy could be interpreted as anti-intellectual, anti-academic, or even anti-scientific. This is far from my intended stance. As a scholar, I recognise that I am a member of a privileged group and that we have a responsibility, or duty, based on our established commitments, to be more inclusive. Although I contest our use of the terms *rigour* and *quality*, I am seeking what I consider a deeper, more critical and conscientious academic practice that does not contribute to cycles of disparity.

That being said, I make no claims to objectivity or neutrality. While I have attempted to maintain an open and relatively egalitarian community, there is still no denying a certain inevitable stratification in the community, influenced by my position and role as director and by a constant effort to engage with meritocracy and other group conventions that influenced the evaluation and application of the framework within the IDRC and the larger Inclusive Design community. This larger community might be considered a full instantiation of a "community of practice" as defined by Etienne Wenger or a group of people who share a concern or a passion for something they do and improve as they interact regularly (Wenger, 1998). The framework as defined and applied in the thesis was conceived and refined as a reflexive inclusive design process. I have tried, in the interests of full disclosure and transparency, not only to write about

the aims, strengths, and affordances of the framework, but also to share a number of areas of critique and some perceived shortcomings of the framework.

The framework is neither complete nor stable. It is not intended to be either. This PhD thesis merely takes a 'snapshot' of the framework at this moment. In this way, the framework is an instance of a design that is created in an internally consistent fashion. It is constructed to be extensible. The structure is intended to be akin to an extensible trellis, supporting organic growth, rather than to function as a fixed set of containers. In the future, it is possible that a fourth dimension of Inclusive Design will be added to the framework, for example. The existing three dimensions should not be seen as fixed anchors but as subject to continuous re-interpretation and extrapolation. The guiding compass is inclusion. The framework is intended to represent an evolving and sufficiently supportive structure to progress toward this challenge of inclusion.

The essential premise of Inclusive Design is that systems enabling the participation of the full range of human diversity benefit not only persons and groups currently excluded by the design but society as a whole.

It might be posited that this area of design is already a crowded space. There are indeed several domains with overlapping areas that can be identified: for instance, the field of Accessibility (a term recently expressed as A11Y), Universal Design, Universal Design for Learning, Design for All, and the co-evolved UK version of Inclusive Design (see Chapter 4 for a review of related fields). Yet, another new and more inclusive framework and theory is most definitely required. The rationale is included in detail throughout the thesis; a distillation of the reasons is included here.

The first more obvious reason for insisting upon a specific field of Inclusive Design for our digitally transformed and increasingly complexly connected society is the recognition of the special place of digital and networked systems and practices that require a rethinking of Universal Design, which is not sufficiently contextualised by the field of Accessibility. More importantly, none of the systems in the domain adequately address the issue of exclusion. Specifically, the exclusion of individuals who find themselves at the margins and who do not belong to any represented groups.

In fact, one of the factors that galvanised my determination (and convinced me that we need to rethink our approaches to social justice, universal design, and accessibility) was observing the

same exclusionary phenomena and divisiveness happening within the movements that had been intended to address accessibility issues. Even as recently as 2018, I have heard colleagues expounding the benefits of prioritising 'high-incidence disability groups,' government funding programmes to address exclusion asking for 'high-number impact' that implicitly requires homogeneity and excludes minority groups, and competition for exclusive support by social justice advocacy groups. All these examples further marginalise individuals who are the co-designers of this study. Traditional measures and methods simply do not represent the margins: even the most well-meaning efforts using existing methods tend to exclude further.

The test I have presented for this framework is whether it reaches the jagged edge of human society, including individuals who find themselves unrepresented and who do not belong to any advocacy group. The framework thus enacts a version of Mahatma Gandhi's test: "The true measure of any society can be found in how it treats its most vulnerable members" (Gandhi, 1966).

I argue throughout the thesis that the proposed framework, according to Gandhi's challenge, not only provides a measure of a society, but also that 'measuring up' to this challenge is in our society's best interests.

1.3 What is disability?

Discussing Inclusive Design requires both a framing of the concept of disability and a contextual definition of the terms associated with disability. The terms 'disability'' and 'disabled' are both highly contested, sensitive, and politicised terms. As with other emancipatory movements that are fighting discrimination, the Ability movement sees language about ability and 'disability' as an instrument of power and oppression. The right to agency and self-determination over the words used to identify ourselves is recognised as an important element on the road to equity. Language is also inherently in flux, as associated meanings and cultural nuances or signals adhere to terms but shift and change over time and across contexts. It is therefore understandable that the language favoured by the disability community and disability culture movement are continuing to evolve.

What has become known as 'people-first language' has for some years been broadly adopted by organisations such as the World Health Organisation and the United Nations to acknowledge that disability is not a defining characteristic of a person's identity. Thus 'person with a disability'

is generally the preferred term over 'disabled person,' acknowledging that the person or people referred to are 'people first' and that the characteristic or condition of having a disability is secondary. This choice of more positive wording is an acknowledgement of humanity for a group of individuals who have been denied personhood in the near past and whose personhood is perpetually under threat (Blaska, 1993). Yet even this seemingly simple and positive choice of language is not universally welcomed even within the circle of disability studies scholars, some of whom contest the use of 'people-first' terms, arguing that the convention was arrived at from outside the disability community (Titchkosky, 2001). These opponents of 'people-first' terminology tend to contest the rationale, arguing that the term 'person with a disability' denotes a characteristic belonging to the person, whilst the term 'disabled person' denotes a social act imposed upon a person. The disability culture movement adopts the 'disabled person' framing as a source of pride in belonging to a strong culture associated with disability.

More problematic still is consideration of derogatory nicknames used for people experiencing disabilities. Terms such as 'crip,' for instance, have been used pejoratively for many years, but have also been recently re-appropriated to re-value the term and disempower the effect of the pejorative use. A corollary shift in perception and use of pejorative nicknames might be seen in the decision to describe 'people of colour' using negative words from previous generations, which have also been embraced by some members of the community in recent years, though generally only when used by a community member about her or himself or by another close member of the community (but not by 'outsiders'). Language has power, and agency can be claimed differently over time from different positions.

This debate over the appropriateness of different forms of language to refer to disability is further challenged by another factor: what has become known as the 'medicalisation' of ability. Many contend that recent use of the 'person-first' language is closely linked to a shift from a medical framing of disability—where disability was viewed as a medical condition located in the individual, who was considered to have a deficit or 'condition' that required fixing or healing—to a social framing of disability where the individual is not seen to have any deficit or to be defined by any medical condition, but rather to be restricted by social constructs created by an oppressive society.

By whatever definition, disability has indeterminate bounds. Many conditions associated with disability have gradients without defined thresholds. At what point, for instance, does a vision

impairment or hearing impairment become a disability? Countries or jurisdictions vary in what conditions they include under the term 'disabled.' There is no definition that has exclusion and inclusion criteria that can be used to unambiguously sort real human beings (Fujiura and Rutkowski-Kmitta, 2001).

A further complication arises when we consider the impact of personal choices regarding whether or not any individual may choose to identify as having a disability. Many individuals who are aging, for example, may meet formal criteria for being labelled as 'disabled' but do not see themselves as 'disabled.' Individuals with invisible disabilities such as dyslexia, dyspraxia, extreme but largely correctable vision impairment, etc., often face the difficult choice of whether or not to disclose their disability.

When exceptional benefits are associated with the personal status of disability, the authoritative judgment of a doctor is usually required. This belies the misguided association of disability with sickness. Classifications used by formal institutions and administrative processes, as well as disability advocacy groups, often categorise persons experiencing disabilities by their deficits. Even when the intent is to provide a service, unlike other service organisations, the framing is deficit-based rather than based on functional requirements and associated services.

In the practice of the IDRC, I have framed disability from the perspective of the designer. The definition I proposed was that disability should not be viewed as a personal trait but rather relative to the individual in context and the goal. The disability comes about through a mismatch between the needs of the individual and the service, product, or environment available to them. I have used the example of an individual who is blind when there is a power outage: the lights go out, and we have to find our way out of a building. It is the individuals who have not learned to navigate without sight who experience a disability. This definition of disability as 'a mismatch between a person and their environment' was adopted and socialised by my centre in order to recognise the responsibility of the designer. The designer had the power to either create barriers or mismatches and thereby to cause the experience of disability, or to remove barriers by co-designing systems capable of matching individual requirements.

This definition was proposed at a time when the disability culture movement and the understanding of disability as an element in the construction of identity was still very nascent. The definition was not intended as a comment regarding identity but as a way of saying that we have no right to view or impose disability as an essential identity trait.

With the emergence of a disability culture, and the contestation of terms to be used, I have taken the position that the person or group being referenced should determine how they wish to be referenced. This uses the approach favoured by other identity groups, including the use of pronouns for individuals in transition between genders.

This approach is not possible in a written work such as this dissertation. With the rising recognition of the knowledge and insights gained with lived experience, I have chosen to use 'people experiencing disabilities,' or the acronym PED, as a means of showing deference or respect to the individuals navigating the complex domain of identity and labels. This is an important debate, but this dissertation does not require the choice of a position in the debate.

1.4   Overview of Thesis

The thesis is divided into eight chapters. Chapter One introduces the meta-design challenge and discusses the conventions adopted in the thesis, including the motivations for choosing the communication styles and methodologies. Chapter Two presents the proposed Inclusive Design framework or the three dimensions of Inclusive Design in the form of three blogs intended for a general audience of co-designers. I also cover some of the facets of the framework that do not easily fit into a public blog in this chapter. In Chapter Three I cover both the methodology and the application of the framework to research methods, data analytics, and artificial intelligence. In Chapter Four I situate the framework and provide a manageable portion of the literature review. The remainder of the literature review is distributed throughout the thesis. Chapter Five documents the application of the framework in Education and Learning. Chapter Six documents the application of the framework in Innovation and Markets. Chapter Seven recounts the application of the framework in Policy and Regulations. Finally, Chapter Eight provides conclusions and next steps.

2 : The Framework

Before discussing the literature review and the research methods, as is traditionally the order within a thesis, I feel it is important to introduce the Inclusive Design framework because I have applied the framework in critiquing and rethinking research methods. Inclusive Design strives to be internally consistent, applying the ethos of Inclusive Design to the practice of Inclusive Design. Available research methods, and especially research methods favoured in academia, are not suited to the topic I have chosen. Also, given the broad-reaching scope of Inclusive Design, the scope of the literature review must be narrowly focused and constrained. The framework is intended to address global challenges and opportunities from a design perspective.

2.1 The Challenge

Disparity or inequity, identified as one of the greatest global risk drivers (Collins, 2017), is not static but influenced by compounding and complex factors that are amplified through vicious cycles. Factors such as poverty and compromised access to education, housing, transportation, employment, health services, civic engagement, and security co-occur and complicate each other. Much attention has been focused of late on the indicator of income disparity, but the current design of our markets, education and training systems, research methods, and even the design of our technical innovations contribute to entangled vicious cycles of disparity.

If you are an outlier or at the margins in our society, you will find that most standard things are not designed with you in mind. Whether it is healthcare, education, transportation, housing, employment, financial systems, or the consumer products you depend upon. To find things that fit your needs, you must look harder and pay more because you cannot take advantage of economies of scale. This means that whatever finances or income you acquire will buy you less, further compromising your prosperity. Worse yet, research that we depend upon to improve knowledge and quality of life will likely not represent you. This is a reality faced by many people globally as diverse as persons with disabilities, indigenous women, residents of remote communities, refugees and migrants, or individuals with poor literacy. Even the systems created for minority representation, including advocacy groups and consumer groups, have specific criteria for membership and thereby exclude individuals that do not fit the criteria.

As a powerful example, our systems of research, relied upon as arbiters of truth and objectivity, are systemically biased against diversity. In our attempt to understand complexity and find dominant patterns, we elide the outliers. This creates knowledge disparities that ripple well beyond the topics of research. People who do not fit into any representative sample are less likely to be represented by research or scholarship and are less understood, or worse, they are misunderstood and misrepresented. This has implications for policy, markets, systems of education, systems of employment, government services, and all facets of life.

At an international level this has implications for our goals as nations and our relationships with other nations. Sally Engle Merry, in her book *The Seductions of Quantification* (2016), explores how global indicators are shaped by inequalities in power and expertise. She identifies a phenomenon called 'expertise inertia,' in which "insiders with skills and experience have a greater say in developing measurement systems than those without—a pattern that excludes the inexperienced and powerless" (Merry, 2016). Authoritative expert knowledge is privileged, meaning that local knowledge is often ignored. The expense of collecting new data leads to an associated phenomenon Engle Merry calls 'data inertia': "It is relatively hard to address new problems without new data collection, so the way categories are created and measured often depends on what data are available"(Merry, 2016).

Our academic institutions are responsible for advancing knowledge used to guide policy and innovation. However, as scholars, our research review, tenure, promotion, publishing, research recognition, and funding processes are implicitly biased against minority needs. In the race toward impact metrics needed to be published, receive tenure, be promoted, receive recognition, and garner research funding; scholars are channelled toward research that can yield large sample sizes and homogenous outcomes that result in statistically significant findings. Reliance on peer review perpetuates dominant interests. Researchers value research that strengthens their research domains. Disciplinary silos mean that many topics 'fall through the cracks.' Personal investment in demanding academic development often leads to competitive and elitist attitudes regarding what is worthy of inquiry.

Perhaps more troubling than the gaps and disparities in research topics is the trend for 'Big Data' systems to replicate traditional diversity-and-complexity-aversive research methods. This accelerates the echo-chamber effect, emphasises dominant patterns, and amplifies the bias toward what are deemed 'high-impact' research issues. As reaching the bar of 'high-impact'

requires homogeneity in large numbers, individuals with outlying or minority needs can never reach the bar. Yet collectively these outlying needs may surpass — in urgency and volume — the needs that are deemed 'high-impact.'

Most importantly, this systemic bias has grave consequences for those who are most vulnerable in our society. One of the most disheartening consequences of our research methods is the negative consequence of attempting to apply traditional research methods to minority groups, however well intentioned. Given the criteria of homogeneity, this leaves individuals at the margins who do not fit the minority sub-categories created, stranded with even greater barriers to overcoming the bias. This negative effect may be in direct proportion to the effort and sacrifice associated with the research on the part of the researcher or research organisation that chooses to go against identified research priorities or high-impact topics. Consequently, responsibility for exclusion is often attributed to the excluded individual, as research (and therefore facts and implicit 'truth') show that their needs should have been met and their situation should have been understood given the investment.

A similar pattern exists for our systems of education, employment, media, civic engagement, design, marketing, legislation, and policy. These systems are structurally biased to propagate dominant trends such that the rich will get richer, those with influence will garner more influence, knowledge about the majority will increase, while those at the margins are caught in vicious cycles of poverty, lack of influence, and lack of being understood. This is the pattern experienced not only by individuals but organisations, communities, companies, and even universities. Our current socio-technical advances, while promising to disrupt these systemic patterns, have largely accentuated the dominant trends. From popularity echo-chambers in social media that speed the rise of items with the most hits, to recommender sites that offer choices from users like us, to big data analytics that privilege dominant patterns, to computer-mediated financial trading systems—all amplify the trend toward greater disparity. Compounding this effect, rapid change ushered in by technical advances has triggered strong reactions by many systems to maintain the status quo or stabilise threatened conventions. This makes previous paths out of the disparity divide more difficult to negotiate.

2.1.1 Disruptive Socio-Technical Opportunities

Disruptive technologies and their associated social practices present opportunities to either change the course or reinforce dominant trends. This is the case for research as well as other

domains of inequity. For example, fortuitously, at the same time as there is an echo-chamber of research topics within the formal research community that leaves outlying areas of inquiry ignored, tools and strategies are emerging that can democratise data gathering, processing, aggregation, analysis, visualisation, comparison, dissemination, and replication, and enable non-academic citizens to participate in and guide sophisticated inquiry. These technologies include: Internet of Things monitors and sensors (e.g., biometrics, environmental, and smart home), personal mobile apps, complex data query systems invoked by natural language questions (e.g., "Siri, what is the current population of Nunavut?"), the adoption of open data practices by public institutions (e.g., traffic pattern analysis, energy consumption, employment equity metrics, and public spending figures,), and personalised data analysis tools (e.g., exercise guidance based on personal data). These technologies enable a bottom-up emergence of citizen inquiry that has the potential to fill the gaps left by academic research. Unfortunately, most of these tools are not designed inclusively, excluding many of the very citizens excluded by formal research. Many emerging tools and practices present barriers for individuals with disabilities that require alternative access and individuals unfamiliar with highly technical terms or conventions. Citizens in rural and remote areas and citizens without the necessary financial resources to purchase new personal technologies are also frequently excluded. There are also privacy, security, and loss of self-determination and identity risks associated with these new technologies and practices.

2.1.2 Societal Impact

Social exclusion is a vicious cycle. If someone is unable to participate, their interests will not be considered or understood in the decisions made. In turn, if their interests are not considered they will not be able to participate. Each decision made without their participation bolsters and entrenches the exclusion further, normalising their absence and making them invisible to the process.

Not just the excluded individuals and their families feel the corrosive effects of this systemic bias, but society as a whole is damaged by this exclusion. Extensive evidence aggregated by researchers such as Richard G. Wilkinson and Kate Pickett (2009) has shown that inclusive societies are healthier, wealthier, safer, and wiser. Inclusive societies are also more dynamically resilient and innovative. The good news is that even small systemic interventions to increase inclusion in this complex adaptive system that makes up our society can trigger virtuous cycles.

Most poignant is the situation of groups that are identified and trusted to advocate for and uphold human rights, dignity, and social cohesion. As eloquently expressed by Darren Walker, the President of the Ford Foundation, upon realising that his roadmap for equality failed to include people experiencing disabilities: "We simply cannot and will not defeat the enemies of justice—or dispel ignorance—without taking time to reflect on our own lives, and without asking difficult questions: *Who am I forgetting*? *Which of my assumptions are flawed*? *Which of my beliefs are misbegotten*?" (Walker, 2016). Walker argues that this requires a completely intersectional view of equality and the empathy and humility to remain vigilant and vulnerable to those who may be excluded. Vigilant attention to the margins and vulnerability to constructive critique is the difficult and complex path to eliminating the blind spots and unintended negative consequences of inadequately informed good intentions.

The framework is intended to guide my practice and the practice of my community in navigating these challenges and opportunities. The framework is designed to learn from the shortcomings and unintended consequences of associated frameworks that emerged before our society was digitally transformed.

2.2 The Community of Practice

I have developed the framework in the context of a community of practice. I am at the humbling centre of an informal, evolving, complex, global network that engages not only the team of incredibly talented permanent research staff at the Inclusive Design Research Centre (IDRC), but also: the hugely diverse local, national, and international collaborating communities that share our vision and help to guide our efforts; the students and graduates of the Inclusive Design graduate program of the IDRC; the post-docs and visiting faculty who come to the IDRC; the hundreds of multi-sector partners that work with us; the open source communities we lead; the affiliated programs established by our graduates and partners; and the many global projects in which we are engaged in. This dispersed, multi-talented, multi-perspective, evolving ecosystem was recruited to constructively critique and assist in refining the framework. This global network also acted as a sandbox of sorts to test the framework. The community is accustomed to reflective practice, or, learning about while doing. As part of the commitment of the community is to be inclusive of diverse perspectives, especially edge perspectives, it served as an ideal testing ground for communicating the framework.

2.3   Communicating the Framework

Initially at the start of my doctoral work, I posted the framework on the Inclusive Design Research Centre website. Our choice of the use of Inclusive Design rather than Universal Design had been questioned by faculty members at OCAD University. With the framework, I included an explanation for the choice (Treviranus, 2010a). To gather further input, I chose to express the framework in a series of open online blogs. This compelled me to express the framework in such a way that it would be understandable and engaging for a general audience, including the individuals that we would recruit to participate as co-designers in our research. It also acted as a means of receiving feedback from as a broad range of prospective inclusive designers as possible.

The primary feedback was positive and congratulatory. The sole critique was regarding my more provocative statements regarding Design in general, in which the reviewer argued that Design was better than I suggested. He did not critique the framework. Several readers, including some readers with many followers, suggested that if their followers read one thing this year it should be my blog posts. This generated many further congratulatory and appreciative posts on other social media, including Facebook and LinkedIn. Several readers pointed to promising related work or topics and asked to work together and collaborate in applying the framework. What follows are the three blog posts.

2.4   The Three Dimensions of Inclusive Design: Part One

With the help of my team at the Inclusive Design Research Centre and our amazing global community I have tried to develop a guiding framework for inclusive design, suitable for a digitally transformed and increasingly connected context. It doesn't lay out testable criteria, or an ordered checklist, because inclusive design is about diversity, variability and complexity.

It is not a set of static structures that assist in engineering a solution, because the complex adaptive system that is our current society is a domain where solutions can no longer be engineered but approaches must be grown, and investment in a fix for some creates greater barriers for others. The framework is intended to be more like a trellis that supports organic growth and provides a foundation from which to innovate and evolve. It has emerged, evolved, been tested, and refined over the 25-year history of our centre, in dozens of global initiatives.

The three dimensions of the framework are:
1. **Recognise, respect, and design for human uniqueness and variability.**
2. **Use inclusive, open & transparent processes, and co-design with people who have a diversity of perspectives, including people that can't use or have difficulty using the current designs.**

3. Realise that you are designing in a complex adaptive system.
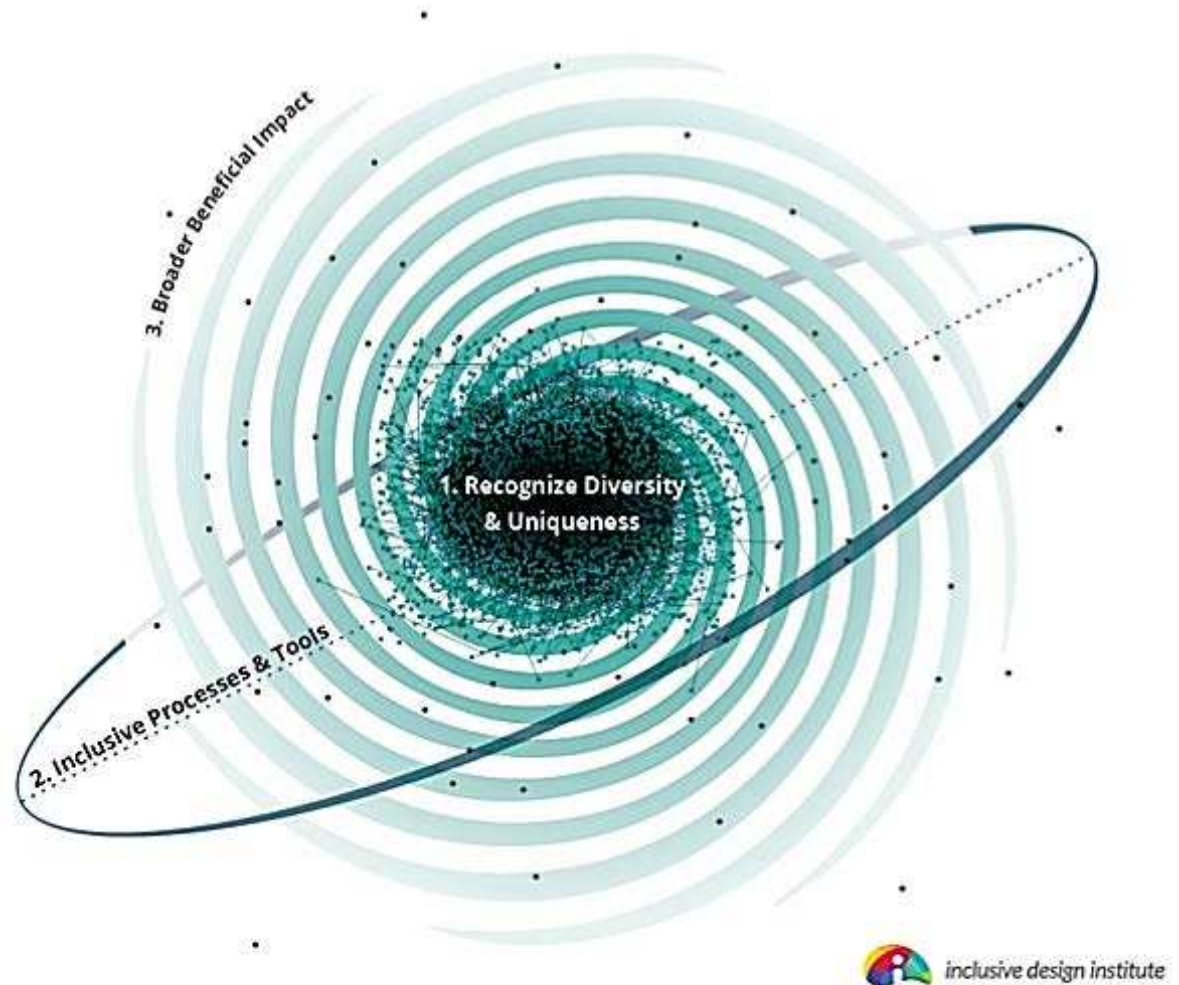
Figure 1: The three dimensions of inclusive design.

I will discuss each dimension in turn in this three-part blog.

Human Uniqueness

The first dimension of the framework is to recognise the uniqueness of each individual. We are each an irreducible and evolving complex adaptive system of characteristics and needs. This uniqueness and wild, organic diversity has been **inconvenient** when it comes to designing products, communication, environments, or policies. It defies mass production, mass marketing, mass communication, mass education, as well as simple and straightforward public policies.

Throughout civilisation there have been attempts to corral and tame this diversity and complexity and find ways to deal with people as a more manageable, simple, and homogeneous mass. The more egregious attempts have employed violence, genocide, exclusion, othering, shaming, shunning and informal or formal discriminatory practices. Other strategies have been coercion, indoctrination, acculturation, breeding, propaganda and schooling. In our quest for knowledge or research and in our governance strategies we have reduced people into simple numbers that ignore this diversity and complexity. Through our laws, policing and penal systems we attempt to contain the edges of this diversity that are

deemed more negative, but we have also institutionalised systems that either deny or suppress the harmless and beneficial aspects of this diversity, adaptation and complexity. If we can't eliminate certain diversities we have sequestered and incarcerated people in camps, ghettos, 'mad houses,' and specialised institutions for 'deviants.' This aversion to diversity is both damaging to individuals and dangerous to our societies. (I would contend, but have not gathered enough evidence to assert, that the suppression of the positive aspects of our diversity contributes to the expression of the more negative aspects of our diversity.)

Let's imagine for a moment that the supposed utopia of a homogeneous mono-culture of ideal human beings were even achievable. Yes, manufacturers could produce a single simple product and market it to the entire customer base. Policymakers and researchers could easily predict behaviours and design policies to accommodate these behaviours. We could communicate a message in a single form and know that it is understood and received by everyone in our mono-culture. The requirements of our built environment would be straightforward and predictable. We would obviate empathy because everyone would be like us. But we would stagnate as a species as there would be no alternative ways of being to evolve toward. Any threat, such as a disease or a natural disaster would fell our society, as there would be no variability in immunity, or alternative responses to the threat. We would have a blinkered and limited perspective of our world and fail to see both all the wondrous but also the possibly dangerous edges. We would end innovation as there would be no disruptive and resourceful new responses emerging to challenges and dissonance. Yes, we could be comfortable and complacent, but we would not move or grow, individually as a person or collectively as a society.

Relaxed Selection

You might ask, isn't it beneficial to prune the diversity by eliminating weaknesses and 'deficits' and thereby strengthening the species? Isn't evolving and advancing our species assisted by Darwinian survival of the fittest? Some people claim we can do this humanely through genetic engineering and doctor assisted suicide. According to Terrence Deacon, if this were the case we would not have developed language. If we trace the periods in our history as a species when we have made the greatest advances, it is at the times when we have had the benefit of relaxed selection. This means an absence of the pressures of survival of the fittest. This is when diversity can thrive. We have come to see the pivotal role that the complex adaptive social system plays in evolution. Variability and diversity, especially what we deem weaknesses and deficits, prompts the system as a whole to evolve and gain resourcefulness. (There are endless modern-day examples of this phenomena that include email, voice recognition, the telephone and aspects of the Web that make it successful).

Perfection and Change

Humans are a social species, we have become ever more entangled and connected. To advance as a species we must consider not only the isolated representatives of the species but the enmeshed collective system as a whole. We need fragility, weaknesses and gaps to enable change. As Leonard Cohen sang, "There is a crack in everything. That's how the light gets in." When we near ideas of perfection, when systems become established, complacent and entrenched, it becomes difficult, if not impossible, to change. Take systems of education in regions where education is institutionalised and revered. Take policies and practices that have become so habitual that they are unconscious. It requires major disruptions, or incidents of 'creative destruction' to prompt the established and conventional to appropriately respond to a changing world. But a system, such as a team, that has diversity

and variability within it and works to make room for and truly include this diversity can responsively change, remains dynamic, has enough collective perspectives to see the entire periphery to avoid and respond to threats and to notice promising opportunities. Such a system can also judge and test potential actions more thoroughly.

Such a system has far more choices. It is better at resisting polarisation because there are more than two powerful viewpoints. Paradoxically, if you have a platform with a huge spread of positions or perspectives you have greater equilibrium and can resist the swing of the pendulum between two extremes. This ensures that a political pendulum never swings too far into any extreme direction.

Enlightened Self-Interest

As a society we need people who lead in facing challenges (that we often characterise as deficits and weaknesses), to stretch our boundaries as a society. We need these involuntary pioneers to not only stretch our boundaries in designing our environment, policies and products, but also our boundaries regarding the qualities we have come to see as our humanity. It is a bad day for our species when it becomes obvious that elephants, whales and dolphins surpass us in these 'human' qualities of empathy, kindness and social cohesion. Every human, and every society will face challenges. As our mothers would remind us: 'what goes around, comes around.' Karma is not mystical, it is logical. If we help to develop a society that responds respectfully to human variability, there will come a time when we ourselves benefit from that respect. If you prefer, this can be seen as a form of selfishness. We can also see it as enlightened self-interest. It is an investment in our long-term interests and the interests of our children. It is a way of preparing for the unpredictable and the unplanned.

Not Charity

I can argue that both Ayn Rand's and Adam Smith's views of the virtues of self-interest are too reductionist, impoverished and short-sighted. They fail to consider our complex, adaptive and entangled world and our inter-dependencies. To be clear, I'm not promoting charity. Charity, where the powerful, privileged and well-resourced deign to assist and give of their wealth to the less privileged, less fortunate and weaker, sets up an untenable power imbalance. It reinforces the superiority of the giver and the inferiority and expected indebtedness of the receiver. It is also vulnerable to 'charity fatigue.' The receiver or supplicant must compete with many other possible receivers in a race to the bottom. Each potential recipient of charity competes for the position of the most pitiable. This competition normalises the horrors of inequity. It is a vicious cycle and can only be a temporary Band-aid in a dire situation while we address the underlying causes.

What I'm recommending is a society or social system that is designed to respect and include diversity and human variability at every nested level. We need a society where it is possible for people, with the full range of human difference, to participate and contribute.

Responsible Designers

Designers play an ever more important role in this as all fields of design and also design thinking are ascending and applied in more and more contexts. However, to apply this dimension of inclusive design requires unlearning many established conventions of design. Designers are taught to reduce and ignore complexity and diversity by creating representative persona of the typical or average user. As Todd Rose eloquently argues in his book *The End of Average*, there is no average person. Average is an artificial construct. There is not even an average us, we each vary from context to context, from goal to goal. Designers

reduce contextual complexity by working in sterile and isolated labs. However, the design will not be applied in sterile and isolated conditions. Design research works toward finding one winning design that meets the needs of the largest customer base. This excludes anyone that is different.

Approaches at the Margins

Even the design practices that are intended to address the needs of people at the margins of our society, people who are viewed as different, often employ practices that ignore diversity. For example, we have propagated the notion that there is a one-size-fits-all version of accessibility for people who experience disabilities. However, the single defining characteristic of disability is difference — sufficient difference from the norm that things are not made or designed for you. In fact, people who experience disabilities are even more diverse than people who can use standard designs. They also have less degrees of freedom to adapt to a design that doesn't fit well. Sorting and filtering people into categories and classifications based on a specific characteristic, such as a medical diagnosis, and designing for that category is another way of taming diversity. However, this leaves people falling through the cracks and stranded at the edges.

The Qualities of the Digital and the Networked

So, what am I suggesting designers do? I'm suggesting that we design to include diversity by leveraging the affordances that our digitally transformed and connected world provides us; to offer one-size-fits-one configurations that can be optimised to each user and stretch out to the edges of our human scatter-plot of needs and characteristics. The digital and networked presents many challenges but it also presents some powerful qualities and tools that make it easier to respect and optimally design for diversity and complexity. Unlike a door to a building that demands compromises and choices regarding how people enter, in a digital system we can present a different door configuration to each person, even if they are entering as a group, and going to the same destination. Using such things as style sheets, personalisation, adaptive and responsive design, the door can morph and adapt to the needs of each visitor.

As far as adaptation and personalisation, I need to add three provisos.

Not Segregated or Separate

First, the one-size-fits-one design cannot be separate or segregated. If it is separate from the general market it will cost more. If it is designed separately from the standard application, it will be less interoperable. It will require special training and separate maintenance. Interoperability is a critical factor in the entangled, quickly evolving, complex networks that we depend upon, and a separate solution soon becomes orphaned and incompatible.

Enabling Smarter People

Second, if smarts are used to learn what each individual requires, we need to make sure that the person directs and gains the insight. The intelligence we gather should make the person smarter about their unique needs, rather than, or as well as, the machine smarter about how to adapt. This requires transparency regarding choices made and the reasons for the choices.

Optimal Fit

Thirdly, one-size-fits-one implies an optimal fit for the goal, it doesn't necessarily mean a comfortable fit. If the goal is to learn, then the optimal fit will provide a challenge that is at the limits of achievement. The echo-chambers, and cushioning from alternative views, created by personalized media and news is not an optimal fit and does not serve to inform or

present an accurate view of the world. An optimal fit in this domain would be to provide language and presentation choices that can be personalised to the individual's needs so that more can be understood. It means translating currently foreign viewpoints, so they can be understood by strangers. Academics, scholars and researchers need to learn to use this form of design so that knowledge can be more democratically shared. Inclusive personalisation builds bridges across differences and reduces fragmentation.

Pooling, Sharing and Matching Needs Over a Network
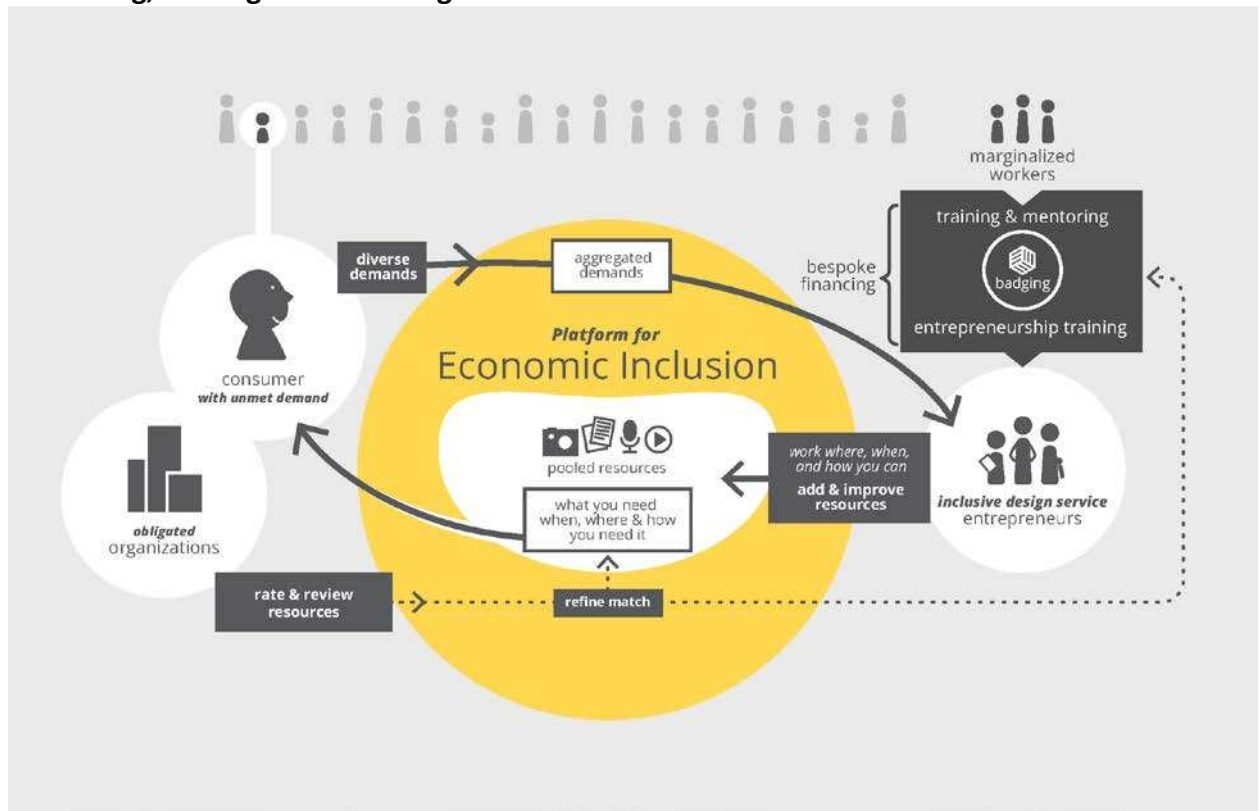
Figure 2: The use of a network platform to address our diverse unmet needs

A networked system makes it possible to share and pool resources so that we can create a wealth of variants to match the full diversity of needs. We can reach out across networks to find diverse innovators that can fill gaps and unmet demands. A networked community can help find a match, augment or translate designs so that everyone has choices that optimally meet their diverse and variable personal requirements.

Diversity is our most valuable asset. Inclusion is our biggest challenge. Taking up the challenge will make our design better, and the human community we design with better.

2.5   The Three Dimensions of Inclusive Design, Part Two

This is the second part of a three-part blog that describes a guiding framework for inclusive design in a digitally transformed and increasingly connected world. The three dimensions of the framework are:

1. Recognise, respect, and design for human uniqueness and variability.

2. Use inclusive, open & transparent processes, and co-design with people who have a diversity of perspectives, including people that can't use or have difficulty using the current designs.

3. Realise that you are designing in a complex adaptive system.

The Lessons of Unrecognised Technology Pioneers

Design is an awesome responsibility. There are many things that can go wrong or ways it can go 'sideways.' As argued by Jaron Lanier "Because computers are growing more powerful at an exponential rate, the designers and programmers of technology must be extremely careful when they make design choices. The consequences of tiny, initially inconsequential decisions often are amplified to become defining, unchangeable rules of our lives"(Lanier, 2010). To avoid doing something embarrassing or dangerous requires more than creativity and a sense of aesthetics. It requires a keen understanding of all the people that will use the design, their goals, and their variable contexts. Design is an especially daunting responsibility when you are designing things that are essential to someone or designing things that require a significant personal investment from the user.

I came to this realisation many years ago when I started working with some of the invisible and unsung technology pioneers. These are the individuals that have been labelled 'extreme users' or 'edge users.' They have no choice but to risk the frontiers of technology design, and what they personally invest is profound and deep.

The pioneers I worked with included technically courageous kids that learned a complex code during kindergarten, so they could talk and communicate (in this case it was a form of Morse code because it only took the timing of the one voluntary action they could reliably control). They included a hugely innovative and resourceful couple that learned a new means of writing almost monthly because the husband gradually lost functions as a debilitating progressive illness took its course. They also included a brilliant math student that had the patience to struggle with the inexcusably bad translations of math notation to synthetic speech, so she could obtain a math doctorate without sight. Over my 38 years in this field I have had the personal privilege to work with many more. It is working with these technical pioneers that has taught me the most about the process of design.

The Responsibility of User Investments in Technology Designs

Most of us can survive without the majority of the technologies we use. If the technologies stopped working, it is no doubt that we would be inconvenienced. It might be a shock to be forced to travel to see someone because our cell phone isn't working, to write with a pen or pencil because our computer is misbehaving, to go to a shop to buy the things we need because the Website is down, to pick up a book or visit a library to find some information we need; but we would get by.

For a growing group of people, the loss of the use of certain technologies means you have no way to talk, no way to write, no way to travel or move about, possibly no hands or legs, or no way to see, or hear, or understand. Relying on technology for these individuals has always meant a deeply personal and intimate relationship, akin to most people's current relationships with smart phones or glasses.

This also means that the design that is available to you (because often there are very limited choices, if there are any choices) requires a significant personal investment. If the technology is to fulfil its role it needs to become habituated and its operation needs to become largely unconscious or automatic. Just as we are not aware of moving our tongue, mouth and breathing apparatus when we speak, you can't be worried about the mechanics of finding and selecting a word to communicate when you use a communication device. It interrupts the flow and the very purpose of communication.

It takes a huge training investment to get to that automatic stage of use. You don't want to have to learn to talk, write, walk, or read all over again too many times in your life. These are individuals that have many other barriers to face on a daily basis and for whom time and energy is an overspent precious commodity. It behoves us to create the very best personal fit and not require these individuals to unnecessarily squander precious time in struggling with and trying to decipher the interface/interaction/experience design.

Impossible Understanding

One of the first lessons I learned is that no amount of background research and statistics; no persona (however well researched, fulsome, evocative, and motivating); and, no empathy exercises or disability simulations; can ever teach you enough about the very personal and unique requirements and characteristics these individuals bring. It is a shameful conceit to suggest that you are an expert, or that you have more knowledge and insight, it is even hubris to suggest that you really understand. You cannot understand until you have no option but to live it. Even if that were to happen, it won't be the same experience.

Inverse Effects

One of the distressing phenomena I observed during my career was the degree to which excelling in the respected design methods often led to worse design for the individuals that most depended on a good design. The more the designers engaged in rigorous research, or observation behind one-way mirrors, or focus groups with token representatives of high incidence disability groups, the more the designers failed to 'get' these pioneers and what was needed in the design. It was almost like the research and rigor was a shield to really understanding, while at the same time bolstering professional stature and distance.

The larger the data set and the greater the power of the statistics, the more likely the unique needs of these pioneers would be lost or overpowered. It often became a tug of war between a design that stretched to where the edge user needed it versus a design backed by the research data—which would lead you away from the edge and toward the mean. Even the more creative design practices that involved an empathy cycle accompanied by ideation or brainstorming often landed on a design that completely missed the mark. While the designers could step out of their own assumptions and preconceptions, it didn't necessarily mean they could step into the perspective of the edge user.

Authentic Expertise

This led me to the conviction that we need to recruit the most relevant and authentic expertise to the design team, namely the edge users or pioneers themselves. Not as research participants and subjects of study and analysis, but as full-fledged design team members, or co-designers. Not just during 'empathy' and 'user testing' stages, but throughout all design and development phases. We came to realise that 'nothing about us without us' was not just a social justice mantra but a good design practice.

Co-design for the Mainstream

You might say this is great for design that is specifically about people experiencing disabilities, or people who face literacy, aging, cultural or geographic barriers to access; what does this have to do with design in general? How is this relevant to mainstream user experience design?

During our 25-year history my team has employed co-design with edge users and edge scenarios in many design projects that are not directly connected to people experiencing disabilities, whether it is designing better learning management system user experiences, restructuring a government ministry, rethinking what a museum experience should be,

planning better emergency procedures, helping to organise more effective transportation systems, working towards more fool-proof voting systems, creating more successful open source communities, or designing more effective schools. Through this process we were able to verify Scott Page's findings that the best planning, prediction, risk aversion and innovation happens when you bring together the broadest range of diverse perspectives. Scott has termed this the '*diversity bonus*.' Our team, the broader community, our partners, and the graduate program I launched are organised around this insight. At a basic level we don't separate designers, researchers, developers and quality assurance people. They all work together. But also, the people that fill those roles bring the richest variety of perspectives we can muster. However, you cannot invite all possible users or their representative perspectives into your design teams.

People who can't use or have difficulty using a design
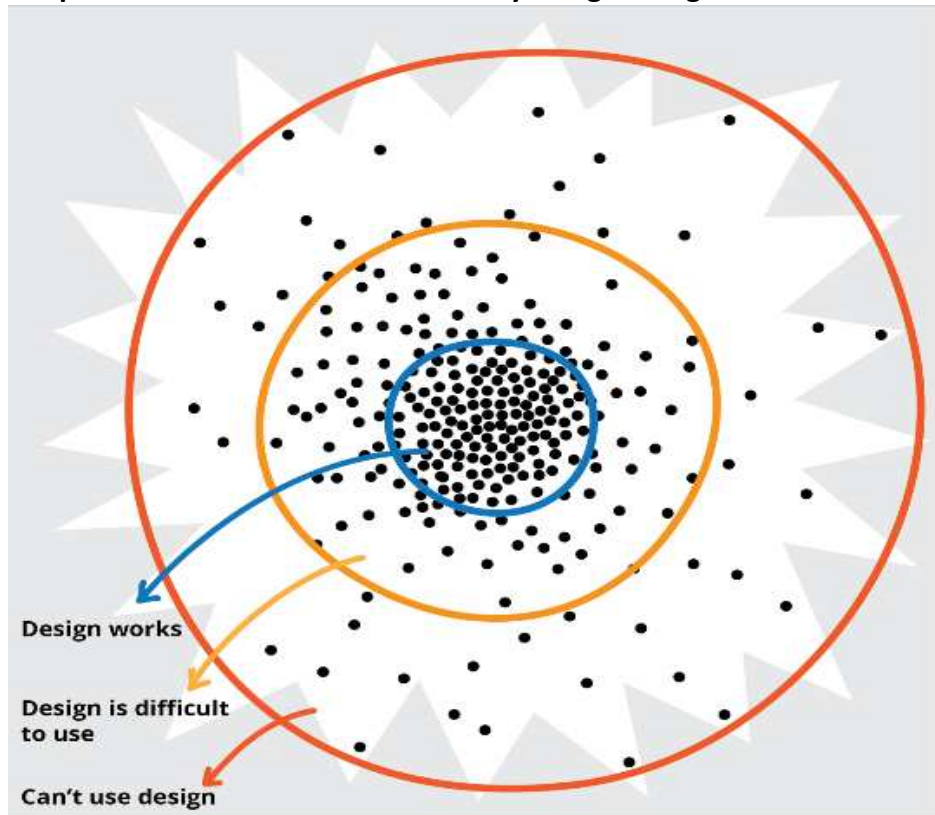
Figure 3: The Co-designers

What we have discovered is that it is predominantly the edge users that contribute the most relevant, innovative, insightful and grounded perspectives to a diverse design team. To them, design isn't abstract, it is essential and real. These edge users are also less likely to validate and defend a current design that doesn't meet their needs. This led me to the obvious realisation that if you want innovation or even design improvement, the best people to have at the design table are people that have difficulty with a current design or can't use the current design. They are not invested in keeping the current design and they will stretch or expand your design further.

Earning Trust

However, genuinely and meaningfully engaging edge users in your design process is not an easy feat. With many communities you have to overcome a justifiable trust barrier. Many

communities have been burned by exploitative researchers who come to verify their preconceptions. Ask any indigenous community regarding this experience. Or the community has been disillusioned and disappointed by entrepreneurs who feel they have found a solution to a perceived problem, and the experience feels more like the entrepreneurs have identified a nail for their hammer. Many other edge users have consultation fatigue because they have made the rounds as token representatives, so that a box can be checked on the equity and diversity policy checklist once all the important design decisions have already been made. It takes humility, respect, clear terms of commitment, and unwavering transparency to earn this trust.

Inclusive Design Methods and Tools

Another practical issue is that most design tools and activities are predominantly visual and spatial, whether it is the use of sticky notes, the various wire-frame options, mind maps or prototyping tools. If you want to include someone that relies on sound and/or touch, you must thoughtfully and consistently translate, or find alternatives. Most of these tools also require dexterity and manual manipulation to participate. We have played with many less traditional strategies but frequently need to resort to thoughtful teamwork as a fall-back. At minimum, we document every design decision, the rationale, and the remaining questions in an accessible digital format such as our Wiki.

Essential Role of Open

Openness and transparency are essential tenets of inclusive design. Proprietary, closed systems always exclude and prevent interoperability. They also prevent extensibility which stunts the growth of knowledge and the integration of diverse perspectives.

Designing the 'Table'

We have a commitment to continually ask, who are we missing from the 'table' and how can we design our 'table' (a.k.a. design process) so that it is more inclusive, and so we arrive at designs that bring about change. We find that the hardest aspects to redesign are not the physical factors, but the presumptions, assumptions and conventions brought by the institutions, organisations and expert designers we engage. People easily slide into traditional scripts and hierarchies and we need to regularly re-calibrate. Designing the structures that guide the process, so that the individual strengths of the design team members are engaged and produce more than the sum of the parts, is often harder than arriving at the brilliant design. The ability to both give and receive truly constructive critique is a valuable group skill. Willingness to take risks and learn from failures, early and often is also a fruitful strategy. A well-functioning and diverse design team is a wondrous, energising thing that deserves careful maintenance.

A Worthwhile Investment and Smart Strategy

Respectful, inclusive co-design takes a little longer initially but is a valuable investment in the long run. We have confirmed, what others have observed, that the resulting design is less brittle, easier to update, requires fewer accessibility patches, fewer service calls, shorter training, and generally lasts longer.

If you have a complex problem that requires community adoption and participation, addressing the edge scenario is often the best design strategy. For example, if you want to design a smart, sustainable neighbourhood in a city where the citizenry distrusts your motives and your plans for managing data, addressing the needs of the individuals that can benefit the most from smart services but are also most vulnerable to data abuse and misuse is a strategically fruitful place to start. This might include engaging people who are blind in

designing smart intersections, or people with episodic health issues in designing emergency services, for example. In both cases it is critical that the data remains private and secure. If the data protections are designed to safeguard the people most vulnerable to data abuse, the protections are more likely to meet the needs of the rest of the citizenry. Innovative services for people who can benefit from them the most will produce compelling examples that inspire further engagement. This will work far better than addressing the needs of the average citizen who has less compelling reasons to require smart services, and for whom data privacy threats are more theoretical. If you focus on the design for the majority first, you will need to address the edge scenarios soon enough and your design will lack the flexibility to stretch, so you will need to 'bolt on' provisional approaches, which will make your design less sustainable.

Mapping Success
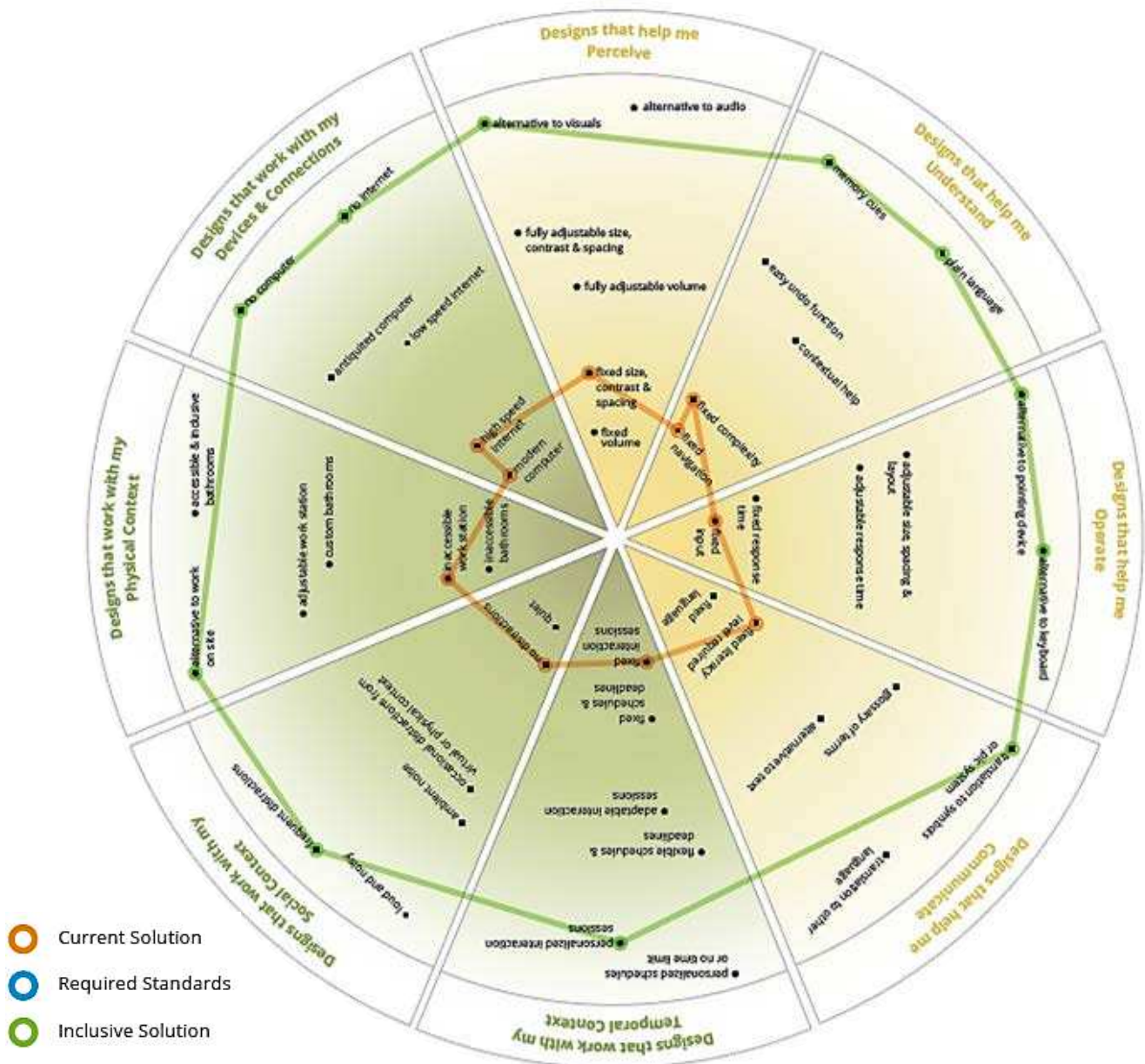
Figure 4: Inclusive Design Mapping Tool

Our criteria for a truly successful design is a design that reaches the edge requirements that we collectively identify within the co-design team. If you reach the edge, the design will also work better for the centre. It will be more flexible and generous. If you design with the edge user, someone who isn't an edge user will have more configuration choices. They don't need to abandon your design when their needs, goals and contexts change. We often use an inclusive mapping tool to track our progress. We design in short, iterative, full cycles that produce testable functionality as early as possible. Reaching the edges doesn't happen in the first go-round, but we strive to address more and more requirements and scenarios in each iteration.

Planning Using a Virtuous Tornado

Because we are guided and grounded by the co-designers, and engage in iterative cycles, our process confounds project planners who like linear logic models, and require Gantt or Pert charts to closely track progress. We believe our process is better suited to the quickly changing context of our current society. Who could have predicted the current political and technical situation two years ago in a linear logic model and charted it in a detailed Gantt chart?
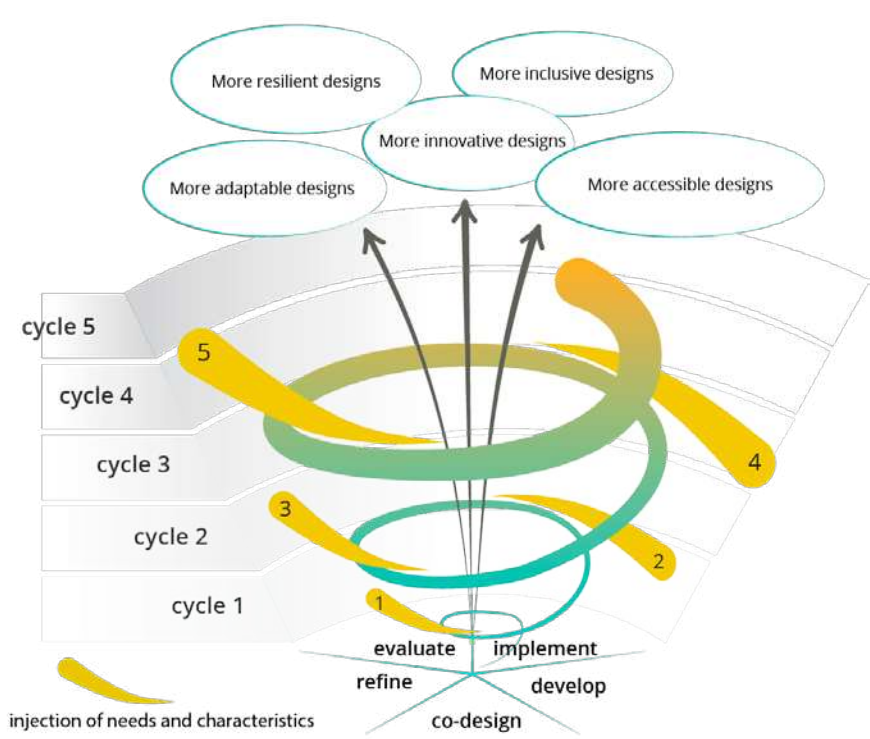
Figure 5: The Virtuous Tornado

We have developed a process we call our 'virtuous tornado,' adding more functional requirements and use scenarios at each cycle to expand the design. This way we remain responsive and agile and make more relevant progress that will have greater impact in the long run. Because we don't iterate toward a single solution but toward a system that can provide an optimal configuration for each user, what we design is more dynamically resilient.

Lasting Change and the Inclusively Designed Process

Many of today's problems are too complex, people are too diverse, and the context is moving too fast to design a definitive fix or solution. Investment in a definitive fix leads us to ignore the changes, deny the complexity, and exclude the diversity. Inclusive design begins with no predetermined end point and no generalised success criteria but arrives at greater innovation, flexibility, and general usability. Employing an inclusively designed process will achieve a more lasting and productive change than a checklist of design criteria. Inviting the unrecognised technical pioneers to the design table is a gift that keeps on giving.

2.6 The Three Dimensions of Inclusive Design, Part Three

This is the third part of a three-part blog that describes a guiding framework for inclusive design in a digitally transformed and increasingly connected world. The three dimensions of the framework are:

1. Recognise, respect, and design for human uniqueness and variability.

2. Use inclusive, open & transparent processes, and co-design with people who have a diversity of perspectives, including people that can't use or have difficulty using the current designs.

3. Realise that you are designing in a complex adaptive system.

Inclusive design plans and facilitates change. Change in environments, products, services and processes, but also social change. By stretching the responsiveness and adaptability of the designs we live with, it supports a diversity of human knowledge, skills, and perspectives. The third dimension of inclusive design attends to the relationship between the individual/s that will be included and the larger nested complex adaptive systems they must participate in.

The Inclusive Design Paradox

Within inclusive design there is an apparent paradox. Inclusive design must hold and support both diversification and cohesion (or inclusion). It must accomplish the feat of including greater variety while keeping the whole from splintering or fragmenting. Inherent in this feat is respecting the inherent value of both the individual and the society. Counter examples would be sacrificing an individual for the good of the group, or conversely privileging an individual at the cost of the good of the group.

Inclusive design can be applied to any design, from the design of a product, a process, a service, an environment, a policy or an organisation. When designing interfaces or applications attending to the challenge includes maintaining interoperability and usability while adding options or possible configurations. Within products and environments, the challenge is also to maintain a unified aesthetic while adding affordances for difference. Redesigning more inclusive services, processes, or organisational structures requires a culture change, while also sustaining social cohesion.

Navigating the Paradox

Navigating this paradox is the third dimension of inclusive design. In our increasingly connected and complex world, no design decision is made in isolation. Conversely, no design that demands change will succeed or survive unless you consider the complex adaptive system that encompasses it.

Take a student and the change required to enable greater inclusion within a classroom. The inclusive practice will require that the teacher change her teaching. This will require the cooperation of the school administration. This in turn will require the consent of the school district or board, which will in turn require the support of the educational ministry or department. If any of these nested systems does not also change, there will be a misfit and

point of friction. The part of the system that has changed without the context changing will bear the cost of this friction. This change burden will take a toll that threatens the survival of the inclusive design.

Take Cary, a student who relies on a switch controlled on-screen keyboard he operates with a voluntary head movement. Cary is in an integrated classroom. To optimise Cary's learning and enable him to participate fully in his class, he requires that all the learning resources be available on his computer which he can control. The presentation of the resources (e.g., layout, size, spacing) must also be reconfigurable so he can navigate and manipulate the resource without a standard keyboard or mouse. This means that his teacher needs to be able to source all the curriculum materials in an open digital format. This implies that the school needs to support digital textbooks, learning resources and assessments. This has an impact on the procurement processes and policies of the school board or district. The implications of this change can spread all the way to the national and even global level as it affects how textbooks and teaching supports are designed and delivered.

On the other hand, this demand for a systemic change for one student, if met, can also result in greater usability, innovation, sustainability, and agility for the entire education system. It means that when the system must transition to more participatory models of pedagogy, the learning resources are in a form that students can augment and edit. They will be in a form that educators can translate, localise, augment and update. The system-wide change brings about greater agility or dynamic resiliency in the system. The system, in turn, is more prepared for a change in the world that it is embedded in, such as changes in the future of work and the demands made of its students upon graduation.

Turning Vicious Cycles into Virtuous Cycles

The challenges, or 'pain points' that inclusive design seeks to address are often embedded in and feed into vicious cycles. For Cary the student, having a disability (especially a disability that is not 'high incidence') means that he is caught in a vicious cycle of exclusion and impoverishment. Products he needs are not produced by the mainstream market, they have no economy of scale. Hence, when they are available they will cost more, be less readily available, require special skills to operate and maintain, and the likelihood that they will be compatible with the systems everyone else uses are remote. This means that access to education will be harder, this also means that employment possibilities will be more constrained, which will mean that his income is lower while his costs for essential things will be higher. The chances this will change are reduced as it is highly unlikely that he will be at the decision-making tables to advocate for his needs. It is also less likely that anyone like him can be there to represent his needs. This vicious cycle will lead to impoverishment, of opportunity as well as resources, and all the social, physical, emotional and cognitive ills that poverty brings. The vicious cycle Cary is caught in also has an impact on his family, community and society as a whole.
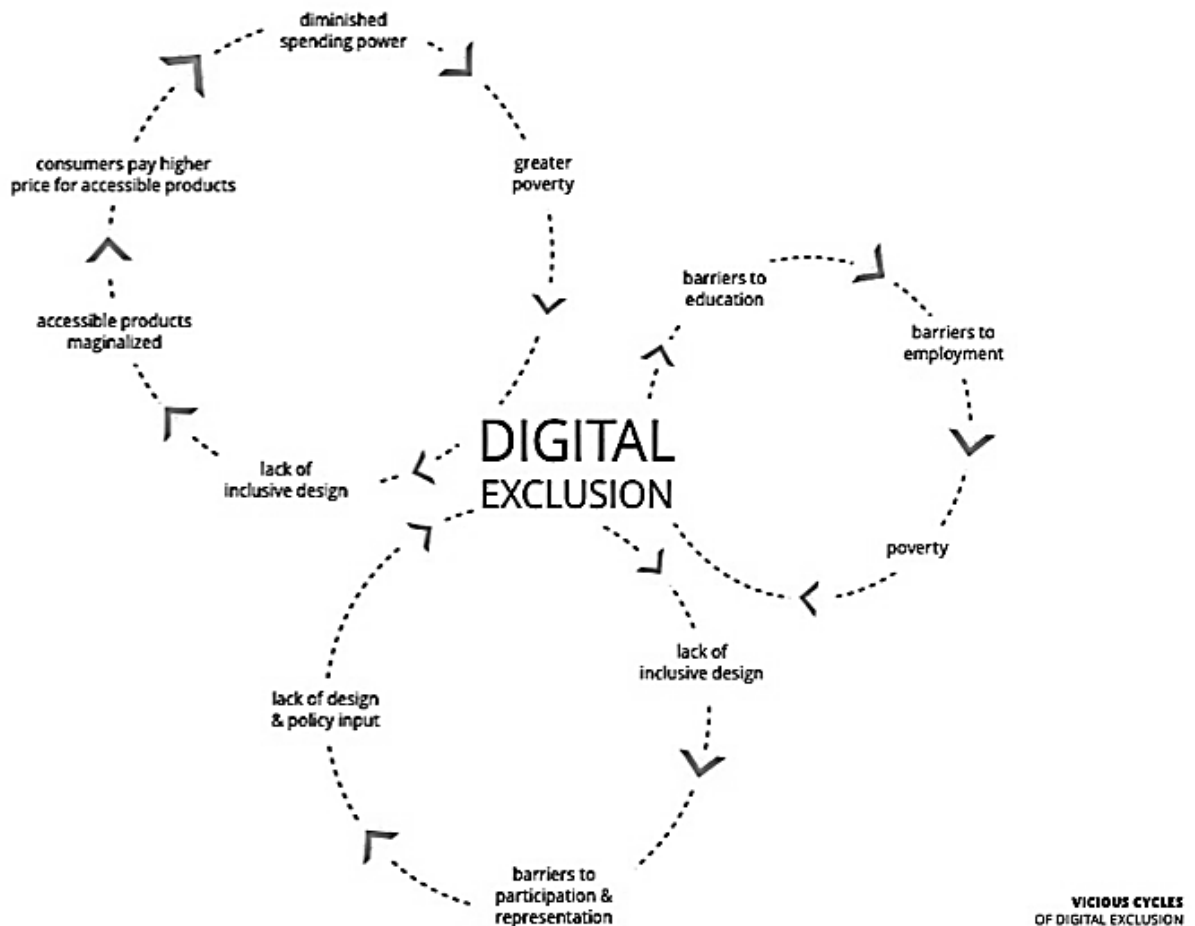
Figure 6: Vicious Cycle of Digital Exclusion

Interventions in Complex Adaptive Systems

However vicious cycles can be broken by strategic interventions. For example, if we require that someone like Cary be at the table when educational policy decisions are made, and also helping to co-design the educational resources, the resources he needs will be available to him, will not cost more, will be better integrated and maintained, and they will be enriched by the community of educators. He will have better access to education, which will improve his chances of employment, which will make it more likely that he can participate in decision-making in his community. Interventions in vicious cycles are more likely to survive, thrive and trigger a virtuous cycle if the context and the broader beneficial impact for the system as a whole is considered, understood and addressed in the inclusive design.

Donella Meadows (Meadows, n.d.), the late prescient systems thinker listed 12 ways to intervene in complex adaptive systems in increasing order of effectiveness:

12. Constants, parameters, numbers (such as subsidies, taxes, standards).

11. The sizes of buffers and other stabilising stocks, relative to their flows.

10. The structure of material stocks and flows (such as transport networks, population age structures).

9. The lengths of delays, relative to the rate of system change.

8. The strength of negative feedback loops, relative to the impacts they are trying to correct against.

7. The gain around driving positive feedback loops.

6. The structure of information flows (who does and does not have access to information).

5. The rules of the system (such as incentives, punishments, constraints).

4. The power to add, change, evolve, or self-organise system structure.

3. The goals of the system.

2. The mindset or paradigm out of which the system — its goals, structure, rules, delays, parameters — arises.

1. The power to transcend paradigms.

Figure 7: Virtuous Cycle of Digital Inclusion

Inclusive design itself can be seen as a new paradigm that requires a shift in mindset. The respect for and integration of diversity inherent in inclusive design also requires a relinquishing of a single paradigm. Within inclusive design we employ a 'yes, and' response to difference.

System Behaviours

We need to keep in mind that while systems have certain common behaviours, they are just as diverse as individuals. Some will react in very unexpected ways. Have you ever played with a [mixture of corn starch and water](#)? Unlike most fluids, this mixture will become more rigid and less viscous if you apply pressure or try to mix it too quickly. Some social systems

display this non-Newtonian behaviour when you trigger the social system's defensiveness. Counter-productive values and behaviours will become more entrenched. Change that is imposed from the top, down; or change that does not involve the individuals or groups that are impacted is more likely to elicit this response. For this reason, inclusive design grows from small successes and employs organic, non-linear models of growth that engage as many perspectives as possible.

Avoiding Cobras

Our approaches need to match and consider the complexity of the issue we are addressing. The German economist Horst Siebert termed the unintended consequences of simplistic solutions for complex problems the ['Cobra Effect,'](#) after an anecdote in an Indian city during British rule. The anecdote recounts an approach taken by British colonialist who attempted to reduce the population of cobras in the city by offering a bounty on cobras. Enterprising Indians bred cobras to gain the bounty. The government assessed the effectiveness of the effort by the number of dead cobras being turned in for bounty and assumed that it was successful. When the breeding scheme was discovered, the government cancelled the bounty. The cobras, which no longer had a monetary value, were released resulting in more cobras in the city, or the opposite of the intended effect.

An example of a Cobra Effect in the realm of accessibility is the simplistic implementation of accessibility standards. I once visited a school which proudly claimed that they had made their standardised exams 'fully accessible.' The student that demonstrated the exam used a single switch which he activated with the only movement he could voluntarily control to drive a cursor across the rows and columns of an onscreen keyboard. To control the movement of the cursor he needed to repeatedly select arrow keys and a select key. This meant that for each question, he would need to make up to 30 selections on the onscreen keyboard. Each selection would require multiple switch hits. Consequently, the process of operating the exam involved far more cognitive load than knowing the answers to the exam questions. However, the school had met all the [Web Content Accessibility Guideline](#) criterion and was therefore fully compliant to accessibility regulations and policy.

One of the activities employed in inclusive design is the ['grandparent, toddler' conversation](#), in which, like a toddler, we continuously ask "why?" This leads to reframing the question or the problem and extending the focus to the broader causes, rather than the symptoms. Considering individuals who are currently marginalised encourages a focus on the essential elements of the system. In the example of designing inclusive learning experiences, this means considering what the learning goal is, rather than focusing on the problems with the specific instructional material.

Avoiding Polarisation

A defensive phenomenon that can quickly degrade any effort is polarisation. Polarisation within a society tends to result in greater and greater extremes. This prevents either side from advancing because it prevents self-critique. It promotes rigid adherence to the espoused position of the side you belong to. Any self-criticism or proposals for alternative strategies are viewed as causing vulnerability and as providing the opposite side a target for attack. Rather than welcoming constructive critique, each side uses blame to fortify the polarity that they are defending, so that neither side evolves.

As mentioned in Part One, inclusive design is itself an antidote to polarisation. I liken it to a pendulum, the further you push it in one direction the further it swings in the opposite direction. Add one or more sideways pushes or diverse perspectives to the pendulum and it

stays away from the extremes. Employing another physical image, if you have a platform balanced on a point, the best way to keep it balanced or in equilibrium is to distribute many weights across the whole platform. If you have this diverse distribution, the impact of the loss of one weight won't have as catastrophic an effect. An inclusively designed system recruits the energy and participation of many agents, coming from many perspectives to push the pendulum or balance the platform.

Riding Waves and the Last Frontiers

Some [anthropologists, who take a long view of change](#), have encouraged optimism regarding the fate of rigid social structures that exclude: "Much of recent history can be seen as waves of tolerance and acceptance breaking against the rocky headlands of rigid social structures. Though it can seem to take almost forever, the waves always win in the end, reducing immobile rock to shifting sand. The twentieth century saw headlands beginning to crumble under surges of anti-slavery movements, women's rights, racial equality, and more recently, the steadily growing acceptance of the rights of gay, lesbian, transgender, and bisexual people" (Ryan and Jethá, 2012).

Including difference is how we evolve as a human society. Inclusive design is about far more than addressing disability. But disability has been called our last frontier. It is the human difference that our social structures have not yet integrated. This is paradoxical because disability is a potential state we can all find ourselves in. If we reject and exclude individuals who experience disabilities, we reject and exclude our future selves and our loved ones.

The Change Workers

People at the margins are most vulnerable to the negative consequences of an unhealthy system. However, change and innovation happens at the edge. The individuals that find themselves at the margins of our society can be seen as our change workers. If we abandon and disenfranchise our change workers, we risk the survival of our society. Stasis is not sustainable. Closing off difference threatens the system. As we know from the Second Law of Thermodynamics: "closed systems inexorably become less structured, less organised, less able to accomplish interesting and useful outcomes, until they slide into an equilibrium of grey, tepid, homogeneous monotony and stay there" (Pinker, 2018). A homogeneous system can be felled by a single threat. Integrating difference and supporting members when they are vulnerable leads to a self-healing system that fosters a richer array of responses to the inevitable unexpected threats that arise.

Collective Flow

[Mihaly Csikszentmihalyi the author of Flow,](#) asserts that the self grows by becoming more complex, which is the result of two processes: differentiation and integration (Csikszentmihalyi, 1990). Applying this notion to society as an entity, this implies combining the movement toward optimising individual uniqueness while maintaining social cohesion and collaborative integration of skills. A cooperative system of humans with a well-coordinated set of diverse areas of expertise will likely achieve something more complexly challenging than a single generalist or a team of people with similar specialisations. The key to this collective state of flow is collaboration and integration. Given the complexity and shifting nature of our world this collaboration needs to be dynamic and responsive.

Our understanding and social skills in collaboration are poorly developed, especially when addressing complex, unpredictable challenges. Our education systems, business practices, and politics favour competition over collaboration. We have come to equate cooperative

societies with communism and equality with sameness. Neither fosters difference. When we think of coordination we often think of rigid, hierarchical structures with conscripted roles, confined responsibilities and blinkered domains of interest. These are most often hostile to people that are different.

As researchers in [biomimicry](#) have discovered, we can find more advanced forms of collaboration and coordination in natural ecosystems. Our advanced, but relatively extremely young and immature species can learn much from the rest of the inhabitants of this globe. Many researchers have become fascinated with the set of simple rules each member follows in a hive or ant colony to achieve very complex collective outcomes. The Golden Rule may be a human version of a simple rule that sustains our human society. We also continue to discover the many [wondrously woven symbiotic relationships](#) between the other members of our world.

The Power of Potential

Our society's favouring of perfection and completion is a form of rigidity that disenfranchises difference. I have promoted the notion of [Wabi-Sabi](#) in learning and in design. Wabi-Sabi is the Japanese aesthetic that values the imperfect, impermanent and incomplete. Incompleteness and imperfection invite participation. Impermanence welcomes change and renewal. We learn far more from failure and mistakes than from success. Appreciating and seeking constructive critique is a rare but powerful skill. Most importantly, potential has far more power than perfection in bringing about positive change.

In [Incomplete Nature: How Mind Emerged from Matter](#), Terrence Deacon provides a compelling proposal for rethinking the frame of natural sciences to integrate the realm of 'absential' experiences, so we can explain life, integrate value, and navigate our way out of the existential crisis our human society finds itself in. In his words: "there is more than what is actual. There is what could be, what should be, what can't be, what is possible, and what is impossible" (Deacon, 2012).

Responding to Macauley, the British colonialist who suppressed indigenous languages in India, [Poile Sengupta](#) the Indian playwright eloquently presents the redemptive potential of inadequacy. Speaking about the inadequacy of the imposed English language to express the rich knowledge that is yet to be expressed "words I use are inadequate, an approximation. But that I realise the inadequacy is my victory too, the wealth that sustains me. Do you hear me Macaulay, I have my revenge after all. Across the land and water, over hills and desert, language is a travelling. It can never arrive" (Sengupta, 2010).

The German philosopher [Hans Vaihinger (Vaihinger, 2014)](#) linked this idea of 'what could be' to our social actions in his philosophy of 'As If.' To act as if a state that we hope to bring about exists. [Adrienne Clarkson](#) applies this philosophy to fostering belonging in new members of a society, in her Massey Lecture. To call forth a leap of the imagination into the realm of possibility, especially when people disappoint us and we feel our society is failing. "When we behave As If we care about each other. As If we encourage everyone to be part of the group. As If we are all equal, we are actually living a metaphor…. when we live As If, the As If can become the actual reality" (Clarkson, 2014).

The Inclusion Challenge

Inclusive design recognises that diversity is our greatest asset and inclusion is our greatest challenge. To meet this challenge, we must consider the many nested complex adaptive systems that make up the complex adaptive system of systems that is our world. One key to

that challenge is recognising the individual potential in all of us and the awesome potential that we can realise when we include and integrate our collective differences.

2.7   The parts that didn't fit into the blog

There are many aspects of the framework and more nuanced associated concepts that did not fit into a consumable blog. I wanted to stay under a 15-minute read. The following are some of these.

2.7.1   Not techno-triumphalism, not technical determinism, awareness of risks

Because my centre and community works proactivity with emerging technologies, it can often be interpreted that we are promoting technology. That is not the case. We recognise that participation in the digital transformation should be a choice and that along with that choice should come the opportunity to participate in shaping the digital transformation. When we are advancing technology, it is not for technology's sake but as a tool to address current barriers. When we engage proactively, we engage to help steer the course in more inclusive directions by ensuring that the decision-making is more inclusive. As Jaron Lanier states, "It is impossible to work with information technology without also engaging in social engineering" (Lanier, 2010). The risks are as great as the opportunities. We are very cognisant of the risks. We promote the benefits of a commons but are aware of what can go wrong. Trebor Scholz warns of the extractive, disparity-amplifying nature of platforms that proport to be part of the sharing economy (Scholz, 2017). Jaron Lanier warns of the loss of individual identity as we are manipulated by social media (Lanier, 2010). Ursula Franklin speaks of privileging the horizontal at the expense of the vertical or local (Franklin, 1999). We are acutely aware of the brittleness of large systems and the risks that come with increased scale. The list is much longer and continues to grow. Part of the third dimension is to understand the risks.

2.7.1.1   Changing the Game

At a certain point in my career, I realised that equity or equality in the same system was not what I was fighting for. We need to change the rules of the game, and we need the individuals who are currently excluded to participate in changing the rules of the game. In other words, it isn't about being granted membership in the exclusive club but about creating more inclusive alternatives to the clubs. Our society requires the participation of people who are currently marginalised just as much as people who are currently marginalised need to be able to

participate. Monocultures are not sustainable. An exclusionary society is ultimately not liveable or sustainable. A society that is inclusive is ultimately happier, healthier, and more prosperous (Wilkinson and Pickett, 2010).

My view of intelligence also shifted at the same time. To me this insight seemed so obvious that once it was seen, it couldn't be unseen. However, one of the smartest people I have ever known, a graduate of a highly respected university and recruited for his brilliance by some of the most advanced think tanks, looked at me with incredulity and asked, "You believe that there is a broader benefit in inclusion, that it is beyond a social justice issue?" This was a scholar of philosophy, among other disciplines, yet the logic escaped him. It was at that point that I realised the massive entangled bulwark of beliefs, barriers, and blind spots that maintain discrimination, prejudice, and current hierarchies even in 'the best of people' and certainly among the 'smartest of people.'

This is why emphasis on process is so critical. The process must be inclusive. Whatever is designed must be inclusive from the start. Retrofitting might add entrances to the faulty system, but it doesn't change the system. This can be seen in other social justice movements. When women fight to join men in exclusionary hierarchies, the pressures to conform to the normative behaviours often pressures women to adopt behaviours that are just as discriminatory (Enders-Dragaesser, 1988). Gaining entry to a system that was not made for you does not address inequity, as many individuals who have gained access to jobs in governments can attest to. The relentless and daily encounter with the misfit of factors needed to perform your job puts you at a disadvantage and jeopardises your performance.

Universal design principles (including Universal Design for Learning), accessibility checklists, and accessibility legislation have focused on the outcome criteria and not the process or the broader context or system (Mace, 1997, Rose, 2000, Treviranus et al., 2000). I have contested outcome criteria that are static and absolute and have put the emphasis on the process and the context of the design.

2.7.1.2 Challenges to Applying Framework

This stance comes with certain challenges, and it implies that there are no authoritative, testable criteria to verify success other than the consensus of the co-designers. It also implies that there is no point of completion, no permanent fix or solution, only an ongoing and evolving practice. It

then fails to satisfy organisations and individuals that desire certification and anyone wishing to make a one-time investment in inclusive design. My stance also resists placing boundaries around inclusive design. The approach I have put forward resists resolving barriers in a segregated and constrained way. Barriers are resolved by addressing the misfit between the individual and the design as well as the nested contextual misfits that the design must operate within.

In the blog I mention the example of designing more inclusive teaching practices that address the needs of a student, which requires addressing the misfit between the teacher and the school administration, and in turn the administration and the school board, and the school board and provincial or national education authority. It also requires addressing parent and community expectations, curriculum providers, assessment strategies, teacher and school evaluation metrics, and funding sources. My contention is that unless these are addressed the design cannot survive or perform its function.

The other contention is that if these contextual misfits are not addressed, each student or each effort made in the domain of Inclusive Design will need to replicate the effort of the previous student. The overall long-term cost within the system in this context would be very high, and the chances that each subsequent student would have an equitable experience will be low. The impact of the misfit must be borne at some point in the system. I have known teachers who try to protect their students from this misfit at great costs to themselves, and principals who try to shield their teachers and students. This leaves a single point of defence that renders the inclusive design approach vulnerable to disruption. From the other perspective, it also robs the larger group or context of the benefits of more inclusive participation.

2.7.1.3 The New Rules of Complex Adaptive Systems

The third dimension in addressing the challenge of inclusion is a countermovement that all our dominant domains of influence have primed us against. Education promotes competition and exclusion, business is about survival of the fittest, politics is about attack, and even dominant religions are about 'the chosen.'

I have privately coined one of the most powerfully corrosive influences 'the King of the Hill Syndrome.' This encompasses the competitive race to the top. The currently pervasive incarnation is the race for popularity and attention fuelled by social media metrics. The race is

for the biggest number of likes, followers, friends, citations, or retweets. Propagation of ideas is desirable. Attention and broad reach of influence are vehicles for quickly propagating ideas. However, speed may not be the best way to integrate ideas, and competition for ownership can be a deterrent to making ideas your own.

Joshua Cooper Ramo calls the current state of our world a "sandpile" world (Cooper Ramo, 2009a).This refers to the mathematical impossibility of predicting which sand grain added to a sandpile will trigger an avalanche. This conundrum was first identified by Per Bak, as part of the theory of self-organised criticality (Bak et al., 1987). Cooper Ramo recommends that the strategy for working in a sandpile world is to use systems-style leverage: "Avoid direct conflict, use the forces already at play, manipulate so quietly as to be unnoticed, know that no effort truly ends"(Cooper Ramo, 2009b). Networks, reciprocity rather than exploitation, disintermediated and distributed power, and the ability to adapt are all promising means of thriving in a "sandpile" world. He also argues that past data loses its effectiveness in predication or planning because we don't know that what didn't work yesterday won't work today. Most importantly, we need to strive for social cohesion and inclusion, especially when most frightened, rather than striking back, alienating others, and isolating ourselves.

2.8   Conclusions

I have outlined the framework I have entitled 'The Three Dimensions of Inclusive Design' in three blogs, explaining the motivations and experiences that led to the framework. This framework continues to evolve and is intended as a supportive structure for growth, rather than a set of outcome criteria. The framework has been applied by my team and the partners we collaborate within a number of domains. The remaining chapters will document the application of the framework in a number of implementation domains, beginning with research methods and evidence.

3 : The Framework and Inclusive Research Methods

To discuss methodologies and research methods applied in this doctoral work, I must first present my unease and critique of research methods and methodologies as they relate to outliers and individuals at the margins. I contend that favoured research methods, like quantitative methods, are not suitable for my topic. I also contend that the biases within research have threatened our understanding of human diversity, especially the outer edges of human diversity that I hope to reach with my design. This has created blind spots in our perception and understanding of complexity. To fully argue these critiques are beyond the scope of this thesis, however, I hope here to adequately explain my approach in evaluating and refining the framework.

Beyond choosing not to apply quantitative methods, I have also chosen not to propose a hypothesis in my research, as I did not want to test a predetermined theory. My goal is to let promising approaches and insights emerge. Unlike descriptive research that employs categorisation, I have also tried to avoid categories, other than in describing the implementation domains of the framework. Brian Cantwell Smith asserts: "Any classification scheme, and especially a formal one, will inevitably 'do violence' to its subject … any act of classification fails to do justice to at least some dimensions of that which is classified, (Brophy) have serious ethical, economic, political and other consequences" (Smith, 2009). In order to remain true to the valuing of diversity at the heart of Inclusive Design as a discipline, the research for this thesis has deliberately employed a multiplicity of methods. Also true to the Inclusive Design ethos, the process of the research has been reflexive and interactive. It has resisted categorisation in traditional terms. Nonetheless, if the methods must be categorised for purposes of the PhD, then they can best be described as aligned with other forms of reflexive research aligned to deeply held and enacted personal beliefs and worldviews, e.g.: in this instance to my own alignment to, for instance, feminist, indigenous and ethnographic research methods.

In this chapter I will also discuss the application of the three dimensions of inclusive design to forms of evidence and design research and explore research methods and methodologies that can be used to recognise and understand diversity and complexity. I am convinced that there is a fundamental flaw in the currently dominant forms of evidence that leads to discrimination against people and scenarios at the margins, a flaw that is amplified and automated through Big

Data and data analytics, machine learning, and artificial intelligence. My work in this area is very preliminary and largely at a problem-framing stage. However, I have made inroads in drawing attention to this issue within the emerging fields of artificial intelligence ethics. Along with fellow concerned researchers, I am amassing a co-design community, and we have started to investigate possible approaches to overcoming the biases.

3.1 Visual Model of an *Exploding Star*

At the core of the framework for Inclusive Design is a visual model that was made manifest by the serendipitous combination of a number of projects. Through many applied research projects developing a personal preference system called AccessForAll (Cheetham et al., 2014), the research team that I lead arrived at a large anonymised data set of personal preferences. This data set consists of the specified needs and preferences of individuals who participated in projects that I led, such as Web4All (Treviranus, 2002) and The Inclusive Learning Exchange (TILE) (Treviranus and Roberts, 2008). (Web4All enabled the discovery and exploration of personal needs and preferences with respect to computer interface configuration, and TILE enabled the discovery and exploration of needs and preference with respect to learning experiences). Through a collaboration in data visualisation and modelling I had the opportunity to explore and play with data visualisation software (STHDA). I was intrigued by three-dimensional visualisations, such as data clouds and data plotting that went beyond the x and y coordinates (TAPoR3, 2015). I was bothered by the top-down assumptions that accompanied parametric statistical analysis and wanted to explore non-parametric statistical analysis, but wanted to find ways to reduce the influence of my assumptions in identifying significant parameters. I was very intrigued by the use of three-dimensional data visualisation for non-parametric methods to discover what significant parameters would emerge. For example, Guerin and Hennessy (2002)discovered that if pupils were given the freedom to define bullying themselves, the definition differed significantly from the definition assumed by researchers investigating bullying. Through the original Inclusive Design Mapping Tool developed for this research project (introduced and explained both in the thesis section on the 2nd Dimension, and also in more detail in Appendix B: Inclusive Design Mapping Tool) and applied in Inclusive Design sessions over the course of the PhD project, I had concluded that there were often too many relevant facets of a user to capture in a two-dimensional map. In the FLOE project which I

directed also as part of this PhD (Treviranus et al., 2014), it became evident that the bell curve (or Gaussian curve) typically used in assessment of formal education and in grading, was far too reductionist a representation of a 'normal' distribution of students. Inclusive Design questions the very concept that there is a 'normal' student, or a 'normal' distribution.
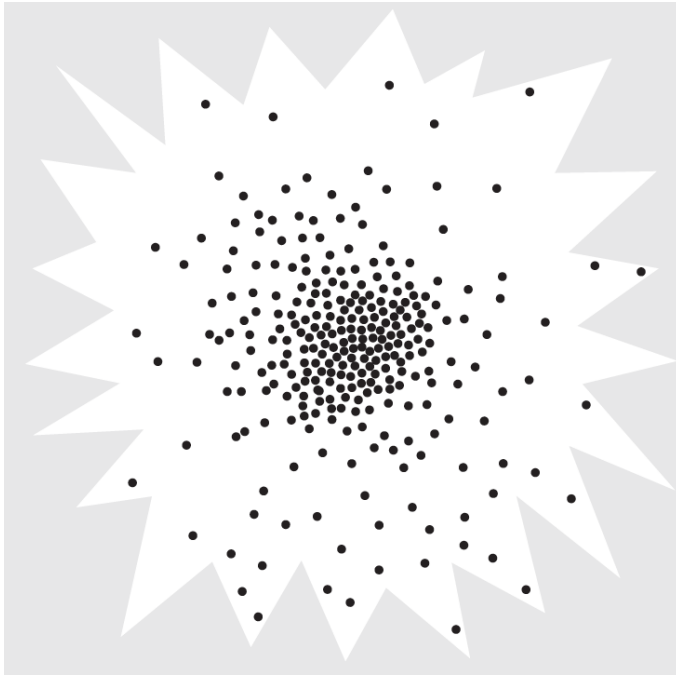
Figure 8: Exploding Star Scatterplot

These various explorations led me again and again to exploding stars, many variants of what resembled exploding stars. When I took the personal needs and preferences of any group and plotted them on a three-dimensional scatterplot, I would arrive at an exploding star. I experimented initially with needs and preferences that could be quantified, such as preferred audio volume, target size, contrast level, speech rate, and time required to complete task. This left the non-quantifiable preferences, such as desired tools and features: text captions, hand stabilisers, and spell-checking. Through a collaboration with the TAPOR project, I began to experiment with text analysis tools, which I used to plot non-quantifiable needs and preferences, and arrived at the same exploding stars (TAPoR3, 2015). Looking at students with learning differences, whose strengths and weaknesses are obscured by bell curves that conflate all measures into a single scale, I realised that the bell curve is simply a flattened and reductionist view of student performance that hides the real strengths and weaknesses of students. The bell curve is a poor representation of this recurring image of an exploding star.

In carefully analysing the exploding stars, it became clear that there is a jagged threshold, some distance from the middle of the star, beyond which are needs and preferences that predominantly, but not exclusively, belong to individuals who have been identified as having a disability. The other thing of note was that the needs and preferences beyond this threshold were far apart, while the needs and preferences closer to the middle of the star were close together. Like an exploding star, the dots become progressively further apart the further away they are from the centre. The needs and preferences associated with disability are more diverse than the needs and preferences that are not associated with a disability.
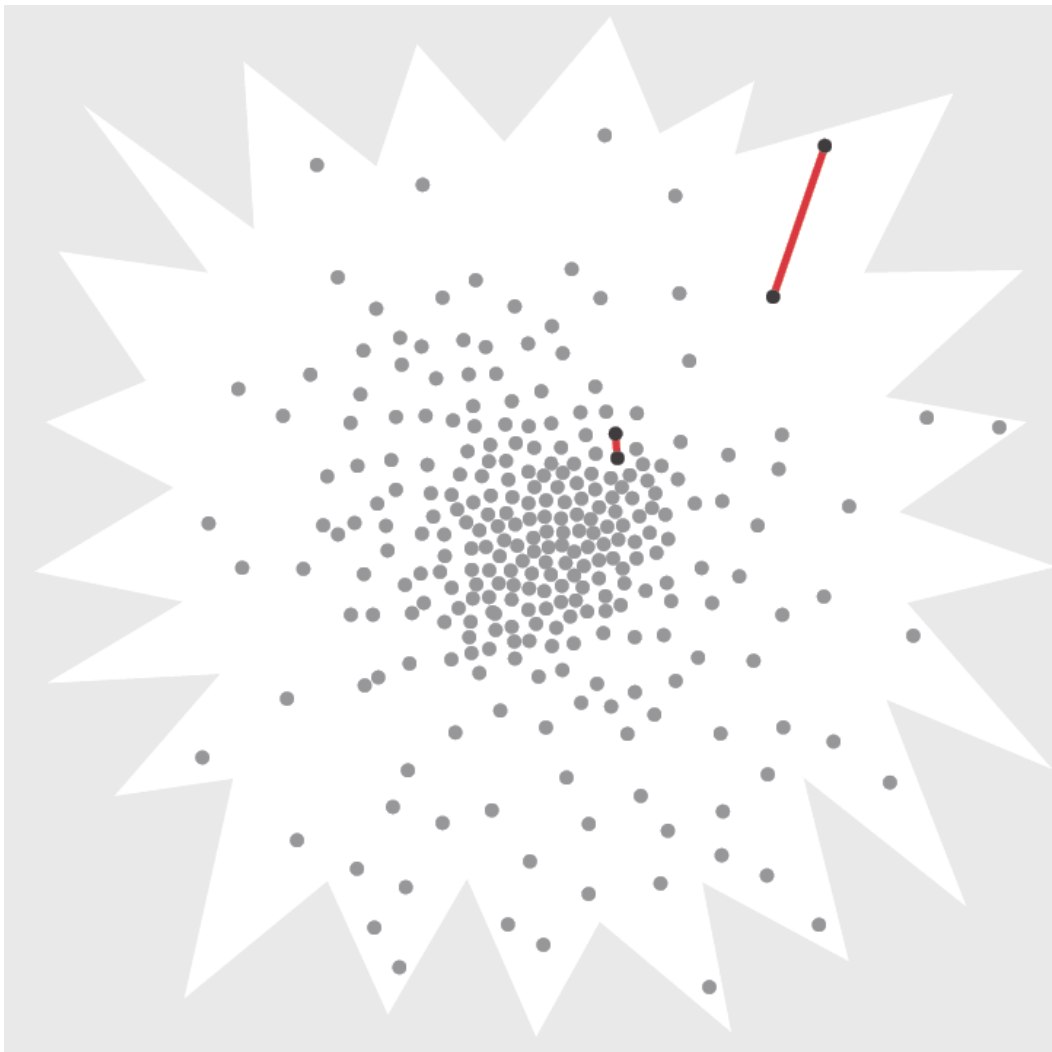
Figure 9: Distance and difference of needs and characteristics at periphery versus centre

Interestingly, when I isolated the full set of needs and preferences of a single individual, I would also arrive at less well-formed exploding stars. Individuals who were not identified as having a disability had needs and preferences closer to the collective centre. The stars were

slightly skewed for individuals identified as having disabilities. But, nonetheless, individuals identified as having disabilities had needs and preferences that covered the whole plot.

These findings did not surprise me, as they were not new, and they surfaced, galvanised, and provided a means of modelling the insights I had arrived at through many other approaches. The model of an exploding star also acted as a means of seeing and expressing the connection between inclusive design and many other theoretical fields. Understanding that characteristics we associate with disability are merely an arbitrary distance from a central cluster. Knowing that we all have multi-dimensional jagged sets of needs and preferences, and there is no average or typical person (Rose, 2015). Knowing that innovation occurs at the margins of a domain (Rose and Meyer, 2002). That the edge is the most vulnerable but also the most creative.

The exploding star model also made evident the flaws in current approaches to accessibility; the flaws in our current approaches to research, evidence, and design; the flaws in our approaches to education; and the misfit of existing market models and consumers with disabilities.

3.2   Growing Unease with Numbers as Evidence

I did not come to my unease with applying quantified research and the use of numbers naturally. As a young student, I loved the beauty of numbers and math; they were unequivocal and absolute. In school I chaffed at the restrictions and constraints put on ideas and frequently rebelled and failed to follow the prescribed assignments, especially when there was no outlet for creativity. This resulted in poor marks, especially from teachers who were uncomfortable with non-conformity. I received several lucky breaks when more progressive and surprisingly radical teachers made very brief appearances in our rural school. One was a grade four teacher, Mr. Doyle, who adopted a purely non-didactic strategy. As students we could do whatever we wanted to do, learn whatever we wanted to learn; we set our own goals and he would help us. While many students struggled without the structure, I thrived. I decided to complete three grades in one year. A large part of my time was spent on exploring math. The teacher helped me figure out what I needed to cover and stepped out of my way, other than to help me determine whether I had mastered the content. He lasted only one year at our school. The principal agreed that I could skip one grade rather than two. The rest of my teachers did not appreciate my efforts and found my perceived rebellion as a sign of poor scholarship. Math and numbers

afforded an objectivity that other subjects did not. Even when I was docked marks for arriving at an answer the 'wrong way,' I had the satisfaction of knowing that the answer I arrived at was right. I was not being judged subjectively.

Perversely, I also learned to like exams and tests as measurement and evidence and welcomed them as a challenge. During elementary school, our school board had instituted a form of standardised IQ testing, taken in a large auditorium. Prior to taking the test my parents had been called into school to meet with a guidance counsellor who was concerned that I was not learning English as fast as I should and might need to be removed into a remedial program. The counsellor questioned my ability to learn and my prior schooling. Not one month following this, all students sat in the auditorium to take the standardised test. I never discovered what my score was, but I was moved into the advanced English class, the only 'gifted' class offered by our rural school. There was no more discussion of my capacity to learn. In hindsight these experiences were in part caused by the largely homogeneous and unevenly xenophobic rural community we moved into. The community was made up of proud English and Scottish farmers. As immigrant children who did not speak English upon our arrival, my four siblings and I were teased mercilessly. Some teachers expressed this dislike of foreigners in more subtle ways. However, somehow, my highly non-conformist parents were able to forge an amazing and hugely supportive bond with the community over the years.

Thus, I have experienced first-hand the objectivity and removal of bias that research tools and automated processes can bring. It was only when I was required to apply my beloved numbers and math to research regarding people at the margins that I felt increasingly uncomfortable. Conducting research in the late 1980s at the then unfortunately named "Ontario Crippled Children's Centre" was one of my first introductions to the formal application of research methods and attempts to publish in peer-reviewed journals. I soon learned that the single-subject and within-subject research possible with the highly unique children I was working with would never rank in high-impact journals. There was also a stark contrast between the natural interaction with the children in exploring possible ways to write and communicate and the protocols required for research. While numerical measurements were prioritised in the research publications, I felt that the greatest insights were not captured by the numbers (Treviranus, 1994).

During my transition into a research university I witnessed the implicit and explicit hierarchies, favouring the disciplines that could produce more significant statistical results. This privileging of quantitative research influenced academic publishing, research funding, tenure, and promotion. I saw colleagues in the social sciences and humanities contort their inquiry and prioritise any aspect of their research that would fit quantitative research methods. This distorted the inquiry, and the choices of methods were biased by what would fit the favoured statistical methods. In the 1990s, notions of alternative ways of knowing, indigenous research methods, and data justice were not discussed. Feminist research methods and critical disability studies were only just being introduced and were generally dismissed by the power hierarchy at my university.

Early on in the work of my research centre, we came to learn about the way research had been abused as a colonising tool. As part of a project called CulturAll (Law and Treviranus, 2005), we partnered with indigenous communities on Manitoulin Island and First Nations centres in Toronto. To these communities, research was seen as a hostile concept. The communities had experienced the misuse of power, assumed superiority, and lack of respect that dominant research methods are often used to justify. I am indebted to our partners at De-ba-jeh-mu-jig for patiently addressing our naivety (Hengen, 2007). We learned very quickly the reasons for mistrust of academic research. They helped us to craft our early community principles that protect the precarious values of respect, dignity, and self-determination, and thereby foster trust.

Margaret Kovachs' recounting of her personal struggle with traditional research methods that self-replicate and lock out alternative ways of knowing and creating knowledge has many points of resonance (Kovach, 2010). Indigenous research methods have responses to and share many of the concerns we have had with dominant research in our Inclusive Design community. The emphasis on unpacking the deeper motivations of the research and the reasons for choosing the research methods, respect for a diversity of ways of knowing, and most importantly the importance of self-determination and self-knowledge resonates with Inclusive Design. Our work with De-ba-jeh-mu-jig challenged us to include without subsuming and taught us the importance of respecting culture and limits as a precursor to sharing knowledge.

In an attempt to articulate this unease and communicate the problem to our inclusive design community, I created a blog post for a general audience and posted it on Medium. The editors of

the Medium publishing platform chose it as one of the pieces to record in audio format. Below is the blog post.

If you are unique (and aren't we all), numbers are not our friends

Humans have been counting since before recorded history. Apparently, even some [animals use rudimentary counting](#). With the ascendance of 'Big Data' and the proliferation of connected internet-of-things sensors and monitors we are automatically counting more and more aspects of our life. This leads to more, and larger numbers.

Generally, whether we are measuring potential profit, impact, popularity, and even truth; the bigger the number the better. Businesses want to reach the largest customer base, governments want to invest in measures that benefit the largest number of voters, and if you are vying for attention you want the largest number of likes. Our expectations regarding the size of the number keeps rising.

Counting even determines such fundamental qualities as truth and worth. If you assert that something is true, as a scholar or researcher, you want the largest number of consistent measures; and to qualify as evidence, it must be measurable. Generally, only that which can be counted is attributed worth or value, and the higher the number, the better.

Who counts?

What happens if you are a small number? If the value you create is not quantifiable? If what you want or need to write or talk about is not popular? If the government program that is essential to you does not benefit many other people? If the products and services you depend on only have a tiny market? You will likely discover that you do not count or you do not measure up.

Your efforts won't be valued. Think of the innumerable caregivers and their essential roles and how they are remunerated.

The things you say or write will receive little attention. Who pays attention to the painful indignities of dying from a rare incurable illness?

The programs you depend upon will be de-funded. Ask the many people who experience 'low-incidence' disabilities whose critical services are at the mercy of political whims.

The products and services you need will be hard to find and if you find them they will cost more and be less reliable. Have you ever gone shopping for information or services in small minority languages?

Because you are an anomaly, security systems will perceive you as a threat. Try going through airport security with a declared gender that doesn't match your physical parts.

Because the numbers don't represent you, you won't be understood, and you won't be recognised. Search for research, publications, government grants or courses that address the unique needs of small, rural, remote communities.

You may find yourself in a vicious cycle of exponential injustice. Because you don't count for very much, you can't participate, because you can't participate, you can't help define what counts, so you don't count.

The Divisiveness of Digits

Most of our counting requires sameness and conformity. Deviation discounts you. You may find that even groups that fight for justice disqualify you. Advocacy groups fight for representation of an identity group with a well-defined and defended set of common characteristics. What if no one can represent your unique needs and characteristics? What if

no one claims you as a counting member? What if you exist at the dividing line between defined identities? Even our existing instruments of justice rely on being measured and counted. It's hard to measure equivalence when we have unbounded diversity.

Dividing Lines and Totals

Counting also demands clear boundaries. Something fuzzy and indeterminate is hard to count. Enumerating things like the characteristics of human variability has no endpoint or closure. Possible relationships and imaginable futures have no total. Complexity is impervious to counting. The cyclical has no sum.

Human Equations

We ignore the small numbers, the uncountable, immeasurable, unbounded at our peril. It's the rare, small numbers that have the largest, disruptive heft. Weak signals are usually the only warning signals we have of life changing events. Not very many people populate the extreme edges or margins, but that is where true innovation can be found.

If we can't escape the seduction of large numbers, it should be noted that adding up all those small and diverse numbers that are discounted, collectively comes to the biggest sum.

Unless we include those small, heterogeneous and frequently immeasurable numbers we have a distorted truth, our evidence is incomplete, and our blind spots occlude the most critical bits. If it takes large homogeneous numbers for us to pay attention, assign worth, and acknowledge truth we are setting ourselves up for an impoverished and inhumane life. Difference and unbounded variability is a human reality, anything living is not made to be a digit.

I'll trade you any big homogeneous number for the immeasurable, the ineffable, and the invaluable.

At the request of the Michener Institute the blog was reprinted for the audience of allied health professionals with an added section (Treviranus, 2018a):

Bad for Your Health

This bias toward large homogenous numbers also bears health risks if you're part of a small minority or very unique. Researchers who hope to publish, receive competitive research grants or ultimately receive tenure are discouraged from studying minorities because it will be difficult to achieve the statistical significance needed to be accepted into high impact journals, or to achieve the impact metrics you need to compete for funding. Companies producing pharmaceuticals and health products want to cater to the largest customer base. User testing facilities want to test their designs with the typical, average user. As a result, your health will not be understood. Medical devices and medicines won't be designed for you. Treatment regimens may not take your uniqueness into account. This often means that medical interventions will be a mismatch for your needs.

If you are lucky enough to have researchers willing to study your health, they will have difficulty finding research participants to represent you. If your data is included in Big Data analysis, it will be overwhelmed by data from the majority or normed from the data set as an outlier or noise. Artificial Intelligence decision-making systems won't recognise or understand you.

The best approach is if you represent yourself in research, if what is called small data is gathered, and knowledge is built from the bottom up. If your data is pooled with others,

patterns can be discovered after the fact rather than patterns and assumptions being imposed on you.

3.3 Truth Making and Persons Experiencing Disability

In this chapter I argue that our dominant practices of research are methodologically biased against diversity, complexity, and outliers. This bias is amplified by the technical application of traditional research methods in emerging sociotechnical practices, such as Big Data and artificial intelligence. This bias has negative implications for individuals and groups at the edge, as well as for society as a whole. Together with a loose global consortium of scholars that have come to the same realisation, I am beginning to shape ways to address this mismatch.

Using individuals with disabilities as the illustrative example, the only common, defining characteristic of disability is difference, meaning difference from a hypothetical average or the 'norm.' As discussed earlier, we all differ, but what a society nominally defines as disability is at the further edges of the scatterplot of how we measure humans, beyond the threshold that triggers the binary determination between 'able-bodied' and 'disabled.' It is these differences that cause the mismatch between the needs of the individual and the services, products, or environments available. It is this difference that has also resulted in a mismatch with research methods and the production of evidence.

A commonly held, implicit belief is that research, and the scholarly pursuit of knowledge, is unbiased, objective, and the trusted means of achieving greater collective understanding. The 'academy' as a whole is depended upon to dispel false assumptions and the injustices that accompany them. The academy is assigned the role of revealing facts, arbitrating theoretical conflicts, and determining truths (Franklin, 2014). Research is used to shape our perceptions of what is 'real'—to prioritise, guide our planning, and support prediction. Research undergirds every sphere of civilisation and daily life. Tight calibration with research is seen as an aspirational goal and a touch-stone of quality, value, and fairness. Research is the basis and source of evidence used to verify our perceptions of reality. Given the roles and responsibilities we have placed on academic research, it would seem critical that research be worthy of our trust. Especially in the current 'post-truth' era, science and evidence is depended upon to support progressive and liberal agendas, and it can be argued that it is risky to question or disturb trust in institutions of science. However, if advocates for equity are to use science as an

effective measure against social injustice, we need to ensure that it does not itself propagate social injustices.

Rather than a general critique of favoured research methodology, I will focus on the impact of research methodology on persons at the edge or at the margins (also encompassed by the experience of disability using the definition and relative framing that I proposed earlier). However, there is an interesting alignment between the concerns with research methodologies as they effect persons at the edge and the critique of dominant research methodologies by scholars concerned with complexity and complex adaptive systems (Miller and Page, 2007, Byrne, 2002).

The bias against persons at the edge is manifested in a number of entangled ways. These can be roughly categorised into the following list, persons at the edge are:

- systemically excluded from funded and published research (as the focus of research)
- excluded or eliminated from research samples (as subjects or participants of research)
- subject to misapplication of inferences and assumptions arrived at through research
- subject to the misapplication of research tests, instruments and measures (e.g., IQ tests and measures and pharmaceutical research)
- underrepresented or unrepresented as researchers (lack of researchers with experience of disability)

The collective global academy has established and settled on a fairly pervasive and well-entrenched system of norms, conventions, and values that are self-perpetuating. These are embedded and reinforced by the tenure and promotion system, the academic publishing system, the peer review process, departmental structures, and the research funding systems. These norms ripple out to choices made by governments regarding the allocation of funds to specific granting agencies, power and funding hierarchies within academic institutions, and recruitment processes for students and faculty (for example, in Canada the Social Sciences and Humanities research council consistently has the lowest funding level).

Would-be scholars are acculturated to the understanding that the most effective formula for success within the academy is to conduct quantitative research that garners clear statistical power and to publish in high impact journals within a well-established field. This strategy is most likely to garner positive peer review, lead to tenure and promotion, and receive competitive

research funds (DeMarco et al., 1993). You can optimise your chances further by allaying yourself with a specialised, well-established, "walled-off micro-domain" (Becher et al., 2001). Academic institutions that wish their members to succeed, reinforce and reward this strategy in their allocation of budgets, the disciplinary structure of the institution, and in the recruitment of faculty and students.

Critiques of the dominant research methodologies abound within and outside the academy. Tricia Wang characterises the favoured research method as equating measurement with truth, and the conceit that objectivity and truth can be arrived at through a single perspective (Wang, 2013). Werner Heisenberg and complexity theorists critique the reduction into constitutive parts, arguing that knowing the parts does not constitute knowing the whole (as quoted by Piechocinska, 2005).

According to the dominant formula, people in general are not the most optimal subjects of research, unless you can break these subjects into smaller, simpler, more predictable, and homogenous parts. If you insist on studying human subjects, the most efficient way to achieve statistical power and clear, demonstrable effects is to choose a very large, very homogenous group of people as your participants (Ziliak and McCloskey, 2008). Efficiency becomes even more important as funding for scholarship and research becomes scarcer. There are obvious ways to improve efficiency. You can use very simple measures with few degrees of freedom or variability. You can also increase efficiency further by using existing data and data sets; the larger the data set, and the smaller the variance in the data set, the better.

Given this implicit system of rewards, embarking upon the study of persons with disabilities is systemically discouraged. If you have a disability you are not only different from the average or norm, but you are generally also significantly different from other people experiencing disabilities. As discussed earlier, this can be seen in the natural distribution of a three-dimensional scatterplot of any set of human characteristics. The data points at the edges are usually further apart than the data points toward the centre. This makes it very challenging to pull together a homogenous sample group and to get a sample group of any significant size. Not only are the characteristics of people at the edge more diverse, the variables that you are likely to study are also more diverse and the effects are more diverse. All of this compromises your chances of optimising statistical significance. Even if you were to successfully mount a quantitative study with a sufficient sample size, it is highly unlikely that your findings would be

generalisable to other persons at the edge given the diversity, variability of effects, and the tendency of contextual conditions to be less stable when you live at the edge.

If your goal is to use quantitative research methods to better understand a group of persons experiencing disabilities, you will have difficulty finding a representative sample, isolating the conditions, and generalising your findings. For many persons with disabilities, you will find that the only valid representation is self-representation or a sample group of one. This usually implies that you must resort to qualitative research, mixed methods, and single-subject and/or within-subject research. These are valued less and often dismissed as not 'hard' or rigorous enough to earn respect within academia.

This phenomenon may also account for the apparent hierarchy of research and knowledge within the body of research regarding persons with disabilities. More homogenous causes of disabilities, such as blindness or spinal cord injuries, have a higher incidence of research studies and publications, while causes of disability with less homogenous characteristics, such as cerebral palsy, have fewer studies and publications (Woo et al., 2016). This is likely entangled with the relative strength of advocacy groups for these research domains as well.

It is the case that many research domains that are not 'hard sciences' are subject to this bias in our academy; however, people at the very edge, and the scholars that choose to research them, are at the very extremes of this bias, and most vulnerable to the effects. This ultimately results in significant blind spots within our collective knowledge base and feeds into the vicious cycles of exclusion that further disqualify persons at the edge as candidates for 'rigorous' research.

3.4   Persons experiencing disabilities within general research

If your research focus is not disability but human phenomena for a general population, the data collected for persons experiencing disabilities is more likely to be anomalous, an outlier, and determined to be noise in the data set. To reach statistical significance you will be compelled to eliminate these anomalies from your data set (Osborne and Overbay, 2004). This means that your ultimate findings or conclusions will not apply to persons experiencing disabilities and will not take persons with disabilities into account.

Despite the fact that people who experience disabilities are not likely to be represented in research findings, research findings and assumptions are applied to them (Thiese et al., 2015).

Expectations and conclusions arising from research are used to design services, products, laws, policies, and processes that are then a misfit for persons experiencing disabilities. Whether it is the length of time it takes to traverse an intersection, assumptions about the allowance required to purchase clothing, or the design of communication, research results are misapplied.

These biased effects ripple into Big Data analytics and machine decisions, which amplify and automate these biases. Fair and equitable treatment in our social structures minimally requires being recognised (i.e., as holding status and rights) and being understood. These essential prerequisites become even more critical as our functions of identification and decision-making are being delegated to machines. Like the implicit beliefs in academic research, there is an implicit belief that machines are less biased and free of human error and prejudice (Eubanks, 2018). By their powers of replication and pervasive connectivity, disruptive computer and network technologies can significantly amplify any social phenomenon.

The implicit hierarchy of research within the academy that favours empirical, quantitative research with clear statistical power and sample sizes that will pass the confidence level or statistical significance threshold is 'locked-in' through data analytics and machine learning. 'Hard' data is seen to trump 'soft' data, as a foundation for inference and for making evidentiary claims. Simple proofs are favoured over complex multi-step proofs. In order to achieve this favoured ideal, several tactics are used that in aggregate result in a systemic bias against diversity and difference.

Statistical power is promoted by reducing variability in the sample population (Israel, 1992). Outlying data, noise, and data anomalies are eliminated from a data set to find dominant patterns, increase the signal to noise ratio, and support clear conclusions (Rahm and Do, 2000). To increase statistical power, large homogenous sample groups are preferred. People experiencing disabilities are the opposite of homogenous and may not have any available representative sample. In fact, many individuals at the periphery of the multidimensional scatterplot may constitute a population or 'n' of 1. To efficiently arrive at useful inference scenarios and measures that have the potential to be directly beneficial to a large group of individuals, large 'n' quantitative data sets are preferred over data from research more tolerant of multivariate effects or the less deterministic, 'less focused' non-parametric data collection (Sra et al., 2012).

3.5   The Problems Made Manifest

It was not until I became more familiar with current and potential applications of artificial intelligence and machine learning that much of the dissonance I have felt with dominant forms of research, evidence, and knowledge making, as they are applied to the edge of the human scatterplot, galvanised and became manifest.

My team was engaged in planning workshops for the 100th anniversary of the Ontario Ministry of Transportation. One of the workshops we were engaged in was a workshop to develop a plan to design policies for automated and connected vehicles. To familiarise myself with the topic I had the opportunity to play with machine learning systems and artificial intelligence models that would be used to determine the decisions automated vehicles would make when approaching an intersection. I presented a three-dimensional capture of a friend of mine approaching an intersection. This friend propels herself backwards in her wheelchair using her feet. She has cerebral palsy and has better control of her legs than her arms, but not enough to stand or walk. She is fairly erratic in her movements. Her cerebral palsy also impairs her speech. Often well-intentioned pedestrians will misunderstand her movements and her intended path and grab her chair and try to pull her off the intersection and back on the sidewalk she came from. Her speech makes it difficult to explain her intent. Intersections are a daily trial, especially busy intersections. I thought this would present an instructive challenge for automated vehicles. I never realised just how much of a challenge it would be. The simulated vehicles did not recognise or accurately predict her path and would run her over. Some of the models were early in their training and had only been exposed to a small percentage of the data sets that would go into their training. I was told that I should try again after the machine learning system had been exposed to data that included data from intersections that had frequent wheelchair traffic. However, when we tried again after the model was further developed and had been exposed to data regarding wheelchair traffic in intersections, the simulated vehicle made the same decision but with greater confidence. (It has since been postulated that the first death caused by an automated UBER car, which hit a woman pushing her bicycle, may have been caused by similar design flaws (Rebane, 2018). Of course, this particular glitch can be fixed by explicitly training automated vehicles to address this scenario, but for me it pointed to a larger glitch in addressing exceptions and individuals not represented by dominant patterns or large data sets.

This experience led me to examine what was happening with the data sets used to train machine learning systems. I had the opportunity to talk to data brokers and hear of the processes used to clean data, normalise data, and increase the signal to noise ratio or eliminate the noise in the data set. The processes employed are intended to surface dominant patterns and enable machine learning systems to reach a stage where they could make useful inferences for the majority of decision scenarios faster and more effectively. This selling point is reflected in the promotional material of data brokers such as RingLead: "RingLead offers a complete end-to-end suite of products to clean, protect and enhance … information, leading to improved organisational efficiency, reliable business intelligence, and maximised ROI on CRM and marketing automation investments. Since 2003 RingLead has helped solve the dirty data problems of large enterprises, Fortune 500 companies and small businesses across the globe" (RingLead). However, a casualty of this data preparation is outlying, anomalous, or exceptional data. This data is often eliminated or ignored in the analysis.

This led me to question other applications of AI-guided decisions or machine decisions. I became aware of just how many critical decisions are made by machines or guided by machine intelligence. In talking to banks, I learned that critical decisions, such as employment for competitive jobs, loans, credit, and insurance, were all determined by machine intelligence. More alarming, in talking to a number of banks, I learned that human intervention in the decision-making has been given an imminent sunset date.

However, in speaking to data brokers, I realised that the origins of this blind spot are not in artificial intelligence, nor in Big Data which is the fuel for this intelligence. It can be traced far back to the ascendance of statistics. Shogan (1998) highlights the role of statistics in the social construction of disability. Fendler and Muzaffar point out the impact of the bell curve in sorting students and in constructing the notion of normal within child development and education (Fendler and Muzaffar, 2008).

3.6   Automated Vehicles and the Outliers

To alert the industry engaged in designing, developing, and deploying automated and connected vehicles, I wrote an opinion piece in 2017 for *Transportation 101*, a quarterly publication of the Canadian Institute of Transportation Engineers. In this publication I also highlight the competition I launched with the support of the BIG IDeA project funded by the Ontario

Government. The challenge invites AI developers to compete to address edge scenarios developed by university students and community members that might not be included in their data models. What follows is the opinion piece that describes the challenge

3.7 START YOUR MACHINE LEARNING ENGINES & RACE TO THE EDGE!

A friend of mine, Adam, moves about the city in a very unusual and unexpected way. He propels himself backwards in his wheelchair with his feet. His pace is faster than most pedestrians, and he cranes his neck to look behind him. His path is not straight and seems to be erratic at times. This is his most efficient and independent means of mobility given his cerebral palsy. Whenever he approaches an intersection he faces the risk that some well-meaning pedestrian will doubt his competency, sobriety and safety, grab his wheelchair, turn it around and push him back on the sidewalk. Clarifying his competency and intent is complicated by the fact that his speech is also affected by his cerebral palsy. He challenges the expectations of most humans not familiar with him personally, it is unlikely that he will be better understood by machines given the trajectory of machine learning. There are many individuals, like Adam, that do not follow expected patterns. If current machine learning strategies used to develop the artificial intelligence that controls automated vehicles do not consider outliers like Adam, they will dangerously amplify the impact of the lack of understanding.

One of the oft-cited promises of automated and connected vehicles is the benefit they can provide to persons with disabilities (Kelly, 2012). This is a compelling motivation, as almost all Canadians will experience a disability in their lifetime (Grondin, 2016). But **before an intelligent machine can be of help, it must understand us.** There is nothing more frustrating than negotiating with a machine that does not recognise our request, or that misunderstands our command. Automated and connected vehicles must balance a number of goals and priorities when choosing a course of action. This adds additional risk to the prospect of not being recognised because you are excluded from the machine intelligence models.

Machine intelligence is formed by machine learning engines using training data. A variety of learning processes (whether supervised, or unsupervised by humans) are employed to use data to create models from which the intelligent machines recognise patterns, formulate inferences and make decisions. Accuracy is honed through feedback processes that identify and correct mistakes. The emergence of 'Big Data' and connected sensors and monitors (e.g., smart phones, health and fitness monitors, security cameras, bio-sensors, connected vehicles, etc.) feed this machine learning: creating intelligence that is more comprehensive and detailed than ever before.

'Big Data' inherits methods from quantitative, statistics-based research. Data is 'cleaned' or normed and thereby reduced to find dominant patterns and generalisable findings. This implies eliminating 'noise' or outlying data that is assumed to be an anomaly that could muddy the conclusions. For automated vehicles this data is used to recognise elements in the path and decide the best course of action. It is also used to recognise human commands. **However, people experiencing disabilities are, by definition, different from the norm.** This difference, especially extreme difference, is predominantly treated as outlying data to be eliminated in the process of efficiently finding dominant patterns from which to make inferences (O'Neil, 2017).

The effect of this data handling in machine decisions can already be felt in the failure to recognise impaired speech, process unusual requests, diagnose complicated illnesses, accept unusual applications, or give security access through unexpected biometrics. As machine intelligence permeates our daily lives, this effect will drive a larger wedge of disparity between those that are served and those that are not understood, recognised or served. The most pessimistic scenario is an exponentially amplified vicious cycle of exclusion for individuals already at the margins (O'Neil, 2017).

There is a hopeful thread in this entangled and complex inevitability. As with all wisdom gained and substantiated by supporting precarious values such as accessibility and inclusion, we find that considering the edge benefits everyone. While it is more expedient to move quickly to dominant patterns; if we learn from edge scenarios and develop our intelligence by exposure and understanding of diversity and difference we gain in the long run. Intelligence that understands diversity and stretches to encompass the outliers is more noise tolerant, better at predicting risk and opportunity, more capable of processing the unexpected, more adaptable, and more dynamically resilient (Treviranus, 2014a).

The Inclusive Design Research Centre has challenged machine learning innovators and developers to participate in a 'race to the edge' (BIG IDeA). Participating universities and colleges will be creating a series of secret tests to see which machine learning engine can effectively and efficiently address scenarios and requests that are not typical or average. The most popular machine learning developers have expressed interest in taking up the challenge. The race will begin this October with the release of the secret tests and the results will be publicly available through the BIG IDeA website. It is hoped that this event will be one of many to enable more diversity supportive artificial intelligence.

As we delegate more and more tasks and decisions to machines, it is important that we attend to what we teach machines. Do our machines understand and serve individuals that are different, or fail to recognise and ignore anyone that does not conform to the model of an average human?

3.8   Inequity in Research

Given the scarcity of research funding, competitive peer-review processes, the self-perpetuating nature of academic disciplines, the demand for high impact results, the propensity to reduce and contain complexity, and the overwhelming proliferation of data; minority and highly complex issues are rarely recognised or investigated by established formal research efforts. Many challenges that do not fit recognised disciplinary classifications, match current research priorities, or garner high-impact publications go unanswered, leading to knowledge disparities and a growing segment of the population whose unique needs are not understood or addressed. There is an expanding disconnect between academic inquiry and 'real-world' problems at the margins. However, collectively, marginalised needs may outnumber 'high-impact' research domains. A broad diversity of perspectives is required to achieve the prediction, planning, and innovation needed to traverse and attend to the many entangled challenges our society faces.

As verified by Scott Page (2007), diverse perspectives are often more critical than the best and brightest minds in addressing complex or wicked problems.

3.8.1 Big Data: Amplifying Bias

Perhaps more troubling than the gaps and disparities in research topics is the trend for 'Big Data' systems to replicate traditional diversity-and-complexity-aversive research methods. This accelerates the echo-chamber effect, emphasises dominant patterns, and amplifies the bias toward what are deemed 'high-impact' research issues. As reaching the bar of 'high-impact' requires homogeneity in large numbers, individuals with outlying or minority needs can never reach the bar. Yet collectively these outlying needs may surpass — in urgency and volume — the needs that are deemed 'high-impact.'

3.8.2 The Opportunity of Small Data

As expressed by Brooke Foucault Welles (2014), an unexploited opportunity provided by Big Data is that "those who might otherwise be represented as a single outlier in a more traditional dataset can number hundreds or thousands in a Big Data dataset—hundreds or thousands whose experiences are currently absent from the scientific record. Rather than actively removing these voices through sampling and data cleaning, or passively silencing them through statistical aggregation … embrace the opportunity to examine the statistical outliers.… By choosing to make Big Data small, we can rectify historical omissions and biases in social science research and build better, more comprehensive, bigger understandings of human behaviour." Small, thick data is personalised data in context and practices that enable bottom-up data analysis. Rather than imposing the research parameters, relevant parameters emerge, data can be aggregated, and patterns are identified post hoc.

Our systems of evidence are systemically biased against diversity. In our attempt to understand complexity and find dominant patterns, we elide the outliers. This creates compounding disparities that ripple well beyond the topics of research. Persons that do not fit into any representative sample are less likely to be represented by research or scholarship and are less understood, or worse, are misunderstood and misrepresented. This has implications for policy, markets, systems of education, systems of employment, government services, and all facets of life.

Sally Engle Merry in her book *The Seductions of Quantification* explores how global indicators are shaped by inequalities in power and expertise. She identifies a phenomenon called

'expertise inertia,' in which "insiders with skills and experience have a greater say in developing measurement systems than those without—a pattern that excludes the inexperienced and powerless." Authoritative expert knowledge is given privilege, meaning that local knowledge is often ignored. The expense of collecting new data leads to an associated phenomenon Engle Merry calls 'data inertia': "It is relatively hard to address new problems without new data collection, so the way categories are created and measured often depends on what data are available"(Merry, 2016).

3.8.3   The Role of Peer Review in Peerless Research

Reliance on peer review perpetuates dominant interests, as researchers value research that strengthens their research domains. Disciplinary silos mean that many topics fall through the cracks. Personal investment in demanding academic development often leads to competitive and elitist attitudes regarding what is worthy of inquiry. As scholars, our research review, tenure, promotion, publishing, research recognition, and funding processes are implicitly biased against minority needs. In the race toward impact metrics needed to be published, receive tenure, be promoted, receive recognition, and garner research funding, scholars are channelled toward research that can yield large sample sizes and homogenous outcomes that result in statistically significant findings.

There is a tendency to dismiss scholarship that does not have clear (and homogenous) impact for a large group. However, logically, and as verified by demographers (Knight et al., 2010), individuals who are outliers and excluded may outnumber the 'norm.' The impact of addressing this systemic deficit may be transformational, however the domains of impact are diffuse, and the evidence of impact is unpredictable. The cumulative change may be significant, but it would be diverse and would not lend itself to simple quantification or unidimensional measurement.

3.9   The Potential of Citizen Research

Enabling and recruiting 'ordinary citizens' to engage in research and science may be the only way to tackle the profusion of challenges and to sensibly navigate the combinatorial complexity brought about by our connected and quickly changing society. Elite science and research leads to knowledge disparity with respect to both research subjects and access to knowledge. It hampers transfer of research findings and reduces the possible diversification of inquiry, resulting in marginalised knowledge domains. A broad diversity of perspectives is required to

achieve the prediction, planning, and innovation needed to traverse and attend to the many entangled challenges our society faces. Intelligent democracy requires informed citizenry capable of independent investigation and analysis.

Added to this implicitly biased system of formal research is the profusion of data produced by the thriving digital mesh encasing our world. Elite scientists cannot realistically process or make sense of the current flood of data, let alone the exploding volume of data to be unleashed by "Internet of Everything" sensors and monitors. The privileging of mechanism and concrete evidence keep our gaze on the immediately evident and specific, hampering methods of inquiry and exploration that might give more holistic oversight of our quickly changing terrain. The self-perpetuating competitive disciplinary silos we have constructed prevent the collaboration and collective cooperative production needed to merge our insights to see more of the whole.

3.10 Citizen Science to Assist Evidence-based Governance and Outliers

The Canadian government and many other governments have committed to evidence-based decision-making. However, evidence-based decision-making within government will inevitably privilege decisions and issues for which there is available data. This leaves marginal issues, problems without supporting, data and challenges that do not fit targeted categories of investigation without attention or support. This will result in data gaps and disparities that complicate related and co-occurring disparities such as economic, health, and education disparities. Anticipated risks associated with lay science are increasingly allayed through emerging practices that ensure quality, accuracy, and ethical practice in open processes (Cohn, 2008). Given the diversity and complexity of issues at the margins, one of the most viable approaches and opportunities appears to be recruiting the broadest diversity of citizen researchers in addressing gaps, which requires inclusively designed tools and infrastructure.

Most importantly, intelligent democracy requires informed citizenry capable of independent investigation and analysis. Engaging the public in research helps to raise the level of understanding, promote more nuanced interpretation, and may help to reduce reactionary reductionist tendencies when asked to participate in democratic decision-making.

Citizen science collectives, such as the Citizen Science Alliance, show that scientific validity and data quality can be equivalent to professional research given appropriate support and guidance (Newman et al., 2012). Citizen researchers also enable greater vigilance to unexpected

and unconsidered phenomena or occurrences. It has been noted that when lay researchers lack the academic background to understand the standard 'school of thought' on a subject or why it has become the general consensus, they are more likely to arrive at novel and disruptive ideas (Feltman, 2016).

3.11 Proposed Project and 'Rigour'

As an anecdotal example, together with a large consortium of partners I proposed a 'Citizen Collaboratory' for citizen research and design to the Canadian Foundation for Innovation. The fund is intended for elite infrastructure for elite scientists.

The following are excerpts from the proposal summary:

The Global Citizen Collaboratory takes Community-based Participatory Research (Minkler and Wallerstein, 2008) to communities at the margins and creates an infrastructure for what Ollerton (2012) has named Inclusive Participatory Action Research, or the melding of Inclusive Research and Participatory Action Research. The Collaboratory recognises that any person can experience a disability if their needs do not match the available designs and leverages emerging technologies to enable individuals that experience a barrier and their communities to address these mismatches. These mismatches are encountered in systems of research, systems of governance, policies and services as well as products and environments.

The project will produce a more informed citizenry, conversant in research methods and connected to diverse talents and interests. This will undoubtedly lead to greater innovation and empowered resourcefulness. This research 'workforce' will help to improve both public and private processes, providing valuable and informed input to social services. This populist research 'workforce' will be empowered to address issues of sustainability, accessibility and inclusive economic growth and prosperity.

The project will provide greater and more inclusive functional access to data assets. It will diversify innovation, and economic endeavours, creating greater economic resiliency. The project will also contribute to the reduction of disparity, provide more inclusive access to education, employment and civic engagement for individuals whose needs are not currently addressed by traditional research efforts.

The social impact of the initiative will be experienced from the outset of the project. By virtue of engagement in co-design and research, participants will benefit from the learning opportunities, social collaboration, collective effort and meaningful productive engagement in addressing gnarly challenges and previously unanswered questions. The project will lift previously excluded and marginalised lay researchers and designers to a new level of efficacy. This will benefit not only the citizen researchers and designers, but also Canadian society as a whole.

The proposal gained the highest points for collaborators, partners, and suitability of requested infrastructure, but was rejected because of 'lack of rigorous methodology.'

3.12 Learning Analytics and Education Funding

At several points between 2010 and 2015, I was invited to a variety of think tanks regarding educational policy in the US. I was alarmed that quantitative statistical data would be used to determine the level of funding of educational programs and to determine whether a program would be funded. This led me to write the following opinion piece for Educause.

THE VALUE OF THE STATISTICALLY INSIGNIFICANT

During times of financial constraint, governmental and educational policy-makers are faced with difficult decisions, and this difficulty is intensified by the heightened public scrutiny surrounding public spending decisions. No distribution of limited funds can make everyone happy. A rational solution is to guide and justify difficult decisions using scientific research and evidence.

The legitimisation of policy and public commitments using scientific empirical validation is not new. The pendulum between policy steered by ideology and policy driven by rationalist knowledge has been in motion for countless transitions of administrations globally (Ian, 2002). The current resurgence or reanimation of the appeal to evidence-based governance is at least in part fuelled by the fervour that accompanies new technologies (Liebman, 2013). Big data and data analytics, including learning analytics, have been nicknamed the "power tools" for more responsible governance (Kalil, 2011). This new, more proficient, and better-connected means of measuring and monitoring the impact of candidate initiatives has captured the imagination of educational decision-makers at all levels.

Evidence gathered through learning analytics has been recommended both as a way to set spending priorities and as a reasonable gate that must be passed to justify any specific investment of public funds(Diaz and Fowler, 2012). Given the rising popularity of big data, opponents to these data-supported strategies are cast not only as anti-science but also as anti-innovation.

What about the Outliers?

Leaving aside the more general debate regarding empirically driven policy, the proposed approach to making policy decisions with the use of the celebrated 'power tools' amplifies and heightens serious issues faced by individuals who are outliers and candidate measures that are at the margins (Zarb, 1992). These concerns cannot be dismissed as side issues, since the outliers and/or margins may collectively outnumber the norm.

Who are these outliers? This considerable group includes anyone not captured under the body of the bell curve. Among the margins are learners who are classified as having a disability, learners who are gifted, and learners who have been termed the 'doubly

marginalised'—those who are not served by the standard educational system but who also do not qualify for special education.

Traditional or established research methods have always privileged the norm or majority. Individuals at the margins are frequently eliminated or discounted as 'noise' in large data sets. There is an implicit hierarchy of scientific evidence. The pinnacle of the hierarchy is a well-controlled experiment with a large representative sample size. Although small-sample quantitative and qualitative methods have been reluctantly admitted into the academy, they are viewed with greater scepticism. The yardstick of research findings is statistical power, since it justifies our measures of probability. When measuring impact to support high-stakes decisions, we want a large degree of certainty. At the other end of the scale are fuzziness, variability, instability, and unpredictability—all hallmarks of the margins and the outliers. The outliers are deemed insignificant. Big data and learning analytics have inherited the same yardstick.

Evidence to Support Funding Decisions

If evidence regarding impact levels arrived at through big data and learning analytics is used to determine spending priorities, learners at the margins and the diverse programs that support them will never pass the threshold. Outliers are by definition highly diverse or heterogeneous. The programs or measures that are effective for these individuals are as diverse and variable as the learners themselves. Any candidate measure intended for learners at the margins will serve a comparatively small number of learners and will therefore have a comparatively small impact. Therefore, specialised programs for the margins cannot compete with programs suitable for the norm.

Even empirical evidence of impact as a gate to funding of a specific initiative can be problematic when addressing outlying learners. Outcomes are often diffuse and inconsistent. The dominant research methods have never worked for outliers. It is difficult, if not impossible, to find a representative sample, let alone a sufficiently large sample to achieve external validity.

A cogent example is research into the impact of assistive technologies in special education for students with disabilities (Alper and Raharinirina, 2006). There is no lack of research in the domain. Several countries have supported the aggregation, review, and dissemination of research findings on this topic. However, there is almost no external validity or generalisability with respect to these findings. Most of the research is single-subject, within-subject, or anecdotal. Many years are needed for sufficient research replications that will increase the statistical power, at the same time risking significant changes in conditions and threatening the longevity and relevance of the findings.

One of the benefits of the internet to individuals at the margins is the increased opportunity to find other individuals with common needs or interests. Finding a common soul in a small local community may be difficult, but doing so is easier when the pool of possibilities spans the globe. Does the same advantage not apply to big data that aggregates data points from a much larger pool than any single research study? Unfortunately, to date, the tools and algorithms have not been designed to expose and pool minority effects. Big data has inherited the biases of traditional research. Not unlike the popularity echo-chamber of the Web, which intensifies the impact of popularity, big data algorithms intensify the statistical power of the norm (Treviranus and Hockema, 2009).

<u>The Difference</u>

Beyond the obvious issues associated with gathering supporting evidence for initiatives required by outliers, marginalised learners are also least served by the status quo. Evidence-based governance, on the other hand, is most likely to support the status quo—the 'tried and true' or 'proven' measures for which it is easier to amass data.

Sharing the limelight with big data and learning analytics is the acknowledgment that we live in transformative times and that our educational system must transform in response. We are no longer living in the Industrial Age; we live in a creative/knowledge/digital/networked economy. Conformity, uniformity, and rote learning are no longer useful values. We need diverse, creative, responsive, collaborative, resourceful, and resilient learners. These values are most easily found at the margins where diverse learners are given personalised support. This is also where innovation thrives(Meyer and Rose, 2005).

Design based on metrics for the norm may be detrimental to the margins, but the converse is not true. That is, design based on the margins can benefit the norm. For example, stairs exclude anyone in a wheelchair, but a ramp in the sidewalk helps everyone get up the curb. Design that encompasses the margins tends to make the world more usable for the whole of humanity (Jacobs, 1999).

At a macro level, the vicious cycle driven by exclusion presents huge risks, not just for the excluded individual but for society as a whole. These risks have been empirically documented by researchers such as Richard Wilkinson and Kate Pickett (2010) and recognised by the World Economic Forum, which ranks severe economic disparity and lack of inclusion as the greatest global risks (above global warming and terrorism) (Barnato, 2013).

<u>Beyond the Mass</u>

Economies of scale have great appeal; however, the social and environmental costs may outweigh the benefits. Through disruptive practices such as 3D printing, social networks, and digital repositories, our economies are slowly moving away from the mass—mass production, mass marketing, and mass communication. Our educational system can follow suit.

The most promising power tool for responsible educational governance and policymaking is not big data but small data, not certainty but responsive and dynamic instability. We need informed governance for education in general but also informed decisions for each unique and diverse learner. More important, we need informed self-aware, self-governing learners. We can design our systems to enable learners to discover and refine their understanding of what works best for them in a given situation in pursuit of a given goal, bolstering meta-cognition and making sure each learner learns to learn (Inclusive Design Research Centre). We have the opportunity to replace education for the masses with one-size-fits-one learning at comparable cost by leveraging open education, connected classrooms, and peer learning (Treviranus, 2010b). Learning analytics, designed for diversity, can provide a dynamic research engine that informs this process. We can dispense with the impossible challenge of finding a representative sample to support external validity, since each learner is self-represented.

Our world is not becoming less complex: the combinatory factors are only increasing. So what makes us think that technology can give us easy answers? If our research tools are working as they should, they can accurately reflect that complexity. These tools can help us

navigate and leverage that complexity. In turn, doing so can help us design our education for diversity and inclusion. The margins, the locus of innovation, are not to be dismissed.

3.13 Raising Awareness of AI Bias

Since I first became aware of the potential threats of AI with respect to outliers, the issue has been amplified by the press and numerous public efforts have emerged. Cathy O'Neil's book *Weapons of Math Destruction* (O'Neil, 2017) served to raise alarms globally. Sufiya Ujoma Noble (2018) and Virginia Eubanks (2018) powerfully framed the role of AI in amplifying and demonising poverty and automating racial bias. All three authors highlight the systemic vicious cycles of discrimination experienced by individuals sorted, filtered, and processed using machine intelligence.

Increasing awareness of the threats posed were reflected in the European Union privacy regulations in the form of the General Data Protection Regulation (enacted in 2016 and taking effect in 2018). The right to explanation pertains to algorithms that guide machine decisions. The Microsoft Inclusive Design team, once alerted to the issues by a variety of scholars, convened several meetings and design sessions that attempted to capture and communicate the types of bias that can occur with artificial intelligence. Five forms of bias in AI were identified:

1. dataset bias (similar to sampling bias),
2. associations bias,
3. automation bias,
4. interaction bias, and
5. confirmation bias (Chou et al., 2017).

The Vector Institute, Canada's leading research centre for AI, bases its approach on early work regarding fair representation, whereby the treatment of protected groups is compared to the treatment of the population as a whole (Zemel et al., 2013). Joy Buolamwini (2017) began the Algorithmic Justice League at MIT Media labs. There are many other initiatives emerging each week to combat bias.

3.14 Outliers, margins, and tiny minorities

To date, none of the efforts that fight AI bias have addressed the margins, very small minorities, and outliers. These individuals at the margins resist categorisation and do not fit neatly into any protected group. The issues for outliers are not captured by the five types of bias that Microsoft

Inclusive Design has identified. Even if data sampling is rigorously representative of the population, if the algorithms are completely neutral and if no human bias has intentionally or inadvertently been expressed in the algorithm, people at the margins will not be recognised or understood in population-based data sets. The needs, preferences, and competencies of outlying individuals will be overwhelmed by the majority.

I experienced this first hand when I compared a data set that I had gathered in 1988—when I worked with several children to train an early voice recognition system to recognise repeatable dysarthric speech—with the performance of a current speech recognition system. These children were able to produce consistent utterances for a range of words and phrases. Although these would not be recognised by untrained listeners, their family members and close assistants had come to understand their intended messages. The early pattern recognition system required lengthy training, but came to recognise up to 200 utterances. The current speech recognition system never reached recognition of any of the utterances. This is precisely because the current system is 'smarter' and has data from millions of individuals. The dysarthric utterances do not sound like the recognisable speech productions of the majority.

It can be argued that this bias against outliers has always been the case. That is the nature of population data or any data set regarding a group of people. However, we have not based so many decisions on data before. Outliers have had the opportunity to request exceptions to decisions, to appeal to 'human judgement.' It is true that institutions and agents of institutions have developed rules that disregard exceptions, and there are many stories regarding heartless officials and unreasonable policies. As Ursula Franklin points out, institutional policies and rules act to absolve us of responsibility for inhumane treatment of our fellow beings (Franklin, 1999). However, we often create a means of appeal. We have not developed means to request exceptions in our machine-based systems.

3.15 Early explorations in diversity supportive data models

Together with a group of students completing their capstone assignments in AI and informal study groups experimenting with open source machine learning tools, I have been experimenting with data manipulation that will address this issue. We have experimented with two strategies with very early positive results. This is not the topic of this thesis, and I only mention it here to illustrate my earlier points.

The first approach has been dubbed the 'apple coring the data' approach. In this approach we train the machine learning model using all but the central core of data. The machine learns from the outliers. What we have found is that the learning process takes longer before the model can make any reasonable decisions. However, the resultant model is better at addressing new or anomalous decisions or recognition challenges and is eventually faster at transferring to related but new decisions. However, if we use statistical processing, we still arrive at the mean or average. This means that prediction based on probability is still drawn away from the edge where the individual with outlying needs is situated.

The second approach is what we have dubbed the 'lawnmower of equity.' Here we cut off repeat data points at a given number. This reduces or stops the data points at the top or middle of the Gaussian curve from overwhelming the tails or margins. It is a form of 'levelling the playing field.' These experiments have just begun, and we have not been able to adequately test them. However, in exploring this data approach in the intersection simulation that I discussed earlier, the automated vehicle model accurately decided not to run over the anomalous movement of the individual going backwards in the wheelchair.

3.16 Small, thick bottom-up data

At the heart of the issue of quantitative research bias is the issue of representation. When you, your needs, and your characteristics are unique, there is no adequate representative sample group that would enable any valid conclusions that can be transferred to you. The only solution is to represent yourself. This is the approach taken in small data methods. A leading lab in small data is the Small Data Lab at Cornell University led by Deborah Estrin (small data lab). Only your own data is used to draw inferences.

Another issue with scenarios at the edge is that the context is complexly entangled with the effects or measures. It is impossible to isolate the variables. Thick data implies that the data is contextualised (Wang, 2013). Data analytics can combine numerous data sets and determine correlation of contextualised data. Aggregate patterns regarding multiple individuals are detected post-hoc.

Through several IDRC projects we are investigating applications and programs that enable an individual to instrument inquiries using their own data. One version of this is called 'My Life Long Learning Lab.' Data can be brought in from any number of sources, including live data, processed

using a variety of algorithmic processes, and then visualised in a way that is accessible to the individual (Harnum, n.d.), n.d.)

3.17 Personal Privacy Preference Standard

In an attempt to create protections for data abuse and misuse, I have been working with the Canadian Office of the Privacy Commissioner and ISO/IEC to create a privacy preference standard. Persons with disabilities, persons who are aging, members of the LGBTQ community, and other minorities are the most vulnerable to the misuse or abuse of personal information. Among the risks are: denial of insurance, jobs, or services; and fraud, identify theft, and cyberbullying. Paradoxically, these same consumer groups frequently have the most to gain from 'smart services' that respond to personal information shared with service providers.

In response to this dilemma, we developed a mechanism to empower the consumer to determine and assert personal preferences regarding the use of private information through the extension of the international standard AccessForAll (also referred to as ISO 24751) that I brought forward to ISO with the help of my team and that was adopted as a standard in 2008. The privacy preference extension to the international standard was co-designed with community members and presented to the international standards body (ISO JTC1 SC36) for proposed adoption. We developed utilities that offer clear decision support to non-technical users so they can select preferences and understand the risks and implications of preference choices. The primary goal is to empower currently vulnerable consumers to take advantage of emerging services without risking abuse of personal information. The project proposal was approved by ISO/IEC JTC1, and I am currently convening an international ISO working group to finalise the standard. The ISO proposal can be found in Appendix C: ISO/IEC 24751 Information Technology—AccessForAll Framework for Individualized Accessibility—Personal Privacy Preferences: Committee Draft 1. Both the European Union and the Canadian Government have expressed interest in referencing the standard, to reverse the all-or-nothing terms of service agreements currently used by most service providers.

3.18 The Three Dimensions and Research Methods

3.18.1 First dimension

By adopting personalised data collection with bottom-up approaches and self-representation, we recognise and preserve the integrity of each unique user in an integrated way. As the user is

the data scientist and benefits directly from the data and analytics, we support self-determination.

3.18.2 Second dimension

The democratisation of data-based research ensures that edge users and a large diversity of users can participate and help to co-design data practices and methods.

3.18.3 Third dimension

Rather than reducing complexity and thereby ignoring and eliminating the outliers, the small, thick bottom-up methods reflect the complexity of the real world and use the power of computing systems and algorithms to navigate the complex scenarios without eliminating knowledge available to guide decisions and alert to threats.

3.19 Conclusion

Our current systems of academic research leave a host of issues and individuals stranded at the edges: students who don't fit under the constraining mantle of average or the clusters of recognised classifications, patients whose unique condition means there is not a large enough representative research sample to reach statistical power to draw conclusions, or consumers whose unique needs will not warrant a product because the size of the customer base will not be profitable. Our current systems of research funding perpetuate this pattern, leaving peerless research, subject matter without well-established support, and academic institutions that are not already part of an elite group without support to sustain inquiry.

This dominant and pervasive pattern of academic study puts our society at risk of knowledge blind spots: hampered in predicting the occurrence of biological, medical, or social threats; unable to address the needs of all but the set of conforming individuals; and without the innovation and creativity birthed by addressing the edges.

I am part of a small, but growing, consortium of researchers globally working to find ways to address this bias. The most promising strategies employ small data, n=1 studies that inform the data owner, and the democratisation of data research. Artificial Intelligence and machine learning that threaten to amplify and automate the bias have also helped to make the nature and extent of the threat manifest. In teaching our machines to recognise and understand diversity and complexity, we may find a way to address the bias against diversity and complexity in our society.

4   : Literature Review and Situating the Framework

In this chapter I wish to both situate the proposed Inclusive Design framework within the broader field of Design and provide a manageable review of directly relevant literature. The Inclusive Design framework I have developed is intended to address inclusion in a digitally transformed and networked society. The framework emerged with the maturation of the concern for digital inclusion for people experiencing disabilities and the Design theories and practices that address this challenge. However, the framework, as I have conceived it, recognises that anyone can experience a disability (Treviranus, 2014a). Also, digital and networked systems and practices have permeated and touched all aspects of our society and daily lives. A literature review that covers all relevant areas of inquiry is beyond the limits of this dissertation. This literature review will address related Design theories and practices. I will also outline the emergence of the field of digital inclusion for people experiencing disabilities. Necessary excursions to other topics will be integrated throughout the dissertation.

4.1   Background of Knowledge Domain

A review of seminal works in the field can be characterised as a symphony of threads responding to the evolution of computing devices, the internet, and the Web. To frame and provide a navigational structure for the topic of inclusive design for digital inclusion requires an understanding of the evolution and emergence of the field and its many associated branches and interwoven topics. Among the major threads are: the emergence of personal computers; the rise of the internet and the Web; the continued growth of the human rights movement with respect to people experiencing disabilities and others who are marginalised and excluded from participation in the digital transformation; the emergence of laws, policies, and regulations to enforce those rights; and the waves of technical innovations and their socio-technical practices that have disrupted our views of economics, education, work, governance, and culture.

The challenge of digital inclusion emerged with the arrival of the personal computer in the late 1970s. Prior to this, computers were not a household item or concern; they were limited to large companies and more well-equipped academic institutions (Ceruzzi, 1996). A distributed, and as yet unorganised, group of individuals working with people experiencing disabilities (PED) quickly recognised both the opportunities and challenges presented by this new consumer item.

These individuals came from a variety of fields and services. They included: individuals working in services for people experiencing disabilities; engineering groups, such as rehabilitation and biomedical engineering that addressed disability; linguists and speech and language pathologists or therapists who worked with people who were non-speaking; and advocacy groups for and with disabilities. They also included individuals innovating and developing computers and networks who had family members or loved ones who were experiencing disabilities.

With the emergence of early personal computers in the late 1970s—such as the Apple II Plus, the Texas Instruments TI-99/4A, the TRS-80 Model 100, and the Commodore 64—people who had been struggling to provide access to reading for individuals who were blind, communication to individuals who could not speak, writing to individuals who could not hold a pen or type, saw the enormous potential of these devices to translate available actions to provide control over communication and translation into modalities that would unlock information. What was needed were interfaces that would enable interaction (Vanderheiden, 1980). The conventions for how to interact with these machines had not yet been established, so the world seemed to be the limit. Experimentation and 'skunkworks hacks' that would be unheard of today due to the complexity and proprietary nature of computing were accomplished. If you wanted to insert alternatives to the keyboard, you unplugged the keyboard from the motherboard of the Apple II Plus or IIe and inserted a Y-connector that then provided keyboard signals (Weyhrich). Text-to-speech that spoke the command line and any text for someone who is blind, speech-to-text for someone who can't type but can speak, Morse-code entry using any two voluntary movements that could activate any switch for someone lacking hand control, primitive eye trackers for someone limited to eye movement, or puff-sip switches could all be easily hooked up to a computer to act as alternative controls and alternative displays (Treviranus and Petty, 2002). Before the graphical user interface emerged, there was a magic moment when individuals who were blind had control of computers virtually on par with anyone else (Rosenberg, 1986).

4.1.1   The emergence of a new field

A full recounting of all the grassroots efforts—the coming together of therapists, engineers, early computer hackers, gamers, linguists, user groups, and parents—would be a daunting task. Books such as *Computer Resources for People with Disabilities* by the Alliance for Technology Access(Hawking, 2004) and *Independence Day* by Peter Green and Alan Brightman(1990) provide a snapshot of the proliferation of 'liberating' technologies that emerged. It was a crazy tapestry

of interactions that sparked many evolving innovations. As an illustration, I'll attempt to incompletely recount just one segment of the pivotal early computer access systems: alternative input systems for people with mobility and speech constraints. One of the first generative innovations was the Adaptive Firmware Card for the Apple II Plus, developed in 1979 by Paul Schwejda in Seattle, Washington, a physicist who drove a taxi and was a Radio Shack enthusiast. He got the idea because he met Judy McDonald, a speech language therapist, over coffee and he was encouraged and promoted by engineering student Gregg Vanderheiden, who founded the TRACE research centre at the University of Wisconsin. He was popularised at a conference called Closing the Gap in Minneapolis, which was founded by Budd and Dolores Hagen, parents of a child with disability (Vanderheiden, 2002). The Adaptive Firmware Card was purchased by Prentke Romich, a growing assistive technology company and evolved into Ke:nx.

Meanwhile in Canada, the National Research Council founded the Rehabilitation Technology Unit, where a group of engineers and a therapist, including myself, created a similar device called the MOD Keyboard, which used a Commodore VIC-20 computer as a smart keyboard for a Commodore 64. This device offered an array of additional alternative ways to control a computer for people who couldn't use the standard keyboard, and later the mouse (Nelson et al., 1983). Shortly after, with the release of the Windows operating system, Prue Fuller, a speech-language therapist, Mick Donegan a Deputy Head of School and their team develop a similar product called SAW (Special Access to Windows), in a spare classroom at Ormerod School in Headington, Oxford (Lysley, 1988). Dr. Donegan used his passionate interest in the needs of children with severe physical and communication disabilities to later re-purpose an eyegaze monitoring system as a gaze communication system for anyone that is limited to gaze control. This coincided with the development of another project I was involved in called WiViK, an on-screen keyboard software program that extended strategies for transforming limited movement to control a computer and thereby everything a computer can control. It was developed at the Ontario Crippled Children's Centre in Toronto in the newly formed Microcomputer Applications Program (MAP) (Nantais et al., 1994), where Shirley McNaughton, an elementary teacher, repurposed a universal symbol language called Blissymbolics as a communication system for children who were non-speaking (Kates and McNaughton, 1975). MAP collaborated with Randy Marsden, an enterprising, young engineering student in Alberta, who founded Madenta to market a product he developed for his friend who was paralyzed. Randy later developed Swype,

a texting strategy that is available on many smart phones today but that began as an alternative computer access strategy for friends who had dexterity constraints (Cook and Polgar, 2015).

This ferment of early effort, of compelling challenges colliding and merging with new opportunities, is where many innovations, that we now take for granted, emerged. These include text-to-speech, speech-to-text, keyboard disambiguation, word prediction and completion, and augmented reality (Jacobs, 1999). People at the margins and their communities, families, and friends sparked a wealth of innovations. This replicated and amplified a pattern established earlier in the field of computing. Vint Cerf, rightfully credited with founding the internet, communicated with his wife, who was deaf, through his computer, thereby inventing email (Cerf, 1999). Ray Kurzweil created the first Optical Character Recognition program as a reading device for people who are blind (Massof, 2003).

A similar symphony of innovation was sparked by the blind community. Jim Thatcher created the first screen reader for fellow staff at IBM in 1986 (Adams et al., 1989). Around the same time, George Kerscher, a computer scientist who was blind, founded the Computerized Books for the Blind and Print Disabled which later became Recording for the Blind and Dyslexic. George helped to establish the International Committee for Accessible Document Design (ICADD), which focused on SGML and XML and influenced later forms of HTML. This early effort led to the DAISY Consortium, which led to EPUB, the international talking books format (Nazemi, 2015).

Another contributing thread was educational software, for anyone struggling with education. Hypermedia released the creative potential of teachers, educators, and enthusiasts to create interactive stacks of educational material. Once this was combined with the emerging alternative access systems, the combination allowed unprecedented access to education for students with disabilities (Cannings, 1993). Here one of the hotspots was Boston, with the user group the Boston Computer Society and the Boston Center for Independent Living. Boston was home to both the Tufts Centre (Buxton et al., 1986) and the Center for Applied Special Technologies or CAST, launched by David Rose and Ann Meyers, the founders of Universal Design for Learning. This was also where Fred Fay grew many of the policies that led to the Accessibility for Americans with Disabilities Act and associated legislation, such as the Rehab 508 Act (Pelka, 2001).

4.1.2   The inclusive Web

I have argued that one of the best examples of inclusive design was the early Web, before proprietary and competitive influences closed off more open inclusion. Tim Berners Lee developed the markup language of the Web, HTML, from SGML, adding the linking modelled by Hypermedia and HyperCard (Hughes, 1994). Many of the people, who were mobilised by the potential response of technologies to the challenges facing people experiencing disabilities, participated in the development of the World Wide Web Consortium. This involvement was formalised in 1997 with the founding of the Web Accessibility Initiative (WAI), which had been planned and incubated by a team of individuals led by Mike Paciello (out of our centre in Toronto) with the support of the Yuri Rubinski Foundation (Paciello, 2000). Yuri was the CEO of SoftQuad and was a tireless supporter of equal access, influenced by George Kerscher and others. He died early, without seeing the fruition of his efforts, but nonetheless he catalysed a powerful set of connections that led to the launch of the WAI (Dardailler, 2006).

My theory is that the Web was able to flourish in large part because of the design choices influenced by individuals mindful of users at the margins. This led to the aspects of W3C specifications that enabled flexibility and greater interoperability. Tim Berners Lee and other Web pioneers agree (Berners-Lee, n.d.).

4.1.3   Human Rights Legislation

The influence of accessibility on emerging technology was catalysed by the swelling human rights movement leading to the Accessibility for Americans with Disabilities Act, released in 1990, which sparked similar legislation in other countries and jurisdictions and led to the United Nations Convention on the Rights of Persons with Disabilities adopted in 2006. The WAI guidelines acted as trusted points of consensus that could be referenced in regulations that followed the ADA (Larson, 2014).

4.1.4   The role of open

Digital inclusion was also supported by the open movements, including the open source movement and the later open access and open courseware movements expressed in the Creative Commons licences (Geith and Vignare, 2008). Openness addressed both economic barriers and barriers to interoperability, extensibility, and variation needed to include human diversity.

4.1.5   Gaps in documentation

Some of the most pivotal work within the field did not find its way into academic publications. There is a woeful memory gap in published and digital memory during the early years of the field. The digital traces are locked away in floppy disks that are no longer readable or in lists, bulletin boards, and forums that are no longer maintained. There was a general opinion that the field was moving too fast to capture in articles, and books were far too slow a medium. It was only when participants were able to catch their breath that articles and books documenting the progress could be written. Also, the many pioneering efforts did not coalesce into an academic field until much later; they existed at the periphery of many other scholarly and professional domains. The catalysts for the maturation of the field can be in large part attributed to a number of conferences that brought together the many people concerned with the challenge. As digital systems and networks became inextricably woven into more areas of our society and daily lives, the topic gained notice in all human services including education, employment, government, culture, and commerce.

4.1.6   The role of conferences

Among the early conferences were what is referred to as the 'CSUN conference' or the Technology and People with Disabilities conference hosted by the California State University at Northridge, now rebranded as the CSUN Assistive Technology Conference (CSUN, 2018). It has become one of the largest conferences and trade shows on the topic of technology and people experiencing disabilities. The 33rd annual conference took place in San Diego in March 2018. The most well-organised and well-resourced advocacy groups are the groups of and for the blind. This is evident in the attendance and topics covered at CSUN. CSUN published annual proceedings and subsequently launched the *Journal on Technology and Persons with Disabilities* in 2013 (CSUN).

The RESNA conference was originally called the Rehabilitation Engineering Society of North America conference, but has since generalised beyond rehabilitation engineering (2018). It publishes the *Assistive Technology* journal, with a focus on technology for people experiencing disabilities. Allied to RESNA are both the Assistive Technology Industry Association (Rehabilitation Engineering and Assistive Technology Society of North America) and the Global Initiative for Inclusive ICTs (G3ICT), which was launched by the UN to support the implementation of the CRPD with respect to access to information and communication

technologies. The G3ICT publishes white papers and research that promotes digital inclusion globally. G3ICT also hosts an annual conference called M-Enabling together with the Federal Communications Commission in the US that enacted the 21st Century Communications and Video Accessibility Act (CVAA) (Rehabilitation Engineering and Assistive Technology Society of North America). In Europe, the International Conference on Computers Helping People with Special Needs (ICCHP) is hosting its 16th conference this year with an associated journal (Zagler et al., 1994).

The early energy and heady creative freedom of the 1980s and early 1990s met with commercial interests, proprietary code, walled social media gardens, and closed application interfaces. Many of the alternatives for people experiencing disabilities, especially individuals with edge requirements, have not survived (Blanck, 2014). What was a small, fairly well-connected community has become more fragmented. Strands such as augmentative and alternative communication—represented by the International Society for Augmentative and Alternative Communication, which energised many of the early innovations—are no longer as influential or well-connected (Zangari et al., 1994).

4.2   Design and Digital Inclusion for People Experiencing Disabilities

At the same time that the challenge of accessibility met digital technologies and networks, it also met design. As mentioned above, the area of accessible design for digital inclusion emerged in response to the failure of mainstream design to address the needs of people experiencing disabilities. In the computing field, design itself was 'late to the table.' Early software was conceived and developed by programmers and engineers and released without much thought given to usability or design (Capra et al., 2008). Humans were expected to adapt to and learn how to interface with the computer. It was only with a push for broader consumer adoption that designers were invited to assist. Even then design was referred to as 'lipstick,' an inconsequential outer veneer to make the functionality of the software look good (Cooper et al., 2007). In the open source software movement, this relationship was reinforced by the methods of assessing contributions within the meritocracy. A member's worth and rank was assessed by the lines of code contributed and accepted. Designers generally don't contribute code.

4.2.1 Human Computer Interaction and User-centred Design

With the push for greater consumer adoption emerged a number of design methods that addressed the interaction between people and computers. These were informed by the field of human computer interaction (HCI), which remains an often less-respected subfield of computer science. Some of the earliest work that explores both the need to and potential of considering the human interface was *Readings in Human-Computer Interaction: A Multidisciplinary Approach* edited by Ronald M. Baecker and William A.S. Buxton (1987). User-centred design gained recognition with the realisation that software and interfaces needed to work for end users, namely humans. The users in this approach were generally represented by persona of the typical or average intended client of the software, followed by focus groups to select or evaluate a winning design. As the importance of design gained greater recognition in the commercial software and hardware domain, the field of interaction design emerged. This was later revised or expanded to user experience design, acknowledging that the larger user experience required design consideration (Garrett, 2010).

4.2.2 Participatory Design and Co-design

A side branch of these fields, that gave the intended users of the product greater agency and determination, was participatory design (also called participative design). Participatory design invites the participation of the end users into the design process. Participatory design emerged separately in Scandinavia as a means of engaging factory workers in identifying and addressing corporate inefficiencies, and in North America as a form of community engagement. Participatory design as it is applied in software design has been critiqued because participants are often viewed as research subjects, observed by the design researchers to study the efficacy of a design choice, but not as equal participants. The related practice of co-design is seen to offer these end users a more equitable role (Sanders and Stappers, 2008). Empathic design is another variant that strives to understand the needs and constraints of the user to direct design choices (Leonard and Rayport, 1997).

4.2.3 Design Thinking

This democratisation of design was woven into the emerging field referred to as Design Thinking. There is little agreement on the history of Design Thinking other than the publishing of two works. The first is Peter Rowe's *Design Thinking* (1987), which addresses designing in architecture and urban planning, characterising design thinking as procedures for solving

problems. He explores manifestations of an underlying structure of inquiry common to all designing. However, the formalisation and making of the field is attributed to Richard Buchanan's *Wicked Problems in Design Thinking* (1992). Richard Buchanan's introduction opens with discussion of the elusive nature of the foundations of Design and Design Thinking. The formalising of the practice of Design Thinking is attributed to the Stanford School of Design's d.school and IDEO (Brown and Katz, 2009). This extends the practice of design beyond products, services, and environments to the application of design thinking to all problems.

4.3   Beyond Universal Design

With respect to accessibility, prior to the emergence of personal computers, the field of barrier-free access to the built environment had significantly matured. Early work included Selwyn Goldsmith's book, *Designing for the Disabled* (1963). Goldsmith created the curb-cut which is seen as a model of the ideal 'universal design' and which is also a good illustration of the intended impact of Inclusive Design, in that it was designed for people experiencing disabilities, but benefits everyone.

The architect Ron Mace first coined the term 'Universal Design' and founded a Centre for Universal Design in 1989 (Mace, 1997). In 1997, one year before his death, he led a group that developed *The Principles of Universal Design ©*.

The principles are:

1. Equitable use,

2. Flexibility in use,

3. Simple and intuitive,

4. Perceptible information,

5. Tolerance for error,

6. Low physical effort,

7. Size and space for approach and use.

The domain of Universal Design has been embraced by many industries and was intended to make a step towards inclusion of anyone excluded in the larger design process. Many academic departments and government policy groups have also embraced Universal Design over the years, and there is no doubt that Universal Design made a fundamental step and hugely

beneficial step toward inclusion, especially in architecture and industrial design of physical objects and structures.

I have frequently been asked why we didn't call what we did at the Inclusive Design Research Centre 'Universal Design.' This was a challenge that was put to us by faculty at OCAD University when we moved our centre to OCAD U. I created a post for our website to explain the rationale:

4.3.1   Why not use the term Universal Design?

Inclusive Design, as we use it, can be seen as Universal Design with a number of provisos.

When we chose the term, we wanted to distinguish it from the then current associations with the term Universal Design. The associations that we want to avoid are not necessarily part of any formalised definition of Universal Design, but nevertheless are part of the popular assumptions about the term.

The distinctions we wanted to make were:

The Context: Universal design has its origins in architectural and industrial design - we work in the digital realm where the constraints, design options and design methods are very different. The most important difference is that we do not need to design one-size-fits-all, the flexibility of the digital gives us the luxury and freedom to take a one-size-fits-one personalised design approach to inclusion.

The User: Universal design, despite the fact that it has the term universal in it, and counter to the intentions of the originators of the term, has become associated with disabilities and a fairly constrained categorisation of disabilities. Other than the commonly quoted principles of Universal Design, much universal design guidance categorises design advice according to constrained categories of disability. We want to stress that the individual is multi-faceted and the constraints or design needs they have may arise from a number of factors or characteristics, and they all need to be taken into account (e.g., I may be blind, but I don't read Braille, I have some residual vision so the pictures help me navigate, also French is my second language and I'm currently juggling my kids and my job and haven't slept all night so I'm stressed and a little bit distracted).

The Method: While the common goal is inclusion; because we are dealing with digital design, our design considerations are very different from the non-digital, we can have a differently configured 'entrance' for each person, in fact we can have multiple entrances for one person, each for a different context. Similarly, we can have a different 'handle' for each person and each context or each goal. The design constraints are very different from the domain in which Universal Design originated. While Universal Design is about creating a common design that works for everyone, we have the freedom to create a design system that can adapt, morph, or stretch to address each design need presented by each individual.

The common notions with Universal Design that we espouse and stress are:

1. Designing systems so they work for people experiencing disabilities results in systems that work better for everyone.
2. Segregated, specialised design is not sustainable and does not serve the individual or society in the long run. You may ask are we not taking specialisation to the extreme? Yes, in one sense we are, but it is common specialization that comes as an integrated part of the system – whether you have a disability or do not have a disability.

4.4 The Emergence of Inclusive Design

Surprisingly, given the sense of global connection within the domain, two fundamentally different versions of Inclusive Design emerged virtually simultaneously. The UK version of Inclusive Design emerged from the engineering, industrial design and business groups active at the Engineering Design Centre, University of Cambridge; these groups were led by Clarkson, Coleman, Hosking, Waller and colleagues (2007).

The UK version emerged to address product design. The original focus was physical products. It was developed as a business compromise to engage with some of the aims of Universal Design whilst still focussing on commercial solutions; it positioned itself as a kind of response to the perceived unrealistic aspirations of Universal Design. The Inclusive Design Toolkit site of the University of Cambridge explains the distinction between Universal Design and (the UK version) of Inclusive Design as follows: "In contrast, inclusive design originated with product design, and focuses on choosing an appropriate target market for a particular design and making informed decisions to maximise the 'Product performance indicators' for that target market. While inclusive design intends to extend the reach of mainstream products, it acknowledges the commercial constraints associated with satisfying the needs of the target market." (Cambridge University, 2018).

The Canadian version of Inclusive Design, by contrast, was co-designed and co-developed by a community tackling computer access and digital inclusion rather than industrial or architectural design. The Canadian version emerged from the global community of practice focusing on personal computers, digital documents, software applications, interfaces, Web systems and all things computer-mediated and networked. Rather than prioritising the business challenges associated with Universal Design, we were pursuing the potential opportunities for a more flexible design afforded by digital systems and networks, and the opportunity to personalise design for everyone. We emerged with a different starting point and ethos.

The application and transfer of the UK Inclusive Design principles to digital systems, networks, software and services came later in the UK, and was adopted and influenced by other groups from the UK, including researchers in Computer Science at the University of Dundee and the Helen Hamlyn Centre for Design at the Royal College of Art in London (Buckley, 2014), which was co-founded by Roger Coleman and Jeremy Myerson.

The extensive work and publications by the Cambridge, UK group focused primarily on supporting businesses and building out realistically achievable business processes for designing inclusive products.

The Canadian version of Inclusive Design (Inclusive Design Research Centre) and the sister group in Ireland who took up the work of the IDRC and began to apply the ethos and methods to practical case studies in Ireland and across Europe and the EMEA region (SMARTlab with the Inclusive Learning Project Team (Europe): Goodman et al., 2014) share the same definitions, mission, ethos and aims and have applied the 'Treviranus' definition and model of Inclusive Design to their five years of research into the domains of ability and assistive technology for the Marie Curie Programme of the European Commission. Dr Anna Kelly's PhD focused on the framing and instantiation of this new working model of Inclusive Design in the Irish academic landscape[1] overall: (Kelly, 2017). The UK version emerging from Cambridge, and the Canadian version shared with Ireland, are highly complementary and well aligned, however there are a number of divergent facets.

These divergent areas can be in large part explained by our respective fields of origin. With respect to process, while the UK group employs the waterfall process and integrates consideration for users with disabilities, we stress an agile, iterative, and open process. We have found that the more opportunities there are to test and refine a design as it is being developed, the more likely it will be inclusive. This divergence makes sense given the origin and grounding of each group. The UK group emerged from the fields of industrial product design, engineering, and business, while we emerged from early computer science, the Web, and open software processes. Agile, iterative processes are employed by open source communities and have been adopted by most software companies. Proprietary industrial product design continues to employ waterfall processes, which culminate in a launch or big reveal. Another divergence can be found

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[1] SMARTlab, the global social enterprise supporting Technology Innovation for Real Social Change (founded by Lizbeth Goodman with Huw Williams et al at the BBC in 1991) became deeply engaged with the IDRC of Canada in 2008 from London; and worked towards creation of an Irish-based European sister lab, which was founded and ratified by the Academic Council of University College Dublin in 2013). This PhD has been undertaken in the IDRC of Ireland in collaboration with the SMARTlab, with use case studies conducted mainly on the ground in the IDRC of Canada and at other global partner sites.

in the approach to product goals, the UK process outlined by Clarkson and colleagues in their popular and well-designed *Inclusive Design Toolkit* supports the explicit articulation of compromises, such as that "the product should be usable by 95% of adults aged 16–70." We iteratively stress including as many people as possible and beginning with edge users. While the UK inclusive design process funnels and reduces design ideas, our process has the opposite outcomes in which the design is iteratively stretched to encompass a greater number of user needs. Even visually, our virtuous tornado, non-linear logic model cycles out while the Cambridge model cycles in.

The UK version represents people experiencing disabilities or edge users primarily through persona and user observation, while we employ persona as a compromise and encourage the integration of edge users as co-designers. Cambridge recognises co-design as a difficult and possibly unaffordable technique. The Cambridge process culminates in a solution, while we focus on an ongoing process, with many iterations, that support refinement and greater inclusion, recognising the quickly shifting digital domain. This also makes sense given the grounding of the two approaches. It is far easier and necessary to update software regularly and far harder to update industrial designs. Cambridge addresses the diversity of needs through a 'portfolio of products.' As we emerged in the digital space, where interoperability is critical, we stressed that separate products for persons with disabilities results in interoperability risks and discourage addressing accessibility in a segregated way. Part of the Cambridge strategy is to identify homogeneous market segments. We stress the negative impact of categorisation on individuals that fall through the cracks and are stranded at the edges. We also stress that people at the margins are extremely diverse and cannot be corralled into homogeneous groups. While the Cambridge group covers capability simulators extensively in their evaluation phase of the design process, we both stress that these tools are no replacement for engaging edge users directly. The Cambridge capability and exclusion audits and application of a disability survey focus on the number of customers excluded and the selection of features based on these figures. This prioritises functions that benefit the largest customer base. We have found that this approach leads to greater brittleness in software, as greater reach is requested by customers or demanded by a moving market.

We diverge philosophically in these approaches to market coverage promoted by the Cambridge design framework. The Cambridge toolkit implies that design choices should be

based on the incidence of disability and a compromise that addresses the needs of the largest proportion of the potential customer base using demographic data regarding incidence of disability categories. I find this to be problematic for several reasons. My first critique is in the survey data used to determine the incidence of specific disability categories. As anyone that has attempted to measure disability will attest to, counting disability is a difficult and highly inaccurate process (Mont, 2007). Many people do not wish to identify as having a disability or recognise that they have a disability. People experiencing disabilities are often unable to participate in surveys, and their family members may be hesitant to include them. Many disabilities are invisible, episodic, or situational (caused by the environment or the task, such as poor lighting, busy hands, or noise). None of these issues with the survey data are taken into account in the Cambridge toolkit. The most revealing flaw can be seen in the very low incidence of cognitive disabilities. It is generally recognised that cognitive disabilities are the most prevalent; however, very few people identify as having cognitive disabilities because of the associated stigma and difficulties in classifying and measuring cognitive disabilities.

I also argue that basing Inclusive Design coverage choices on the proportion of customers perpetuates the fundamental flaw in design that Inclusive Design aims to address. It simply pushes the problem further out, creating even greater barriers for people that remain excluded. Not only does it ignore the degree of exclusion and the impact of that exclusion, but from a business perspective it significantly reduces all the benefits of Inclusive Design. There is less impetus for innovation, there is less room to accommodate changes in the context, there remain a significant group of customers who will advocate for modifications. This philosophical divergence can also be partly attributed to the origin domains. Networked digital systems have far greater affordances for adaptation, extensibility, and flexibility than industrial design, making it easier to obviate hard choices regarding coverage[2].

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[2] It is interesting to note that the digital traces of the UK model are very prominent, while we have been characterized as "the best kept secret" by Ron Baecker at the launch of the Knowledge Media Design Institute. Kat Holmes of Microsoft explains the low profile as a side effect of our academic application of Inclusive Design. It may also be due to the lack of the actual words *Inclusive Design* in the titles of papers we have published over the years.

4.5   Associated Initiatives

4.5.1   User Sensitive Inclusive Design

Newell and colleagues at the University of Dundee Computer Science department also worked within the domain of Inclusive Design for computer systems (Newell et al., 2011). The team at Dundee have pointed out the difficulties of user-centred design when the end users are people who are older or people who have disabilities. They argue that there is a far greater variety of needs and characteristics, that it is very difficult to find representative users, and that there may be conflicting needs with people with other disabilities or with the general population. They also point out difficulties of consent and inability to communicate for some users. They assert that the aspirations of Universal Design or Design for All set up unrealistic expectations that can lead to designers paying 'lip service to an unachievable goal.' They argue that responses to this unachievable goal are to create an accessible alternative that is not equivalent or interoperable, or to address 'Universal Design' as a last-minute add-on. They have promoted a methodology they call 'User-Sensitive Inclusive Design.' Their choice of Inclusive Design is in line with the UK use of Inclusive Design, as a more achievable compromise of Universal Design that also takes business processes and constraints into account. They have replaced 'Centred' with 'Sensitive' to address the issue that it is rarely possible to produce a product that is accessible to all potential users and that a small representative sample of users with disabilities is also not possible. Sensitive also encompasses a more empathic relationship with the users, rather than treating them as test subjects for usability experiments.

4.5.2   Design-for-All

The Design-for-All philosophy emerged in Europe and was formalised in the European Institute for Design and Disability Stockholm Declaration of 2004 (Bendixen and Benktzon, 2015). Design for All recognises three approaches to providing access to information and communication technology (ICT): ICT that can be accessed by nearly all users without modification, ICT that can be modified to provide access to different needs, and standard technologies that will interoperate with assistive technologies. The Design-for-All philosophy is applied across all areas of Design. It aligns well with our philosophy of Inclusive Design. The Stockholm Declaration states: "The practice of Design for All makes conscious use of the analysis of human needs and aspirations and requires the involvement of end users at every stage in the design process."

4.5.3   Universal Design for Learning

David Rose and Ann Meyers, the founders of CAST in Boston, are known for Universal Design for Learning (UDL). In 2002 they published *Teaching Every Student in the Digital Age: Universal Design for Learning* (Rose and Meyer, 2002). UDL has three core principles: 1) provide multiple means of engagement, 2) provide multiple means of representation, and 3) provide multiple means of action and expression. As user-centred design shifted to put the user at the centre of the design, UDL shifts the learner to the centre of education. We, the IDRC, have collaborated with CAST extensively since the early 1990s. The point of divergence is that our work on education has focused on open education and open education resources, while CAST has worked extensively with educational textbook publishers. Our focus has been on the application of educational technology to enable the personalisation of learning through projects, such as The Inclusive Learning Exchange, Flexible Learning for Open Education, ATutor, and other projects, or the personalised one-size-fits-one delivery of learning experiences through the system. CAST has served learner diversity through curriculum approaches that provide students with diverse curriculum options for a given learning goal. The CAST approach has been likened to the Universal Design of a built environment that anticipates the range of visitor needs in advance. The student needs are anticipated in advance rather than adjusting the curriculum when the student arrives. The two approaches are complementary. Our latest collaboration is on a project called Center on Inclusive Software for Learning (CISL), in which we are focusing on Open Education Resources (CAST, 2018). A related teaching philosophy, Differentiated Learning (Morgan, 2014), is an approach that bases the design of the curriculum on iterative assessments that guide the modification of the instructional material and teaching approach to diverse students.

4.6   Conclusions

The framework I have developed is shaped by this confluence of diverse practices, theories, and experiments in creating a more inclusive society by addressing the challenges and leveraging the opportunities of emerging technologies and their associated social practices. The Canadian version of Inclusive Design (also instantiated in Europe by the sister lab in Ireland) is suited to, and leverages, the affordances of Computer Science, open software development, and user-centred design. While sharing the values and convictions of social justice movements for people

experiencing disabilities, Inclusive Design as we have conceived it argues that it is possible to optimise design for every person, moving from a one-size-fits-all approach to a one-size-fits-one approach enabled by an inclusive system. This is made possible by digital systems that fundamentally change design and development and by global networks that fundamentally change communication and transactions.

5 : The Framework Applied to Education and Learning

In this chapter, I discuss the application of the framework for education. The framework has been used to develop more inclusive models of education in the broader open education movement, in graduate education, and in promoting the notion of deeper learning as envisioned by the William and Flora Hewlett Foundation. The framework has also been applied to developed strategies for welcoming and supporting students with learning differences into integrated settings where learning occurs, such as youth movements. This chapter documents some of these applications.

The application of the framework in education and learning is best exemplified in our FLOE project, which is the culmination of a series of projects that leverage open educational resources to provide one-size-fits-one education within an integrated system. The transformation of education inherent in this approach has been recognised as an approach that is more in line with future-friendly education. I used the invitation to provide a keynote at the Web for All conference in 2016 as part of the 25th anniversary of the World Wide Web conference to communicate how we can apply the Inclusive Design framework in education. The following is the paper prepared for this event.

5.1 Life-Long Learning on the Inclusive Web

INTRODUCTION

Our current formal systems of education are failing to address the learning needs of a large number of students, the designs of our schools are a misfit for their requirements, contexts and goals. This systemic deficit becomes increasingly dangerous as our society moves inextricably into a knowledge economy and sources of income become more and more dependent on education (Hanushek, 2013). We are leaving many students struggling at the margins of our society; this contributes to disparity, which affects the well-being of all community members. There is also a growing consensus that our formal education systems are not designed to address our current transformed realities —let alone the learning demands of future social and economic scenarios.

To address this situation, we must go beyond surface adjustments to our systems of learning. We need to re-examine the foundational structures, deep-rooted assumptions and underlying goals. To truly realise this goal would require at minimum the following transformations:

- Viewing learning as life-long and not a staged set of age-linked grades or degrees;
- Empowering learners to assess and guide their own learning;

- Valuing and recognising a diversity of skills and competencies that is potentially as diverse as the diversity of learners; and
- Supporting collaboration and collective production over competition with others.

Transformation is difficult for the highly complex and frequently entrenched 'system of systems' that is our collective academy. It is a system that has many established structures designed to resist change and very few mechanisms for renewal, adaptation and responsive reorganisation. However, stasis is not an option and the demand and pressure for change is mounting (Kamenetz, 2009).

The movement for accessible and inclusive education for persons with disabilities is juxtaposed on this complex adaptive education system in a heightened state of struggle and resistance(Pijl et al., 1997). Though the proposed transformation of education is in alignment with the aspirations and ultimate goals of inclusive education, the current strategies for achieving accessibility appear to be more closely aligned with an older paradigm, older tools and a static endpoint. As a social justice movement, accessibility efforts may be pushing to a destination that will be vacated when we finally arrive. To leverage and proactively help guide the educational transformation, the accessibility movement must be open to a number of alternative paradigms and approaches. These include:

- Accessibility strategies that recognise that accessibility is relative (to the individual requirements, goal and context), not absolute.
- Guidelines and regulations that are responsive and evolving, not static.
- Systems of evaluation that are decentralised and vest authority and judgment at the level of the individual with a disability.
- Measures of accessibility at the level of the system not the instance, or the ultimate outcome, not each step used to get there.

CHANGE RESISTANT, CONFORMANT & ELITE

Our institutions of learning grew up as strongholds against parochialism and superstition (Cole, 1950). They are built to resist the transitory political forces of the day. They have evolved to uphold the principles of science. In the process they have bestowed sanctity to armaments such as statistical power and quantitative evidence, to guard against the whims of popular ideologies and vigilantly arbitrate our understanding of truth. Institutions of higher learning create protected and self-perpetuating silos of expertise, or disciplines, with challenging and strongly fortified gates. Our peer-review processes uphold accepted values and proven knowledge and defend these from upstarts and peerless notions (Weller, 2001).

In times of scarcity, our institutions of learning added mechanisms to sort the 'deserving' from the 'undeserving.' Our halls of learning are home to practices that bolster elitism, competition and exclusion. We sort and filter students well before they are formed (Shavit and Müller, 2000). We create tests and instruments of judgment that are deterministic, ignoring lessons regarding self-fulfilling prophesy —students tend to perform according to their predicted capacity, irrespective of actual potential (Brophy, 1983).

Whenever there is pressure to educate at scale or educate the masses, we change our pedagogical approaches to take advantage of economies of scale, resorting to passive, didactic, mass education (e.g., PSYCH 101 lectures for more than 1000 students). This is bolstered by structures of standardisation, motivated to control and sustain quality, but also to support equality across schools and districts. This standardisation requires and is sustained by increasingly centralised authorities of education. Take for example the US Common Core (Motoko, 2015), the Bologna accord, PISA (Programme for International Assessment of Students), PIACC (Programme for the International Assessment of Adult Competencies) (Willms, 2004) or national, state-wide or province-wide standards of education. Each was intended to indicate a baseline for schools, provide a comparative measure of quality, and a way to monitor progress. The unintended consequence has been that schools teach to the test and constrain learning. Each unintentionally confiscates self-determination from our teachers and students (Bushweller, 1997).

Of course, economic agendas have influenced our educational structures (Barlow, 1967). During industrial times and again during the rise of white-collar professions we created structures that promote conformance and means of ensuring that we graduate interchangeable and consistent workers. To compete internationally we privilege hard sciences at the expense of art and the humanities. We favour formula over play, sequential competencies over discovery or unbounded creativity.

It is still evident that the foundations of our schools were laid in a time when knowledge was scarce, knowledge storage and access was constrained, only select members could arbitrate and bequeath knowledge, authority structures were centralised to guard the castle, and only the elite few could compete to climb the ladder to higher knowledge (Hiltz and Turoff, 2005). These deep foundations are antithetical to inclusive learning and ill prepared for the changed reality we find ourselves in. A reality where: knowledge is there for the taking, we are connected to a bounty of experts, there are no constraints on stored information, we have tools that can help us self-monitor and self-regulate our progress, everyone must climb the ladder to participate productively in our society, collaboration is essential to deal with the complexity of our connected world, and we require diversity and creativity, not conformity (Kim and Mauborgne, 1999).

Given the armaments against change and deviation in academe, what is the likelihood of the innovative leaps needed to escape our current trajectory? Change theorists point out that the best opportunities for change are during periods of disruption or crisis (Hay, 1999). The emergence of the World Wide Web and associated practices have wrought this disruption more surely than any other socio-technical change since the printing press (Tapscott and Williams, 2008). Our education systems are compelled to change from within, or they will be changed from without, or replaced (Kamenetz, 2009).

EDUCATIONAL *MISMATCH*

At the same time as our schools are alarmingly ill prepared for future trends, they also remain a terrible mismatch for students with disabilities (Fulcher, 2015). Addressing the second deficit may help to address the first deficit.

It has been 22 years since 95 nations affirmed that all persons deserve equal access to education and that this education should not be segregated or second class (Salamanca Statement) (Ainscow and Cesar, 2006). It can be resoundingly conceded that we have failed to achieve our goal. To add to this, in a time when education is essential, more and more students disengage from formal education. In countries that offer special services to qualified students with disabilities, many students are among the 'doubly-marginalised.' They do not qualify for special education, but standard education is also a misfit (Battin-Pearson et al., 2000). Not only do students with learning differences face a mismatch, but teachers or professors that support inclusive teaching and assessment methods, and institutions that support inclusive policies, also face a mismatch within their nested context (Rolf and Ulrich, 2001). The tenets of inclusive education are in direct opposition to deep-seated structures of education, especially within higher institutions of learning. We did not take into account the entrenched defences against difference when we set our targets for inclusion.

FROM ABSOLUTE TO RELATIVE

As an accessibility community, how do we leverage and help guide the inevitable transformation of education? In the context of the quickly changing complex adaptive system that is our current society, we need to focus not on righting the inequities of the past (or perhaps even of the fleeting present) but in collectively working toward realising the inclusive possibilities of the future. We would be more effective if we shifted our focus from the transient instances of inaccessibility and worked toward a more inclusive system.

People with disabilities are more diverse than any other group. The only commonality and centrally defining characteristic of disability is difference (Barton, 1994). People experiencing disabilities also have far fewer degrees of freedom to adapt to designs that do not fit. Paradoxically we have created systems of accessibility whose implicit assumption is uniformity and homogeneity by attempting to achieve accessibility through one-size-fits-all accessibility requirements. We further constrain our accessibility approaches by striving to create accessibility regulations, guidelines and laws that are simple —static (or 'consistent') accessibility checklists with absolute and testable criteria (Thatcher et al., 2002). This is understandable. Accessibility is a precarious value (Treviranus, 2014a). When any excuse can and will be used not to comply; simple, static, absolute rules are seen to be more effective. As an accessibility community, when we are threatened we act like any other group under threat: we resort to rigidity, armour ourselves, appeal to higher authority, use the force of law, resist change and argue in absolutes. This may allay the immediate threat. But this approach sacrifices the far greater long-term possibilities, and compromises the flexibility needed to address difference.

In the learning context this approach results in maddening scenarios. I recently watched a student use an onscreen scanning keyboard and single switch to go through more than twenty complex steps to simply select a submit button in a mandatory math test. The mechanics of the test took far more physical and cognitive energy than what was being tested, but the school was proud that the test was 'accessible' and 'WCAG 2.0 compliant.' I witnessed another teacher remove all images and interactive elements from curriculum

because it was not 'accessibility compliant,' despite the fact that it was known that several students in the class learned best using images and kinaesthetic manipulation.

Given that accessibility can be characterised as designing for diversity, and that we have transformable and connected digital systems to work with, can we not move from an absolute to a relative framing, from one-size-fits-all to one-size-fits-one? To encourage an understanding of the responsibilities and potential impact of design, the Inclusive Design Research Centre frames disability as 'a mismatch between the needs of the individual and the environment, product or service' and not a personal trait (Treviranus, 2014a). People are different, we have outfitted our environment and products to fit some of those differences (e.g., clothing for humans whose lack of fur causes a mismatch with cold climates, or glasses for people with different eye shapes), we can extend this same adaptive fitting to encompass the full range of human diversity and thereby spur greater innovation and better tap human potential. Someone who is blind is not disabled when power is lost, the lights go out, and she needs to leave the house; someone who is dependent on sight is disabled in that context, with that goal. Accessibility is framed as the ability of the environment, service or product to match the needs of the individual, in a given context, for a given goal. Both disability and accessibility are seen as relative.

This implies that we need to relinquish the binary classification of disabled and non-disabled and view ability as a jagged spectrum. It creates difficulties for scarce special services that are managed by qualifying recipients, such as accessible parking spots and special education (Meekosha and Shuttleworth, 2009). However, does the current socio-technical transformation provide affordances that can extend special services to the full range of human diversity? We may also object to this deconstruction in defence of emerging disability culture. I would argue that it is not antithetical to a powerful disability culture movement. Culture movements and safe spaces to develop a shared identity remain vibrant when membership criteria are less absolute (Riddell and Watson, 2014). It is the common interests and concerns, the affinities that provide strength, more than the criteria for exclusion.

Pragmatically (when given the freedom to reflect away from politicised debates), we 'know' that optimal accessibility is relative. We can't determine whether something is really accessible unless we know the unique needs of the individual, their current goal and their current context. Anything else is a compromise. However, when we have a disability we often become highly skilled at compromising and making do. We fear risking any precious gains we have made. That risk only seems worthwhile when we have nothing more to lose or when we feel highly secure; and disability comes with vicious cycles of insecurity (Yeo, 2001).

Broader Focus

Equality is also frequently simplified or reduced to sameness. Our absolute approaches to equity and accessibility are likely rooted in notions of fairness and prudent judgments regarding compliance (Rutter et al., 2006). We can claim that anything else is unrealistic, idealistic, abstract and theoretical. It is easier to determine that something is equal at the level of mechanism than at the fuzzy, 'subjective' human level. However, it is at the human level that it matters. I could not care less that I can access the same print button you do as

long as I can access the function of printing as quickly and efficiently as you do. I could not care less that I go through the same steps to learn division as you do, as long as I know how to divide when that skill is required. In the fields of equity we use the notion of lenses: 'the disability lens,' the 'gender lens,' etc. I fear that we have focused our lens too narrowly and specifically. Our measures of equality are on the instance not the system; the Web page, not the function; the interaction not the experience; the sub-sub-goal, not the mission. We need more future-friendly, broader-focused lenses.

As an illustrative example, a municipality was recently struggling to regulate Taxis and the mobile transportation platform Uber. The proposal was to require that all vehicles be wheelchair accessible. However, UberX and Uberpool were services that intermediated ride sharing between ordinary citizens. Uber had also launched a wheelchair accessible vehicle service and a service that assisted riders from door to door (with an associated training program for drivers). A more systemically minded approach to regulation, that was likely to be achievable, was to require that riders needing a wheelchair accessible vehicle or assistance from door to door should experience the same timeliness and the same personal fit, at the same cost, as riders without disabilities. This did not require that all vehicles be wheelchair accessible and it leveraged the aggregated data the platform could provide to monitor and measure compliance. The desired result of equitable transportation services for all accessibility requirements was achievable more quickly and reliably than a staged outfitting of all vehicles (Black, 2016).

Similarly we could demand Web Content Accessibility Guidelines (WCAG) 2.0 AA compliance for every Web page, a uniform accessibility experience for every visitor, assessed at the page level (Caldwell et al., 2008); or we could assess the capacity of the Web site (as a system) to meet the accessibility needs of each individual visitor, meeting the WCAG 2.0 AA criteria at the level of the system, and supporting a personalised experience that recognises the diversity of disability and making it possible for Web sites to create new ways to provide one-size-fits-one tailored experiences (e.g., AccessForAll portable personal preferences) (Nevile and Treviranus, 2006).

I argue that at the same time as we focus more systemically, we can divest authority and judgment to the individual and use more bottom-up approaches to accessibility by employing emerging tools (Treviranus, 2014a). This allows a diversification of requirements and relinquishes the need to know and predict all current and future requirements. As an illustrative example, a regional authority recently planned the launch of an accessibility certification program for businesses in the region. The original proposal was the formation of a central authority with a centrally determined set of criteria. This quickly led to heated debates about what the certificates should reward, what accessibility requirements and what forms of disability should receive priority, what types of accessibility measures were most achievable and how should they be measured? Most contentiously: who will have the authority to judge? An alternative approach is to create a bottom-up adaptive system modelled on services like TripAdvisor or Google Places. The platform would support customers in reviewing businesses based on the business's ability to meet the customer's personal accessibility requirements. The benefit of this is: customers with disabilities don't need to fit their needs into pre-defined categories; the categories arise out of the aggregate reviews. Businesses are not constrained from using

innovative and personalised approaches to addressing the needs of customers with disabilities. Also, accessibility is reviewed and verified by the actual customer with a disability, not by the business or by an authority that is disconnected from the experience of customers with disabilities. The certification would be dependent on a threshold of positive customer reviews. Emerging best practices can be highlighted and celebrated as models. The proposed platform could allow customers with disabilities to search the certified businesses using their individual specific requirements. The model encourages continuous improvement by businesses to maintain or improve their certification level or ranking (not just during a formal centralised audit event but with every customer that comes into the business).

Of course, these more systemic and bottom-up approaches do not obviate the need for legal baselines supported by the force of law. We need both the carrot and the stick to drive change. Regulations and meaningful penalties are needed to motivate organisations that do not have the enlightened self-interest to understand the benefits of inclusive design. But while we are maintaining the rear guard we should also help motivate and steer the explorers and innovators. Concern for the laggards should not imply that we sacrifice new and promising possibilities.

STRATEGIC INTERVENTIONS IN COMPLEX ADAPTIVE SYSTEMS

Our education systems can be characterised as complex adaptive systems within the larger complex adaptive system of our society (Dombkins, 2013). Inclusive education is a highly complex challenge; the failure of education to serve all students is a wicked problem ("a problem that is difficult or impossible to solve because of incomplete, contradictory, and changing requirements that are often difficult to recognise") (Rittel and Webber, 1974). As complexity theorists point out, we have always existed in a complex adaptive system of systems (Sánchez López et al., 2012). Only recently have we instrumented a digital mesh that allows us to see it more holistically (the internet, the Web, mobile systems, the Internet of Things). That digital mesh has also become a huge and disruptive factor in the rapidly evolving complex global system of systems. Like the person who is blind who has undergone surgery to gain sight, we need to learn to use this new sense and integrate it into our way of being. The question posed in many domains is whether we can learn to use this new sense wisely before the many rapidly moving global crises that threaten humanity overtake us. Can we, as a society, move from data, to information, to knowledge, to wisdom in time? Can we progress through skills, to competencies, to the expertise needed to avoid disaster? Or as some suggest, have we gained sight only to find ourselves in the driver's seat of a vehicle about to crash (Rifkin, 2009)? Is it possible that the learned resourcefulness and insight gained through lived experience of disability can help in this challenge? By addressing inclusion can we recruit the diverse human capacity to address other global challenges? Microsoft has recently bet that inclusive design can guide the needed transformation of the large, complex Microsoft enterprise (Kuang, 2016). Can we make the same bet with our larger, complex systems of education?

Wicked problems are impervious to traditional means of research, established forms of project management, and currently prescribed modes of planning (Jackson, 2006). Effects cannot be isolated —they are complexly entangled. Outcomes cannot be engineered, they

are unpredictable and influenced by unexpected factors. Policy analysts argue that complex problems cannot be solved through simple solutions or you engender 'cobra effects' —the unintended effects of over-simplistic or reductionist characterisation of issues (Goodsell and and others, 1992). There is general agreement that the only approach is to gather the broadest diversity of perspectives, choose a spectrum of small, full-cycle interventions, monitor what happens, and be prepared to adjust and pursue successful directions. This process works better if you fail early and often and learn from mistakes. Bottom-up, open processes are more successful; the bureaucratic skeletons many of our large institutions have constructed hamper the speed and agility required.

Collaborate with Others, Compete with Yourself

There is general consensus among complexity theorists that collaboration is essential to solve complex problems (Dombkins, 2013). Our systems of education focus on individual excellence, we do not reward or teach collaborative excellence. Obvious forms of collaboration are called cheating and strictly punished. We ask each student to redundantly repeat the same steps taken by the previous cohort, rather than starting from where predecessors have left off. Our structures of intellectual property discourage sharing and remixing knowledge and innovations. We rarely recognise the pooling of complementary skills to achieve academic milestones (Goodsell and and others, 1992). This structure also fails to take advantage of the diversity of skills learners represent and the powerful potential of orchestrated collective effort. Can we use ever more sophisticated data capture tools to better support attribution, so we can set knowledge free for collaborative use without losing credit?

A key to our global systemic health may lie in the critical balance between supporting diversification while maintaining social cohesion and inclusion. Several programs are beginning to experiment with this dynamic balance. The Inclusive Design graduate program at OCAD University recruits a cohort that is as diverse as possible with respect to disciplinary and experiential background, stage in career, language, culture and ability. The students become co-constructors of an inclusive learning community and an inclusive learning experience. It is this process of creating social cohesion and collaborative problem solving that it is the most powerful learning tool in mastering inclusive design and generating individually unique and impactful innovation. In another effort, Christine's Ortiz, the Dean of Graduate Education at MIT, recently announced that she is establishing a University without majors, lectures, classrooms, disciplines or degrees (Navarre, 2016). Students design their unique curriculum online to complete a collaborative project with mentorship from faculty and peers. The goal is to harness collective intelligence to address global challenges such as health, water and climate.

Individually Unique Life-long Journey

In his book *The End of Average* Todd Rose marshals evidence that our assumptions about the sequential stages of cognitive development, upon which we have developed our grade structure, do not hold true; neither do the developmental milestones associated with 'normal' development. Routes to excellence are highly variable in path and pace. Competencies and skills do not need to be constructed through a fixed set of building blocks, one piled upon the other (Rose, 2015). We can achieve expertise backwards and

sideways. More importantly students should not be measured using a mythical yardstick of average.

The world is also changing too quickly to support the assumption that learning is ever complete. In many subjects what we learn one year is no longer the accepted truth the next year. Skills and competencies in all professions require continuous renewal and relearning. New forms of work are superseding longstanding professions. The very nature of work is changing. To avoid obsolescence, we must all continue to learn.

Self-Guided Learners

Just as grades have disadvantaged learners with disabilities, so has ranking and systems of grading. Todd Rose shows persuasive evidence that there are no fixed personal traits or strengths —our traits are highly influenced by context (I may be an introvert at school and an extrovert at home, a perfectionist at sports but careless in English). People cannot be ranked; their skills and strengths are diverse and jagged (good in one thing but poor in another) (Rose, 2015). IQ measures are reductionist and misleading.

The more unique you are as a learner, the more likely education designed for the masses will be a misfit for you, and the less likely anyone will have expertise or competency in optimising your learning potential. Even if you happen upon a dedicated personal tutor or mentor, learning is life-long and this assistance will be transient. The only sustainable approach is to become an expert in your own evolving learning requirements (Treviranus, 2010b).

Can we use emerging learning analytics to support this goal? Yes, with some fundamental modifications. Traditional research, including big data and learning analytics, aspires to draw generalisable conclusions that can be applied to the majority, or a large prescribed group, with predictable results. The veracity of the conclusions depends upon an accurately representative group of 'subjects,' and the accuracy of predictions depends upon statistical power through numbers. By definition these generalisations do not hold true for learners that are outliers. This is in large part due to the fact that there are no representatives that meaningfully reflect the unique interconnected complexity of requirements to be represented, let alone a large enough group of representatives to garner conclusive results. This means that there are large knowledge gaps regarding how learners who are not 'average' learn best or what causes failure. These outlying students frequently outnumber the norm (Treviranus, 2014b).

The only viable alternative is to represent yourself and to iteratively discover and refine your understanding of your own learning requirements with the help of supportive facilitators or tools. Tools can support this discovery by measuring and presenting 'small' data (n=1) and 'thick' data (contextualised or situated, without isolating the conditions) about the factors that optimise learning for a given context or learning goal, allowing you to refine these conditions and monitor the results (Estrin, 2014). Taking from models in sports and gaming, students can hone their learning performance. We can create novel ways of presenting the data that are personalised to student mental models and socio-emotional affinities. Students can become investigative scientists in their own learning: constructing experiments, monitoring progress, garnering metacognition and progressively mastering life-long learning.

However, the structural barriers to this approach are many. Education itself is grounded in paternalism and the belief that students do not know what is best for them. Students who have disabilities or students who are at risk face a strange duality of infantilisation or demonisation. Either there is an added layer of protection or assumed vulnerability, dependence or incapacity; or the students are blamed for failure and distrusted. Any understanding of their 'condition' is usually hidden from them (Munyi, 2012).

Like all discovery, this is an evolving, messy, risky process requiring trial and error, play, mistakes, failure and patience. Learners with disabilities, especially, are protected from failure and using failure and error as a tool for learning is rarely valued. Failure in current education is deterministic and used to predict all future performance (an indelible mark on the tabula rasa), putting students further at risk (Brophy, 1983). Patience is rare in our rushed society where hot-housing often begins at infancy (Blakemore and Stern, 2005).

Standardisation, establishing norms, and corralling and guiding performance through impact measurement and statistical evidence regarding the majority, are inextricably fused with our values and aspirations in education. Individualisation will lead to divergence and may go astray. The individually chosen approach won't conform to the target metrics — causing systemic disruption to reward systems and existing certification of academic achievement.

Learning Outcomes as Diverse as Learners

Counter to our intuitions, in these times of increased complexity, accelerated change, amplified instability, and global entanglement, we need human diversity, not uniformity or simplicity. The benefits of diversity have been acknowledged for centuries in domains such as biology and economics. Evidence of the striking advantages of human diversity is steadily mounting. Including diverse perspectives and skills makes for significantly better planning, more accurate prediction, more successful risk-aversion, more effective response to threats, dynamic resiliency and greater innovation. Or as amply supported by Scott Page 'diversity trumps ability.' Creativity and novel strategies are also most at home at the margins, where we find the greatest variability (Page, 2007).

Our current and planned aspirations for education seem counter to these findings. Diversity is generally seen as an issue to be addressed, not an important outcome to be fostered. We attempt to simplify diversity by categorising the norm and the outliers or special —a costly and destructive approach for both sides of the equation.

However, our education system does not need to produce graduates that are replaceable copies of each other. In today's economy and increasingly connected growing global society (beyond contested foundational building blocks for learning) we don't all need identical toolkits of skills and knowledge. People are social beings. We may need survival skills if caught alone in the wild, but in our connected communities we can depend on others to fill in most skills we haven't adequately learned or knowledge we have forgotten from our schooling (if not on ever more capable machines, and computers). Even in standardised essential professions and tightly controlled disciplines, the knowledge and skills that can be replicated are the skills that machines can help with or replace (Rifkin, 1995).

You may ask: how can our education system support a unique learning experience for each learner? We barely have the capacity to deliver mass education. If designed correctly one answer may lie in the Open Education Resource ecosystem on the Web. An open license enables use by anyone, but more importantly it allows the creation, pooling and sharing of variants. This means that a truly open resource pool that supports modification and mashups will always be richer and more diverse than a locked collection. Correctly designed digital resources can transform to the unique specifications of each learner, presenting the visual layout, presentation modes (e.g., audio, visual, tactile), and method of control that suits the individual learner. Metadata associated with each resource can help match the resource to the unique needs and learning goals of each learner (Treviranus et al., 2014).

What happens to assessment if everyone has a different desired outcome or a different role to play? As discussed earlier, we need to explore the option of engaging learners themselves, supported by personalised learning analytics —as aspiring research scientists in the important subject of self-regulation and self-determination. There is also the rich pool of peer learners who will simultaneously gain the critical skill of giving, receiving and valuing constructive critique. As for maintaining quality control of the ever growing, diverse pool of learning resources, we should all master the learning potential of the impermanent, incomplete and imperfect. The act of improving and refining resources for the next learner may be one of the most effective learning experiences (Treviranus, 2010b).

Trust and Quality

There is no clearer sign that our systems of education are fraying at the edges, than in the many challenges to academic qualifiers. We have come to recognise that our hallowed halls of learning are not the only purveyors of knowledge and expertise — with Wikipedia, Google, Blogs, MOOCs and burgeoning communities of interest on the Web. The proposed response has been to reserve certification of academic achievement to formal and established educational institutions. The proposal is that you can learn the content through mechanisms such as MOOCs and online courses and then pay Universities to verify what you have learned and certify this with a degree or diploma (Taneja and Goel, 2014). However, even this role has been contested. It appears that university degrees and high school or college diplomas do not cover the diversity of skills and forms of expertise required in today's economy or of interest to the diversity of learners our society needs. Formal education is not the only way to achieve competency or provide evidence of learning. Some say it is an inferior alternative.

Innovations that deconstruct, decentralise and dis-intermediate accreditation and certification of academic achievement are proliferating. From ePortfolios that provide an online record of evidence of achievements, to Open Badges that provide more granular certifications of competencies, to Prior Learning Assessments that support the integration of experiential learning outside the institution —all iterate toward more diverse ways of recognising learning achievements (Aceto et al., 2014).

One of the latest candidates is the blockchain. "A blockchain is a massive, fraud-resistant distributed ledger that could be the new infrastructure of the future. The open ledger uses consensus algorithms to transparently record and verify any transactions without a third

party. It replaces the middleman with mathematics. Because the blockchain infrastructure is decentralised, there's a lot less friction and time wasted than traditional, centralised processes." (Ravinsankar, 2015) The blockchain is seen as a way to create an immutable record of human capital that does not require a central authority. The hope is that by removing the central authority there is freedom to diversify and proliferate the competencies that can be certified. So far existing schools and institutions have experimented with blockchains to create trusted certificates. There is yet to be an implementation that removes a central authority and allows the diversification of certified competencies.

THE WEB AND DISPARITY

Educational disparity is a cog in the vicious cycle of other disparities. While the Web was heralded as a mechanism of democratisation, the design directions that ignore inclusion and diversity also feed into these cycles of disparity. Many of our current political, economic, technical, social and commercial structures are inclined to accentuate disparity. The rich will get richer, those with influence will garner more influence, knowledge about the majority will increase; while those at the margins are caught in vicious cycles of poverty, lack of influence, and lack of being understood (Treviranus, 2014b). This is the dominant pattern experienced not only by individuals, but also organisations, communities, companies and even universities. Our current socio-technical advances associated with the Web, while promising to disrupt these systemic patterns, have also accentuated these dominant trends. From popularity echo-chambers in social media that speed the rise of items with the most hits and cause the less popular to disappear, to recommender sites that offer choices from users 'like us' shielding us from difference, to big data analytics that privilege dominant patterns and eliminate the outliers or 'noise,' to computer-mediated financial trading systems that give advantage to the well-resourced — all amplify the trend toward greater disparity (Treviranus and Hockema, 2009).

A global effort is attempting to leverage the Web and Web technologies to counter this trend and create a platform for economic inclusion (Treviranus, 2014a). Originating in Canada (but at various stages of implementation in the US, Europe and across Spanish-speaking nations), is an approach and multi-sided platform called AccessForAll (also referred to as Cloud4All, Prosperity4All, Web4All, FLOE and GPII). Simply described, AccessForAll provides a means to discover, explore, refine and declare (using an ISO AccessForAll standard), what it is that works best for each individual user with respect to digital resources and user interfaces; the infrastructure then delivers a personally customised resource or user interface wherever and whenever the individual happens to access services. When they request a specific service or resource this infrastructure matches the stated individual preferences by transforming the resource or interface, augmenting it, replacing it with an equivalent resource from a federated repository of pooled resources or reaching out to producers and suppliers who can fill any gaps. This approach capitalises on the pace and path of technical innovation rather than trying to continuously catch up to it.

While not originally intended to address the needs of marginalised producers and suppliers, the AccessForAll platform is being tested as a means of removing barriers to market entry for young entrepreneurs (including youth with episodic or invisible

disabilities), small enterprises, indie developers and emerging economies. It offers a potential means of supporting a new, organic, agile, inclusive market or flexible economy. Individuals that face barriers to employment and have disengaged from education have access to training in portable skills that are directly linked to demands, then given demands to fill, reviewed for their work, paid for their service, and certified for the skills acquired in progressive iterative cycles. Once they have mastered a skill, they act as mentors for less experienced youth. Once they have acquired a threshold of skills they are supported in forming service entrepreneurships. The same process will be offered to youth in refugee camps to build portable skills and to reduce barriers to accessibility regulations by increasing human capacity to achieve the regulations. Thus, potential suppliers and producers at the margins are meeting the unmet demands of consumers at the margins (Treviranus, 2014a).

We need to create mechanisms that attend to the edges, connect us with people that are different from us, invite the serendipitous and unexpected, and create systems that are not dependent on categories, limited containers, and homogenous impact thresholds to assign value. The Web has released us from the linear and two-dimensional representation of knowledge and forged a global mesh of connections. Can we design the next generation of the Web as a learning platform to support human variability, navigate rather than reduce complexity, and engender collaboration and trust?

THREE DIMENSIONS OF INCLUSIVE LEARNING

Ideally, learning is a continuous and iterative process of designing a fulfilling life. At the Inclusive Design Research Centre we apply a framework called "the three dimensions of inclusive design" that recognises that inclusive design in a digitally transformed and connected society can be relative to the individual, the goal and the context (Treviranus, 2018b). The same framework can be used as a notional scaffold for inclusive learning (Treviranus, 2014a).

The first dimension is the understanding that full inclusion requires the recognition of individual difference and uniqueness; that design, and learning must be individualised; that individual requirements vary given the context and the goal; and that inclusion requires personal agency by fostering the self-knowledge of each learner. Adaptations to individual needs must be integrated, not segregated, to remain sustainable and current. Choices must vest with the learner, and any intelligence gained about the learner must be shared with the learner to support meta-cognition and self-guidance.

The second dimension is an inclusive process of design or learning design. This ensures that the learner is an active participant in the full design cycle through co-design. The design, development or instructional tools used must be accessible to the full diversity of co-designers. The design team should consist of a diversity of perspectives. This would mean that learners co-create with diverse peers and experts and that all learners not only consume curriculum but also produce curriculum.

The third dimension recognises the larger context: the complexity and interconnectivity of phenomena and systems. The design and learning process must take into account the greater impact of any design and strive to effect positive systemic change and at minimum

do no harm to linked systems. Here the learner recognises their unique, evolving role and impact within the complex and evolving global community.

CONCLUSION

In our interconnected and crowded society, we need to go beyond tolerating or respecting diversity, we need to prize and learn to orchestrate and create synergy out of our differences. We should shift focus from how we are each better or worse in the same skills, to the unique, evolving set of talents, passions and competencies we each bring to tasks at hand. It is our variability that gives us collective strength. We can 'complete' or complement each other by negotiating the fluid merger of diverse strengths, making the whole far greater than the parts. Can we design the Web inclusively so that it becomes a platform to enable all students to reach their diverse, full potential, so that they can be prosperous, self-guided contributors to our global community? Our collective well-being and survival may depend upon our success.

5.2   The Role of Open in Inclusive Education

The applications of the inclusive design framework I developed in the domain of open education shows how it is distinct from an accessibility framing. The strategies of inclusive education that we have co-designed are dependent on open education. To collectively create a resource pool that has sufficient variability to meet the diversity of student needs and preferences, especially unexpected needs, requires the very qualities that the 'open' movement provides and values (Open Education Consortium). An unfortunate complex interaction occurred between the open education movement and the accessibility community. I was part of both and was asked to intervene to bridge the divide by the philanthropic organisations that initiated and supported the open education movement, the William and Flora Hewlett Foundation. To understand the conflict requires an understanding of the emergence of open courseware (OCW) and open education resources (OER).

5.2.1   The Emergence of Open Courseware

The Open Education Resource community or movement gained broad attention and impetus in 2002 with the unprecedented move by the Massachusetts Institute of Technology (MIT) to release nearly all of its course content under an open licence to be accessed for free by anyone, anywhere in the world, over the Web (Lerman et al., 2008). Other prominent and broadly revered academic institutions followed suit.

What made the MIT move so brave and ground-breaking was that it was completely contrapuntal to the dominant postsecondary academic rhetoric at the time. Most discourse was

focused on the potential to make profit from academic intellectual property. Professors and researchers were recruited to workshops to learn how to protect and market their knowledge with titles like 'What are your ideas worth?' and 'How to turn your knowledge into profit.' Institutions were in complex and fraught negotiations with their faculty associations regarding who owned and had the intellectual rights to curriculum. Academic publishers were in a race to 'snatch up' and create contracts with academic stars and potential stars. This protectionist and profit-making frenzy was brought on in large part by the perceived potential of new means of distribution through digital media and the internet making traditional publishing obsolete, as well as the austerity measures in education that prompted the pursuit of new sources of revenue (American Association of University Professors).

5.2.2 Learning Object Movement

The MIT OCW initiative was the most widely heralded adoption of an open approach: in essence, to broadcasting curriculum freely. However, this was not the first initiative to share and enable the open use of educational resources. Among the earlier efforts was a movement, frequently referred to as the 'learning object movement,' which emerged and evolved with the popularisation of the internet, the emergence of the Web, and the digitisation of content. The goal of the earlier learning object movement, in contrast to OCW, was to harness the potential of digital media, internet-enabled networks, and interactive applications to pool, share, re-purpose, and re-use curriculum(Hodgins, 2006). The use of the term 'object' was an allusion to object-oriented software programming that supported a component-based construction of an application from multiple interoperating parts. The ideal conception of learning objects was that educators could construct a lesson or 'learning design' from a set of learning objects, just as you would construct a Lego construction out of Lego blocks. Given this orientation, much community effort was focused on establishing interoperable standards and practices.

The community engaged in extensive debates regarding the definition and qualifying criteria for a learning object. Would a picture of a tree frog qualify as a learning object or must a learning object include a full lesson plan? What learning object granularity and design is most likely to facilitate reuse and repurposing? Much time and controversy was also devoted to the form that labels for learning objects should take to enable their discovery and to share information about their intended use. Heated debates regarding the benefits of specific

metadata standards, such as Dublin Core versus IEEE LOM, consumed many hours in international forums.

The learning object effort had evolved sufficiently to feel the need to, and to begin to, address the issue of quality standards for learning objects. Efforts such as Merlot enabled a five-star rating system for learning objects (Koppi et al., 2005). Other repositories developed their own standards and review mechanisms ranging from user feedback and usage-based metrics to formal educational gateway and approvals-based quality measures.

Not all learning objects were freely available and openly licenced. Some repositories required membership and some learning objects were copyrighted and required licence fees. There was a move by private educational publishers to create and sell learning objects; however, many learning object initiatives were publicly funded and supported free and open use of resources. Among the most prolific were efforts funded by the Canadian government through the CANARIE e-learning fund (Richards et al., 2002) and by European efforts, including JISC (Campbell, 2003).

5.2.3 E-Learning

The Learning Object effort was situated in the larger e-learning effort and inherited many of the associated issues and debates. Not least among these was the fear among educators that they would become redundant, and that educational institutions would simply take the content educators created and distribute it through learning management systems and bypass teachers altogether. A watershed of review research released in multiple forms between 2001 and 2009: as a book (Russell, 2001) and as a report by the US Department of Education in 2009 (Means et al., 2009) finally laid the debate to rest. The review was nicknamed the 'No Significant Difference' report. It showed through multiple, replicated comparative research studies that e-learning did not save teachers time, did not reduce or increase the cost of education, and did not improve student-learning metrics (Russell, n.d.).

5.2.4 Creative Commons

The Open Education Resource (OER) community benefitted from the foundational knowledge established by the learning object effort, but also largely ignored much of it. A number of thought leaders in learning objects made the transition to Open Education Resources (e.g.,(Wiley, 2000, MERLOT, 1997)). A critical advance that set the stage for the MIT OCW move was the emergence and popularisation of the Creative Commons licence. The Creative Commons

licence enabled content producers to customise their own copyright licence, retaining whatever rights they wished to retain (Caswell et al., 2008, Lessig, 2004).

5.2.5 Publishers versus OER

The market tug-of-war between open and closed educational resources has played out in the education domain in the form of competition between established educational publishers and nascent openly licenced education resources or OER (Open Education Resources). OER provide greater equity for disadvantaged regions globally and students who are economically disadvantaged. OER are openly licenced to support what are referred to as the '5R Permissions of OER,' the right to:

1. retain and make your own copies
2. reuse in a wide range of ways
3. revise, adapt, modify and improve
4. remix by combining two or more
5. redistribute to share your contributions with others (Green, 2017, Lumen Learning, 2014).

OER thereby offer the potential to create many variants and choices to match the variability and diversity of student needs. This same latitude and variety is not available to mass-produced, copyright-protected traditional publishing.

5.2.6 Digital Rights Management and Alternative Formats

Students experiencing disabilities that require alternative formats (and their parents and support services) report spending inordinate amounts of time and energy addressing digital rights management (DRM) restrictions that prevent the creation of variants and lock out the opportunity to translate from one modality to another (Whitehouse, 2008). While hard-won exemptions to DRM restrictions for students with print disabilities have been granted in certain markets (e.g., the Marrakesh Treaty) (Fitzpatrick, 2014), the burden to prove that a student has a disability and the parallel supply chain that is required to acquire an alternative format textbook, result in an onerous process for an already taxed student and their support system. The open licences of OER would circumvent this complex and difficult means of acquiring accessible learning material.

The most acrimonious battlefield has been in the United States, where educational publishing has been an extremely lucrative and well-entrenched market. In the primary- and secondary-grade market, large textbook publishers are aided by a highly competitive 'textbook adoption' framework that structures competition for public funding in such a way that large profits are

guaranteed to the winning textbooks and other choices are left with little support (Petrides et al., 2011). Textbook adoption was enacted to promote, protect, and curate the quality of textbooks that receive public funding. The design of the curriculum and textbook ecosystem then further entrenches this competitive advantage by granting management of textbook clearinghouses to these same winners in the adoption contest, thereby granting further advantage to the dominant publishers. Students with disabilities have been used as a 'pawn' of sorts in this battle.

To understand the complex role that students with disabilities have played in this struggle requires an understanding of regulatory frameworks that support accessibility.

5.3   Accessibility Regulations and Laws Applied to Education

As mentioned in the WWW25 keynote article, accessibility, or design that works for people experiencing disabilities, is a precarious value: most people agree that it is important, but it is one of the first things to be compromised when other pressures arise, such as time and budget constraints. To protect this precarious value, progressive public institutions and governments have been compelled to create laws, regulations, and policies that oblige accessibility. However, laws, regulations, and policies are very blunt instruments. They are most effective in changing behaviour when compliance can be easily tested using consistent, objective measures. Creating clear, concise, and objectively testable criteria inevitably requires reduction and compromise. It does not lend itself to enumerating the broad, complex spectrum of diverse needs. Thus, certain needs are inevitably left out or compromised.

Movements to legally enforce digital inclusion have been pushed to support inflexibility which reduces the freedom to innovate. To support diverse learners requires flexibility. To address unmet needs requires innovation. Several promising alternative regulatory designs have emerged, but these have not received the popular support that prescriptive accessibility checklists have received. One reason may be that popular support favours simple, graspable concepts rather than nuanced and indirect strategies. (Chapter Seven outlines a strategy in development that attempts to create more diversity and innovation supportive regulations related to accessibility).

5.4 Aligning Open Education Resources with Accessibility

The legislative compromises that the accessibility field has had to make to create regulations that can be broadly understood and enforced, has meant that the accessibility movement has become misaligned with the OER movement. OER are a potentially powerful ally that favours diversity and the innovation that is birthed by variability in education. The OER ecosystem boosts flexibility and the more long-term systemic growth that supports the emergence of designs that span the spectra of human diversity. As far as OER provide a means to create a rich array of choices and a process for finding satisfying choices for the full diversity of students, the OER ecosystem will offer more inclusive and long-term digital equity in education. The largely unregulated, organically organised, opportunistic OER production effort, however, does not naturally lend itself to absolute criteria.

Publishers that see OER as a threat have used this to their advantage and have claimed that the adoption of OER in formal education systems should be disallowed because they do not adhere to accessibility laws. We proposed a simple response to this dilemma to the Web Accessibility Initiative (that has yet to be formally articulated by the adjudicators of this struggle): that compliance with accessibility requirements should be judged at the system level rather than the individual resource level. Thus, if the pool of resources offers options for the full diversity of learners to meet each learning goal, it is compliant with the accessibility requirements and each resource does not need to meet all the fixed criteria. Thus, a student who is blind would use a resource that is text based and can be read by a screen reader, where as a student reliant on visual learning would use a resource that relies on graphics and visual images to achieve the same learning goal. This would reduce the compromise that students, who don't fit defined categories or criteria, need to make. It would also support the innovation that comes from diversification.

This, however, requires a system that matches the diverse individual requirements of students with a satisfying resource or learning experience. Resourceful parents, educational assistants, and teachers have been attempting to perform this function. OER portals, such as OER Commons (OER Commons, 2007) and Gooru (Gooru), have begun to integrate search features that stretch to the edge requirements of students with disabilities.

The FLOE Project (Inclusive Design Research Centre), which I lead, is helping to provision the OER ecosystem with an infrastructure or platform to deliver a learning experience that matches

the needs of students with learning differences. FLOE aims to use the platform model to pool and share reusable resources and supportive tools that enable a growing, diverse, global community to diversify and create a rich pool of learning experience variants. To achieve this ambitious goal requires OER resources that are amenable to reuse and a large, diverse pool of OERs. If the default OER is inaccessible to a specific student, the inclusively designed system would either:

a) transform the resource (e.g., through styling mechanisms);

b) augment the resource (e.g., by adding captioning to video); or

c) replace the resource with another resource that addresses the same learning goals but matches the learner's specific access needs.

We argue within the FLOE project that to achieve this functionality requires:

- utilities that help learners discover, explore, refine, and declare their learner preferences (thereby also supporting learning-to-learn and metacognition).
- markup, metadata, or algorithmic means of locating resources that match specific learner needs or preferences.
- a private and secure means of storing and transporting personal learner preference files from one learning experience to the next.
- a matching service that can reconfigure, augment, or search and find a resource that matches a learner's preference specifications.
- supports to help OER producers create reconfigurable resources and provide helpful metadata regarding the learner preferences the resource can match. (Ideally these supports would be embedded in the tools used to create OER.)

The FLOE project has created the necessary pluggable building blocks that are being integrated into projects that deliver OER. Fortuitously, these steps are not foreign to the OER effort but can be seen as impetus to advance the OER agenda as a whole. However, this approach is helped by conceptual and practical adjustments in both the OER and Accessibility communities. The approach requires that the OER community:

- fully adopt and support the principles of cumulative authoring, derivative works, reuse, and repurposing that is already part of the OER mantra;
- improve learner-focused resource discovery and the prerequisite labelling;
- promote an authoring attitude that lets go of the tight control on a fixed presentation or rendering;
- invest further in a learner-centric approach to resource design;
- commit to support open interoperability standards for both file formats and programming and scripting environments;

- support open source tools with open communication protocols to enable interoperability with assistive technologies; and
- improve portability or device independence of resources.

The Accessibility community must:

- adjust the interpretation and implementation of accessibility legislation and policy to judge accessibility by the ability of the system (rather than each resource) to address the individual needs of each student (notably this does not require that the letter or spirit of existing legislation be changed only the interpretation and implementation);
- recognise that OER are a viable alternative to the complex, confounding, and deeply entrenched Digital Rights Management conundrum that is consuming so much accessibility effort and passion;
- let go of the focus on equivalent content and focus on equivalent learning; and
- recognise that in the digital realm it is possible and effective to shift from a one-size-fits-all to a one-size-fits-one approach to providing universal access.

A growing community of interest in OER accessibility, including the FLOE Project partners, supports this shift in both communities through practical tools, advocacy, and education.

Figure 10 provides an overview of the FLOE process and infrastructure:
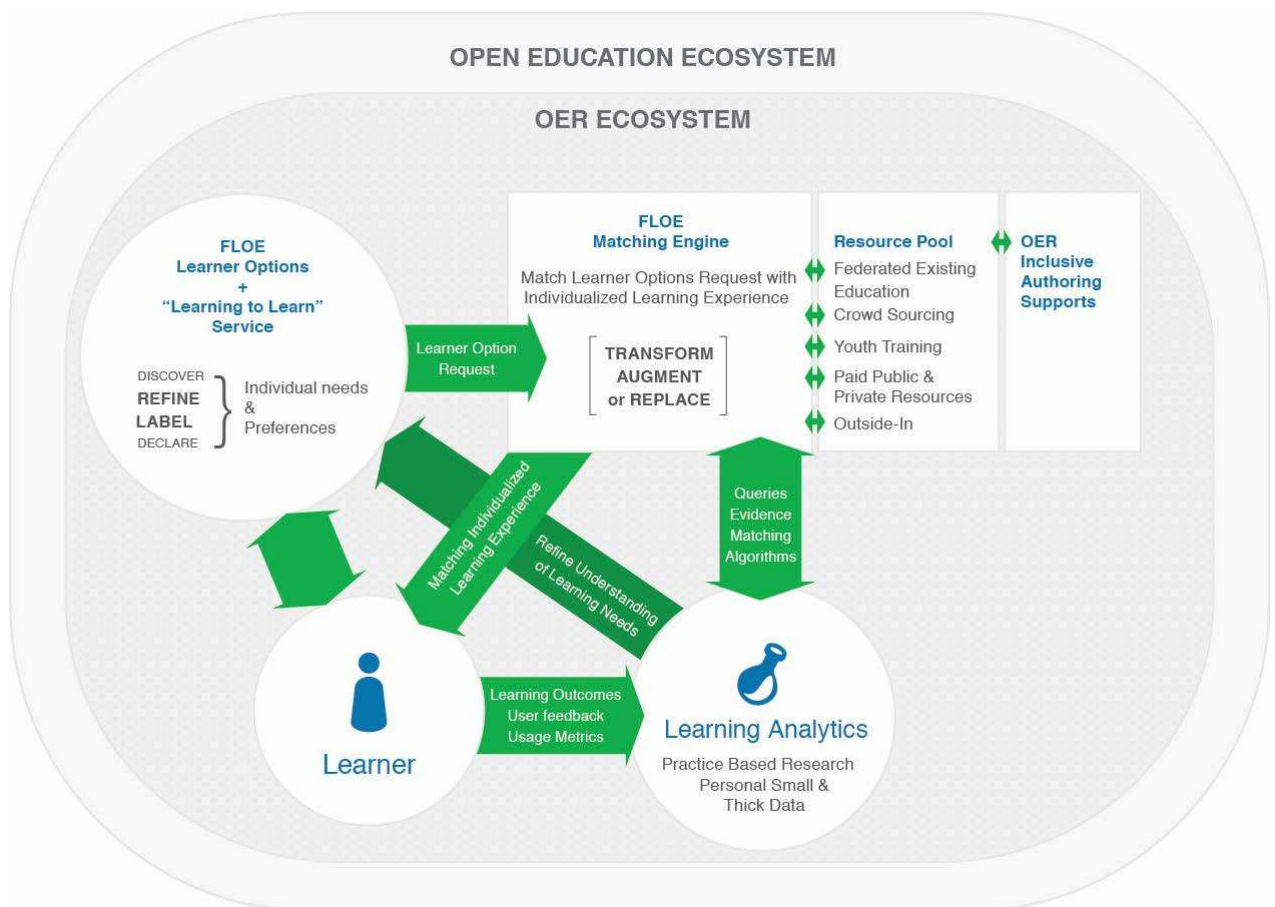
Figure 10:The FLOE ecosystem enables the learner to refine their understanding of their needs and preferences, request a matching resource, and provide feedback regarding the match

provided. This feedback provides important evidence regarding what works for learners who are outliers.

FLOE leverages an international interoperability standard called AccessForAll. This is expressed both as an International Organization for Standardization (ISO) standard (ISO/IEC 24751)(International Organization for Standardization, 2008) and an IMS specification (IMS AccessForAll) (Jackl et al., 2004). AccessForAll supports a common language for describing personal needs and preferences (or student accessibility requirements) and a common language for describing resources that might match the needs and preferences. This standard and my role in developing the standard is further explained in Chapter Six.

5.5   Personalisation

Projects such as FLOE that implement AccessForAll are also aligned with diversity-supportive e-learning trends toward personalisation. Both are promoting one-size-fits-one education rather than one-size-fits-all education and the rejection of mass 'cookie-cutter' education. The trend to personalisation is in part motivated by evidence that better learning outcomes are associated with personalised learning (Beetham and Sharpe, 2007).

The label of 'personalisation' has been used to cover a broad range of very different initiatives. These initiatives differ in the following ways:

1. What is personalised, including the:

- path or sequence of steps to achieving a learning outcome, including repetition of specific items;
- pace or how much time is devoted to each part;
- personalisation of the content used, including using local information, a favourite topic (e.g., teaching math using dinosaurs), using first and second languages at the same time, etc.;
- presentation of the content, including the style of text, magnification, colour contrast, spacing and layout, density of content, etc.;
- modality of delivery including video, audio, text, images, immersive content, etc.;
- degree and type of interactivity, including games, quizzes, collaborative exercises, etc.;
- form of pedagogy used, including constructivist, didactic, experiential, project based, problem based, collaborative, competitive, etc.;
- form of motivation, including external feedback, internal feedback, affinity topics (e.g., trains, panda bears, or currently popular personalities), peer support (e.g., buddy system);
- form of social support, including peers or instructor; and
- scaffolds provided, including prompting, calculators, dictionaries, thesaurus, etc.

2. What kind of learning trajectory or plan is supported? This could include the following forms of planning:

- predetermined by education authority or instructor;
- self-guided by students themselves;
- a formal and constrained trajectory;
- a responsive and opportunistic learning plan; or
- a life-long learning plan that has no terminus.

3. Who decides what and how things are personalised? This could include the following strategies:

- machine intelligence makes decisions based on fixed algorithms or adaptive algorithms (and either informs the learner or does not inform the learner);
- educators or teachers control the factors to be personalised; or
- the learner is informed about the choices and what has worked for them and decides what is personalised and how it is personalised.

4. What data is used to guide personalisation? This includes:

- personal data for each student;
- representative data from previous students or a pool of students; or
- a combination of representative data and personal data.

5. Who the data is presented to? This includes:

- the machine intelligence engine and the company creating it;
- the students and learners themselves through dashboards and visualisation tools; and/or
- the teachers and educators.

5.6   Metacognition, Smarter Machines, and Smarter Students

Projects such as FLOE differ from mainstream personalisation initiatives in one important respect. Personalisation initiatives are often used as a raison d'être for applying artificial intelligence to education. Adaptive education systems make data-backed decisions regarding the learning design that will bring optimal results for a student (Schunk and Zimmerman, 2008). The FLOE project is guided by the ethos that students should become experts in their own learning; that students should be able to experiment and draw conclusions about what works best for them. The FLOE project asserts that machine learning should not supplant student metacognition, self-regulation, and self-determination but assist students in making informed

decisions about their own learning requirements. FLOE and similar projects also support students in developing their own learning plan.

Becoming an expert on your own learning requirements rather than leaving this up to a data-driven inference engine is better suited for students who are outliers (Cheetham et al., 2014). Research, including big data and learning analytics, aspires to draw generalisable conclusions that can be applied to the majority, or a large prescribed group, with predictable results. The veracity of the conclusions depends upon an accurately representative group of 'subjects,' and the accuracy of predictions depends upon statistical power through numbers. By definition these generalisations do not hold true for learners who are outliers. This is in large part due to the fact that there are no representatives that meaningfully reflect the unique interconnected complexity of requirements to be represented, let alone a large enough group of representatives to garner conclusive results. The only viable alternative is to represent yourself and to iteratively discover and refine your understanding of your own learning requirements with the help of supportive facilitators or tools. Tools can support this discovery by measuring and presenting 'small' (personal) and 'thick' (contextualised) data about the conditions under which you learn best for a given context or learning goal, allowing you to refine these conditions and monitor the results (Welles, 2014). Taking from models in sports and gaming, students can hone their learning performance. As mentioned in the *Life-long Learning on the Web* article above, there are many structural and attitudinal barriers to this approach.

5.7 Quality Control

Prescriptive quality standards, especially centrally controlled determination of quality, is often an impediment to more diversity-supportive inclusive design of formal education. Ironically, safeguarding equal access is frequently used as the motivation for centrally imposed quality standards (Goldberg, 2003). Unfortunately, this removes self-determination from teachers and students and restricts leeway for diversification, customisation, and personalisation — or designing for diversity. However, common education standards, such as the US Common Core, can be used to provide useful descriptive metadata regarding the learning goals met by a learning resource (Achieve, n.d.). When this is combined with accessibility metadata or metadata regarding the accessibility requirements met by the resource, this Common Core

metadata can be used to find learning resources that address personal needs and also achieve an equivalent learning goal. These are approaches that are supported through the FLOE project.

Since the launch of the FLOE project in 2011 at the beginning of this doctoral work, many of the goals of FLOE have been realised. The OER community has formed productive allegiances with the accessibility community. All OER initiatives now contain an accessibility and inclusive design statement and plan. Our inclusive design guidelines have been integrated into the UNESCO OER guidelines (Commonwealth of Learning, 2015), and the US Department of State OER playbook (SPARC*, 2018). The William and Flora Hewlett Foundation requires adherence to our inclusive design guidelines as a condition of funding. Many OER projects have integrated the FLOE components and functions (Inclusive Design Research Centre). This integration of inclusive design practices has resulted in a closer integration of the OER and deeper learning programs within the William and Flora Hewlett Foundation–supported initiatives (William & Flora Hewlett Foundation, 2018). I have been invited to advise the foundation board on the reframing of their programs in education.

5.8   The Unlearning Necessary for Inclusive Design

While the FLOE project focuses on all levels of formal education and all areas of study, I have also applied the framework in designing a graduate program that focuses on Inclusive Design. In 2011 I launched a master's program in Inclusive Design at OCAD University. My aspirations were to inclusively design a graduate program that would be committed to the reflexive study and practice of Inclusive Design. In other words, the students would not only learn about Inclusive Design, they would participate as co-designers in shaping their own inclusively designed learning experience. This would give them an opportunity to learn about Inclusive Design while practicing inclusive design.

The program I envisioned and launched differs from most other graduate programs in the following ways:

- Each cohort of no more than 24 students would be as diverse as possible with respect to disciplinary background, age, gender, cultural background, and lived experience of barriers.

- The program would accept as many individuals who faced barriers to education as possible.

- Instruction would come from a broad range of sources, with a heavy emphasis on peer instruction.

- Students would not be ranked on a single scale, but would be encouraged to excel in their own unique learning goals.

- Rather than competition, the program would emphasise collaboration and team work.

- Constructive feedback would come from peers as well as the instructor.

- Scholarship would be focused on current real-world challenges and issues.

- Design work would be motivated and guided by the needs of co-designers as the beneficiaries of the design, not by advancing a particular technology or area of study.

- Membership in groups would be determined to achieve optimally diverse perspectives, not based on affinity groups.

Moving my research centre to OCAD University was in part motivated by the desire to find a university that would be more open to academic innovation. OCAD University has a studio tradition that is conducive to educational personalisation and pursuit of a personally tailored learning path. In 2011, it had not yet adopted the super-sized classes of other universities. Many faculty were both practitioners and instructors. The disciplines were limited to art and design, and a liberal arts faculty. The remainder of the scholarly landscape had not yet been divvied up and secured with protected boundaries. However, OCAD University functions within a post-secondary system, and has only recently achieved university status. The pull to normalising OCAD University practices to secure its tenuous stance among the established hierarchy of universities meant that OCAD University has been compelled to shed some of its distinctiveness and adopt the very practices and policies that I had been hoping to escape. In the seven years since establishing the programme, I have realised that I have grossly underestimated the resistance to change of the higher education system and its culture. The tragedy is that I have watched OCAD University pulled to become what I see as a bad copy of larger, established universities, rather than optimising its distinctiveness, at a time when our society needs more of what makes OCAD University distinct.

5.9 SMARTlab UCD and the formation of IDRC Ireland

At this time, I began my doctoral studies at SMARTlab which was also undergoing a relocation to University College Dublin. The ethos and commitment to inclusion and to respecting diverse ways of knowing, helped to inform the design of the Inclusive Design graduate program at OCAD University. This included the model of a practice-based thesis and the opportunity to engage in research creation. The global community of educators and learners associated with SMARTlab helped to sustain, and in a sense, 'bootstrap' the OCAD University program at a time when we had not yet recruited sufficient faculty at OCAD University. SMARTlab faculty helped to supervise the graduate students and joined the Inclusive Design Institute research community that I head. This led to the formation of the Inclusive Design Research Centre in Ireland, a sister program to the IDRC in Canada. This relationship has been a rich and generative source of research, publications and collaboration. This work is situated alongside the parallel research conducted by colleagues in Dublin on topics of inclusion and ability that inform this study in: (Cohen, 2016, Cohen et al., 2017, Çubukçu et al., 2016, Çubukçu et al., 2017a, Çubukçu et al., 2017b, Politis et al., 2017b, Politis et al., 2017a, Robb et al., 2017) (Yakkundi et al., 2017b, Yakkundi et al., 2017a). Appendix G: provides a partial list of the publications that arose from this partnership.

5.10 Challenges to Inclusive Design in Higher Education

Inclusive Design up-ends many of the implicit and explicit lessons of formal education. It challenges centuries-old traditions, foundational assumptions, and implicit conventions (Nishida, 2016). Among these are the power hierarchy, the exclusiveness of higher learning, the reflexive (and often vicious) competitive climb to the top that is veiled through the pretence of academic civility, the disciplinary cliques with carefully constructed and defended boundaries, the need to rank students on a single scale, the peer review process that is hostile to peerless scholarship, evidence through representation by large homogenous numbers, and the demand for conformity. My early, and possibly naive, belief that the academy was a bulwark against totalitarianisms and irrationality has been tarnished. While Academia plays the important societal role of calling out 'the emperor's lack of clothes,' in my experience, it quickly pulls rank on anyone who would internally critique the artifice of academic traditions.

The following is an op-ed article I wrote that highlights the uniqueness of the program. It describes the course that introduces students to the program in the form of a two-week resident intensive called 'Unlearning and Questioning.'

5.11 Unlearning, questioning, and re-imagining Canadian innovation

For the past six summers a new group of unique students gather at OCAD University to participate in an unusual course called 'Unlearning and Questioning.' This begins the most difficult part of their two-year Masters study in Inclusive Design: to question assumptions, unlearn conformity, and remove boundaries to thought. To help this process along, the students in each class are as diverse as possible. A refugee grandmother from Iran, a recent graduate of quantum physics from Romania, a retired judge, a journalist who navigates the world without sight, a software programmer from Asia who is transitioning from male to female, one of the youngest self-made millionaires, a professor of advanced math that credits her success to neuro-diversity, a musician that knows what it is like to be in residential schools in Canada, the director of an NGO in Africa with a background in economics that reads lips, a dancer and choreographer who dances using a wheelchair, and up to two dozen students with personal insights into the broad facets of the human experience, may all find themselves in the same class. In this course there are no taboo subjects, sacred notions, or authoritative experts. Everything is open to constructive critique and thoughtful examination, including the educational experience the students help to co-design and the university process they are engaged in.

The most important question the students re-learn from their time as toddlers is "why…?" The most meaningful progress the students make is to take a step back, focus the mind more broadly and reflect. The most significant skill is self-awareness and an understanding of personal biases, blind spots and the value of their unique perspective. One of the biggest challenges is to unlearn the fear of 'drawing outside the lines,' the compunction to label, sort, rank, filter and conform. The students re-learn the priceless educational value of mistakes and failure.

The ultimate learning outcome is a 'radical form of inclusive design' that is seen as the next generation of design thinking and is sought by entities as diverse as: Microsoft to distinctively improve their user experience, Uber to position itself as a problem solving company, the US Department of Education to address learning disparities, banking associations to achieve financial inclusion goals and thereby improve stability, the World Economic Forum to avert global risks, Google to expand thinking on geo-spatial navigation, the European Commission to create online platforms for inclusive prosperity, and international cyber-security organisations to find new ways to avert risk … among many other beneficiaries.

Innovation (the benchmark Canada is failing, according to international metrics) is one of the topics of reflection. Rather than analysing Canada's competitive weaknesses, reviewing comparative data of countries that rank at the top in the global race for innovation, or identifying promising global trends, the class has stepped back and asked more fundamental questions. What is the definition of innovation? What is the goal of innovation? How do we measure innovation and why? What would we gain if we rank the top in the current measures of innovation, what would we lose? Does the current race benefit humanity or our environment globally? Do the measures of success reflect Canadian values? And more specific

questions such as: do we need to invent, mass-produce and market more 'shiny gadgets'; and is it ultimately productive to pit our bright young minds against each other in highly competitive, time pressured contests?

OCAD U is the University of the Imagination. The inclusive design students imagine scenarios of successful innovation agendas, stretching into several successive generations. They consider the potential impact on the complex adaptive system that is our global society. They ponder how to avoid creating 'cobra effects': or the unintended negative consequences of over-simplistic solutions to complex problems. Scott Page, a professor and researcher at the University of Michigan, has shown that diverse perspectives are better at prediction, risk aversion, planning and innovation than a group of the 'best and brightest minds.' The potential scenarios the successive classes have explored are hugely diverse and nuanced. The scenarios leverage the understanding that comes from the wide range of educational backgrounds, cultural perspectives and life experiences that the students contribute.

The students test their ideas with a growing, global, inclusive design community. At the hub of this community is the Inclusive Design Research Centre, an international centre of expertise on digital inclusion focusing on emerging technologies and practices. In its 23 year history the IDRC has formed over 300 partnerships around the world. Of benefit to inclusive design students, the global community of the IDRC has a policy of 'open' — open access, open source software, open data and open interoperability standards — ensuring that students have unfettered access to relevant knowledge and tools and the opportunity to contribute to and refine these resources.

The conclusion each inclusive design class has collectively arrived at is that we need to rethink innovation. Canada needs to strike out in a better direction because the ultimate destination of the global race is not to our benefit or the benefit of our greater society. For Canada, there is no real gain in becoming a bad copy of other, leading nations. We need to find better answers to: what are we competing for and how do we measure success? We need to ask questions such as: how do we support Canadian values, how do we leverage Canada's distinct strengths and how do we avoid global risks?

The students from around the globe generally agree that diversity is Canada's most valuable asset; collaboration and inclusion are Canada's most relevantly important strengths. We need to learn to value and leverage these.

The class soon discovers that if we are rethinking innovation, we also need to rethink common assumptions about entangled factors such as markets, customers, employment, design, research and development. The old formulas treat human beings as a mass — designing for the largest customer base to take advantage of economies of scale, mass marketing, and mass-producing. Economies of scale are dependent on a uniformity that is not the Canadian or global reality. As Todd Rose recently pointed out in his book *The End of Average*, there is no average person.

Our business strategies leave out a large and growing group of customers. It compromises the fit for any customer that does not conform to the mass-produced design. This also leads to greater waste. The number of customers that experience a misfit often far outnumber the 'largest customer base.' With aging and global mobility, we are all diverging further from the imagined average (a recent Gartner study estimated that there is an $8 trillion market for people with disabilities globally).

This misfit, of mass design for a population that is diverse, leads to vicious cycles of exclusion and disparity, especially as products and services are depended upon to take part in

education, employment, civic participation and social engagement. This is compounded by our methods of research, evaluation, and gathering evidence — we ignore the outliers and norm the 'noise' out of the data set. Our entrenched systems of assessment and proof are not tolerant of diversity. However, lasting prosperity requires inclusion and cannot survive significant disparities or growing gaps between 'haves' and 'have-nots.' As Wilkinson and Pickett point out in their recently vindicated book *The Spirit Level*, an inclusive society is healthier, wealthier and wiser.

Lucky for Canada, we can opportunistically take advantage of the monumental socio-technical change our global society is experiencing. Lagging behind in innovation may give us an opportunity to 'leap-frog' nations that have established innovation agendas and infrastructures —or start our own race. We can forego investments in established strategies and invest in strategies that integrate emerging opportunities brought about by converging disruptive technologies —or as one of Canada's celebrated sons, Wayne Gretzky, has put it: go to 'where the puck will be.'

Current socio-technical disruptions our rethinking should consider include: the move from ownership to access (e.g., sharing rather than owning cars, vacation properties, bikes, books, music, apartments …); personalised manufacturing enabled through 3D printing of everything from food to prosthetics; connected communities of interest, maker culture and citizen science; collaborative mashups (e.g., music, apps, videos, etc.); responsive interfaces and portable automated personalisation (e.g., as in the Global Public Inclusive Infrastructure, gpii.net); open data and open government; and new forms of investing such as crowdfunding and the emerging value exchange without intermediaries enabled by blockchain technologies.

Part of the exercise is to design an innovation strategy that does not depend upon big enterprise companies, large-scale and risky investments, cut-throat competition, 'king-of-the-hill' dominance, or iron-clad defence of intellectual property. Instead it should leverage Canada's assets, including but not limited to: communities, rugged resourcefulness, opportunistic responsiveness, diverse small enterprises, cross-sector collaboration, indigenous knowledge, and, of course, diversity.

The cohesive learning community (that the diverse inclusive design students become) ponders many gnarly challenges. How do we transform our institutional hierarchies and rigid silos of expertise? How do we move from standardised jobs that demand that people conform, to jobs that fit diverse people and their diverse lives? Can we create manufacturing systems that engage the customer in design and development, moving from pushing products to responding to consumer pull? What are the benefits of agile, iterative development that values failing early and often, over traditional 'waterfall' development that completes a product and waits for customer response at a big reveal? Can we create research methods that are designed for diversity and complexity and that do not depend on statistical power or finding large representative groups, especially for individuals so diverse and unique there are no representatives to be found? Each candidate response is more than a mental exercise. The diverse team of students and the broader community afford a rich toolbox that can be applied to iteratively implement and refine the proposed designs.

Invariably, the inclusive design students propose that the innovation race we should embark upon is not against other nations but a race against escalating economic disparity and environmental deterioration. They have concluded that, when we broaden our perspective — collaboration and inclusion are good economic strategies and challenges Canada is uniquely prepared to accept.

5.12 Imaginaries

When the Trump administration gained office, I was dismayed by threatened regressions in education policy and by the apparent polarity in views of what education should be, not only in the US but elsewhere. I was also dismayed by the use of artificial intelligence in education, thereby perpetuating and amplifying past biases. In response I began to hold informal conversations with as diverse a group of individuals as I could engage in conversation in my international travels. Appendix D is a short opinion piece I wrote for the conference Open Education for Peace that relays these conversations.

5.13 Lab School for Inclusive Life-long Learning

Recognising that many of the aspirations for inclusively designed education cannot be achieved within the structures and systems of current formal education, I have initiated the next iteration in the application of the framework to education with a global team of educators. We are coalescing to experiment in achieving more inclusive educational opportunities. A project (in early planning stages) is a Lab School for Inclusive Life-long Learning, formed outside of the postsecondary academic structure, as an experimental learning initiative. The Lab School would enable exploration of alternative forms of:

- Recruitment and enrolment of students (including more inclusive processes)
- Instruction (including peer instruction, alternatives to courses)
- Assessment (tests, assignments, peer and self-assessment)
- Certification, (including badging, the use of blockchains, etc.)
- Classes (including post-disciplinary project-based classes, etc.)
- Calendars and scheduling (not constrained by an academic calendar)

The Lab School would collaborate with similar international efforts such as Station 1 established by Christine Ortiz, former Dean of Graduate Studies at MIT (Navarre, 2016)as well as the SMARTlab at University College Dublin. The current plan is to create a co-op structure whereby the members of the co-operative would both act as students and instructors. This would leverage the collaboration between my team and the Platform Co-op Consortium led by Trebor Scholz at the New School . Membership would be life-long, and members would play the role of both learners and educators. Membership would include a scholarship for learners who can't afford membership. The Lab School would borrow many of the successful or promising practices of the master's program in Inclusive Design, without the constraints placed by

univarsity academic policies. It would adopt open education practices. This approach is supported by several universities and colleges, as it would enable the testing of new educational designs without risks to established programs and institutions. It is also supported by the eCampus Ontario (ecampus Ontario) whose mission it is to encourage greater collaboration among post-secondary institutions and promote adoption of more 'future-friendly' academic practices.

5.14 Conclusions—The Three Dimensions Applied to Learning

Because of my engagement in a number of think tanks, consultations, advisory meetings, and colloquia regarding the future of employment, I am worried that we are preparing our students to be unemployed. They have the expectations of engaging in work that will, in reality, be unavailable to them because it will be achieved by machines. We have emphasised formulaic subjects that we can educate at mass. These are the topics and competencies at which machines excel. At the same time, we have demoted many of the aspects of education that will be of value in the near future. We have not developed adequate programs to address the essential skills of this age or the age when they will leave formal education. We continue to place an emphasis on the 'what' of learning, rather than the 'how' of learning.

In our attempts to promote equitable access to learning, we standardise learning outcomes, thereby excluding diversity. Most countries recognise education as a right, but treat diverse learners as an issue, not an asset.

We continue to promote the notion that education terminates; that there is a 'terminal' degree, and that once you graduate you have completed the learning process. These practices will be compelled to change.

Inclusive education, as I have conceived it with my community of co-designers, takes into account the complex adaptive system of systems that is our evolving society. We are working toward a system in which everyone's learning can be optimised and everyone's diverse contribution can be valued. I've summarised the application of the three dimensions in these iterative cycles of applying the framework to education below.

5.14.1 First Dimension

The first dimension is applied by fostering the uniqueness of each learner by personalising not only the learning experience but also the learning outcome. Learners are supported in

continuous self-discovery and self-determination through initiatives such as My Life Long Learning Lab and other preference discovery and exploration techniques. These processes are integrated into a general life-long learning system for every learner, not into a specialised or segregated system.

5.14.2 Second Dimension

The second dimension is applied by engaging learners as co-constructors in their own learning, and by creating as diverse a learning community as possible. The mechanisms for teaching and creating curriculum are also made accessible. Through a co-op model for education, participants are both learners and educators. Experiential and project-based learning encourages a team process that requires a diversity of contributions. Disciplinary boundaries are deconstructed or bridged. Previous barriers to participation in education and participation in planning or co-designing education are addressed.

5.14.3 Third Dimension

The third dimension is applied by viewing education as a complex adaptive system. A diverse, agile approach has been taken that attempts to intervene at multiple points. Interventions have been tried within the current system and by launching an alternative. We have tried to leverage and ally ourselves with other kindred disruptive interests, such as the open education movement, 21st Century learning, the platform co-op movement, future of work thought leaders, and deeper learning. Most importantly, we have attempted to initiate a paradigm shift in education that goes beyond a focus on the human rights aspects of education equity to creating a diverse, integrated educational community that benefits society as a whole.

6   : The Framework Applied to Innovation and Markets

In this chapter I outline the application of the framework to alternative market models, entrepreneurship, and our notions of innovation. I provide an overview of a number of attempts to create a platform for economic inclusion that connects consumers at the margins with producers and suppliers at the margins. I also describe the economic arguments for the design decisions.

6.1   Ursula Franklin and Prescriptive Technologies

When our centre was at the University of Toronto, I had the great fortune to meet, become friends with, and be mentored by Ursula Franklin. She approached me because she was losing her sight and she was good friends with another professor who was blind and who was having difficulty in his lectures. She took me on as one of the many people whose career she nurtured and patiently nudged forward. She provided support while I made the difficult decision to move my centre from the University of Toronto to OCAD University. She was also one of my thesis advisors before she passed away on July 22, 2016.

Ursula was a feminist, pacifist, Quaker, physicist, metallurgist, and pioneer of archaeometry. She was also a systems thinker. She was the first woman to be awarded the prestigious title of 'University Professor' at the University of Toronto. I had the honour of witnessing the granting of her 52nd honorary doctorate at Ryerson. My daughter even attended a high school that was named after Ursula. Ursula was born in 1921 in Munich, Germany, where she survived internment in a death camp during the Holocaust to study experimental physics and come to Canada on a research scholarship. She understood the shared complex histories of that era.

Ursula gave her famous Massey Lecture 'The Real World of Technology' in 1989. I'm embarrassed to say I didn't read the book until 2007, after I had known her for many years. I expected it to be outdated, as any writing about technology quickly becomes. It wasn't. It was prescient, hugely relevant and articulated many of my inchoate intuitions regarding technology that I had suppressed in my drive to find funding for my centre. Ursula never pointed me to her writing, even when I inexpertly expressed ideas she had coherently articulated years before. However, her mentorship helped to galvanise my views of the role of technology and socio-technical practices. Rather than pushing me forward, Ursula patiently listened as my ideas

matured, intervening caringly and introducing me to fellow scholars she felt would be helpful. She stretched my network of collaborators to include scholars in a large range of disciplines through our weekly lunches at the communal tables of Massey College.

Ursula defined technology as a shared practice, the way we do something, not the usual definition of "the sum of the artefacts, of the wheels and gears, of the rails and electronic transmitters" (Franklin, 1999). She saw it as the practice that consists of "organization, procedures, symbols, new words, equations, and, most of all, a mindset" (Franklin, 1999).

Most relevant to my work at the time was her conception of prescriptive technologies. This concept encapsulated my unease with many of the techno-deterministic narratives I was compelled to participate in to garner funding related to emerging technologies. Prescriptive technologies, as Ursula conceived them, split the doing of something into small, identifiable tasks. Each of these tasks could be performed by separate people or specialised units. I saw the impact of this in the production of complex software, and the effect on the programmers and the product. With prescriptive technologies, "control over work moves to the organizer, boss, or manager" (Franklin, 1999). Prescriptive technology sees humans as mechanical entities whose tasks can be optimised for more efficient output. The mindset of prescriptive technologies was driven by the notion of mechanised labour from the Industrial Revolution. The mindset enables remote management, mass scaling, surveillance, and monitoring.

The same mindset powers modern capitalism, continuously making more, newer things, faster, and better. It also undergirds modern financial markets, in that it provides the conditions to be able to structure, quantify, control, and predict the output of labour. That mindset creates the conditions whereby workers learn to do as they are told without the ability to shape either the process or the outcome. The structure creates a culture of compliance "ever more conditioned to accept orthodoxy as normal and to accept that there is only one way of doing 'it.'" Through our narratives of progress and innovation we have created a society that is accustomed to being ruled and monitored without questioning the ultimate output of our collective effort. Command and control is carried out by a class of experts who follow the plans and execute the tasks. Resistance such as the Luddites and Occupy are seen as unfortunate side effects of the disruption caused by innovation. Ursula points out that in this mindset we view "people as sources of problems and machines and devices as sources of solutions" (Franklin, 1999).

These cautions about technology aligned well with the practices of the centre. I resisted a command and control structure. We were early adopters of transparent, agile, iterative processes that included people in all roles of planning. I tried to consult with the whole team before embarking upon a new goal or direction. Our efforts were not driven by advancing the technologies but by intervening in technical progress to push it in more open, transparent, democratic, and inclusive directions. One area where Ursula and I differed was with respect to the question of whether access to technologies or participation in technological 'progress' was essential for people experiencing disabilities. I felt that people at the margins should have a seat at the table; that it was up to people with more power to mount the resistance and resolution not to participate. I also felt that the participation of people currently at the margins could redirect the more dehumanising elements of the technological juggernaut. True to her pacifist conviction, Ursula disagreed. She encouraged abstinence from technologies that corroded social cohesion and self-determination. Her disagreement was tempered by the fact that she was reliant on the technologies herself, due to her failing vision.

Where Ursula and I aligned most strongly was in our worries about the academy and the role that science plays in the overall narrative. She saw science's failure to act as a means to understand and confirm general truths in shared ways. Current science is an imperfect tool that is overapplied. It is particularly weak in contexts where a constant variable cannot be isolated. Many of the human things that matter are impervious to scientific 'proof.' Provable facts trump human experience. Experts and members of the academy with scientific authority become the arbiters of who and what matter and who and what is valid. This value system, ruled by what is scientifically 'provable' supports a notion of progress that focuses on the artefacts produced by innovation, and ignores the human collateral damage. Ursula reminds us that the plural of *anecdote* is not *data*.

Where we differed was in how we should address this. One of Ursula's oft repeated admonishments was "not all problems can be solved, but all problems can be illuminated." In her wise manner she reminded me that an egg can't be unscrambled. I naively felt there must be a way to intervene, not to unscramble the egg, but to produce something more humane with the mess.

6.2   The Injustice of Markets and Outliers

It was with the backdrop of Ursula's prescient wisdom about prescriptive technologies that I came to see the injustice of the markets and the current economy for persons experiencing disabilities. I also came to see the same phenomena biased against any marginalised group or individual. People experiencing disabilities are outliers. Their needs are very diverse. There are no economies of scale for many of their critical needs. This means that what is essential costs more. People experiencing disabilities are also more likely to be below the poverty line. The injustice of mass markets is that those who have less must pay more to survive. Of added impact for people experiencing disabilities is the uniqueness of their needs and the frequent constraints to adapting to a misfit. If I'm paralyzed, it doesn't matter how many physical keyboard options you give me or how inexpensive some of them might be, none of them will work. If I'm not literate in the language of the keyboard layout, I can adapt, I can learn the language and habituate the extra keystrokes needed to write. The vicious cycles of poverty that capture so many people at the margins are harder to escape, and any escape is more tenuous if I'm experiencing a disability.

6.3   Technology as the Solution?

Most of my colleagues in the field were of the attitude that technology was the answer to disability. Even now, 'design' has taken the place of technology. I have a hard time explaining convincingly to some team members why I think it is misguided to say that disability is solvable by design. It seems a rationale extension to our definition of disability. If disability is a mismatch, we can design a match. My sense is that we can intervene and prod the complex adaptive system toward a more generous and inclusive manifestation. In the complex adaptive systems that we live in, there are many things that we cannot control that are needed to vanquish the mismatch. Having witnessed the evolution of assistive technologies over several decades, I knew that even if we create a technology to address a barrier that does not mean it will be financially available or that it will be supported, maintained, and remain interoperable.

   People experiencing disabilities are often used as inspiration to fuel the progress of technologies as a way to silence the detractors. Our centre and the communities we serve are sought out, in a sense, to whitewash the more unpalatable aspects of technical progress. Even now, objections to AI-based monitoring and surveillance are countered with stories of

applications that enable people who are blind to see through pattern recognition and remote human assistance (Charleston, 2017). This is not to suggest that there are not amazing, liberating advances for people experiencing disabilities, but the rhetoric and hype often exaggerate the benefits and downplays the issues.

My unease with the innovation narrative we were inevitably participating in were partially expressed in the *Globe and Mail* op-ed that I included in Chapter Five on learning.

6.4 Alternative Market Models

What I now see as my 'master plan' (Ursula saw planning as a form of technology and instrument of power), was to reuse and reshape selective technical innovations and craft a technical system that could provide more equity, self-determination, and democratic control. This is a plan that is still evolving. What I hope to harness is the mutability and plasticity of the digital and the connectivity of the network or global platforms. Analogous to white-water canoeing which requires riding the rapids and deftly avoiding barriers, and reading the river, flowing with the river, but charting your own course; I thought I could use a similar strategy if I charted the sociotechnical progress river with eyes wide open.

6.4.1 Non-linear Planning Tools

As a side project that accompanies the larger effort, I have initiated research and co-design to create planning tools, evaluation instruments, and project monitoring systems that are more suitable for open, agile, and inclusive co-design. The motivation is to reduce the prescriptive and deterministic nature of planning and make room for more inclusive input. This would replace linear logic models with non-linear models, such as our virtuous tornado, and Pert or Gantt charts with our inclusive mapping tool. Current research monitoring and evaluation tools implemented by funders such as the European Commission or other funding agencies require the creation and adherence to planning tools that lock a project team into a preapproved plan that prevents responsiveness, innovation, or community input. This is not conducive to open processes, agile programming, or co-design. In the process I proposed, each iterative full cycle of co-design would be followed by a reassessment of direction including asking "who is missing?" and "what scenarios are not covered?" I am engaged with a number of third-party project evaluators in the US, the EU, and Australia to formalise the instruments and tools. These same

tools are being considered to monitor progress indicators in public education (Center for Assessment, 2018).

6.4.2 Plan A: Economies of Scale by Aggregating Demand for Specialised Products

The iteratively evolving plan is to create platforms for economic inclusion. One of my first thoughts was to seek out economies of scale by reducing fragmentation and aggregating global demand for specialised products. The costliness of specialised products that do not have economies of scale is an acceptable condition if the special products represent discretionary goods and services, but this comparative pricing becomes highly problematic if most of a consumer's essential needs are special—such as housing, transportation, clothing, tools, computer interfaces, services, educational supports, and other products and services of daily living, as is the case for many people experiencing disabilities.

What is the impact on spending power for the majority of people experiencing disabilities and their families, who live below the poverty line and are struggling to 'make ends meet'? Could the solution be to seek economies of scale in specialised products, such as assistive technologies, by addressing market fragmentation and consolidating demand through the globalisation of products for people experiencing disabilities? Also, will the increased incidence of disability brought about by aging increase demand to sustain a separate assistive technology industry and drive competitive pricing?

I soon found out that there are two issues with this potential scenario: the nature of the disability market and the challenge of interoperability with quickly moving digital systems. As mentioned earlier, people experiencing disabilities are the outliers in the market. Their needs are extremely diverse. Add to this that disability is accompanied by a lessoning of the degrees of freedom to adapt to a suboptimal design. Seeking economies of scale may work for pseudo-majority requirements within the disability market, but if the assistive technology market is to reach the margins, each product must become more specific and diverse, thereby confounding any economies of scale. Exploiting economies of scale in this market only intensifies the disparity of the consumers who are left stranded at the edges.

Second, although certain relatively static manufactured products, such as canes, may find economies of scale, in the digital realm assistive technologies must maintain fool-proof and dependable interoperability with mainstream products, as they are intended to bridge the gap between standard interfaces and the requirements of individuals with disabilities. It is

challenging to remain interoperable with software and hardware systems that are updated almost daily, whose provenance is hard to determine because of the distributed nature of software and network development, and whose specifications for interoperability may be trade secrets. The reliability and currency of computer access systems for people experiencing disabilities is tenuous at best and dependent on agile adjustments in response to mainstream products.

6.4.3 Mass production and flexibility

Mass production to achieve economies of scale lessens flexibility and responsiveness within the supply chain, making the task even more challenging. This conundrum cannot be addressed through a separate or segregated approach, such as an assistive technology industry leveraging economies of scale. What is needed is an integrated approach if we are to address disparity. This implies changing the mainstream approach to design, development, and production.

6.4.4 Accessibility Regulations and Innovation

The relative diversity of individuals with disabilities also presents a challenge to the design of accessibility regulations that govern the digital domain (Treviranus et al., 2010). Enforcement and compliance evaluation requires testable criteria (Blanck, 2014). It is impractical to establish and enforce the relative criteria needed by the diverse group of people who face barriers to access. This compels regulators to create fixed homogeneous criteria in a quickly changing, highly heterogeneous domain. This leads to the perception that accessibility is antithetical to innovation, aesthetics, and diversification, which could not be further from the truth. The resulting conundrum is intensified by the slow pace of legislative change. One area that is most affected is the area most in need of proactive intervention: digital inclusion or 'eQuality' (Blanck, 2014, Treviranus et al., 2010).

6.4.5 Rising Urgency

At the same time, the incidence of disabilities is increasing globally due to a number of factors. The World Health Organization reports that there are between 750 million and 1 billion persons with disabilities around the globe (World Health Organization, 2011). In most Western nations, seniors will surpass children aged 14 or under for the first time sometime between 2015 and 2021. The incidence of disability increases dramatically as we age: 37% of persons age 65 to 74 and 60% of persons age 75 and over experience a disability compared to 15% of the general population. A second factor is improved survival rates from injury, illness, or problems in

pregnancy or birth. This is largely due to improved health systems globally. This is compounded by natural and manmade disasters, violence, or conflict.

While computing systems have become pervasive intermediaries in our daily living globally, assistive technology is not available globally. Specialised accessibility technologies (AT) intended to bridge the gap between standard technologies and the needs of people experiencing disabilities are available in less than 30% of the world. In most countries they are not sold or maintained or they cost more than 50% of an individual's annual income (Borg et al., 2011).

The AT bridge to digital inclusion for people experiencing disabilities is not sustaining the load and it is crumbling. While most information and communication technology is going down in price and increasing in functionality and availability, most AT is increasing in price and decreasing in functionality and availability. The small companies that produce these systems have the impossible technical challenge of interoperability with a broad range of rapidly changing technologies. Many of the technical strategies AT developers rely upon will cease to work as software applications shift to a more component-based, distributed paradigm. The cost of 'getting online' for consumers requiring assistive technology is up to ten times the cost when compared to consumers using standard, mainstream systems. Individuals with disabilities are three times more likely to be among the digitally excluded. These consumers are also overrepresented below the poverty line (B. and Rasool, 2008). The current system of AT as a bridge between the needs of persons with disabilities and mainstream systems may be accentuating economic disparity.

6.4.6   Leveraging Disruptions

Learning from complexity theorists, I thought to take advantage of the disruptions of the conventions of design, production, and marketing (Cooper Ramo, 2009b). First, there was a nascent culture shift in design. Mainstream designers were beginning to recognise the innovation that occurs when designing, not for the typical or average, but for the edges (Brown and Katz, 2009). In some leading corporations, standard tools of design, such as personas, use cases, and scenarios, were moving from capturing the typical or average consumer to capturing 'extreme users.' Several design firms recognised that by addressing the needs of the margins, you encompass the needs of the majority (Donovan, 2012). It was unclear whether this trend would permeate the industry, but even companies like Nike were dabbling with this notional shift (Kassenbrock, 2015).

More significantly, emerging technologies, such as affordable or consumer-grade 3D printers and accompanying 3D capture and editing technologies, help to significantly reduce the barrier to personalised manufacturing. Systems were emerging that enabled the additive printing of everything from clothes to food. It is predicted that it would be possible for every household to have the equivalent of a mini-factory to download 3D designs, make necessary modifications, and produce personalised variants of required products (Lipson and Kurman, 2013). This trend is bolstered by a drive for greater environmental sustainability (reduced shipping costs and reduced waste resulting from production overruns), the ability to create more complex and intricate designs, and the agility and flexibility this brings to industrial design.

Added to this is the Internet of Things (IoT) instrumentation of our environment (Vermesan and Freiss, 2011). These add 'smarts' and connected monitoring and sensing to everything in our environment from fridges to surveillance drones, to our vehicles and city streets, and to personal devices that monitor fitness and health. The associated risks are ominous, including loss of privacy and vulnerability to fraud and misuse, especially for people who are most vulnerable to cognitive barriers, increasing the imperative for people experiencing disabilities to be active in navigating this new territory (Blanck, 2015, G3ICT, 2015). The opportunities are also undeniable, as these innovations may increase the specificity of our 'smarts' regarding optimising our environment and tools to meet our unique needs. These technologies may reduce the necessity to estimate, clump, and cluster around a majority or norm and reveal the full spectrum of diverse human characteristics. Combined with 3D printing (or 4D printing, which adds the temporal element), we may be able to produce technologies that intelligently respond to our changing needs (e.g., supports that adjust to our patterns of movement and medicine that automatically calibrates to our vital signs) (Lab, Autodesk).

Associated with these disruptions are changes in market dynamics. We are moving from an economy that is driven by mass marketing of products (and the associated waste and debt these encourage) to a market where the consumer plays an active role (Rifkin, 2014). Whether it is prosumerism, multisided platforms such as the Android platform or eBay, or platforms for supposed 'sharing economies' like Uber and Airbnb, economies are becoming more demand driven. It is my hope that these will lead to a diversification of demand as consumers are free to express their individual needs and preferences (Morris et al., 2016, Treviranus, 2014b), which may lead to a diversification of supply and production.

6.5   AccessForAll Approach

Together with my team, I initiated a global effort, referred to by many different names but all implementing what we have called the AccessForAll approach, to capitalise on digital adaptability, network-enabled collective production, utilities that enable the discovery and refinement of awareness of personal requirements, and global platforms that connect consumers at the margins with producers and suppliers at the margins to deliver one-size-fits-one products to consumers with disabilities (Lewis and Treviranus, 2013, Vanderheiden et al., 2013).

The envisioned platform for economic inclusion using the AccessForall approach was dependent on an international interoperability standard I spearheaded. We developed the AccessForAll metadata guidelines for the Web4All project (Adaptive Technology Resource Centre), implemented in Canada through a partnership between the Canadian government and our centre at the University of Toronto. In successive years we implemented the approach in projects such as TILE and brought the AccessForAll concept to the IMS Global Learning Consortium Accessibility working group with the support of WGBH SALT funding in 2001. The full IMS specification was implemented in 2003. Since then, the IMS Accessibility Working Group has developed several versions of AccessForAll. In 2004, I acted as project editor when the Canadian government sponsored the adoption of AccessForAll as an ISO multi-part standard (for which I was awarded the International Electrotechnical Commission 1906 Award in 2013). ISO 24751 became a standard in 2008 and is currently being renewed through a second revision.

6.6   Iterative Development of AccessForAll Applications

Leveraging this international standard, a growing global consortium that I co-lead has been iteratively refining the infrastructure, tools, and implementations that enable one-size-fits-one online configurations and resources on demand to support digital inclusion of currently marginalised users. The multiple iterations of this functionality support consumers in discovering their diverse individual needs and preferences, and expressing these in a machine-readable form (using the ISO 24751 or AccessForAll standard). The networked system then reconfigures, augments, or replaces resources and interfaces, to match these needs and preferences. This functionality has been piloted in education, government online, public access stations, libraries, mobile commerce, and other networked contexts. Projects include a very early Canadian effort

referred to as Web4All (http://web4all.ca), TILE (http://inclusivelearning.ca) and Cloud4All (http://cloud4all.info). More recently during my doctoral work and influenced by my research, the projects have included FLOE (http://floeproject.org), Prosperity4All (http://www.raisingthefloor.org/prosperity4all/) and a more limited implementation in the Automated Personalization Cloud Project. With the emergence of cloud technologies, the initiatives have moved to the cloud and are coordinated through a global consortium called the Global Public Inclusive Infrastructure (http://gpii.net) administered by Raising the Floor International which I co-direct.

Movement from general networks to cloud services began with the European Commission (EC) FP7 project Cloud4All. Iterative projects integrated and built upon the functionality of previous projects. The Cloud4All project had built upon the original Web4All project to provide a function referred to as 'automatic personalisation': the infrastructure necessary to allow instant auto-personalisation of software, devices, media, materials, and services based on user needs and preferences (stored in the cloud or on a personal device). This infrastructure allows assistive-technology and mainstream-product manufacturers (software, hardware, media materials, and services) to create products that can automatically change their interface or format to accommodate the needs of each individual as the individual encounters them. The long-term result can be a world in which any individual would find that essentially every device approached would instantly and automatically change into an understandable and usable form.

As I began my doctoral research and exploration of possible alternative market models, I shifted the strategy to a market platform approach. The intention was to create a globally networked market platform from which a new market ecosystem could grow over time to address the market injustices at the margins.

6.7 Prosperity4All

Prosperity4All (P4All), a multi-partner, multi-sector international initiative, supported in part by the EC FP7 program, was intended to be the first instantiation of this larger vision of a platform for economic inclusion. P4All was intended to address the needs of marginalised suppliers and producers as well as consumers. The project investigated the opportunity to harness the global network effect to connect consumers at the margins with pooled resources, and if the resources or user experience configurations don't currently exist, with producers and suppliers at the

margins who could address those needs. In this way P4All was to explore the viability of providing 'what you need, when, where and how you need it' to consumers, while also supplying 'work where, when and how you can' for currently unemployed or underemployed workers, including youth and people experiencing disabilities. P4All was to design, construct, and test a multi-sided platform that would support the economic viability of addressing marginal consumer needs and thereby provide work for individuals who face barriers to financial independence.

We argued that the form of market we envisioned would not only benefit consumers with market gaps, but also producers, suppliers, and innovation. Most consumer markets to date can be characterised as push markets. Producers and suppliers develop and mass-produce products and then persuade consumers that they need these products through marketing and commercialisation efforts. These 'push' markets have become so extreme that some producers spend the largest portion of their capital on marketing and commercialisation, leaving very little for production and innovation (Moorman, 2012). This means that new producers cannot break into the market without the necessary marketing infrastructure and new ideas are difficult to launch without expensive commercialisation and branding efforts. This has been linked to youth unemployment and the poor survival rates of start-ups. Given the costliness of marketing, most producers also compete for the largest market, ignoring marginal products and marginal needs (Asmundson, 2017).

In contrast, we envisioned a 'pull market' supported by AccessForAll, beginning the transaction with the demand rather than the supply. This would greatly reduce the need for marketing and commercialisation. Producers respond to demands expressed by consumers directly. This removes the barriers to market entry experienced by new producers, indie developers, and emerging economies. Consumers also drive the design and can thereby steer production in more diverse directions, enabling a diversification of demand that prompts a diversification of supply and triggering greater innovation. This pull market would be dependent on a means of effectively communicating consumer demands to appropriate suppliers and aggregating fragmented demands through our multi-sided platform (Hagiu, 2007).
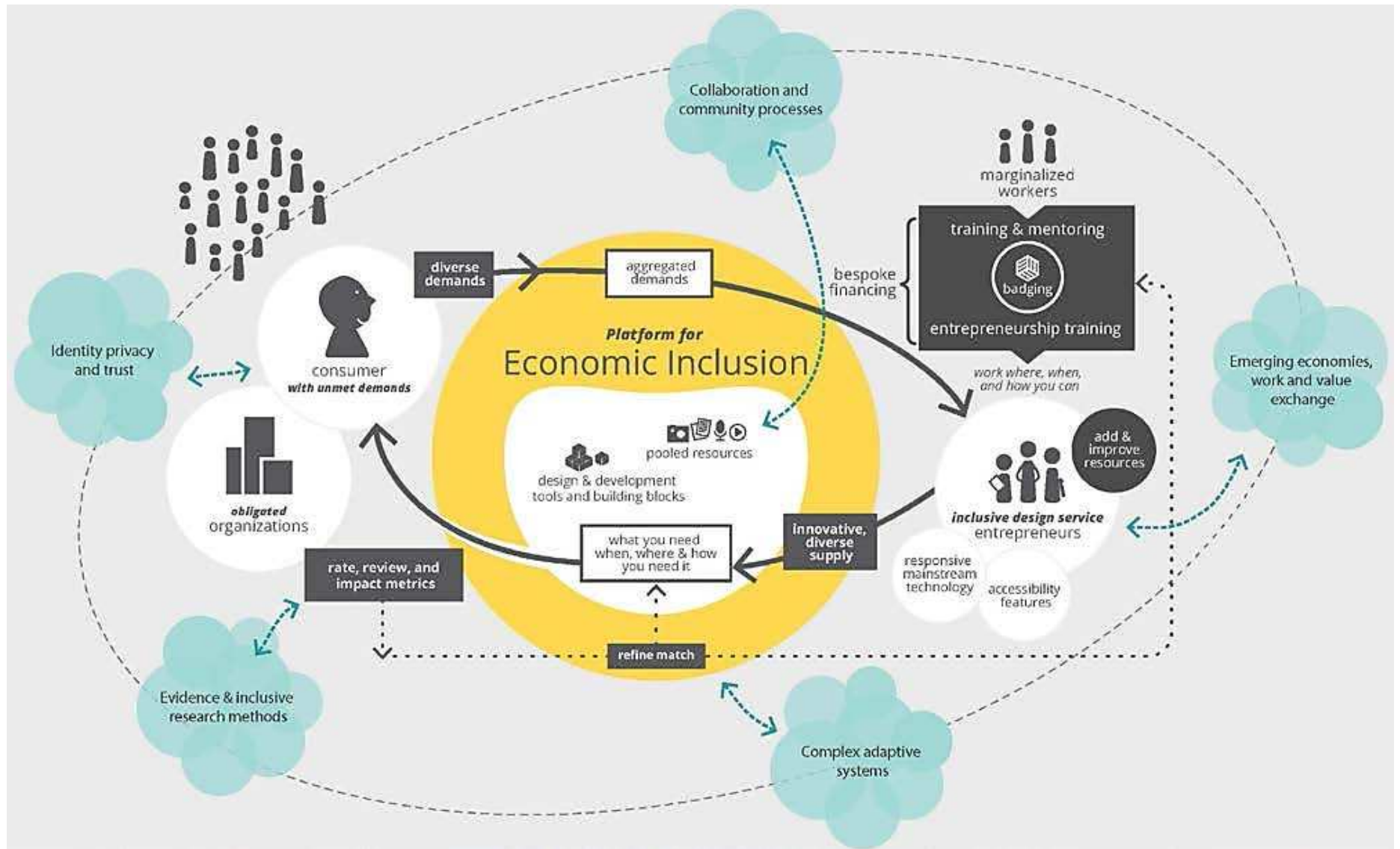
Figure 11:Platform for Economic Inclusion

To support digital inclusion, the demands to be met by the platform ranged from translating material from one sensory modality to another (images to text, text to audio, audio to text, images to audio, etc.), translating from one language to another, enhancing the visibility of material, making interfaces easier and more efficient to control, making interfaces and resources simpler and easier to understand, adding captions, descriptions or transcripts, converting files to more accessible formats, creating apps or applets for specific purposes (such as wayfinding, colour detection, or data mining for decision support), providing live remote assistance, addressing specific barriers or incompatibilities in applications, and modifying mobile device casing using 3D printers, among many others. The skills and knowledge needed to meet these demands could be acquired through training programs and mentorship hosted or linked to the platform. Once the skills are acquired, producers could amass credibility through successful transactions and positive feedback from consumers. This credibility could be certified through badging programs such as those promoted by Mozilla and the McArthur Foundation (Badges, 2016). Training in service entrepreneurship could be offered to support new entrepreneurs in developing a viable business. Thus youth, indie developers, and small enterprises could gain access to a growing global market.

6.8   Difficult Culture Change

The Prosperity4All project was completed in the spring of 2018. While it accomplished a significant set of deliverables, it did not deliver the original intent or vision. I anticipated the culture change required for consumers and producers, but I did not anticipate the degree of culture change required of our many collaborating organisations whose background was in the assistive technology, rehabilitation engineering, and accessibility legislation fields. The Prosperity4All project was funded through the European Commission, which meant that we could not lead the project as Canadians. We were in charge of a subproject that conducted the economic modelling, sustainability models, and business plans for the project. These quickly became misaligned with the remainder of the project. We had envisioned a model in which we would provide the infrastructure that would enable the discovery, exploration, and expression of individual unmet needs, which would then be met by the pooled resources or through a request to potential suppliers and producers. The platform would also provide tools and training for suppliers and producers to create products and services for consumers at the edge, thereby

reducing barriers to market entry. It was to be modelled after other platforms, in which the value, the goods and services exchanged, were to be provided by the consumers, producers, and individuals or organisations that acted as both. We would provide the infrastructure for this market and let the market produce and exchange the items and services of value.

There were several misalignments with our vision and what was actually carried out. The first misalignment was with the views of disabilities. The partners coming from rehabilitation saw the role of matching needs with products as an expert diagnostic role where diagnostic categories of disability should be matched to specific assistive technologies. The partners coming from the assistive technology (AT) field saw the project as a means of boosting the AT market and making the life of AT developers easier and more efficient rather than integrating AT features into standard products. The partners and project leaders, coming from rehabilitation engineering, did not understand the more organic approach to project planning and management whereby we provide a platform that enables others to demand and supply the services and products. They devoted their energies to engineering and equipping the platform with the products and services themselves, rather than recruiting and enabling others. Instead of a platform that connected demand with supply, the project produced a unified listing of accessible technologies, a developer space with tools for assistive technology developers, and a market place where developers could list their products. It was not until the final stages of the project that the majority of the partners fully understood the original vision. This was also in part because at the time that the project began, there was a lack of understanding and popular awareness regarding the economic models of multi-sided platforms. By the time the project ended, Uber, Airbnb and other 'extractive' platforms were widely understood.

While the project did not produce a platform for economic inclusion as we had envisioned it, the project did provide valuable lessons in complex adaptive systems and coordination of many different perspectives or group cultures. Culture change cannot be rushed and needs to begin with the agents of the intended culture change, especially when it is a complex adaptive system of partners.

6.9   The Next Attempt: Platform Co-ops

I have not abandoned my original vision of the P4All project, only tempered and refined it. I'm hoping the understanding within the field will sufficiently evolve to support another iteration

that comes closer to the intended goals. At the time of writing this dissertation, my team and I have formed a partnership with Trebor Scholz, a leader of the platform co-op movement (Scholz, 2017). Unlike the extractive platforms that have hijacked the shared economy narrative, such as Uber and Airbnb, where the workers and homeowners provide the value but do not share in the profit or the governance, the workers in a platform co-op govern co-operatively and share profit. The movement combines the culture of the co-operative movement with the benefits of the internet. We are not starting with the market platform I envisioned but with labour co-ops. Our initial partnerships will focus on care co-ops (child-care, attendant care and elder care). We hope to learn from the studies, insights and advice of researchers who have investigated older carers, the impact on poverty, and the training required for carers of individuals with autism and intellectual disabilities, including the extensive work of Dillenburger, Goodman and colleagues (Dillenburger et al., 2015) (Cohen, 2016, Cohen et al., 2017). In this way we can 'work out the kinks' before attempting to make good on the original vision. We also hope to mount a life-long learning lab as platform co-op, whereby members are both learners and educators with a life-long share in the platform.

6.10 Barriers to Participation

Despite the opportunities presented by emerging technologies and evolving markets, it may still be the case that individuals with disabilities and their supporters are relegated to the role of consumer or passive recipient rather than as active participant in decision making, design, and production, thereby blocking a full, virtuous cycle. Unless the modes of production or authoring are inclusively designed, people experiencing disabilities cannot participate as authors, designers, and producers (Treviranus, 2008). Component libraries, game development kits, mobile app authoring environments, and 'next-generation' software development toolkits democratise the design and development of software and mobile applications. Maker systems and hardware kits enable the creative exploration of the Internet of Things (Morin, 2013). Although some of these systems are designed to be usable by children, work still needs to be done to make them accessible (Washington, 2015).

Similarly, organisations and governance bodies that design and develop standards, specifications, and policies that guide these emerging systems include entrenched conventions and customs that prevent inclusive participation. Whether it is meetings in inaccessible venues,

prohibitive expenses of membership and travel, or inaccessible collaboration tools or information, the disability perspective is excluded to the detriment of people experiencing disabilities, but also to society as a whole. The Web Accessibility Initiative of the World Wide Web Consortium, a notable exception, has included participation of the disability and accessibility community in the W3C from an early stage. This has played a large part in the success of the Web (Treviranus, 2014b). But even here, the technical expertise needed to meaningfully participate is not accessible to many people whose perspectives would enhance the effort.

6.11 Design and Innovation Applied to Wicked Problems

One of the principles that has dominated business and the design of products, causing the marginalisation of the edge needs is the Pareto Principle or the 'law of the vital few.' There are many interpretations of this principle and the associated rules, but the crux of the advice is to tackle the 80% first, which will theoretically require 20% of the effort, and leave the most difficult 20% for later. I attempted to convince an otherwise progressive unit within the Ontario government to abandon this practice and principle after they committed to 'starting with quick wins.' I was invited to author a blog at the time of their annual conference. In it, I suggest that you should do the opposite of the interpretation of the Pareto Principle and address the edges first (See Appendix E: Blog Post Contesting the Pareto Principle in Design).

6.12 Conclusions and Three Dimensions Applied in Innovation and Markets

People at the margins are caught in vicious cycles of poverty and exclusion. Some of the sociotechnical trends that are disrupting markets may also provide interventions in these cycles of poverty. I have applied the framework to develop alternative market models.

6.12.1 First Dimension

With the help of my team, I have attempted to create a market that recognises that everyone's needs are unique and not best addressed by mass markets. We have created tools, environments, and supporting technical standards that empower all consumers to discover, explore, and refine their understanding of their personal needs and preferences. We have tried to move away from a market model whereby digital inclusion for people experiencing disabilities is addressed through a separate AT market, and move toward an integrated approach whereby 'special is the norm.'

6.12.2 Second Dimension

I have attempted to recruit and provide the tools for diverse consumers to participate in the design and production of markets and the products and services they exchange. Associated with this is the democratisation of the modes of design, development, and production through more accessible coding tools and design tools.

6.12.3 Third Dimension

I have led the field in applying a systems approach to addressing the needs of consumers with unmet needs at the margins. I have, however, not taken into account the complex adaptive system that is the field itself. I hope that the next iteration will be more cognisant of the evolutionary stage of the field.

7 : The Framework Applied to Policy

This chapter outlines a case study of the application of the Inclusive Design framework to the design of policy and regulations, specifically the refresh of the Accessibility for Ontarians with Disabilities Act (AODA) (2018), Information and Communication Standard in 2017. Ursula Franklin argued that planning and policies should be viewed as a technology and thereby subject to the same cautions and design processes (Franklin, 1994).

For many years, in many presentations, I had asserted that laws and regulations are too slow to change to adequately regulate the accessibility of the quickly changing information and communication technology domain. I also argued that the requirement for specific testable criteria meant that laws were too blunt an instrument to meet the range and diversity of needs of persons experiencing disability. Laws, regulations, and policies require absolute testable criteria. Compliance is judged on a binary basis: either you are compliant, or you are not. There is little room for prioritisation, or adjustment and tailoring to the specific scenario of the individual requiring access. However, accessibility laws have been a powerful impetus for greater accessibility. They are especially effective in areas where requirements and the things to be made accessible do not change quickly or often, such as the built environment.

My unease with technology-specific regulations in the domain of information and communication technology (ICT) was reinforced by my participation as the expert witness in a number of human rights trials. Two pivotal trials were the Australian Human Rights case representing Bruce Maguire against IBM and the Sydney Olympics Committee Organising Group in 2000 (summarised and analysed in detail by Joe Clark (2001) in his book *Building Accessible Websites*), and later the Donna Jodhan Case against the Canadian government (BakerLaw, 2012). In both cases it became clear that the existing laws, while powerful tools, were a poor fit for the specific needs of the individuals who faced barriers. This made it difficult to conform to the requirements of the legal process while also testifying regarding the nuanced relationship between the 'claimant' and the socio-technical system. The requirement for 'black and white,' unequivocal responses was difficult. The individuals faced significant barriers, but rigid adherence to the letter of the law was also not optimal. As background to the application of the Three Dimensions of Inclusive Design to a regulatory framework, I will recount the details of the

more recent case and review the web accessibility standards that form the technical requirements of most ICT regulations globally.

7.1 The Case of Donna Jodhan versus Government of Canada

Donna Jodhan is a business consultant active in the Web accessibility community who is blind. She had attempted to apply for a job with the Canadian government. The process required an online application which was inaccessible to Donna. Before Donna Jodhan and her lawyer David Baker approached me to act as an expert witness in a human rights case against the Canadian government , I had worked with the federal government for several years to attempt to ensure that government services would be accessible to people experiencing disabilities (Jodhan, 2013). As a member and chair within the Web Accessibility Initiative of the W3C, I had worked with others to integrate the Web Content Accessibility Guidelines (WCAG) into the Common Look and Feel, the standard established for Canadian government websites. For several years there was also a great deal of work within the Treasury Board to design a Federated Architecture that would embed accessibility. My team and I had helped create a large set of personas that would better represent the range of requirements of people experiencing disabilities, to guide the design of the information technology architecture of the government.

However, in the months preceding Donna's request, experts and staff responsible for accessibility were terminated or drastically reduced. Several initiatives, including an effort to create procurement language that would ensure that tools and services procured would be accessible, were terminated. In speaking to colleagues within the government, it became clear that there was a systemic problem that could not be addressed internally by individuals responsible for accessibility within the government.

Ironically, this was in large part because of the accessibility requirements enacted by the government. The Common Look and Feel that guided government websites prescribed WCAG 1.0 written in 1998. This first version of the guidelines prohibited the use of scripting languages such as Javascript or Ajax (unless the functionality was available without these scripts). These scripting languages were just emerging in 1998 but were necessary to create interactive content in the early 2000s.

These guidelines were in direct conflict with a major government initiative at the time. Government webmasters and developers were mandated to move government services online,

which required the use of scripting languages such as Javascript and Ajax. Thus, government Web developers were caught in a bind. They could not perform their job and comply with the accessibility requirements in the Common Look and Feel (Treasury Board of Canada Secretariat, 2010). When we spoke to government developers we discovered that most of the discussion regarding accessibility was not in how to make websites accessible but in how to justify an exemption and the administrative steps that needed to be followed to be granted an exemption from the accessibility requirements. The general opinion of accessibility requirements held by government Web developers was that accessibility was counter to technical innovation, constrained usable design, and dictated aesthetically ugly sites. We attended and spoke at many meetings regarding government IT infrastructure, and the tone of the meetings was generally either hostile or dismissive of accessibility requirements.

At that time the W3C WAI had addressed the issue of scripting languages and accessibility. The new version of WCAG, in candidate recommendation stage and applied broadly at the time of Donna's request, had altered this guideline (Caldwell et al., 2008). A new W3C technical note called Accessibility for Rich Internet Applications (ARIA) to guide the accessible use of scripts had been drafted and was in common use (W3C, 2017). We asked the government to update the Common Look and Feel and to train government web masters in ARIA. This was denied with the justifications that WCAG 2.0 was not yet a recommendation. However, the WCAG 2.0 guidelines were stable and applied in other countries, such as Australia and New Zealand. Also, the US had omitted the guideline regarding scripting in their Rehab 508 regulations (Foley and Regan, 2002).

We also heard from staff within government that the WCAG guidelines were too difficult to follow. We had recommended that the government adopt authoring or development tools that complied to the Authoring Tool Accessibility Guidelines (ATAG 1.0) recommended by the W3C at the time (Treviranus et al., 2000). Compliant tools would produce content that automatically created accessible content or guided authors in creating accessible content. At minimum we requested that templates issued centrally by the government and used to create online content integrate accessibility features. This recommendation was dismissed.

The situation was grim at several levels. Government staff with an interest in accessibility were extremely frustrated and communicated a sense of powerlessness. We were approached by an increasing number of citizens with disabilities who found they could not use the government services because of accessibility issues. I represented Canada in many international

forums, and while the politicians and government representatives continued to claim that Canada was exemplary in its Web accessibility practices, the people who were technically knowledgeable internationally knew better, and Canada's reputation was declining. I had seen international reports that showed Canada was seriously lagging in ensuring that there was equal access to online government services (United Nations, 2010).

When Donna and David approached me, I had already concluded that other routes to achieving equal access for Canadian's with disabilities had been depleted. The message I received from sympathetic staff within the government was that the pressure and action for Web accessibility needed to come from outside the government and that their hands were tied.

The final deciding factor came when I heard rumours from US and Canadian colleagues that the Canadian government had procured an inaccessible identity management, secure payment, and secure authentication system. This system had been rejected by the US government because it did not comply with accessibility requirements. At the time, the disability advocacy community did not fully understand the implications of this. Services that required secure sign-on were not as common as they are today. People were just beginning to understand the accessibility of static Web sites and were much less aware of interactive content. However, I greatly feared the implications of this procurement. All-important transactions with the government would eventually require secure sign on. This meant that people experiencing disabilities would not have equal access to critical online government services, such as applying for passports, tax filing, or any online forms that asked for personal or private information. People experiencing disabilities could not enjoy the privacy protection or convenience that other Canadians enjoyed.

Unfortunately, some friends and colleagues in the Web accessibility community did not understand the implications either. My very good friend Cynthia Waddell, who had been a staunch leader and advocate for Web Accessibility in California and elsewhere, was persuaded to act as a witness for the government and to counter my testimony regarding the government's record in accessibility. We had just co-authored an international report on assistive technology for G3ICT, and I greatly respected her expertise in accessibility law. Her testimony in Donna's case was based on the government's performance with static, non-interactive content. Her tool 'Cynthia Says' that tested Web Accessibility did not test interactive content.

From my perspective, the entire legal process felt a bit like completing a delicate and intricate task with oven gloves on. We were dealing with complex and poorly understood technical issues. To achieve what I felt we wanted to achieve required technical knowledge and forethought that was beyond the comprehension of the lawyers and any average judge. The fact that our lawyer understandably did not have the technical knowledge needed to fully understand the issues, meant that there were quite a few regrettable misstatements that I feared would hurt our side. We were saved because the lawyers for the government understood even less and completely missed the misstatements.

I was surprised, and in some ways not surprised, by the government testimony that supported our side better than anything we could have produced. At times it felt that technically knowledgeable and supportive people on the government's side were using the general lack of technical knowledge by the legal individuals to send us information to support our case.

I believe that without the work of young, knowledgeable legal assistants to the judge and to David Baker, the ruling would not have been as perceptive, technically accurate, and effective as it was. We had been warned that the judge had never ruled in favour of a human rights claim and was generally a hard-lined judge. My respect for the judge grew as I watched him diligently seek an accurate understanding of the technical issues while sifting through the technically murky communication from lawyers from both sides. The trials were a great lesson in simplifying the message. At times I worried that we were oversimplifying and were losing necessary nuance and detail. Despite this, the judgment did not suffer from oversimplification or misunderstanding. It was a pivotal case and resulted in far better support for accessibility by the federal government, as periodically verified by third party reviewers mandated in the ruling. (See Appendix F: Affidavit for Donna Jodhan Human Rights Case)

7.2 The Web Content Accessibility Guidelines

The dominant accessibility benchmark applied to digital systems is the Web Content Accessibility Guidelines (WCAG) of the Web Accessibility Initiative (WAI). The WAI is part of the World Wide Web Consortium (W3C), the body that ostensibly governs or develops interoperability specifications for the Web.

The WCAG is one of three guidelines developed by the WAI. While WCAG specifies the criteria for accessible content, the User Agent Accessibility Guidelines specify the criteria for

accessible browsers, players, or viewers, and the Authoring Tools Accessibility Guidelines specify both how to ensure that people experiencing disabilities can author accessible content and how to ensure that authoring and development tools support the creation of content that adheres to WCAG criteria. Together the three guidelines provide a framework for an accessible Web.

The WCAG criteria have been embedded in accessibility legislation and policy in numerous jurisdictions globally and are recognised as the de facto accessibility standards for the range of websites but also for digital documents, mobile apps, and digital media. Over the two decades of the WAI, a strong Web Accessibility community and culture has emerged concerned with the promotion of the standards and its implementation in a quickly changing technical domain.

Despite this proliferation, most websites globally do not meet these standards, and many people experiencing disabilities face significant barriers to using the Web (United Nations, 2010). The most common reason given for this general lack of compliance with legislation and policy is that the guidelines are very complex and difficult to apply. Advocates point to the lack of effective compliance enforcement. Legislatively available punitive action is rarely acted upon. Others have blamed the emergence of automatic testing tools that fail to recognise the importance of human judgment and contextual evaluation in assessing compliance to the WCAG (Vigo et al., 2013). Together with other proponents of authoring supports, I have pointed to the futility of communicating complex standards to the growing variety of authors, most of whom are not motivated to address the needs of people experiencing disabilities. We argue that the focus should be on legislating the Authoring Tool Accessibility Guidelines as most people employ authoring or development tools to create Web content. There are far fewer authoring tool developers than there are Web content developers, and ATAG compliant authoring tools would result in accessible content even if the authors are not knowledgeable or motivated to create accessible content (Treviranus, 2008).

While the WAI WCAG guidelines have not had the desired impact, it can be argued that the WAI has had a profoundly positive effect on the W3C and the Web overall. The presence of disability advocates as part of the W3C process and the commitment by Tim Berners-Lee to a Web for everyone has led to the adoption and survival (despite commercial and proprietary forces) of principles and specification that support a flexible, open, and diversity-supportive Web (Berners-Lee, 2010). It can be said that this has enabled the Web to thrive and become ubiquitous. Technical specifications — such as the independence of presentation from content,

the importance of structure for navigation, the documentation of function, and the clear association of labels with content and functional elements — that support the diversity of requirements represented by people experiencing disabilities also support adoption by the diversity of users globally and prevent the Web from being controlled by a single commercial interest.

Where the Web and the Web Content Accessibility Guidelines support the flexibility and adaptability needed to foster diversity —diversity of production as well as consumption —they have thrived. Due to a number of factors, WAI and specifically WCAG has been compelled to abandon flexibility. The primary influence has been the requirement for testable criterion within legislation.

7.3   Authoring Tool Accessibility Guidelines

When the Web Accessibility Initiative of the World Wide Web Consortium was formed, there were three areas identified that needed accessibility guidelines: content, authoring tools, and browsers or user agents. I chose to chair the Authoring Tool Accessibility Guidelines Working Group because I felt that the authoring process and the tools used to author content were essential to promoting inclusion on the Web. Authoring tools play two very critical roles in Web accessibility: they offer a powerful mechanism for promoting the creation of accessible Web content and they are the key to equal participation in communication over the Web, enabling users to be producers and not just consumers of Web content.

Most Web content is authored using an authoring tool; there are very few authors left who code webpages using raw HTML. These authoring tools greatly influence the Web content created. Some markup is automatically generated for the author by the tool: authors are presented choices and advice, offered pre-authored content and templates, and assisted in checking and revising their content. Each of these functions presents an opportunity to promote the creation of accessible Web content.

To date, the focus of Web Accessibility discourse has been on access to information or on people experiencing disabilities as consumers of information. It is just as critical that people experiencing disabilities be producers of information and participants in the global and local conversations occurring on the Web. This is not possible without accessible authoring tools.

Both the first and second version of the Authoring Tool Accessibility Guidelines provide criteria for enabling people experiencing disabilities to author Web content (Richards et al., 2015).

7.4 The Accessibility for Ontarians with Disabilities Act

This chapter describes my application of the framework to the design of regulations. The regulation that was re-designed was the Accessibility for Ontarians with Disabilities Act, Information and Communication Standard. A description of the inclusive design process requires a review of the history of the AODA.

The AODA was passed in the province of Ontario in 2005 (Beer, 2010). The commitment of the AODA was to create an accessible Ontario by 2025 by creating standards to be followed by both public and private organisations operating in Ontario. The AODA was unique globally in that it removed the burden of litigation and complaint from the wronged party, the person with a disability, who frequently does not have the time or resources to litigate. Accessibility compliance is positioned in line with public health or environmental safety. Non-compliance is viewed as a punishable infraction against the province, which monitors and audits regular reports from all obligated organisations.

The AODA was a response to the critique of previous accessibility legislation in Ontario, the Ontarians with Disabilities Act (ODA). The ODA required public organisations to report barriers to participation by people experiencing disabilities, produce plans consistent with their resources to remove the barriers and to prevent new ones from happening, within reasonable timelines. The ODA had no enforcement, imposed no penalties, and required no deadlines.

The AODA consisted of five standards, beginning with a customer service standard in force in 2008 and followed by an integrated set of standards consisting of Information and Communications, Employment, Transportation, and Design of Public Spaces that was in force between 2011 and 2013 (Moran, 2014). The Information and Communication Standard integrated the Web Content Accessibility Guidelines of the Web Accessibility Initiative of the World Wide Web Consortium.

Each standard, as required by the Act, was developed by a Standards Development Committee (SDC), with representation from both potentially obligated organisations and representatives of people experiencing disabilities. Given the unequal committee experience

and resources of people experiencing disabilities compared to organisations; committee members with disabilities were supported by researchers and other administrative staff.

I was heavily involved in the formulation of the first set of standards. I was on the Minister's Accessibility Standards Advisory Council, which advised the minister in the development of the standards. I also conducted the jurisdictional scan for the Information and Communication Standard together with my team, analysing promising examples and lessons learned from international practices. I was contracted to create a 'seed' standard as a starting place for the Information and Communication Standard and to advise the committee throughout the process. The makeup of the standards committees resulted in an adversarial and often polarised debate regarding the formulation of the standards, with disability advocates pushing for faster and more fulsome requirements and the representatives of potentially obligated organisations pushing for fewer standards and longer timelines.

The resulting Information and Communication standard did not appreciably resemble the 'seed' standard I had proposed, the multiple proposed revisions I drafted in response to committee input, or even the recommendation the committee put forward through a consensus process. The draft standards went to public review twice in the drafting process. The standard laid out a range of timelines that varied with public or private organisations and organisational sizes in terms of employees. It required that public institutions lead the way with earlier timelines, followed by larger private organisations and finally smaller private organisations with 50 or more employees. Ultimately, legislators used the committee recommendation to produce the final standard. Many recommended requirements were omitted, portions were reorganised, and exemptions were added to the final adopted standard. Strangely, the drafts and committee recommendations disappeared from public record, although a disability advocacy group, the AODA Alliance led by David Lepofsky, a blind lawyer who had been instrumental in the passing of the Act, retained and published all the committee drafts and vigorously critiqued the standards (Accessibility for Ontarians with Disability Act Alliance).

7.5   Review and Refresh of the AODA Standards

As part of the required process laid out by the Act, there were two independent reviews of the standards, one by Charles Beer in 2010 and one by Mayo Moran in 2015. Another requirement of the Act was a review and refresh of the standard every five years. In 2017 I was appointed to

the Information and Communication Standards Development Committee to help refresh the standard. I was also asked to Chair a sub-committee or task force, called the Digital Inclusion Sub-committee, tasked with addressing the more technical issues and recommendations. My sub-committee was made up of five members with expertise in information technology, all with extensive industry experience. Most of the committee members experienced disabilities as well, and two were graduates from my master's program.

7.5.1 A New Legislative Framework

The sub-committee was given the reviews of the AODA standards in force, collected by the Accessibility Directorate Office of the provincial government and the Compliance Branch. In addition to reviewing the technical landscape and producing a list of requirements and testable criteria that would address current and predicted future accessibility barriers, the committee was asked to answer the question "What is accessibility?" within the domain of information and communication technology. I interpreted this as licence to rethink the approach to the information and communication regulatory framework.

We divided the task into two phases. I led the committee in producing a Phase 1 set of recommendations that offered necessary revisions to the current standard but left the overall framework in place. I also engaged the committee in a co-design process to arrive at an inclusive design of the overall legislative framework, dubbed 'Phase 2.' This co-design process and the resulting overview I produced followed the Three Dimensions of Inclusive Design. The recommended framework also embeds the three dimensions.

The following is the overview I produced, reviewed by my committee, which outlines the proposed redesign. This document is being edited by a plain language editor in preparation for full public review in Ontario. Together with my team at the IDRC, I developed a set of infographics to communicate the framework and help visualise the parts. Sepideh Shahi, a talented inclusive designer on the team, proposed the mental model of a ship sailing on an uncertain sea. This generated a number of useful and evocative icons, including a compass for the regulations which maintains a true course and direction, a ship's wheel for the Trusted Authority to steer the ship, and a number of resources and tools provided by the Community Hub. During meetings with the Minister's Accessibility Standards Advisory Committee, it was requested that I rename the Community Hub because of a collision with other Community Hubs

Accessibility Ecosystem

From obligation to participation

The AODA Accessibility Ecosystem is like a ship in an unpredictable and changing global and technical context. The Laws provide the compass, the Trusted Authority steers the course, and the community uses the community platform to provide the ideas, tools and resources needed to make the journey.

Culture change

Innovation

ONTARIO COMMUNITY

COMMUNITY PLATFORM

Qualifying innovative methods

Responding to changes in context

TRUSTED AUTHORITY

Retiring outdated methods

Needed Adjustments

How To Achieve It

Training

Community feedback and monitoring

Ensuring tools and resources are available

Opportunities

Measures that bring about long-term culture change

What Must Be Achieved

Pooled resources and tools

Regulating overall process

ACCESSIBILITY LAW

Research and guidance

Innovative approaches to addressing barriers

Functional accessibility requirements that remain constant

Barriers

Figure 12: The Accessibility Ecosystem

Treviranus, J.   The Three Dimensions of Inclusive Design
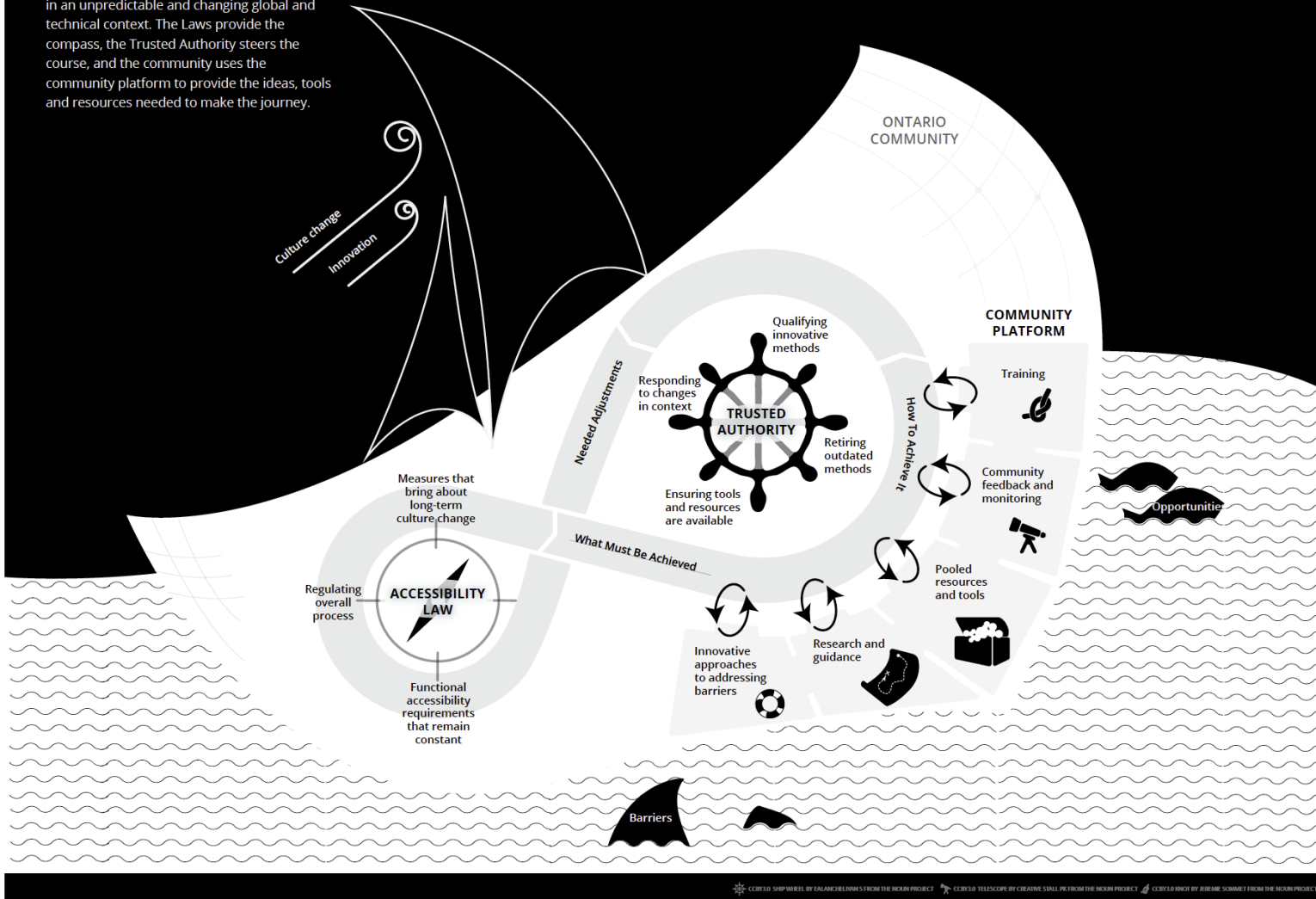
7.6   Phase 2 Overview

Intent and Background

The Digital Inclusion Sub-Committee was asked to answer the question "What is accessibility?", and to propose a strategy to ensure that Section 14 of the Integrated Accessibility Standards Regulation (IASR) would keep pace with changing technology. The Subcommittee was also provided with public feedback and review comments regarding the current IASR to guide their deliberations. A recurring theme in these reviews was the lack of clarity, guidance, support and resources needed to comply to the regulations.

Considering the ultimate AODA goal and timeline "an accessible Ontario by 2025," the subcommittee identified several issues:

- How do we define 'accessible'?
- How do we speed up advances toward an accessible Ontario (recognising that the current rate of change will not succeed in achieving any understanding of an accessible Ontario)?
- How do we create the conditions whereby it is easier for organisations to address the accessibility goals?
- What happens after 2025?
- How do we anticipate and respond to new barriers and opportunities between the five-year updates of the IASR (recognising that technology is changing very quickly and in unpredictable ways)?

The understanding of accessible in the digital domain has evolved since the AODA was drafted. People in the field and the public are recognising that persons that experience disabilities are very different from each other. In fact, they are more diverse and variable than people that are well served by products and services made for the 'average' person. It is also more difficult for a person with a disability to adapt to a one-size-fits-all accessible design that does not fit them well. It is now understood that 'accessible' does not have a single specification. What is accessible depends on the person, their goal and their context. This means that to achieve accessibility requires an inclusive process. It is a process that recognises that all people are variable and diverse and our products and services must make room for the range of human differences.

Even if all the specified goals of the AODA were to be achieved by 2025, there would be people with disabilities that are still left out, for whom Ontario is not accessible. Considering how quickly our society is changing, there would be new barriers and new opportunities for greater accessibility emerging all the time. The Subcommittee concluded that creating a comprehensive accessibility check list that would address the needs of all Ontarians with disabilities was an impossible task. People not represented in the deliberations would likely be left out, unanticipated new barriers would not be considered, and new technologies that can be used to address barriers would not be leveraged.

A new approach is needed. Ontario needs a culture change. This culture change can only happen if Ontarians recognise that an accessible Ontario benefits everyone and is everyone's shared responsibility. The proposed approach must move from presenting accessibility as an obligation that must be borne by a specific group of organisations in

Ontario, to a process only that all Ontarians participate in and benefit from. The approach must also recruit the innovative and collaborative capacity of Ontarians to address the challenge of accessibility.

These realisations led the proposal of an Accessibility Ecosystem. The Ecosystem is designed to support:

- ongoing participation and shared responsibility by all Ontarians,
- an accessible platform to share and review accessibility tools, resources and guidance,
- responsiveness to changes in technology and how technology is used,
- means to address needs that are not anticipated in the standards,
- means to implement and reward accessibility innovation,
- prioritisation of system-wide processes that support continuous improvements in designing services and products that fit human differences, and
- the necessary culture change in Ontario.

Proposed Phase 2

A new organisation of the Information and Communication standard is proposed. This new way of organising the standard is referred to as the 'Accessibility Ecosystem.' The primary aim of the Accessibility Ecosystem is to encourage organisations to see the AODA as something they participate in for their own benefit and the benefit of all Ontarians, rather than as only an obligation. This new way of organising the standard will also provide a way to keep improving and updating how we address barriers faced by persons with disabilities in Ontario up to and beyond 2025.

The objectives of the Accessibility Ecosystem include, to

- Keep up with changes in technology and how the technologies are used;
- respond to new barriers that are brought about by these changes;
- respond to new opportunities brought about by these changes;
- respond to barriers not anticipated when writing the standards, especially barriers experienced by individuals not considered or included in the AODA consultations;
- invite organisations and the larger community to find innovative ways to address barriers;
- discourage an 'us-them' attitude towards accessibility where the interests of persons with disabilities are seen as in opposition to the interests of businesses and encourage working together to make things more accessible to benefit everyone;
- communicate that accessibility is a responsibility we all share;
- show how accessibility and inclusive design help the economy, are a way to practice good design and a good way to do business;
- reduce confusion about the regulations and make it easier to find tools and resources needed to comply to regulations;
- provide clear, up-to-date, specific advice regarding how requirements can be met; and
- Create the conditions and supports so that all Ontarians feel that they can participate and have a role to play in removing barriers.

The Accessibility Ecosystem

The proposed Ecosystem has three parts that support each other. These are the Laws, the Trusted Authority, and the Community Hub. Each part helps to tell organisations what they need to do to remove barriers. The three parts are different in how flexible they are and in how much ongoing participation there is in the activities. Because technologies change very quickly, the less flexible parts of the ecosystem do not name technologies.

The three parts are as follows:

1) The Laws

This is the least flexible part. The Laws provide a compass for what must be achieved. The Laws do not specify how the requirements must be met. The Laws would include three types:

> Functional accessibility requirements (FARs for short)– these would not mention specific technologies. They would reference requirements that are constant. These would be linked to acceptable methods to meet the requirements that are provided by the Trusted Authority.

> Regulations regarding the policies of the Ecosystem – these would specify the policies that govern the Trusted Authority, the Community Hub and the means of updating the Laws.

> Regulations that support system-wide long-term changes and improvements in the accessibility of Ontario. Important examples are:

> - integrating education about accessibility in all education from the start (as early as K-12)
> - requiring accessibility when purchasing products and services (especially when spending public funds)
> - including people with disabilities in decision making and planning processes and ensuring that mechanisms for participation are accessible

2) Trusted Authority

The Trusted Authority would be an ongoing and financially supported group. It would include people with a wide range of expertise, including lived experience of disabilities.

The Trusted Authority must be credible, understandable and reliable. The Trusted Authority would have the power to consult with any individual or group to address knowledge and skill gaps.

The responsibilities of the Trusted Authority would include:

> - Determine and provide clear up-to-date *qualifying methods* for meeting regulations. (The initial set of qualifying methods would include the Web Content Accessibility Guidelines 2.0 and other standards such as EPUB and ISO 24751 to address technologies beyond the Web.)
> - Help to make sure that tools and resources are available to follow the qualifying methods.

- Provide guidance regarding how to achieve the functional accessibility requirements that is tailored to the services and products offered by participating organisations. This would include links to resources and tools in the community hub.
- Retire qualifying methods that are out of date.
- Clarify laws when there is uncertainty or when there are changes.
- Review new and innovative methods proposed by organisations and individuals to determine whether they can be used to meet the requirements.
- Address gaps in qualifying methods that are available to meet the requirements.

3) Community Platform

The Community Hub would include an online platform that is open to everyone in the community and that provides a simple and clear way for community members to contribute their knowledge, expertise and constructive criticism.

The functions of the Community Hub would include, to

- Collect and make accessibility resources and tools easily available.
- Share training and education.
- Make it possible for community members to monitor and review how organisations are doing in meeting the requirements.
- Empower communities to organise events and activities that support accessibility (for example Mapathons and Design Challenges)
- Showcase and share good examples of accessible practices.

Participating in the Ecosystem

The Ecosystem would include an accessible online interactive guide that is designed for many different types and levels of knowledge about technology, accessibility and the law. It would guide organisations in finding out what laws apply to them, what the qualifying methods are for meeting the applicable laws, and what tools, resources and training are available to make their services accessible. It would also provide a way for the large variety of community members to contribute and review new ideas, methods, tools and resources to address barriers and propose ways to take advantage of new accessibility opportunities.

Glossary

Qualifying Methods: a means of meeting a Functional Accessibility Requirement for a type of service or product, that is sanctioned by the Trusted Authority (for example a specific success criteria of the Web Content Accessibility Guidelines). Qualifying Methods can refer to specific technologies and formats and are linked to tools and resources needed to employ the method available in the Community Hub.

Participating Organisations: Organisations within Ontario, including organisations obligated by the AODA, previously referred to as 'obligated organisations.' The renaming recognises that a role of all organisations in Ontario is to participate in promoting and advancing accessibility for their own benefit and the benefit of Ontario as a whole.

Functional Accessibility Requirements: Requirements of the Law stated as functional characteristics that do not change with changes in technology or practices. These refer to the characteristics of services and products and the associated choices that must be offered to enable use by persons with diverse needs.

Platform: An online service that connects people that need something with resources that meet those needs or people that can meet those needs. The platform provides a place to pool shared resources and tools, attach descriptions, including constructive criticism of the resources and tools. Platforms have points of entry suited to the different users and contributors of the platform.

The Addition of Compliance and Enforcement

A late addition to the application of the framework to the AODA is the inclusive design of the compliance and regulatory enforcement policies. At the moment the regulations are enforced by a department of the provincial government. Each obligated organisation must submit a report, and if they do not submit a report or comply with the standard they may be subject to a fine. Organisations may also be audited for compliance.

These policies leave little room to tailor the approach to the unique nature of each organisation. The government has experienced intense critique from advocacy organisations, such as the AODA Alliance, for lack of enforcement and compliance measures (Monsebraaten, 2018). What I hope to add to the policy is both a range of compliance tools and a means of engaging the larger community in a way that also disrupts the polarisation of the accessibility seeker and the accessibility provider. Thus, I hope to engage the expertise and knowledge within the community in encouraging, monitoring and advancing compliance within organisations. The additional measures I have been contemplating are:

- requiring training, with the training tailored to the organisation and how they are not complying;

- requiring that the organisation be assigned a community group, with expertise in the area of non-compliance, to work with to resolve and monitor the non-compliance; and

- assigning the organisation another organisation that has exemplary compliance to help them comply.

The measure would be chosen by a review committee with a diversity of perspectives and areas of expertise. Funding from these could come in part from the fines that are only part of the solution. I have not yet had an opportunity to present these proposals to the sub-committee or the committee.

Approval of the New Legislative Framework

The initial application of the proposed framework was to be limited to information and communication technology requirements within the information and communication standard. The Standards Development Committee recommended and voted to apply it to the entire standard. Subsequently, the Ministers Accessibility Standards Advisory Committee voted to recommend that it be applied to all the standards of the AODA. At the same time as the deliberations of the AODA, the federal government was crafting regulations to meet an election commitment to create a national set of accessibility standards (Employment and Social Development Canada, 2017). At the writing of this thesis the federal and provincial governments are considering collaboration in the implementation and support of the parts of the ecosystem applicable to their jurisdiction. The Manitoba government, which modelled its regulations on the AODA, was also integrating the framework into their committee recommendations for information and communication (Manitoba).

I expected significant push back from multiple stakeholder groups. Change is very difficult when you have fought long and hard for any requirements that would improve accessibility. Any shift or movement can risk loss of previous gains and provide an opening for grudging concessions to be withdrawn. Support within both committees was unanimous. Several members who experienced significant disabilities spoke eloquently about the paradigm shift. Consultation with member constituents was also largely supportive once practical details were clarified. At the time of writing the dissertation the full public review has not been completed. Representatives of the AODA Alliance expressed concern regarding the framing of accessibility as relative, but otherwise supported the reframing.

7.7 Soliciting Constructive Public Reviews

One of the challenges of the proposed Accessibility Ecosystem is to productively solicit constructive reviews (of business performance in reaching accessibility goals) from the public. Accessibility can be a sensitive and charged topic. Reviews may be motivated by frustrating personal experiences. Given the diversity of requirements of customers with disabilities, it is unlikely that reviews can be verified or gauged by the number of replications. We hope to be guided by prior research into collaborative recommendations, social recommender systems and filtering of reviews by researchers such as O'Mahony and colleagues (O'Mahony et al., 2010, Burke et al., 2010).

7.8 Conclusions and Three Dimensions Applied to Policy

Policy, laws, and regulations have the potential to guide, frame, determine, and change culture and behaviour within a society. As interventions in complex adaptive systems, they must avoid triggering Cobra Effects and prompting counter-reactions. Donella Meadows puts rules in fifth place in ranking the effectiveness of possible interventions in systems. Fourth place is the power to add, change, evolve, or self-organise system structures. Ranked most effective is changing goals and mindsets or paradigms. In the redesign of the AODA, I have attempted to affect such a shift of mindset, focus, and goals from obligation by a few to participation as a whole community.

7.8.1 First Dimension

The proposed framework recognises the uniqueness of customers experiencing disabilities but also the uniqueness and diversity of obligated organisations who are the initial users of the standard. It supports the discovery, refinement, and understanding of the unique needs of customers, employees, and business owners experiencing disabilities and the increased self-knowledge of the obligated organisations (renamed 'participating organisations') through a variety of resources, tools, and open data or metrics.

7.8.2 Second Dimension

The redesign was produced through co-design with participating organisations, some of whom experienced edge scenarios. For example, one of the committee members represented a small, under-resourced historical society with little expertise and technical capacity, but with large amounts of archival material that was not accessible. Also, the recommended framework embedded the mechanisms for participatory co-design by the various 'stakeholders' in the process. The recommended Trusted Authority is tasked with continuously determining who is missing and who is unrepresented. The Community Hub ensures that the various stakeholders can review and provide continuous feedback regarding the implementation of the regulation and the ongoing maintenance and refinement of the Qualifying Methods.

7.8.3 Third Dimension

The overall framework recognises that the AODA regulations are intended to operate within a complex adaptive system. The proposed framework itself is modelled after a self-healing and evolving ecosystem that supports participation by the full community. It supports a layering of diverse approaches to requiring and encouraging more inclusive design of services within Ontario.

8 : Conclusions and Recommendations for Future Studies

8.1 Summary Analysis

At the core of my thesis and framework is an evolving and iterative attempt to provide a supportive structure to collectively achieve the feat of fostering and welcoming our individual uniqueness while dynamically orchestrating our social cohesion—within the complex adaptive systems of systems that is our digitally transformed and globally connected society. It is intended to be a supportive, not constraining or containing, structure for a growing global community of co-designers practising inclusive design. It has been iteratively implemented, tested, and refined over the course of my doctoral work. True to my intentions of openness, it has been claimed and expanded by groups like Microsoft (Microsoft, 2018) and centres in several countries, including Ireland and Australia (SMARTlab, 2017, Centre for Inclusive Design, 2018).

Much has changed over the course of my doctoral work, and not all of it has changed in the direction I was hoping and working toward. Resistance to paradigm shifts are more tenacious than I had anticipated, no matter how persuasively and rationally the shift is presented. However, I am buoyed by the transition in the UX design field, the completely unexpected ally we have found in companies such as Microsoft, and the welcoming reception to a rethinking of regulatory frameworks in Ontario. The open education community has embraced the basic framework and forged productive allegiances with the accessibility community. I have helped to raise the alarm regarding artificial intelligence and the risks to people at the margins. With the help of diverse colleagues globally, this may yet lead to a thoughtful recalibration of our notions of evidence and the research methods we use to arrive at collective and inclusive understanding and truth. There is great optimism regarding the potential of inclusively co-designed platform co-ops to bring options for justice and equity in labour and markets during a time of discontinuity brought on by exponentially escalating automation and the rise of the gig economy.

As I wrap up this "incomplete, imperfect and impermanent" thesis, I hear all the contributing voices that I have had to leave out. The perspectives of Hannah Arendt on human nature, Martha Nussbaum regarding the role of emotions, Etienne Wenger on community, Lucy Suchman on participation and collective action, many great complexity

theorists, a full reflection on systems thinking applications that would honour Dana Meadows, the wise insights from our community of practice … the list is too long (Nussbaum, 2013) (Arendt, 1973, Wenger, 1998, Suchman, 1993). These references are captured in the thesis notes; and I will honour their contributing ideas in much more detail in future work beyond this PhD.

8.2 Original Contributions of the Thesis and Doctoral Work

As mentioned in my Foreword to this thesis, whilst I may have first encapsulated and voiced an idea or pointed in a potential direction in my doctoral work, I have done so with the support and constitutive contributions of a larger community of practice (which I acknowledge as having the privilege to belong to, and to nominally lead).

This list of original contributions is not a full list of all the aspects of the research but only a partial list of the contributions made during the years of registration for this PhD. In those years, as part of the research and scholarly contributions for this PhD, I have proposed and refined the Inclusive Design framework for a digitally transformed and complexly connected society. This framework (the Three Dimensions of Inclusive Design) goes beyond the previously existing design success criteria for accessibility and inclusion in the digital and networked domain. The checklists used to determine the accessibility of digital systems (e.g., the Web Content Accessibility Guidelines), the seven principals of Universal Design, and the three guidelines of the Universal Design for Learning framework focus on the measurement of the outcomes of design. My framework adds the dimension of an inclusive process. I have tried to create a design process that enables designing with, rather than for, the people that will use the design. My framework also adds awareness of the complex adaptive systems of systems that the practice of design must function within. Thus, I bring a reflexive process and systems thinking to the challenge of inclusion.

More importantly, I have led the call for a paradigm shift from one-size-fits-all to the possibility of a system that can deliver one-size-fits-one for everyone, using the new affordances of digital products and services and the collective production made possible by global networks. I have proposed this in large part to address the needs of individuals who are stranded at the edge, by standard design practices, but also by design practices intended to increase equity. To support this paradigm shift I have developed several personalisation strategies in education and markets.

In the field of personalisation, I have proposed, and created exemplars, that foster and preserve self-determination, self-discovery, and self-knowledge. This counters the dominant trend to 'make machines smarter' (so they can adapt the interaction, content, and learning to the user) without making people smarter or sharing the data insights with the person. To support this self-knowledge and self-determination, I have led many efforts to democratise production, research, and design (e.g., My Life Long Learning Lab, preference discovery tools).

I have initiated and led the extension of the AccessForAll standard to address concerns of data privacy (see Appendix C: ISO/IEC 24751 Information Technology—AccessForAll Framework for Individualized Accessibility—Personal Privacy Preferences: Committee Draft 1). This is intended to address the dilemma that the people who are most vulnerable to data abuse and misuse are also often the people who are most in need of the knowledge arrived at by data and the services made possible through smart systems.

With the help and support of my amazing team at the IDRC, I have designed tools and strategies to support the framework. These include the Inclusive Design Mapping tools (see Appendix B: Inclusive Design Mapping Tool) and the Virtuous Tornado, expressed in the Inclusive Design Guide. I have also authored many forms of communication to relay and invite critique from an ever-expanding group of co-designers. These bridge academia (e.g., academic journals, books, and conferences) and popular non-academic channels, such as social media, national news outlets (e.g., newspapers, magazines, radio, and television), professional publications, and online blogs.

With the help of my team, I have catalysed a nascent collaboration of the accessibility community and the open education community that begins to heal the rift encouraged by opponents to open publishing. I have also brought awareness to the challenges of students who are 'doubly-marginalised'—not served by standard education, but not eligible for special services.

With the support of my sub-committee in Ontario, I have proposed the application of systems thinking and the Three Dimensions of Inclusive Design to accessibility regulations (see Chapter Seven). I have led the co-design of an alternative regulatory framework that moves from obligation to participation and engages the community as a whole in the challenge of inclusion for people experiencing disabilities.

I have proposed and iteratively moved toward creating a Platform for Economic Inclusion that addresses the failure of markets to reach people at the margins. I have proposed

creating non-extractive platforms that diversify the discovery and expression of demand and the responsive diversification of supply. I have argued that this will add innovation and dynamic resilience to our economy. This has led to further explorations in an effort to address the future of work, transformed by automation and artificial intelligence (e.g., our upcoming Platform Development Toolkit with Trebor Scholz and the Platform Co-op Consortium).

I have raised the alarm regarding Big Data, evidence-based governance, and machine decisions, as they affect people who are outliers and respond to unexpected scenarios (see Chapter Three). This has surfaced and made manifest bias in our dominant systems of research as they propagate and become automated in machine learning and data analytics. This adds an additional dimension to the efforts to fight data bias and encourage ethical artificial intelligence. It highlights the tendency of majority data to overwhelm data at the edges, rendering intelligent systems that do not recognise or understand people at the margins.

I put forward all these contributions for the PhD degree, and also hope that future scholars and practitioners can use them freely, to develop new projects and tools that take up from where I leave off here. I will gladly collaborate on any and all such endeavours which take the Inclusive Design community forward.

8.3   Areas for Future Study

Like a rhizomatic plant, my thesis has sprouted an overwhelming number of further questions, areas to explore and opportunities to pursue. It has also catalysed many new and promising collaborations. Within the page and time limitations and regulations of this PhD, many of these areas for future study can only be identified and encouraged for future research and delivery by myself and collaborators.

For instance: At the final European Commission review meeting of the Prosperity4All project, each of the sub-project leads was asked to discuss innovations and future directions arising from their research. As sub-project lead, in addition to presenting some of the plans for future inquiry, I created a rough sketch of the planned directions, which the talented designer on my team, Sepideh Shahi, turned into the graphic in Figure 13. The five future areas of study illustrated are only a partial list of the areas I hope to explore with the help of my team and my community of practice. I will describe each briefly here.

Figure 13: Future Study, Seeding Innovation

8.3.1 Machine Learning and Outliers

I will be working with machine learning researchers at Microsoft Research and at McGill University. Since I introduced machine learning researcher Abhishek Gupta to the issues related to machine learning and outliers at the FWD 50 2017 conference in Ottawa (Croll, 2017), and invited him to a panel I organised at the European Parliament (Discovery, 2017), he has taken up the cause with great enthusiasm, initiating a range of events and blogs (McKelvey and Gupta, 2018). The 'Start Your Machine Learning Engines and Race to the Edge' challenge also continues, gathering further edge scenarios from students who document unexpected scenarios and create test criteria as challenges for machine learning developers. Six large machine learning corporations are engaged in the challenges. I also hope to expand the early, very preliminary explorations in overcoming bias against outliers, including our nicknamed 'apple cored' data and 'lawnmower of equity' experiments that 'level the playing field' of population data so that outliers are not overwhelmed. Microsoft Research has agreed to assist, and several university programs in artificial intelligence have expressed interest in engaging their students. Given the urgency of the issue and the overwhelming amount of work to be done, I will move from the closed collaboration initiated through the connections established with the Ministry of Transportation to open practices that enable any interested and capable researcher to take up and extend the

experiments. Rather than conducting the development myself or within my team, I hope to catalyse a diversity of efforts in the area.

8.3.2   Small, Thick, Bottom-Up, N=me Data Analytics

I will directly pursue small, thick data for learning and the extension of My Life Long Learning Lab with my team. This will be iteratively co-designed and tested within the FLOE Project and Social Justice Repair Kit projects that I lead. We hope to expand the vision of learners as research scientists in their own learning. The goal is to enable any learner to instrument inquiries into their world and their unique selves in their world. Through the Nexus, developed by talented developers on my team at the IDRC (including Simon Bates and Alan Harnum), learners can connect any data source with any data processing, and then any method of visualising or manifesting the data that is accessible to them (GPII, 2017). Data manifestation includes sonification as well as haptic or tactile models. This will also serve as a means of advancing my notions of Citizen Science, Citizen Research, and Citizen Design to fill knowledge gaps. Once we have gathered sufficient bottom-up anonymised data we hope to explore post-hoc pattern recognition for policy guidance and to identify gaps in services to inform government intervention.

8.3.3   Co-designing Inclusive Smart Communities

I have accepted an advisory role, and my team is engaged in the much heralded and debated Sidewalk Project initiative in Toronto (Sidewalk Toronto, 2018) to create a model Smart City in Toronto's waterfront (WaterfronToronto, 2018). We hope to address the privacy concerns of the community by addressing the needs of people at the margins, who are most vulnerable to data abuse but also have the most compelling uses of smart systems (Inclusive Design Research Centre, 2018a); with the hugely capable core team of Sepideh Shahi, Simon Bates, and Colin Clark, using the Inclusive Design framework I developed in my doctoral work.

8.3.4   Augmented Reality, Virtual Reality, Data informed, Imaginaries

Together with Lizbeth Goodman, SMARTlab, the Inclusive Design Research Centre of Ireland, HTC Vive, VR First/XR First, Microsoft, the World Economic Forum, and the larger AR/VR initiative that Lizbeth has coalesced through her lifetime cross-sectoral networking efforts and recent INCLUDE (Inclusive Design Engineering) Project, I hope to co-create a 'community imaginary.' This will combine open data from cities and municipalities, computer modelling systems that power simulations, and augmented reality technologies. The proposal is to create an augmented reality application that will enable community members to walk

through their community and see the impact of alternative policy decisions. The simulations will be made as realistic as possible by extrapolating data from one community onto another. Where there is no current model with data, compluter modelling will be used to extrapolate, learning from real estate augmented reality simulations (Blum, 2018). The project will start small with a specific community and a short list of possible interventions. We will create an open Application Programming Interface (API) so that others can add interventions and data sources. To leverage my early work in virtual reality in the mid- and late 1990s through our Adding Touch and Equal Access to Distance Education, we anticipate creating a virtual reality immersive version of the imaginary as well (See Appendix H: Adding Feeling, Sound and Equal Access to Distance Education). This work occurred during the 'first wave' of virtual reality. We explored the multi-model extension of virtual reality to include three-dimensional sound, text-to-speech labels, and haptics. It was used to provide a three-dimensional representation of a geography textbook that is accessible to students who are blind, and a virtual, haptic model of both pathological and healthy joints to train medical students in distinguishing and detecting joint anomalies.

8.3.5 Personal Privacy Preference

The timetable for preparing the final proposed ISO/IEC Personal Privacy Preference standard for ballot is during the last quarter of this year. As project editor, I hope to finalise the Final Committee Draft immediately after handing this draft thesis to my thesis committee. Discussions regarding how the standard will be referenced in regulations is ongoing with Canada, the European Union, and Australia. Australian Privacy Commission staff have requested a follow-up meeting at my centre to discuss possible means of using the standard to protect individual data privacy rights in Australia. I will be leading a further co-design session to build out the standard at the RightsCon conference in Toronto during the week of May 14, 2018 (RightsCon, 2018).

8.3.6 Data Platform Co-ops

I plan to explore further strategies to address the dilemma that the individuals who are most vulnerable to data abuse are also the individuals who have the most compelling need for smart systems. Through collaboration with Trebor Scholz and the Platform Co-op Consortium, my team and I will investigate the implementation of Data Platform Co-ops as a means of retaining data self-determination and privacy for individuals who are marginalised. This is modelled and learns from the experience of data co-ops such as Midata and SalusCoop (MIDATA, Salus.coop, 2017).

8.3.7 Non-linear Planning Models

The expansion of alternative non-linear logic models, agile, iterative planning tools, and formative project evaluation systems for inclusive co-design will continue and will be applied in the CISL project, FLOE Project, Social Justice Repair Kit Project, and the soon to be announced Platform Development Toolkit Project funded by the Google Foundation that I co-lead with Trebor Scholz of the New School. We will be creating applications that support planning and monitoring using the Inclusive Design Mapping Tool and Virtuous Tornado developed during my doctoral studies (see Figure 5, & Appendix B: Inclusive Design Mapping Tool).

8.3.8 Corporate Adoption of Framework

Adobe has adopted the Inclusive Design framework. Matt May, who was my staff support person when I was chair of the W3C-WAI Authoring Tool Working group, has been appointed head of Adobe Inclusive Design. He hopes to effect the same transformation at Adobe (May, 2018) that August De Los Reyes and Kat Holmes effected at Microsoft by adopting the Inclusive Design framework (Kuang, 2016). I will be working with him to develop a strategy and to train designers at Adobe.

8.3.9 Platform Co-ops and Platform for Economic Inclusion

As mentioned in Chapter Six, I hope to iterate further toward establishing a Platform for Economic Inclusion through the Platform Development Toolkit project I am embarking upon with Trebor Scholz of the New School in New York. I hope to learn from the valuable lessons that emerged from the Prosperity4all Project. We will begin with a labour platform to support care givers as a first implementation, and then iterate toward a market platform, integrating what we learn about service demands from the first iteration.
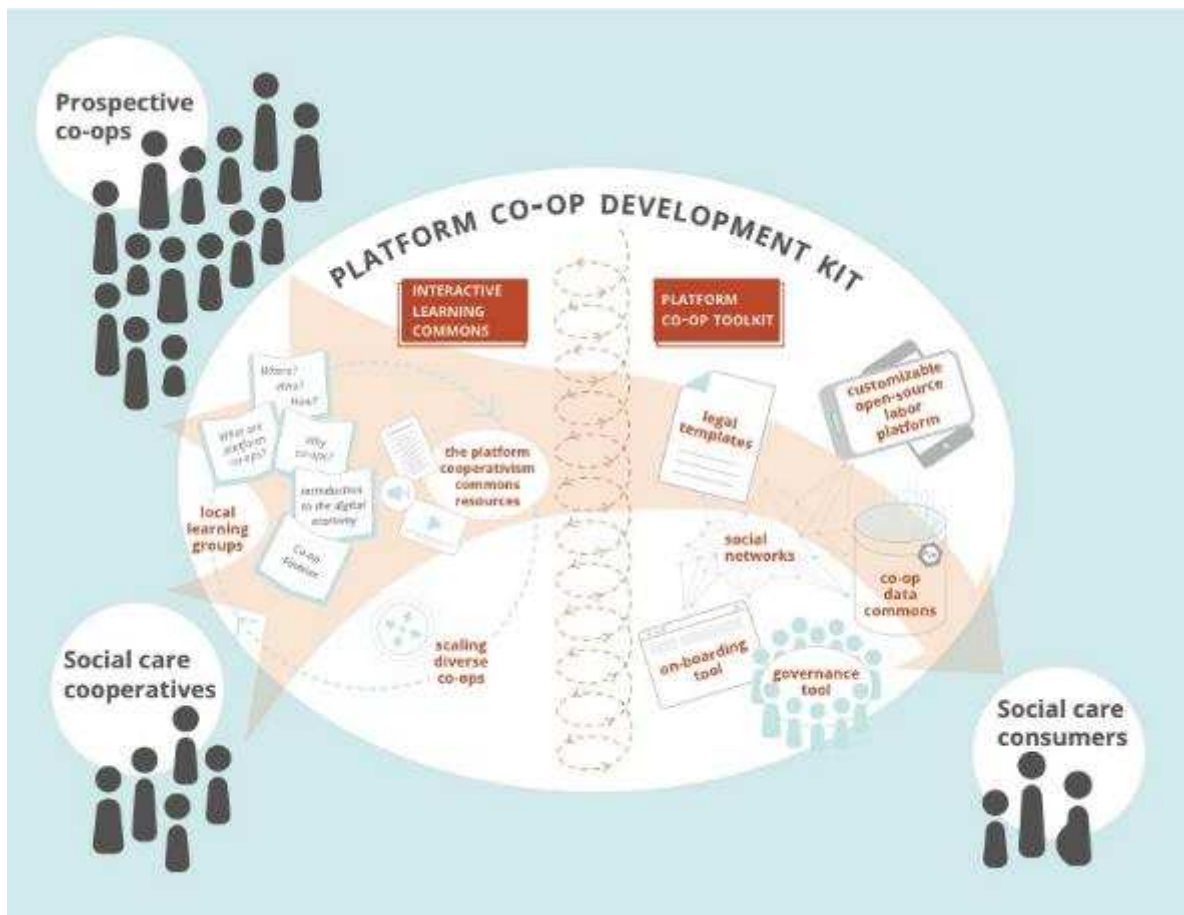
Figure 14: Platform Co-op Development Kit

8.3.10 Lab School for Inclusive Life-long Learning

As mentioned in Chapter Five, this thesis comes to a close at an exciting time of transition for the future of inclusive education. Together with Lizbeth Goodman, SMARTlab, the Inclusive Design Research Centre or Ireland at UCD, Station1, and other partners, I will soon be launching a Lab School for Inclusive Lifelong Learning. This will experiment with more inclusive and future-friendly education practices outside of the constraints of formal academia. The intention is to establish a platform co-op with members who are both learners and educators. The first cohort will include some of the thousands of women in Colombia who were unable to attend school due to the war, as well as designers at Adobe and Microsoft.

8.3.11 Accessibility Ecosystem as Regulatory Ecosystem

The proposed regulatory framework, the 'Accessibility Ecosystem,' that I designed as part of my doctoral work, will be released for public review in Ontario when this thesis is approved and made public. I will continue to work with provincial and federal governments in Canada to realise the three pillars of the ecosystem. It has been proposed that the BIG IDeA project,

led by the IDRC in Canada, will help form the Community Platform function of the proposed ecosystem (Inclusive Design Research Centre, 2018a).

8.3.12 Open Textbook on Inclusive Design

I have committed to produce an open textbook on Inclusive Design and the Three Dimensions of Inclusive Design for the Rebus Project in which we are a partner (Rebus, 2018). This will integrate aspects of this thesis. I have resisted publishing or assigning textbooks in the past, believing that textbooks are too prescriptive and inflexible for the quickly evolving field of Inclusive Design. However, I have been persuaded by many community members that I can produce a new textbook model that can provide a framework for evolving collective contributions.

8.4 The Complex Adaptive Context and the Future

Over the more than six years of preparing this doctoral work, the prospects of inclusion within the larger global context have been a roller coaster careening between hope and despair. If I were to characterise the current global backdrop, as I wrap this up, I would say that we are in a state of uncertainly; that nerve-wracking liminal territory where anything might happen. Much has gone wrong. We have a rise of tribalism, xenophobia, and extreme polarisation. Much about our current society is fragmented and fearful. We leave many stranded at the edges. Visiting a settlement of people who have been stateless for several generations in Kenya, I was recently reminded of Hannah Arendt's notion of the 'right to have rights.' By creating categories such as citizen, immigrant, and refugee, we leave people, including many children, at the margins without even the ability to claim human rights and without the right to claim to be part of humanity. Most of our global leaders would fail abysmally if they engaged in John Rawls' thought experiment of the 'veil of ignorance,' whereby they would create a social structure without knowing which position they would hold in the structure. But also, many people globally have gone to higher ground and mustered a call to a greater humanity. This tension and liminal reality is the precarious state of possibility when our choices have the greatest impact.

This is also a time when a newer generation is finding voice. A week before submitting this thesis I had the privilege of meeting approximately 2000 Guardians of the Environment and Peace in Cartagena, Colombia. These are children and youth who grew up during the violence and conflict in their country, who saw what it did to their communities and families, who are savvy to the threats to their environment. They are clear-eyed and determined and

have no patience for discriminatory distinctions regarding gender, sex, race, or ability. They have learned strategies to deal with bullies. I met a group of former street gang members persuaded by the Guardians to teach dance and help others resist coercive recruitment to gangs. Add this to the Parkland students in the USA who have survived what the powerful NRA can throw at them and remain more articulate and resolved, and we may see a leap forward in the goals of inclusion.

When presenting about the future and the choices we make about inclusion, I often simplify our choices into three future scenarios:

1. Protecting the lucky few

We can choose to support disparity. A lucky few will hold the majority of wealth and opportunity. This choice comes with ever-escalating security costs, as the lucky few must increasingly protect their wealth and security from the excluded. Competition also escalates as the choice of who is privileged and who is not has huge stakes. This also means that the standard for who belongs to the privileged will become more narrowly defined, leading to a risky monoculture that is more vulnerable to threats. This means that there will be a periodic rise and fall of the current dominance for the qualified lucky few. The planet and human race will also be at greater risk as there is little opportunity to act collectively or collaboratively on global issues, such as environmental protection or disease control, as regions will become more polarised, and any broad-scale co-operation can only be achieved through coercion.

2. Charity

A seemingly more humane approach is the charity model. In this model the included support those who are excluded through charity, public social services, and episodic acts of private munificence. As these charity measures are influenced by political forces as well as by appeals to empathy or pity, those who are excluded must learn to persuade the included that their needs are great, if not the greatest. This intensifies the power imbalance as the excluded are encouraged to become more dependent on the included. It also results in divisiveness among the excluded as there is competition for limited charity resources and attention. Charitable impulses wax and wane and become less sensitive to stimuli, meaning that the appeals must escalate in intensity and continuously refresh to avoid charity fatigue, triggering a race to the bottom for the place of the most pitiable.

3. Inclusive Participation

The third choice is to recognise the value of diversity and to design our society so that everyone can reach and contribute their personal optimum. This requires moving away from

mass design to designing for diversity and enabling participation from the full spectrum of members. It also requires a proactive and integrated approach to inclusive design: supporting children before the damage is done and they are acculturated to discriminate, thinking about inclusion before any decisions or choices are made or conventions are set, and assuming that exclusion is not an option in all our planning. This approach has the potential to recruit the power of human diversity to collectively rescue our planet and humanity.

I have found again and again in my work with many diverse and divergent communities that when we reach the point where we have made room for and welcomed our full diversity, we find a deeper commonality. This state of collective flow cannot be measured and there is no hard evidence or formulaic way to reach it, but the group is changed. It is in this state of trust that we find the common truths that are at the intersection of seemingly insurmountable differences.

There is a primal instinct for competition and self-preservation but there is also a deeper fundamental instinct for community, kindness, and inclusion. The 'high' of victory is more tenuous and precarious than the 'high' of belonging and kindness. Exclusion erodes a community and robs a society of potential contributions, but, however addictive winning may be, it also erodes a moral identity. We become less, sicker, disquieted, and ultimately less human the more we isolate and exclude (Wilkinson and Pickett, 2010).

Power won at the expense of others, through the demeaning of others, requires the demeaning of a part of ourselves. We are, each of us, a jagged spectrum. We hold within us the potential to be anyone within the starburst that is the scatterplot of humanity. We reduce and shrink ourselves if we ignore and exclude those diverse edges that stretch our experience and open new frontiers.

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Appendix A: Testing the Framework on Twitter

During the course of my doctoral work I used a number of media platforms to determine whether there was general receptivity to the notions and ethos of the Inclusive Design framework. One of the media platforms was Twitter which was popular within the open education community. The following are some of the tweets with the most retweets and likes, in reverse chronological order.

If we insist that truth = large homogeneous numbers isolated from context (aka statistical significance) we will deny the truth of poverty, disability, isolation & discrimination, because big homogeneous numbers free of context are not found at the margins **#BigData #inclusion**

#ccsummit the power of the commons is the sharing of power- the value of the commons grows when valuing difference - collective power & value expands if we foster potential over requiring perfection- including diverse perspectives is our response to danger **@mchris4duke @krmaher**

Platform data co-ops - a way to take control of our data - built out from the margins, by the margins, to address the dilemma that the people that are most vulnerable to data abuse are most in need of knowledge derived from data **#ccsummit18 @platformcoop**

#CCSummit18 To foster trust and flourish the open community needs inclusive design, like inclusive design needs openness and sharing. I've tried to express this essential reciprocal relationship here:

the inclusive design challenge is to orchestrate diversity to achieve something greater than the parts -- to create the conditions that nurture difference in all its complexity & richness & weave it together to create the unprecedented common good **#inclusivedesign #equity #design**

Including difference is how we evolve as a human society. Disability is called our last frontier -- disability is a potential state we can all find ourselves in. If we reject & exclude, we reject and exclude our potential future selves & our loved ones. **#inclusion #A11y #equity**

Equity & accessibility is more than gaining entry to a system that was not made for you. We don't want to be allowed to play the game, we want to change the game for the common good. Society needs inclusive participation as much as people need to be included. **#inclusion #a11y**

Any policy decisions made using large data sets are biased against small minorities & outliers, they are either normed out or overpowered by the mass, yet they are most vulnerable to the risks of bad decisions. Numbers alone are not the way to decide. **#inclusion #policy #BigData**

If companies are 'data driven' & government funding is evidence-based & efforts are judged on impact measures, a diversity of minority needs will always be overwhelmed by majority needs, even if minority needs are more urgent. We need more humane measures. **#inclusion #diversity**

Quantified research requires that we reduce, dissect & isolate to achieve repeatability. Quantification is hostile to diversity & complexity. Life is complex, diverse & irreducible. We need a better science to understand our complex lives. **#research #inclusive #diversity**

The skills & competencies we can mass produce in education are the skills & competencies that machines can replace. Education should catalyse each learner's unique contributions & thirsts for knowledge & worth. & then teach students how to work together as a complementary team.

When I enter a building I've formed the habit of asking how I would get in if I used a wheelchair. When served I wonder how I would be treated if I looked poor or foreign. When informed or asked, I ponder how I would understand if I couldn't see.. or hear.. or read..or speak..

The beauty of the incomplete, impermanent and imperfect, evolving process is that it ultimately gets you further than the perfect, static achievement -- with supportive people to help you along.

Let us all disengage from the legacy of existing 'winner takes all' and 'best and brightest' ways of shaping values in education and entrepreneurship. Our new society

needs a diversity of 'best.' Difference is a collective strength we should recognise **#inclusivedesign #OER @idrc_ocadu #Education**

Attempting to remind attendees at **#wef18** about the unrepresented, the people not captured in our impact metrics. **#inclusivedesign #inclusion #a11y #AI**

#inklusionstage we need to continuously ask who are we missing at the table, how do we make our table more welcoming? Stretching our process to the edges makes it more generous for everyone. **@idrc_ocadu**

#Inklusionstage now we need to be proactive & lead the change, rather than always catching up — next task: AI that recognises & understands diversity — for machine decisions that don't exclude us from education, jobs, credit, research — or else bias & exclusion will be automated

#Inklusionstage — the survival of our civilisation hinges on the transformation of education to recognise the importance of diversity and inclusion, not conformance and competition — innovation occurs at the edge, not the conventional middle — inclusive education benefits us all

Understanding & recognizing the range of diversity, especially the edge, is essential to innovation & dynamic resiliency -- how can our students, educators, institutions & society learn to understand, recognise & value human variability? Important questions at **#TESS17**

farmers taking back control of own data **#platformcoop @billy_tiller** https://www.gisc.coop/ -- so glad my swather didn't monitor me when I was 12 - part of the data contract should be transparency of how it is used.

Only openly licensed educational resources, **#OER** provide true inclusive access - students need to be free to convert to a format & use a player that works for them or you exclude the largest minority of students - http://bit.ly/2zDAhHT **#inclusivedesign**

If you are not average or typical, watch out for automated systems, they may not recognise or understand you..

"When everyone is shouting, whispering may be the best way to be heard"- my justification of our current dissemination strategy

When was it that the pursuit of knowledge became the domain of probability & calculating odds? What are we gambling away?

The competition is over! We are all now so entangled -we sink or swim together. Survival depends on fitness as an inclusive whole!**#inclusion**

How can so many earnest attempts by researchers to arrive at narrow truths contribute to a bigger lie? By leaving people out. **#inclusion**

Let's teach our machines to be smart, not prejudiced. Inclusive design is smart. **#inclusive @bigideaproj** http://deep.idrc.ocadu.ca/

In Brussels telling EC cybersecurity experts why inclusive design results in better risk aversion & proactive threat reduction **#inclusive**

Elitist academics are as bad as greedy CEOs, it is our responsibility to share knowledge & respect lived experience **#inclusion**

Education disparity worries me as much as wealth disparity, let's stop academic elitism, knowledge is a common right & freedom. **#inclusion**

I want a world where the fragile & vulnerable survive & thrive - not just aggression & competition - we leap forward with relaxed selection

anything formulaic can be done by machines, let's equip our students with lasting & productive knowledge & skills **#opened @idrc_ocadu**

The greatest innovation that benefits everyone can be found at the margins, Ontario is poised to lead in inclusion **@idrc_ocadu**

Machine intelligence that is biased against people at the margins & taught to find dominant patterns will only speed inequality **@idrc_ocadu**

Big data promotes dominant patterns, a misfit if you are not 'average' -- an opportunity for inclusive design? **@katholmes #inclusiondigital**,

If our learning machines are fed our biases, AI will speed disparity. Critical AI challenge - serve the margins. **@IBMWatson @jennylayfluffy**

#oeglobal the next revolution should include the democratisation of research - citizen research- personal tools to find, test & verify truth

If our aim is to produce standardised students, difference is an issue..if we understand human survival, diversity is a strength & a goal

Truth is not flat, but fulsome and multi-sided. Truth can be found and is anchored at the intersection of differences. **#inclusion**

Inclusive design's creative magic happens where differences intersect - make room for diversity to find deeper commonality. **#inclusivedesign**

Asking for transparency at Transatlantic forum -we should know how our personal data is being used **@Discovery_EU @idrc_ocadu @PrivacyPrivee**

At https://habitat3.org discussing inclusive cities - Cities are not thoroughfares for self-sufficient loners - but complex communities

Need new, diversity-supportive research methods or people that are unique or in the minority are less likely to be understood **#inclusive**

Ursula was caring, prescient & timelessly wise to the end. I'm ineffably grateful her great soul was here.

Asked for cost-benefit analysis of inclusive design project..the short-term costs are easy to monetise..the huge long-term benefits are not

We see human diversity as an issue, not our greatest asset, because our institutions & processes are not designed for diversity **@idrc_ocadu**

Our research systems perpetuate knowledge disparity: minority needs & complex entangled problems won't be studied or understood.

Wasted human potential is not inert, it is toxic and corrosive. Help everyone reach their optimum. **#Floeproject** **@idrc_ocadu** **@FluidProject**

The best antidote to polarisation & extremism is the inclusion of diverse perspectives to bring a dynamic balance **@idrc_ocadu** **@MDesINCD**

We need more innovative innovation talk, innovation happens @ the margins -support research of outliers, they outnumber the norm **@idrc_ocadu**

Human diversity is an asset not an issue.. a critical feature not a bug. **#a11y** **@idrc_ocadu** **@DEEP_IDRC**

You don't need to retrofit new buildings to make them accessible & you don't need to retrofit young minds to support inclusion- start early.

Accessibility is the litmus test for good design. People with disabilities are the canaries in the coal mine that signal design failures.

tools that make accessible authoring the default & ensure people with disabilities can be producers, not just consumers of Web content **#atag**

think of inclusive design as accessible design that benefits everyone without the compromises inherent in one-size-fits-all **@MDesINCD**

Refuse to be a mass, then it won't be so costly to be special. Make the dev tools accessible and PWD will drive innovation **#mEnabling15**

I argue that academic publishing is like locking the instructions for opening a safe into the safe- our intended readers are mostly excluded

In a connected knowledge age, vestigial appendages tethering us to the past, threatening global survival aren't anatomical but notional.

I'm ever more convinced that our most important collective task is inclusion and our greatest redemptive asset is diversity.

We know about environmental full cost accounting, we need to develop social full cost accounting.

Our inclusive design challenges have moved from static & predictable, to complicated but unambiguous, to complex and hugely interdependent!

Research methods favour the predictable, repeatable & quantifiable. We need methods to explore the unexpected, unique, fuzzy, chaotic edges.

The symbols we use are not passive statements but a powerful means of framing our attitudes and promoting points of view. **#accessibility**

If we use big data metrics to make decisions we need to account for margins, we need new statistical tools that don't exclude the outliers.

learning is more than consuming content. learning & growing involves action, interaction, exploration, making mistakes & taking risks **#oet09**

plasticity of the digital can enable personalised learning - translating the learning experience to match the needs of each learner **#oet09**

interoperability standards - a place to meet so we can then diverge - an agreed upon meeting place so we have the freedom to explore **#oet09**

Appendix B: Inclusive Design Mapping Tool

The following is a mapping tool I developed. The mapping tool was illustrated by Sepideh Shahi, a highly creative inclusive designer at the Inclusive Design Research Centre and the concepts were integrated into our Inclusive Design Guide by the amazing team at the Inclusive Design Research Centre. The tool is based on the scatterplot of human needs and characteristics. The facets (or pie slices) represent the considerations relevant to a design challenge.

.

Step 1: Choose the facets that are relevant to the needs, preferences and the context you are designing for or critiquing

SOCIAL

INTERNET ACCESS

LEARNING MANAGEMENT

DEVICE PLATFORM

- has no phone
- doesn't have a computer at all
- has a non-smartphone
- has an "antiquated" computer
- has a device with a small display
- construct collabora arrange
- self arra
- has a modern computer
- has a smartphone
- has a device with a large display

PROBLEM SOLVING

ATTENTION

TEMPORAL

PERCEPTION

COMMUNICATION

EXECUTIVE FUNCTIONS

SENSORY

LANGUAGE

MEMORY

DEXTERITY

- needs an alternative to a pointing device
- needs an alternative to a keyboard
- needs an alternative way to hold down two keys at a time
- needs a modified pointing device
- needs a way to stabilize to point
- uses a automatic scanning
- uses manual scanning
- uses directed scanning
- uses voice recognition
- needs an alternative keyboard layout
- uses an eye-tracking to point and select
- needs a modified keyboard
  - uses binary code
  - uses quadrant code
- can use a pointing device and a keyboard well

USER CONTEXTS

USER STATES

Figure 15: Inclusive Design Mapping Tool - Choosing the Facets

Treviranus, J.   The Three Dimensions of Inclusive Design

Step 2: Map your needs, preferences and context on the selected facets. Next, using a different colour, map the product/task/solution you are trying to critique or design.

Figure 16: Inclusive Design Mapping Tool - Mapping onto the Facets

Step 3

Now you can put the facets together, draw a jagged outline, and shade in the gap between the two outlines.

Figure 17: Inclusive Design Mapping Tool - Mapping the Current State

Figure 18: Design Mapping Tool - Finding the Gap

Step 4

Once you have a proposed new design, redo the map, with the goal of fully encompassing the jagged outline of the edge users. While iterating through the design process, the mapping can be very useful for identifying where your design does not stretch enough to meet the needs of edge users.

Inclusive Design Mapping Tool
Proposing the desired state

Figure 19: Inclusive Design Mapping Tool - Proposing the Desired State

The exercise is about stretching and reaching: to include people who are currently at the edges and who are therefore usually excluded from the design process. It is also about balance and flexibility: creating a design that does not compromise the experience of one person to make room for the requirements of another.

In this activity, co-designers choose appropriate facets (or 'slices') from the accompanying set of Inclusive Design Mapping Facets (downloadable pdf), to piece together a map of user needs as well as the functional requirements of a product or service. Once mapped, gaps between needs and requirements can then be identified.

This activity utilises the accompanying Inclusive Design Mapping facets card deck. Co-designers are able to create their own facets if they can't find a desired state or context within the provided set.

The following are simplified versions of the Mapping Tool, and a version that addresses cognitive access:
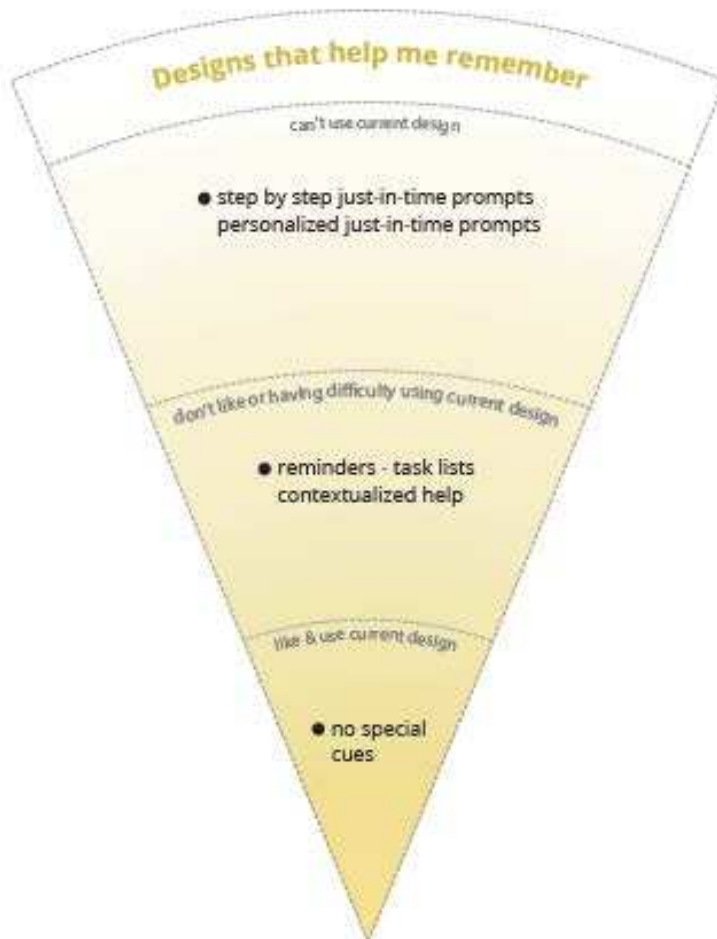
Figure 20: Inclusive Design Mapping Tool Segment
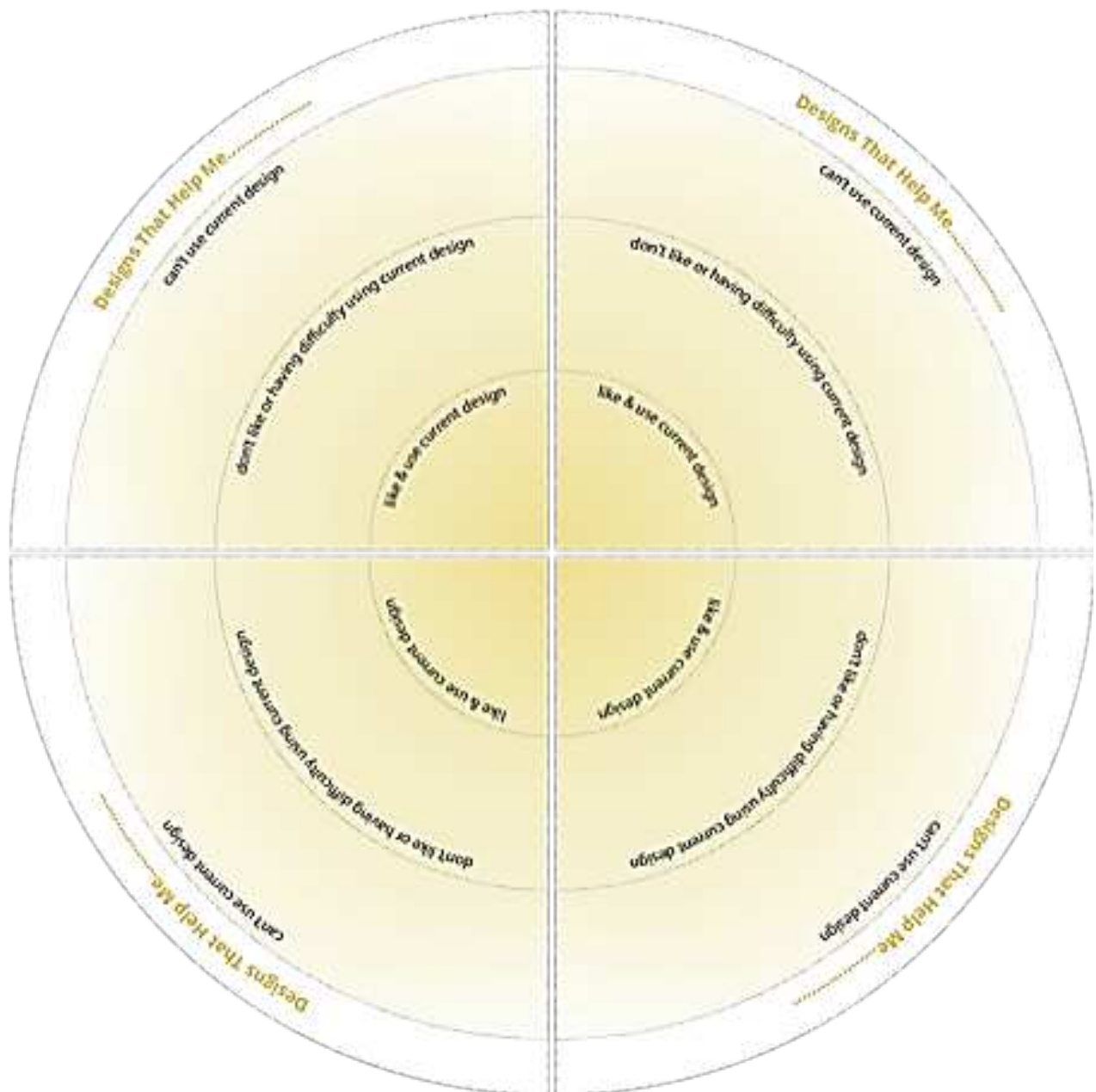
Figure 21: Inclusive Design Mapping Tool

The following illustrates how the Mapping Tool is applied in planning and project monitoring and is reflected in the 'Virtuous Tornado.'

Rather than moving toward a single design solution, inclusive design is an iterative process that expands a design to encompass more possibility, more means of access, and more inclusive dimensions. This activity will help your team address the needs that you have identified in the previous mapping activity, and plan for future design iterations.

You can start small; each time you circle around and up the spiral you will be stretching the design to encompass more and more needs, and moving outward toward the edge of the starburst. At each cycle of iteration, ask 'who are we missing?' Bring in another person, another scenario, another set of needs and characteristics. Plan as many iteration cycles as possible. You will sustain the availability and the accessibility of prior iterations, but continue

to stretch out to create a more generous design. If you are able to change your design to meet the needs of at least one additional person, you are moving in the right direction.

In your groups, instead of competing to find the single best design, try coming up with a diversity of choices. If you are working in multiple groups, sharing with the larger group after each iteration can help to generate more ideas. You can adapt this process as needed to any particular group and particular needs and you can use whatever materials are available.

Consider solving not only for the specific design challenge, but also consider changes to your implementation or process that will improve the ability to solve future challenges. In this way your design will become more adaptable and it will be easier to widen the range of needs and characteristics that it can meet in the future.
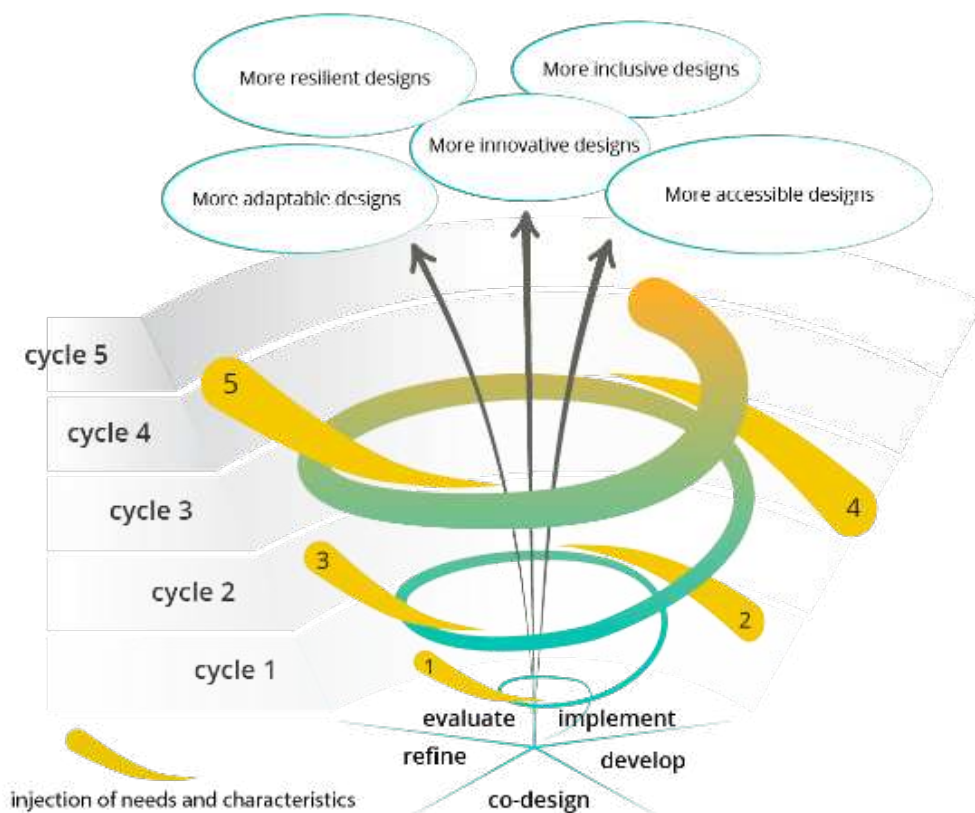
Figure 22: The virtuous tornado describes an upward spiral into which needs and characteristics are injected at each design iteration. As the design moves up the spiral it expands to encompass these needs, becoming more and more inclusive in the process.

Appendix C: ISO/IEC 24751 Information Technology—AccessForAll Framework for Individualized Accessibility—Personal Privacy Preferences: Committee Draft 1

The following is the working draft of the privacy preference standard I am editing to help address privacy vulnerabilities. The standard itself has no effect unless referenced by privacy regulations.

ISO/IEC 24751-5(E)

ISO/IEC JTC1/SC36/WG7

Secretariat: KATS

ITLET -- AccessForAll Framework For Individualized Accessibility -- Part 5: Personal Privacy Preferences

WD stage

Warning for WDs and CDs

This document is not an ISO International Standard. It is distributed for review and comment. It is subject to change without notice and may not be referred to as an International Standard.

Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

ISO/IEC 24751-2 was prepared by Joint Technical Committee ISO/IEC JTC1, *Information technology*, Subcommittee SC 36, *Information technology for learning, education, and training*.

ISO/IEC 24751 consists of the following parts, under the general title *Information technology -- Individualized adaptability and accessibility in e-learning, education and training:*

Currently under development:

Part 1: AccessForAll framework for individualized accessibility - Part 1: Framework and registry

Part 4: TS - Registry server API

Further parts may be added in the future.

97   **Introduction**

98   This document was developed to extend the Access For All preferences standard to include preferences for
99   privacy. Many people rely on technology and smart services to provide accessibility or convenience in their
100   everyday lives. For example, devices that allow voice commands to control lighting or other appliances in the
101   home can significantly improve the accessibility of an interior space. Services that remember a user's log-in or
102   purchasing information can make it much easier to access those services on a regular basis. However, the use
103   of these services comes with the cost and associated risk of sharing personal information online. Those who
104   can benefit most from these smart services, including persons with disabilities, persons who are aging and
105   others who face discrimination, stereotyping, or exclusion, are often the most vulnerable to the misuse of
106   private information - for example through denial of medical insurance, jobs and services, or fraud.

107   Many people avoid using particular services (for example, online banking) due to fear of misuse of their
108   personal information. Too often these choices are based on a lack of knowledge of how personal information is
109   being used and/or of how to protect it.

110   Most current privacy settings are all-or-none. Users must accept the service's privacy policy as given or not
111   use the service at all. A better approach is to fine-tune a policy to allow sharing of some personal information
112   with trusted services while disallowing others. Putting control of online personal privacy into the hands of the
113   user and giving them the tools to declare how and when they want personal information shared will benefit all
114   users.

115   *Note: Identification of patent holders, if any to be further developed with the progression of the work.*

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Information technology -- AccessForAll Framework For Individualized Accessibility -- Part #: Personal Privacy Preferences

1 Scope

This document specifies user preferences for privacy of personal information. Personal information includes, but is not limited to, name, address, phone number, credit card information, digital health information, and browser cookies. Privacy policies are agreements between users and companies or organizations, regarding how a user's personal information is to be collected, used, and shared with third parties. Privacy policies are currently stated by the company for the user to accept or reject. The privacy preferences described in this document reverse this relationship by providing a way for users to list types of personal information, and declare when to collect, use, and/or share it for what purpose.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*

ISO/IEC 24751-1:20nn Information technology - AccessForAll framework for individualized accessibility - Part 1: Framework and registry

ISO/IEC 29187-1:2013 Information technology - Identification of privacy protection requirements pertaining to learning, education and training (LET) - Part 1: Framework and reference model

3 Terms and definitions

Notes:

> 1.   *The terms and definitions presented below are a draft sub-set taken from ISO/IEC 24751-1 (CD2) and ISO/IEC 29187-1:2013. There may be more and the full set of Clause 3 entries will be decided during the progression of the work.*
> 2.   *As ISO/IEC 24751-1 is at the CD2 stage and the terms and definitions are not stabilized, the content   too may change .*
> 3.   *The italicized terms represent terms already defined in the source document. It has yet to be decided if these added terms and definitions will be included in this Part of ISO/IEC 24751-2.*

For the purposes of this document, the following terms and definitions apply.

3.1
access for all
AfA
approach to accessibility in a computer-mediated environment in which the *resources* (3.n) (including their method of delivery) are matched to the accessibility *needs and preferences* (3.n) of an individual user in a specific *context* (3.4)

[SOURCE ISO/IEC 24751-1:20nn, 3.1]

3.2
individual
Person who is a human being, i.e., a natural person, who acts as a distinct indivisible *entity* or is considered as such

[SOURCE ISO/IEC 29187-1:2013, 3.50 and ISO/IEC 15944-1:2017, 3.28]

3.3
needs and preferences
declaration of requirements of a particular user with respect to *resources* (3.n) to be used by them
where needs are essential and preferences are beneficial but optional for that individual

Note 1 to entry: What is a preference for one person may be a need by another, or a need by the same person in a different context of use.

[SOURCE ISO/IEC 24751-1:20nn, 3.7]

3.4
needs and preferences concept
concept used to describe a particular aspect of needs & preferences that has to assume a specific value or be in a specific value range

Example 1 to entry: "Font size is 14pt".

Example 2 to entry: "Language-simplification is on".

Note 1 to entry: The format for needs and preferences concepts is specified in section 7 of this part of ISO/IEC 24751.

[SOURCE ISO/IEC 24751-1:20nn, 3.x]

3.5
needs and preferences ranking
user-declared ranking of needs and preferences and the conditions associated with the ranking (e.g., "when I'm home it is more important that I can hear my son through the assistive listening device than other media")

[SOURCE ISO/IEC 24751-1, 20nn, 3.8]

3.6
needs and preferences statement
user-declared preference/need for a specific needs & preferences concept (regarding its value), in a specific context

Note 1 to entry: A format for needs and preferences statements is specified in section 7 of this part of ISO/IEC 24751.

[SOURCE ISO/IEC 24751-1:20nn, 3.x]

3.7
personal information
any information about an identifiable *individual* (3.n) that is recorded in any form, including electronically or on paper

Note 1 to entry: Some examples would be record information about a person's religion, age, financial transactions, medical history, address, or blood type.

[SOURCE ISO/IEC 29187-1:2013, 3.103 and ISO/IEC 15944-5:2017, 3.103]

3.8
privacy protection (in LET privacy protection)
set of *external constraints* of a *jurisdictional domain* pertaining to *recorded information* on or about an identifiable *individual*, i.e., *personal information*, with respect to the creation, collection, management, retention, access and use and/or distribution of such *recorded information* about that *individual* including its accuracy, timeliness, and relevancy

Note 1 to entry: Recorded information collected or created for a specific purpose on an identifiable individual, i.e., the explicitly shared goal of the learning transaction involving an individual shall not be used for another purpose without the explicit and informed consent of the individual to whom the recorded information pertains.

Note 2 to entry: Privacy requirements include the right of an individual to be able to view the recorded information about him/her and to request corrections to the same in order to ensure that such recorded information is accurate and up-to-date.

Note 3 to entry: Where jurisdictional domains have legal requirements which override privacy protection requirements these must be specified, (e.g., national security, investigations by law enforcement agencies, etc.).

[SOURCE ISO/IEC 29187-1:2013, 3.113; adapted from ISO/IEC 15944-8:2017]

3.9
processing of personal information
any operation or set of operations which is performed upon personal information, whether or not by automatic means, such as collection, recording, organization, storage, adaptation or alteration, retrieval, consultation, use, disclosure by transmission, dissemination or otherwise making available, alignment or combination, blocking, erasure or destruction

[SOURCE ISO/IEC 29187-1:2013, 3.116 and ISO/IEC 15944-8:2017, 3.111]

3.10
resource (as used in this standard)
entity that is or has a human interface, or is conveyed through a human interface

Note 1 to entry: As used in this standard, the term resource includes but is not limited to content, materials, media, devices, interfaces, content, activities, technologies, configurations or services.

[SOURCE ISO/IEC 24751-1:20nn, 3.9]

4   Symbols (and abbreviated terms)

Note: This is a draft list that will be further developed during the progression of the work.

For the purposes of this document, the following apply.

AfA - Access for all

IEC - Electrotechnical Commission

ISO International Organization for Standardization

LET - Learning, education and training

PIPEDA - *Personal Information Protection and Electronic Documents Act* (Canada, 2000)

PnP - personal needs and preferences

URI - Uniform Resource Identifier http://tools.ietf.org/html/rfc3986

W3C - World Wide Web Consortium

5   Information Model - Privacy preference set

Note: To be further developed during the progression of the work.

Each of the terms listed below defines a user's preference with respect to how they want to share some aspect of their personal information.

5.1   Privacy preference - third party tracking

The extent to which a user permits tracking of the their online behaviour by third parties

5.2   Privacy preference - third party scripts

The extent to which a user allows or restricts scripts on a web site or page to run when they are provided by third parties.

5.3   Privacy preference - location tracking

The extent to which a user shares their location with other services.

5.4   Privacy preference - sharing contacts

The extent to which a user is willing to share their contacts. An example is their email address book.

5.5   Privacy preference - clear history

'History'   includes browser history, download history, passwords, auto-fill form data, and any cache(s). 'Clearing' means the deletion of the records associated with one or more types of history. Clearing history is dependent on certain well-known times, such as when disconnecting from a service, or at the end of every day.

5.6   Privacy preference - erase after use

Erasure allows the user to specify their personal information is to be forgotten after it has been successfully used, and is no longer needed.

5.7   Privacy preference - allow advertising

Defines whether advertisements are allowed and, specifically, advertisements that originate from trusted sources.

5.8 Privacy preference - cookies

A set of preferences regarding the creation of cookies, sharing of cookie data, and forcing expiration of individual cookies.[3]

5.9 Privacy preference - data control

Preferences for viewing, updating, deleting, and asking for details about the storage of a user's personal information.

6 Codes

Note: to be decided and further developed during the progression of the work

Example of codes:

```
<xs:complexType name="Route">
 <xs:sequence>
 <xs:element name="routeID" type="tdt:IntUnLoMB"/>
 <xs:element name="routeListID" type="tdt:IntUnLoMB"/>
 <xs:element name="listCount" type="tdt:IntUnLoMB"/>
 </xs:sequence>
</xs:complexType>
```

---

[3] There are a few definitions of "cookie" on the OBP - ISO Online browsing

platform https://www.iso.org/obp/ui/#home.

cookie

data exchanged between an HTTP server and a browser to store state information on the client side and

retrieve it later for server use

ISO/IEC 27032:2012(en), 4.16

cookie

small piece of information (i.e. programme code) that is stored on a browser for the purpose of identifying that

browser during audience activity and between visits or sessions

ISO 19731:2017(en), 3.12

cookie

special integer value that is used to identify an event subscription

ISO/IEC 23004-1:2007(en), 4.1.44

<div align="center">(informative)</div>

<div align="center">**Privacy Preferences Information Model**</div>

Introduction

This is a specification of personal privacy preferences, based on the IDRC's "Privacy Needs and Preferences" project. The information model defines the names and values, and groups of name/value pairs that encode users' privacy preferences with respect to aspects of their personal information. These name/value pairs will be created, transmitted, and stored using a JSON data structure. Examples are provided of each preference using JSON.

Terminology

Some of the terms used in this document are based on the "Personal Information Protection and Electronic Documents Act" (PIPEDA). They are defined here.

Personal information

Information about an identifiable individual. Examples include name, address, and credit card information.

Organization

Includes an association, a partnership, a person and a trade union.

Collection of personal information

An organization or, specifically, a service provided by an organization, gathers personal information from a user and may store it internally. For example, a web site may request a user enter their name, address, and credit card, and then store them on an internal server.

Use of personal information

An organization or service uses collected personal information for the purposes for which it was collected. Use is internal, within the organization. Continuing with the above collection example, a service uses credit card information when an individual purchases an item, and then the service uses the individual's address to ship the item.

Disclose personal information

An organization or service shares information it has collected with external third parties.

Information model

privacyPreferences

The container for all of the user's privacy preferences. In JSON:

"privacyPreferences" : { ... }

An empty privacyPreferences implies using the default settings for all of the user's privacy preferences. Default settings are indicated using bold text.

privacyPreference.thirdPartyTracking

Defines a set of Boolean preferences with respect to third parties tracking of a user's behaviour, and whether to alert the user of any tracking. If the user preference is to block all tracking, and that preference is actually enforced, then the alert preference is superfluous. The default preference is to prohibit all tracking by third parties.

- doNotTrack:
  - Value: **true (default)**, false, onLeavePage, onLeaveSite
  - true: user does not want to be tracked by any third party.
  - false: user allows tracking by all third parties.
  - onLeavePage: temporarily allow tracking until the user navigates away from the page, including ending the session with the page
  - onLeaveSite: temporarily allow tracking while the user is browsing pages on a site, but terminate tracking when the user navigates away from the site, including ending the session with the site
- alerts
  - Value: true or false
  - true: show a dialog alerting the user that a third party is requesting location or tracking information about the user. No limitation is assumed regarding the complexity of the dialog. The dialog can be as simple as an alert dialog with an OK button, or it could contain in context options that allow the user to block tracking.
  - false: do not show a dialog that alerts the user of third party tracking.
  - The alerts preference is superfluous if doNotTrack is true, and the system actually blocks all tracking.

Example:
```
"privacyPreferences": {

  "thirdPartyTracking": {

    "doNotTrack": "onLeaveSite",

    "alerts": true

  }

}
```

privacyPreferences.thirdPartyScripts

Provides preferences for restriction of third party scripts on a web page or site. There is no default setting in this case, since the preference is specified in the context of the page or site. Since there can be numerous sites and pages that these settings apply to, the thirdPartyScripts preference is an array of restrictions on a per site or per page basis. Each site or page is defined by a URI.

- site or page:
  - Value: URI of the site or the page to which to apply the user's preferred restrictions
- allow:
  - Value: one of true, false, or temporarily.

o   true: allow all scripts

o   false: block all scripts

o   temporarily: allow all scripts to run for the current session. That is, when the user leaves the site or page, the preference switches to false.

Example:

"privacyPreferences": {

  "thirdPartyScripts": [{

    "site": "www.somewhere.com",

    "allow": "temporarily"

  },{

    "page": "www.elsewhere.com/login",

    "allow": true

  },{

    "site": "www.nefarious.org",

    "allow": false

  }]

}

privacyPreferences.locationTracking

Provides a set of values and a whitelist of services that track the location of the user. The default is to not allow any service to track the user's location. A service is specified using a URI, designated as a *serviceURI*.

Users can allow all services to track them, or allow no services to track them, or allow only a set of trusted services to track. If the latter, the preferences allow the user to specify a list of trusted services.

- locationTracking:
  - o   Value: **none (default)**, all, or a whitelist of trusted services
  - o   none: indicates no location tracking is permitted by any service
  - o   all: indicates that all services are allowed to track the user's location
  - o   array of *serviceURI*s: a list of trusted services that are allowed to track the user's location.

Examples:

The first two examples show all that is necessary to specify no tracking or, in contrast, tracking by any service. The third example shows how to state preferences for only trusted services.

Example 1 -- no service can track:

"privacyPreferences": {

  "locationTracking": "none"

}

Example 2 -- all services can track:

"privacyPreferences": {

  "locationTracking": "all"

}

Example 3 -- trusted services can track:

"privacyPreferences": {

  "locationTracking": [// whitelist of trusted services

    "*serviceURI*",

      "*serviceURI*",

      "*serviceURI*",

      …

   ]

}

privacyPreferences.sharingContacts

A set of values and a whitelist of services with respect to sharing the user's contacts (e.g., address book). The default is to disallow any contact sharing.

Users can share their contacts with all services, or allow no services access, or share with only a set of trusted services. If the latter, the preferences allow the user to specify a list of trusted services, and whether to ask the user before sharing.

- sharingContacts:
  - Value: **off (default),** on, an optional askMeFirst, or a whitelist of trusted services.
  - off: indicates that the user does not want to share their contacts with any service
  - on: indicates that the user is willing to share their contacts with all services
  - A structure that contains a Boolean value followed by a whitelist:
    - askMeFirst:
      - Value: true or false
      - true: indicates the system needs to alert the user that they are about to share their contacts with services in their whitelist, and confirm that the user wants to share.
      - false: indicates that the system does not alert the user about sharing their contacts with the services in their whitelist.

  whiteList:

- Value: a list of trusted services. If a service is not listed, then contacts are not shared with that service. Each service is specified using a *serviceURI*.

Examples:

The first two examples show all that is necessary to specify no sharing or, in contrast, sharing with any service. The third and fourth examples show how to state preferences for only trusted services, and with and without confirmation.

Example 1 -- do not share contacts with any service:

```
"privacyPreferences": {

  "sharingContacts": "off"

}
```

Example 2 -- share contacts with all services:

```
"privacyPreferences": {

  "sharingContacts": "on"

}
```

Example 3 -- share contacts only with trusted services, but only with user's confirmation:

```
"privacyPreferences": {

  "sharingContacts": {

    "askMeFirst": true,

    "whiteList": [        // whitelist of trusted services

      "serviceURI",

      "serviceURI",

      "serviceURI",

      "serviceURI",

      "serviceURI",

      …

    ]

  }

}
```

Example 4 -- share contacts only with trusted services, but without user's confirmation:

```
"privacyPreferences": {

  "sharingContacts": {

    "askMeFirst": false,

    "whiteList": [        // whitelist of trusted services

      "serviceURI",

      "serviceURI",

      "serviceURI",

      "serviceURI",

      "serviceURI",

      …

    ]

  }

}
```

privacyPreferences.clearHistory

Defines which of a user's browser history features are to be forgotten, and when. The browser features are history, downloads, passwords, autofill form data, and the cache. A special case is where users do not want these features recorded in the first place. This is represented as the special time period "neverRemember", meaning do not record or store historical information.

- clearHistory:
  o   Value: a set of browser features with an associated frequency for periodically clearing that feature. All browser features MUST be listed. The features to clear are:
    ▪   history
    ▪   downloads
    ▪   passwords
    ▪   autofillFormData
    ▪   cache
  o   The associated time periods are:
    ▪   neverRemember,
    ▪   hourly,
    ▪   **daily (default),**
    ▪   weekly,
    ▪   monthly,
    ▪   neverDelete,
    ▪   onQuit

Example:

This example shows a list of all the different browser features and how frequently they should be cleared.

```
"privacyPreferences": {

  "clearHistory": {

    "history": "neverDelete",

    "downloads": "weekly",

    "passwords": "hourly",

    "autoFillData": "onQuit",

    "cache": "daily"

  }

}
```

privacyPreferences.eraseAfterUsing

Defines whether specific personal information, which has been provided, needs to be erased and forgotten immediately after its use. An example is providing one's credit card information for making a purchase. When the purchase is complete, and the information is no longer needed, this preference indicates that the user expects their credit card information will be erased.

- eraseAfterUsing:
  - Value: **true (default)** or false.
  - true: indicates that personal information is erased immediately after use.
  - false: indicates that personal information is retained.

Example:

This example indicates that personal information should be erased immediately after it is no longer needed.

```
"privacyPreferences": {

  "eraseAfterUsing": true

}
```

privacyPreferences.allowAdvertising

Defines a set of values and a whitelist of advertisements. The default is to not allow any advertisements.

Users can allow all advertisements to be shown, allow no advertisements, or allow only a targeted list. The targeted list allows the user to specify trusted services.

- allowAdvertising:
  - Value: **off (default)**, on, or a whitelist of targeted advertisements.
  - off: indicates no advertising is allowed
  - on: indicates that all advertising is allowed
  - array: a list of allowed advertisements. Each advertisement is identified as a *serviceURI*

Examples:

The first two examples show all that is necessary to prohibit any advertisements or, in contrast, allow all advertisements by any service. The third example shows how to state preferences for only targeted advertisements.

Example 1 -- no advertisements:

"privacyPreferences": {

   "allowAdvertising": "off"

}

Example 2 -- all advertisements:

"privacyPreferences": {

   "allowAdvertising": "on"

}

Example 3 -- trusted services can track:

"privacyPreferences": {

   "allowAdvertising": [// whitelist of advertisements

       "*serviceURI*",   // URI of allowed advertisement

       "*serviceURI*",

       "*serviceURI*",

       …

    ]

}

privacyPreferences.cookies

The cookies preference is a container for a number of privacy settings with respect to the creation of cookies, the sharing of cookie data, and when to force the expiration of a cookie.

- allowCreation:
  - Value: never, always, **fromOriginalService (default)**, askFirst, or a whitelist of trusted services.
  - never: indicates that cookie creation of any kind is not allowed. Note that this may mean that a given page or site might not work as expected, especially if it cookies are required for normal functionality
  - always: indicates that there are no restrictions on cookie creation
  - fromOriginalService: indicates that cookie creation is allowed if the site currently visited is creating the cookie. Third party cookie creation from the same page is not allowed.
  - askFirst: requires the system to present a confirmation dialog to the user to confirm if a cookie or cookies can be created when a service attempt is to do so.

- o   A whitelist of trusted services: an array of *serviceURI*s representing trusted services that are allowed to create cookies
- allowSharing:
  - o   Value: **never (default)**, always, askFirst, or a whitelist of trusted services.
    - o   never: indicates that cookie sharing of any kind is not allowed.
    - o   always: indicates that there are no restrictions on cookie creation
    - o   askFirst: requires the system to to present a confirmation dialog to the user asking if a cookie or cookies can be shared.
    - o   A whitelist of trustedServices: an array of *serviceURI*s representing trusted services with which sharing cookies are allowed
- expiration:
  - o   Value: endOfSession, **whenLeavingSite (default)**, daily, weekly
    - o   endOfSession: indicates that cookie data is to be erased at the end of the session
    - o   onLeaveSite: indicates that cookies are erased when the user leaves the site
    - o   daily: indicates that cookies are deleted at the end of the day
    - o   weekly: indicates that cookies are deleted at the end of the week

Examples:

"privacyPreferences": {

  "cookies": {

    "allowCreation": [// whitelist of trusted services

      "serviceURI",

      "serviceURI",

      "serviceURI",

      …

    ],

    "allowSharing": "askFirst",

    "expiration": "daily"

  }

}

"privacyPreferences": {

  "cookies": {

    "allowCreation": "always",

    "allowSharing": [// whitelist of trusted services

      "*serviceURI*",

      "*serviceURI*",

```
        "serviceURI",

         …

     ],

     "expiration": "endOfSession"

  }

}
```

privacyPreferences.dataControl

This group of preferences allows users to view, update, delete, set expiration dates, and ask for details about how their information is being used or disclosed. The preferences represent user requests about their personal information as managed by some organization. The preferences or requests are on a per-organization basis. Organizations are specified by a *serviceURI*. Since a user can supply information to multiple organizations, the dataControl preferences are a list of requests for each organization.

With the exception of the expiration request, the values of each preference are true or false, meaning the user either is inquiring about that aspect of their personal information (a value of true), or they are not (false). A missing preference is equivalent to false for that request.

- viewAll: user wants to view all data held by the organization
- editUpdateAll: user wants to update the accuracy of their data, and submit changes back to the organization
- howUsed: user requests an explanation as to how their data is being used by the organization
- howDisclosed: user requests which third parties the organization has disclosed their personal information to, and for what purposes.
- deleteAll: user wants to delete all the personal information held by the organization
- expiration: user specifies when their personal information is to be deleted
  - Value: date/time in ISO-8601 format (ISO 8601:2004, *Data elements and interchange formats — Information interchange — Representation of dates and times*)

Example:

```
"privacyPreferences": {

  "dataControl": [{

    "organization": "www.somewhere.com",

    "editUpdateAll": "true",

    "howUsed": "true",

    "howDisclosed": "true"

  }, {

    "organization": "www.elsewhere.com",
```

```
            "expiration": "2017-04-05T14:30Z"

        }]

    }

Full Preference Set Example

 "privacyPreferences": {

    "thirdPartyTracking": {

       "doNotTrack": "onLeaveSite",

       "alerts": true

    },

    "thirdPartyScripts": [

      { "site": "www.somewhere.com", "allow": "temporarily" },

      { "page": "www.elsewhere.com/login", "allow": true },

      { "site": "www.nefarious.org", "allow": false }

    ],

    "locationTracking": [  // whitelist of trusted services

            "serviceURI",

            "serviceURI",

            "serviceURI"

     ],

    "sharingContacts": {

       "askMeFirst": true,

       "whiteList": [   // whitelist of trusted services

         "serviceURI",

         "serviceURI",

         "serviceURI",

         "serviceURI"

      ]
```

```
    },

    "clearHistory": {

        "history": "neverDelete",

        "downloads": "weekly",

        "passwords": "hourly",

        "autoFillData": "daily",

        "cache": "onQuit"

    },

    "eraseAfterUsing": true,

    "blockAdvertising": [  // whitelist of targeted advertisements

            "serviceURI",

            "serviceURI",

            "serviceURI",

            …

     ],

    "cookies": {

        "allowCreation": "always",

        "allowSharing": [    // whitelist of trusted services

            "serviceURI",

            "serviceURI",

            "serviceURI",

            …

        ],

        "expiration": "endOfSession"

    }

    "dataControl": [{

        "organization": "www.somewhere.com",
```

```
            "editUpdateAll": "true",

            "howUsed": "true",

            "howDisclosed": "true"

        }, {

            "organization": "www.elsewhere.com",

                "expiration": "2017-04-05T14:30Z"

        }]

    }
```

Bibliography

Note:
To be developed further with the progression of the work.

[1]   ISO/IEC 10646:2014 Information technology - Universal Coded Character Set (UCS)

[2]   Canada (2000) *Personal Information Protection and Electronic Documents Act.* Statutes of Canada (SC)

2000, c.5 *http://laws-lois.justice.gc.ca/eng/acts/P-8.6/*

Appendix D: Preparing a next generation that understands the value of human diversity and can navigate complexity

Abstract

Education provides a powerful lever to address not only the symptoms but the causes of current global crises. However, formal education has modelled a hierarchical, competitive and exclusionary culture. Our pedagogical practices squander and suppress the most valuable quality in students; namely their uniqueness and diversity. Our educational value structure gives privileged place to the formulaic, replicable competencies that can be replaced by machines. Students are implicitly prepared to punch down rather than lift up those that are more vulnerable. If formal education systems continue on the same path, we are preparing our students to be replaced by machines. We are teaching them to compete and exclude, thereby contributing to societal and environmental collapse. There is a nascent global movement to reverse this trend; to foster a more inclusive culture. International partnerships led by the Inclusive Design Research Centre have been building design strategies that empower students and youth to understand and value diversity, including their own unique differences, and to collaboratively navigate the complexity ahead.

Introduction

One of the things that has troubled me lately is that it appears that the plethora of data and information has so overwhelmed us that it has displaced wisdom. At the same time, with truth under attack, we have retreated to an impoverished truth that is uni-perspectival and flat. We have constrained truth to measurable, transferable and therefore scalable surface evidence.

This is happening at a time when we are handing our intelligence and most of our decisions over to machines (O'Neil, 2017). These machines will automate and amplify this mechanised version of a measurable truth. This will mean that what has not been true in the measurable past will likely not be true in the future because there is no evidence that it has a probability of success and therefore it will not be chosen. Past biases, past barriers will determine future opportunities. If someone measurably like me has never succeeded in university, someone like me won't be admitted. If someone measurably like me has never successfully held a competitive job, someone like me will never be picked to be interviewed for the competitive job. The pattern will hold for many other things like credit, insurance, and influence. There will be no leaps of faith. The most chilling example of this was a commitment, voiced by a school, to be purely evidence guided in determining what students would be exposed to and how they would be exposed to it, and to employ educational technology to assist in this commitment.

What counts as evidence is large homogeneous numbers that have statistical power. Implicitly captured in the word 'evidence' is the elimination of variability and anomalies. 'Hard evidence' is inherently hostile to diversity and complexity. With this commitment to dominant and favoured forms of evidence we are dooming our students to be captured by the past and to conform to a mythical conception of average, or else suffer.

A Collective Imaginary

In trying to come up with ways to escape this conundrum, I've been playing with imaginaries. I've been engaging people all over my travels through informal conversation — people of many ages, many walks of life, many political stripes —in imagining a complete school refresh. I've actively sought out people who have given up on education, or who feel betrayed by education, as well as people that have reached the pinnacle of the academies. When appropriate I've used an outdated computer term: I asked for people to imagine an education 'reboot.' I asked people to clear the data cache, remove the preconceptions, remove the data-supported biases and probabilities and imagine a collective construction of an inclusive education. I asked people to base it on wisdom and intuition, that no response would be judged. They were to imagine a new form of education that would bring us joy, that would bring us meaning and purpose; and let us flourish; as individuals and as a collective society.

I used no survey, no standardised interview questions, or script. I tailored the question and the discussion to the people I approached and the amount of explanation that would be needed to understand that I wanted them to imagine 'from scratch.' The only criterion or constraint I put on the possibilities is that both the individual and society as a whole should flourish. I let people imagine without interference and then I asked what they thought of aspects of other people's imaginaries, linking them into a collective imaginary. In the discussions, I was surprised at how much pain and hurt, caused by formal education, people felt compelled to share and how often the moments of joyful learning they recounted were not associated with school. However, no one questioned the critical role of commonly accessible education in a flourishing society.

Because my scholarship involves diversity and inclusion; or put another way, increasing diversity while also creating and maintaining social cohesion; I don't look for the average or the mean, or impose parameters, I'm more interested in the edge and the points of intersection that arise. I also recognise that, on any point, people can't be captured in a single x/y coordinate, we are each of us a jagged scatterplot of needs and characteristics. Because any topic is multi-perspectival and there are many ways of knowing, a hypothesis that I've played with is that truth can be found at the intersection of difference. Associated to this is a phenomenon that I have observed repeatedly, if we make room for and respect our differences, we will find a deeper commonality. I've been trying to plumb these common truths in my co-construction of an imaginary. This is not rigorous, I have not measured, there is no hard evidence.

Below, I have tried to find terms such as 'the knowledge commons' to relay a common idea that was expressed in many different ways. The following are the salient points (that I can fit into the space limits of this paper) at which people from very different perspectives have intersected in my conversations about the collective imaginary:

Learning would be life-long. There would be no end to learning, no terminal degree, no point of completion. Learning would stretch from the minute we become sentient to the instant we die. Many people spoke of the profound lessons that they learned by keeping company with people that were dying. Many others spoke about the most important and lasting lessons they learned before formal education began. People who had disengaged from formal education spoke about the difficulty of re-entering education later in life.

Learning would not be segmented into age-linked stages or grades. A large variety of people relayed the trauma of being sorted into grades and streams and being marched at an imposed speed through a prescribed path (at too slow and too fast a pace). Fundamental skills of literacy and numeracy would be mastered at a personalised pace and path.

It would be intergenerational. The old have much to teach the young and vice versa. Many people spoke of the social aspects of learning, the deep connections they had with people that they learned with or learned from. Often these described deep connections were with people that were outside the affinity group or social group, people that would otherwise be seen as strangers or 'the other.' Learning would involve removal from our insular context, positioning ourselves in new cultures and new geographies.

Learning would not be divided into separate disciplines. People often bemoaned the need to choose, the choices they made and the opportunities they missed and how they benefitted from and needed the insights of disciplines that they did not study.

One of the most important lessons would be how to learn, how to think critically. A skill I stress in my program is how to give, receive, and value constructive criticism. When I asked people what they thought of this they talked about how hard that would be, but also how worthwhile it would be to learn.

Often, otherwise divergent people included integrated, active, project and problem-based learning in the 'real world' especially the outdoors, in their conception of an imaginary. People wanted learning with meaning and relevance, that called forth resourcefulness and sparked innovation. Associated with this was abandoning 'disposable assignments,' or school work whose only purpose is to show evidence of rote learning. School work or scholarly work would contribute to and build on the common knowledge store.

We would mark, celebrate and value accomplishments and contributions to the knowledge commons. These celebrations would not be confined to mastering existing knowledge and skills but also to discovering new knowledge, remixing knowledge, augmenting knowledge and creating new takes on collective knowledge. These would include all forms of knowing. We would not privilege 'STEM' and the forms of knowing that can be replaced by machines. You would not need to qualify to create knowledge. Many people spoke of contributions by people without academic credentials that were discounted at societies peril. Deviation and alternatives would be encouraged for their exploratory qualities.

We would reverse the demonisation of failure and mistakes. Failures are some of our best teachers. Having failed should never be deterministic. Using failure and mistakes to predict our future is one of the worst mistakes of our current systems of education. It shows a complete misunderstanding of learning. People from all walks of life relayed how they overcame the stigma of failure and the sting of punitive judgements. We would remove the current dampers and detractors of inherent curiosity and wonder. People could recount moments when wonder and curiosity was 'stamped out of' them by education.

Knowledge would belong to the commons for all to benefit from. There would be no paywall or lock on knowledge, especially research and knowledge that was paid for by the commons. But people would be compensated and attributed fairly by the commons for their labour on behalf of the knowledge commons. People made a point of stressing the immeasurable value and influence of good teachers and the need to compensate and recognise educators (it should be said that I did identify myself as a professor).

We would use machines to free us from drudgery and redundant tasks, to give human intelligence a lift. We would not deploy machines to determine our choices. We would retain agency over self-determination and self-knowledge.

Everyone would be both a teacher and a student. Often the best way to learn is to teach and the bartering of knowledge builds social cohesion. We would compete with ourselves rather than with others. We would learn to work as a team, to collaborate and orchestrate our diverse strengths and competencies.

To expand the range of competencies we need as a society, we would help each individual build out their own, unique competencies and find optimal challenge to continue to grow. Through this we would respect multiple ways of knowing. Many people listed the current gaps in experiential forms of social and cultural knowledge. "We don't know how to get along. We don't know how to communicate with each other. We've lost touch with our creative side."

My greatest personal insight was that, despite the fractured state of our current society and the polarisation of opinions and world-views, there are many points of intersection and deeply held common truths about education and learning.

Escaping Our Past

Imagining does not make it so. Barring creative destruction or catastrophic events, change is incremental, old habits die hard and many of the things, that we all know are not good for us, are more tenacious than we expect. But it is good to occasionally set our sights in a common direction.

Yuval Harari ([2016](#)) argues that the primary purpose of historical knowledge is to be liberated from our past. "We take this reality for granted, thinking it is natural, inevitable, and immutable." We assume that the 'cold hand of the past' is a natural and inescapable part of who we are, not an accident of history. Strangely we often recoil from joy because we don't think we deserve it or because we think it will leave us defenceless and untethered. Sometimes it is good to untether our imagination, recalibrate our compass free from the magnetic pull of assumed inevitability and look to and beyond the far horizon.

Inclusive Design and Learning

In our toolkit of inclusive design, we have an exercise called the 'grandparent-toddler' conversation in which, like a toddler, we repeatedly ask forms of "why?" to broaden our focus to the causes rather than the symptoms of our challenges and to expose the essential elements of a conundrum ([Inclusive Design Research Centre](#)). We find that another means of removing unnecessary mental constraints, fears and blind spots is to design with individuals at the margins of our human scatterplot, and to find approaches for the edge scenarios they face. This is where innovation and the impetus and courage for change can be found. If we stretch our current designs to be more inclusive, we open up possibilities for our future selves. By making room for the widest range of perspectives we can scan the full horizon to both find new opportunities and become aware of emerging threats. The inclusive design framework we apply at the Inclusive Design Research Centre has three dimensions ([Treviranus, 2018b](#)):

1. Recognise, respect, and design for human uniqueness and variability.

2. Use inclusive, open & transparent processes, and co-design with people who have a diversity of perspectives, including people that can't use or have difficulty using the current designs.

3. Realise that you are designing in a complex adaptive system.

A critical part of inclusive research and scholarship is to address the bias and gaps in our knowledge resources and our ways of knowing. In part this means finding ways to represent people and groups that are unrepresented and underrepresented in the knowledge commons. A respectful and generative way of doing this is to provide a means to tell your story, to give voice to people whose voices have been drowned out, ignored or devalued.

For the storytellers this acts as a form of self-discovery and means to find or rebuild identity (McLean et al., 2010), way to co-create community, and a way to chart the path forward. In our project, The Social Justice Repair Kit (Inclusive Design Research Centre), we are working with youth to co-design storytelling tools. Many of the youth helping us are youth who have disengaged from formal education and youth with learning differences. We see this as a small step to rectify educational injustice and re-engage the storytellers in learning. We also see it as an important function of youth movements and youth social safety nets.

Conclusion

Everyone I spoke to in my informal conversations held that education is a human right, no matter what end of the political spectrum they came from or what level of education they had achieved. While most felt that education has failed people at the margins, overall they stressed the essential role of education "to get us out of this mess." Perhaps we can use the intersections of our deeper common truths to build a system of education and a knowledge commons that will lets us flourish individually and as a global society.

Appendix E: Blog Post Contesting the Pareto Principle in Design

The following is an invited Blog in which I contest the application of the Pareto Principle in Inclusive Design. This was first published on the Medium blog of the Ontario Digital Service (2018)

If you want the best design, ask strangers to help

Editor's Note: Jutta Treviranus is a leader in inclusive design; she started and directs OCAD University's Inclusive Design Research Centre, heads the Inclusive Design Institute and founded the first inclusive design graduate program at OCAD U. In this post, Jutta explains the costs and impacts on the edge and the unrepresented when identity clustering and cookie cutter approaches to digital inclusion occur.

Last spring Hillary Hartley joined the Ontario Government as the first Chief Digital Officer, assigned to design, develop and deploy a friendly, efficient, effective, accessible, inclusive and participatory online government. A tall order, even for someone that has experience wrangling the US administration.

There is also a commitment that the government will act as a model of good practice for other organisations in Ontario, and a leader globally.

Where do you start?

It's not an exaggeration to say that the Ontario Government is a very complex system. The Ontario Public Service has more than 60,000 employees. There are 30 ministries with well-established divisions of power and well worn-in routines (the Ontario Ministry of Transportation, for example, just celebrated its 100th anniversary). There are nine independent 'Information and Information Technology' clusters. As with any large and well-established bureaucracy, the documented rules and policies would take years to read, and this does not account for the unwritten conventions and implicit customs that guide behaviours and habits within an institution. Add to this the Legislative Assembly, the political arm of the government, which serves for fixed terms and needs to deliver on its commitments to garner re-election. And most importantly, the complex relationship with a very diverse public with a huge variety of expectations and opinions regarding good government.

This bold experiment in institutional change is indeed a model to watch. Given this hugely complex and challenging task, where do you start?

The 80/20 Principle?

One of the conventions and pieces of advice often given to individuals attempting an overwhelming task with limited time and resources is the '80/20 rule.' There are many interpretations of this rule, but the crux of the advice is to tackle the 80% first, which will theoretically require 20% of the effort, and leave the most difficult 20% for later. This is based on the Pareto principle or the 'law of the vital few.' In 1896 Pareto showed that 80% of the land in Italy was owned by 20% of the population. Richard Koch popularised the principle in business through his 1998 book 'The 80/20 Principle,' and this principle has been extrapolated to everything from sports to health and safety; as well as to developing new programs in government.

Indeed, I overheard someone reference this principle to Hillary at a digital government conference this past year. I would say that we face a different, more complex and more entangled reality than in Pareto's day, and following his principle will never produce the change we need. I contend that we should do the opposite. Let me explain.

Unlearning and the 'difficult' 20%

As a professor, the most difficult and advanced graduate course I teach is called 'Unlearning and Questioning.' The students that struggle the most in this course are almost invariably the ones that have been highly successful, with the top academic records, who have been dubbed our 'best and brightest.' In contrast, previously struggling students often shine. By the end of the course all the participants report that they have changed each other in profound ways.

You might ask why I would create and teach a course that seems the antithesis to education. Isn't a university education about learning, not unlearning? Also, what led me to recruit struggling students into an advanced course?

The very simple answer to the first question is: because the world is changing. All students face exponentially increasing complexity and discontinuities in every realm of their lives. We need new tools, and a far larger and diverse set of tool choices, to participate and intervene. What gets in our way in coming up with and adopting these growing and evolving tool sets is the over-application of what we are good at, focusing on the things we can do with confidence, and the assumptions to which we are most attached.

Inclusive Design Class called 'Unlearning and Questioning'

Key skills needed to participate productively in this change include many things we have devalued (if not demonised) in education, either explicitly or implicitly. These underdeveloped and much-needed skills include: valuing failure and mistakes, maintaining humility and vulnerability, collaboration, providing and seeking constructive critique, the courage to challenge authority, welcoming dissonance, integrating diverse perspectives, reserving judgement, focusing on process not product, and looking for the right questions rather than rushing to answers. We need to make room for and become receptive to these and other new competencies. Like the chemical receptors in our brain that are blocked from binding in new ways, I try to decouple my educated students from their strongly held bonds to presumptions and assumptions that block new considerations and processes.

Regarding the second question, why recruit students that have struggled? It is because I want to prepare students to take on the hugely complex and difficult challenges facing our society. I want to create a learning community that can respond to our global risks and effect inclusive change. To achieve anything complex requires radical diversity, for what Scott Page calls the 'diversity bonus.' Complex problems require diverse perspectives. The more diverse the better. In the face of adversity and exclusion, these students have honed resourcefulness.

Planning to intervene in change requires prediction. With accelerated change, it has become much more difficult to predict what might happen. It is a fact that the overall group prediction error is reduced in relation to the diversity of the group. Put another way, for more accurate prediction you need as much diversity as you can get.

Representing Diversity

Diversity and inclusion have become trending topics over this past year. The terms are used so casually of late that they have almost lost their meaning. Although we often

glibly state our commitment to diversity, in reality, most of the tools and practices we currently hold dear are in opposition to diversity. This means there is a great deal to unlearn to realistically achieve inclusive change. This includes the 80/20 rule.

The 80/20 rule is apt if you want to serve the status quo. Another way of thinking about this is to consider a scatter-plot of the needs of any group of people.
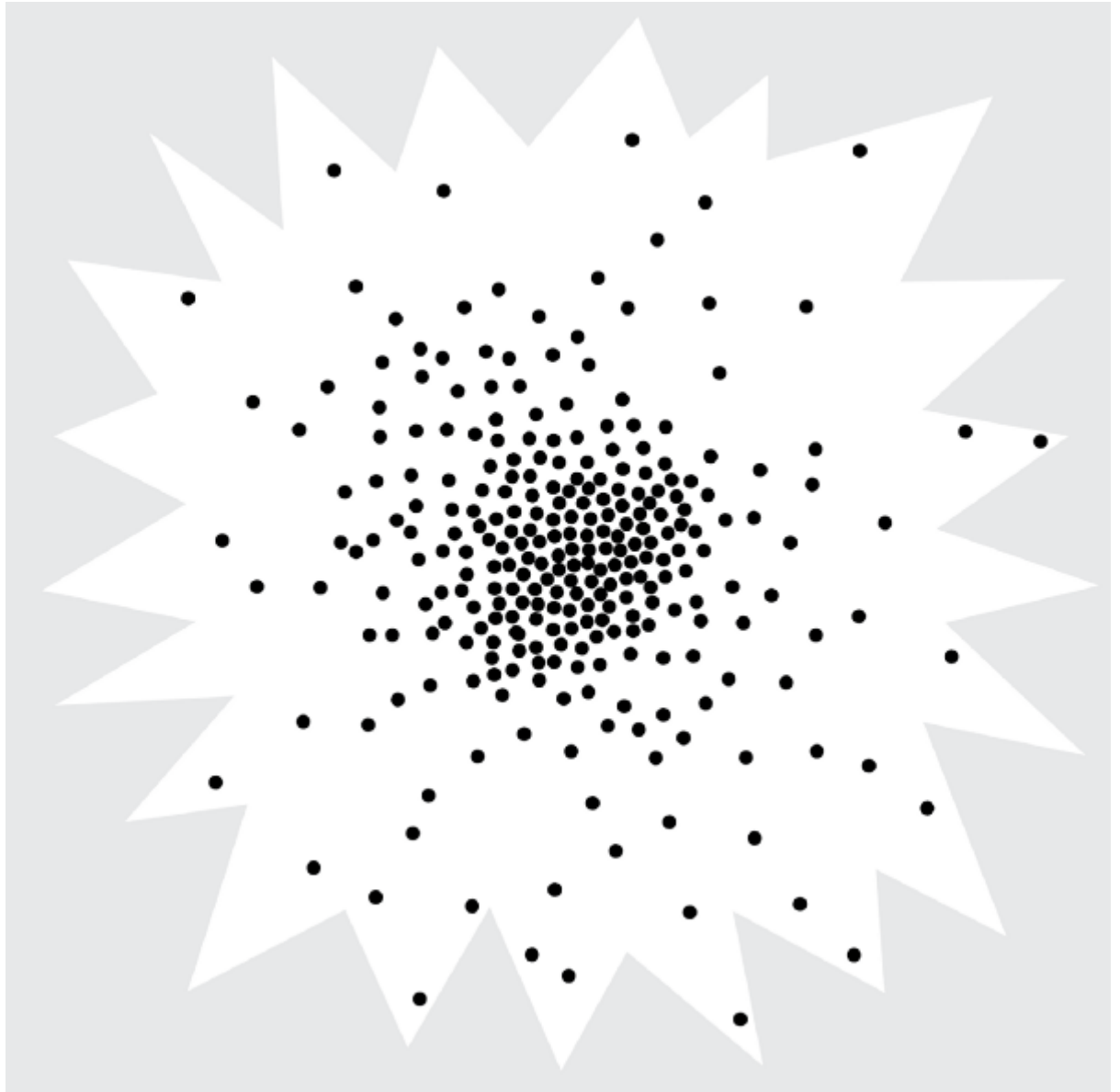
A scatterplot of needs of any given population, the distribution is like an exploding star.

It will look like an exploding star with a denser set of dots (representing the majority needs) in the centre, and more widely spaced dots the further you get from that centre (the minority needs). Distance represents difference. The closer the dots the more similar they are. The wider they are spaced from each other the more they differ. If you want a design that will cover 80% of the dots (or needs), you only need to cover 20% of the space, or that central cluster. This centre is also where you can achieve economies of scale, because needs are very similar. This sounds very reasonable and efficient. It served

industrial markets and mass production well. It allowed for quick wins. However, it comes with some major costs.
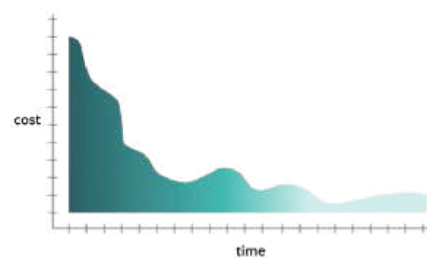
The Costs

Change and innovation are found out at the edge, not in the centre where mediocrity lies. If you are serving a complex system in flux, even that central 80% covering 20% of space will inevitably move and your design won't have the coverage. Your design will be what we call 'brittle.' You will need to respond to more and more exceptions and issues you did not consider. Your design will start to look like a house with bolted on additions, which inevitably will cause the whole structure to collapse. End of life will be sooner. Costs will be greater in the long term.

Our government needs to be here for the duration. If you plan to include the edge from the beginning, your design might take more time and resources at first, but it will be dynamically resilient and adaptable. It will be future friendly in that it will give the centre a great deal of room to shift. It will also cost less in the long term.
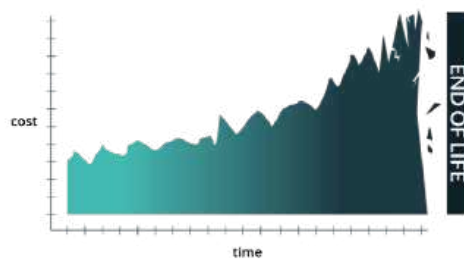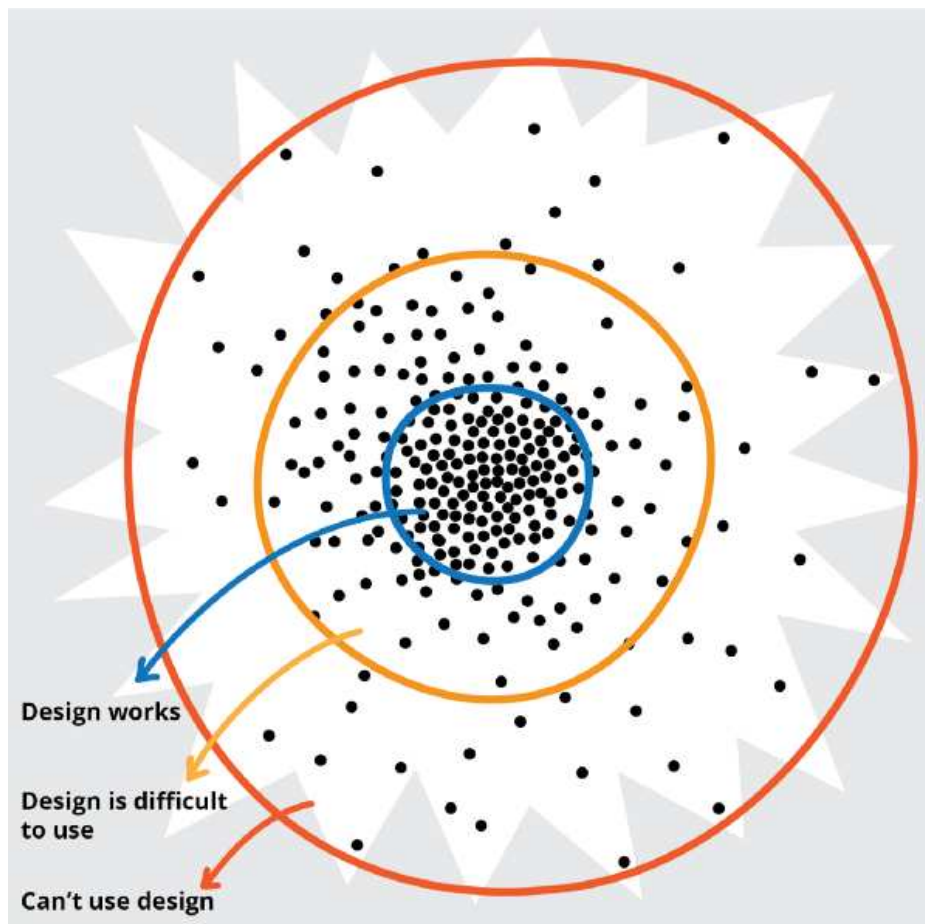

These two groups show the costs over time for when planning for the centre (where costs increase over time) and planning with the edge (where costs decrease over time).

Designing with the Edge

My advice would be to design *with* the difficult 20% first.

The scatterplot showing people who have difficulty using the design and people that can't use the design, out at the periphery.

In inclusive design we recommend inviting people that can't use or have difficulty using your current design to help you redesign. Companies that hope to create more useful machine intelligence are also beginning to realise the advantages of machine intelligence that recognises and understands the full range of diversity and not just the dominant patterns.

Humans and Categories

I want to add a proviso or qualifier. One thing we also need to unlearn is our unconscious reliance on a deeply ingrained human competency. It is a human competency that has figured in the debate about what distinguishes human intelligence from machine intelligence. A problem that stumped artificial intelligence machines but that is easy for most two-year-olds is to classify or sort things like cats from dogs (try articulating rules you would use to tell a cat from a dog). Search for the meme 'dogs or muffins' and you will see further examples. Our sorting and classifying abilities are stellar and ingrained. We also love opposites, binaries or polarities. You may have fond memories of kindergarten exercises and Sesame Street songs that ask you to identify opposites. It is no wonder that we apply these skills so unconsciously and ubiquitously. However, issues arise when we impose this categorisation on people. People are complex, multi-dimensional and evolving. Trying to fit people into classificatory boxes is very problematic.

A common practice when trying to achieve a more inclusive design is to rely on categories of people to achieve representation. The simplest variant is to create binaries: able-bodied and disabled, male and female, for example. More sophisticated variants are to include representation from a list of human categories: people who are blind, Deaf, wheelchair users; or a colour wheel of racial origin. What is wrong with this as a way of achieving better representation? People are complex, variable and multi-dimensional. The classifier used to sort the person may not be the most important characteristic that informs the perspective or needs they bring.

More importantly, if the goal is to cover the 80% of the design space needed to reach the peripheral 20%, creating categories is not going to work. People will fall through the cracks and will be stranded at the edges of our chosen categories. This will drive a wedge between people that are included and people that continue to be marginalised. Where does my gender fluid young niece fit in the categories of men and women? Where does my friend who has a rare progressive disability fit in the categories we have created to sort people who experience disabilities? The further out to the periphery you get the greater your difference.
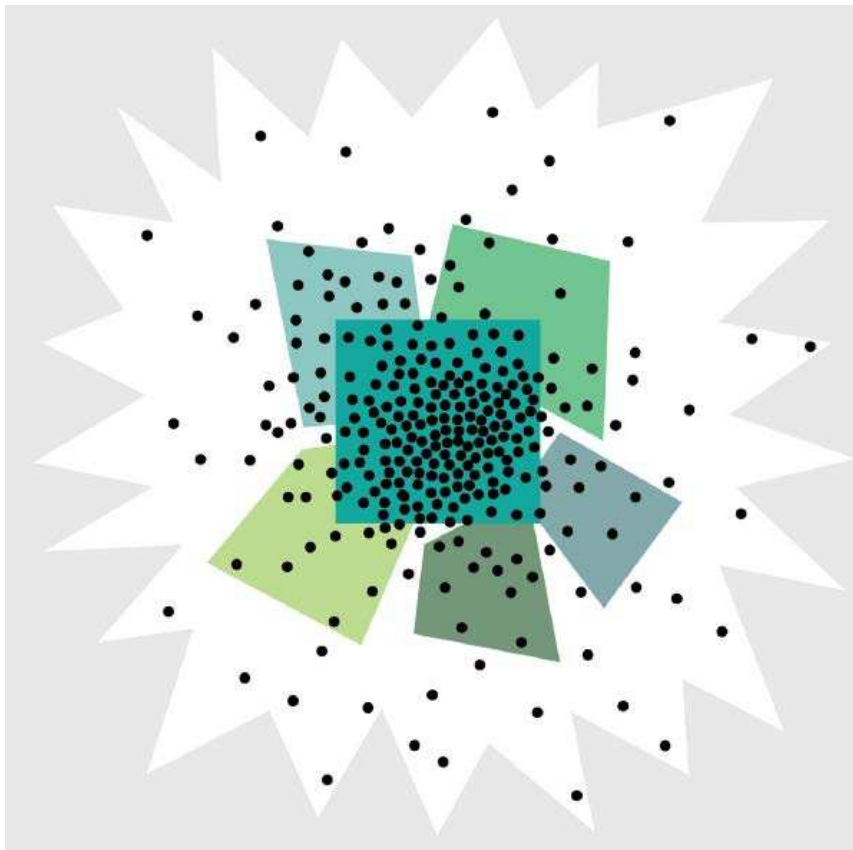
Scatterplot of needs showing how we capture categories of needs, but leave people at the edge and falling through the cracks.

The best approach is to continuously ask "who are we missing?" What perspectives are not at the table and how can we design the table so that they can participate in our process? This is best achieved through iterative, rapid, full-cycles of design, development, implementation and evaluation; by growing from small successes that

invite participation and constructive critique. This provides an opportunity at each iteration to thoughtfully reflect on who is missing.

It is adding these missing perspectives that will bring about change, innovation, and dynamic resilience. The further participants are from the well-served middle, the better. The more dimensions or aspects of the periphery we can include, the better. The magic factor that makes the whole far greater than the parts is the range of difference. This will not only stretch what we produce, but it will stretch our process so that we can tackle the unpredictable complexity ahead.

With the help of 'Strangers'

The late and wise Ontarian, Ursula Franklin, referred to this phenomenon as the "gift of strangers." She felt it was imperative that we continuously extend our world with the help of strangers. It is not a skill that comes easily or unconsciously, it takes effort. Luckily humans can draw upon a struggling urge to grow and improve. Our Ontario community is primed to harness this gift of strangers. Hillary and her team are well on their way to addressing the complex challenge.

Note: Graphics by Inclusive Design Research Centre under Creative Commons Attribution-NonCommercial 4.0 International License.

Appendix F: Affidavit for Donna Jodhan Human Rights Case

The following are the initial and response affidavits for the case against the Canadian Government.

FEDERAL COURT

BETWEEN:

Donna Jodhan

Applicant

And

Attorney General of Canada (Representing the Treasury Board of Canada, Secretariat, Public Service Commission of Canada, and Statistics Canada)

Respondent

AFFIDAVIT OF JUTTA TREVIRANUS

AFFIRMED JUNE 27, 2007

I, **Jutta Treviranus**, of the City of Toronto, AFFIRM THAT:

1. I am aware of the Charter challenge being brought by Donna Jodhan regarding the inaccessibility of the government of Canada's web material, and swear this affidavit in support of that challenge.

About Me

2. As is delineated in my CV I have been an expert advisor in drafting and implementing Web accessibility standards, specifications and guidelines since the beginning of the Web. I have been chair, project editor or contributing editor in many of the Web accessibility standards. I have also consulted with the Federal and Provincial Governments and international jurisdictions and participated in a number of education, advisory and policy initiatives addressing the accessibility of Government Web space.

3. I am deeply committed to an inclusive Web. We are well into an information age and it is critical that no one be excluded from participating in the information and communication exchange afforded by the Web (see, e.g. W3C 'How People with Disabilities Use the Web – Working-Group Internal Draft, 5 May 2005' attached as **exhibit "2"**). Government services that Canadians depend upon and that affect every aspect of their lives are being increasingly offered online. Canada will betray its commitment to inclusion if these are not accessible to citizens with disabilities.

4. I am in contact with many visually impaired consumers of the Federal Government's online material and have reviewed the same sites myself. There are a number of basic accessibility problems which have existed for some time and which could readily be addressed. For instance, there are:

- images without alternative text descriptions (meaning that an individual with vision disability will not know what information is conveyed through the image or what image is being presented);
- lack of alternative text for imagemap hot-spots (for instance, if maps or pictures have areas on them, which, when a cursor is placed, will provide more detailed information or a further link, do not have alternative text, an individual with vision disability will not have access to the information);
- misleading use of structural elements on pages (for instance, if headings and subheadings are created in graphics rather than appropriate heading text, or if heading texts are used to simply bold certain text that is not actually a heading, an individual will have difficulty understanding and navigating the page and will take a significant amount of additional time simply to understand if the page contains relevant information);
- undescribed video (meaning that an individual with vision disability will not know what image is being presented or is meant to represent);
- lack of alternative information for users who cannot access frames or scripts (for instance, if a website uses flash, that cannot be read by a screen reader, and does not alert the user to this fact or provide an alternative to the script in a non-flash format, an individual with a vision disability will not be able to access the functionality or the information presented by the script);
- tables that are difficult to decipher when linearized (since many screen readers review text horizontally, even if a table has three columns with information to be read one column at a time, the tabled text will be non-sensical to the reader); and/or
- sites with poor contrast (this may mean that individuals with low vision cannot decipher the text from the background).

These will cause problems even for individuals who have the most up to date screen readers. Individuals who cannot afford the latest screen reading technologies will have even greater difficulty in accessing the information and controlling the functionality.

Key 'Web' Terminology

5.   To assist in understanding accessibility issues with websites, I have outlined below some key Web terminology:

(a) 'Authoring Tool' - software that people use to create Web pages and Web sites. Many of today's authoring tools create markup that is difficult for people with disabilities to access. Authoring tools can support the production of accessible Web content by generating valid markup automatically; by checking the accessibility of content created; by prompting the author for necessary changes; and by informing the author how to create accessible content.

(b) Web 'content' generally refers to the information in a Web page or Web application, including text, images, forms, interactive scripts and sounds.

(c) Web accessibility means that people with disabilities can perceive, understand, navigate, and interact with the Web, and that they can contribute to the Web. Web accessibility also benefits others, including older people with changing abilities due to aging and people using alternative browsers, hand held devices or those who are more proficient in an alternative language.

(d) Web browsers are software that enables a user to display and interact with text, images, and other information located on a web page (e.g. Internet Explorer, Safari, Firefox).

(e) Evaluation tools are software programs or online services that *help* determine if a Web site meets accessibility guidelines. While Web accessibility evaluation tools can significantly reduce the time and effort to evaluate Web sites, no tool can automatically determine the accessibility of Web sites - the actual experiences of persons with disabilities and informed human judgment are required.

(f) User interface (UI) is everything designed into an information device with which a human being may interact -- including display screen, keyboard, mouse, light pen, the appearance of a desktop, illuminated characters, help messages -- and how an application program or a Web site invites interaction and responds to it.

(g) Style Sheets are sets of statements that specify presentation of a document. They may be written by content providers, created by users, or built into user agents (e.g. a browser).

W3C

6.   The World Wide Web Consortium (W3C) was founded in 1994 and is an international consortium where Member organizations, a full-time staff, and the public work together to develop Web standards. W3C's mission is: "to lead the World Wide Web to its full potential

by developing protocols and guidelines that ensure long-term growth for the Web" (see 'About the World Wide Web Consortium (W3C)' attached as **exhibit "3"**).

7. The W3C primarily pursues its mission through the creation of Web standards and guidelines. Since 1994, W3C has published more than ninety such standards, called W3C Recommendations. The W3C also engages in education and outreach, develops software, and serves as an open forum for discussion about the Web.

8. The W3C has over 300 member organizations who have frequent opportunity to review and comment on guidelines as they evolve. Some member organizations participate directly in the development of the guidelines or in associated working groups. Also disability organizations, accessibility research centers and governments all participate under W3C process (see e.g. 'Fact Sheet for "Web Content Accessibility Guidelines 1.0', May 1999 attached as **exhibit "4"**).

9. The W3C hosts the Web Accessibility Initiative (WAI). The WAI works with organizations around the world to develop strategies, guidelines, and resources to help make the Web accessible to people with disabilities ('About WAI' attached as **exhibit "5"**).

10. The W3C developed Web Content Accessibility Guidelines (WCAG) in 1999 ('Web Content Accessibility Guidelines 1.0' attached as **exhibit "6"**). The WCAG are internationally accepted standards setting out a number of checkpoints with one of three priority levels and conformance levels. Priority 1 checkpoints are those that *must* be developed or one or more groups will find it impossible to access information. Priority 2 checkpoints are those that *should* be satisfied or one or more groups will find it difficult to access the information within (there will otherwise be significant barriers in the Web document). Priority 3 checkpoints are those that *may* be addressed, otherwise one or more groups will find it somewhat difficult to access information within.

11. The WCAG address common accessibility problems on websites including: images without alternative text; lack of alternative text for image-map hot-spots; misleading use of structural elements on pages; uncaptioned audio or undescribed video; lack of alternative information for users who cannot access frames or scripts; tables that are difficult to decipher when linearized; or sites with poor colour contrast (see also 'Introduction to Web Accessibility' attached as **exhibit "7"**).

12. WCAG 2.0 (attached as **exhibit "8"**) have been developed and circulated for approximately two years. They are expected to be officially released in 2007. The updates address changes in Web technologies, browsers (or user agents) and assistive technologies and aim to ensure the Guidelines are easier to understand. WCAG 1.0 is no longer the most current or appropriate document to consult when ensuring accessibility.

13. The W3C has developed 'Authoring Tool Accessibility Guidelines 1.0' in 2000 (attached as **exhibit "9"**) to assist developers in designing authoring tools that produce accessible Web content and to assist developers in creating an accessible authoring interface. An 'accessible authoring tool' can ensure accessible Web content (through prompts, alerts, checking and

repair functions, help files and automated tools), regardless of the experience or expertise of the web designer. Thus, an 'accessible authoring tool' can be incredibly important in ensuring that Web material for an organization (particularly one with many departments) is accessible. ATAG 2.0 (attached as **exhibit "10")** is in public draft form and will be released as a candidate recommendation shortly after the release of WCAG 2.0. This addresses changes in Web technologies as well as changes in the WCAG.

The Common Look and Feel Standards

14. In 2000, the Canadian government (via the Treasury Board of Canada Secretariat (TBS)) implemented the Common Look and Feel Standards for the Internet (CLF) (attached as **exhibit "11")**. According to the TBS, the CLF standards were meant to ensure universal accessibility and "equitable access to all content on Government of Canada Web sites".

CLF 1.0

15. Although the CLF standards were a laudable step towards accessible government Web sites, necessary steps to ensure compliance, consistent and well informed implementation and equitable access for people with disabilities were not taken. Rather than promote a positive attitude to accessibility and a willingness on the part of government Web authors and developers to work creatively toward accessible design, following the release of the CLF standards, accessibility was frequently ignored, relegated to the end of the development process, or seen as a constraint on creative or innovative design. The CLF standards were not uniformly implemented, and there was no consistent enforcement to ensure compliance amongst the many government departments.

16. Authors and producers of Government Web content were not adequately trained or informed about accessibility requirements or accessible authoring techniques. They were not consistently made aware of resources and tools that could assist with accessible authoring. In an informal survey it became clear that many government Web editors did not know that accessibility referred to access for people with disabilities. When training did occur there was no care taken to train successors when there was staff turnover.

17. Across Web content processes and policies within the government there was no consistent policy or workflow process to integrate accessibility considerations at the initial design stages. Accessibility evaluation was not an integrated part of quality assurance or content review. Accessibility was not a consistent requirement in procurement contracts for Web related tasks.

18. The Government did not require the use of ATAG 1.0 compliant (or optimally compliant) tools. This would have assisted in making authors aware of accessibility techniques and would have assisted in creating accessible Web content.

19. Another problem with the CLF 1.0 was failure to comply with its standards. Many government websites were not "Priority 1" or "Priority 2" compliant (see e.g. the Alliance for Equality of Blind Canadian's 'Common Look and Feel Report', February 2005, attached as **exhibit "12"**). No central government body monitored compliance with the CLF 1.0 or otherwise ensured accessibility of government Web material.

20. There were meetings of the federal Access Working Group advising the Federal Internet Advisory Committee and the Common Look and Feel Committees. I was asked to present to this committee on several occasions including in December, 2004 and March, 2005 (see **exhibit "13"**). The issue of government non-compliance was discussed and there was general agreement regarding the problems and solutions required. The committee brought together individuals with responsibility for accessibility within several federal departments. While these individuals were committed to the necessary accessibility agenda they were not able to effect sufficient change and uptake in the government as a whole to follow up on the commitments.

CLF 2.0

21. Revisions to the CLF 1.0 standards were approved by the TBS on December 7, 2006. According to the TBS , the new CLF Standards:

> …were developed to reflect modern practices on the Web, changes in technology and issues raised by the Web community over the past six years as well as to improve navigation and format elements. The standards were rewritten to eliminate duplication and conflict with other Treasury Board policy instruments and were reformatted to improve their structure and organization. ('Common Look and Feel for the Internet 2.0' attached as **exhibit "14"**).

22. A summary of the changes made to the CLF standards can be found in the associated 'Crosswalk Table' attached as **exhibit "15"**. All newly launched websites must be fully compliant immediately. Older websites are expected to be compliant by December 31, 2008.

23. The CLF 2.0 standards continue to reference and require compliance to priority 1 and 2 of WCAG 1.0. WCAG 1.0 is an outdated standard that does not address the technologies currently in common usage. As noted above, WCAG 2.0 has been developed to address this issue and was in public draft form at the time that the CLF 2.0 standards were being developed.

24. One of the technologies not adequately addressed by WCAG 1.0 are interactive scripts and rich internet applications. Like most online services the Government of Canada implemented interactive scripts to deliver many government services online. As many more

government services were offered online the use of these Web technologies also increased.

25. Although it was well known that these technologies would necessarily be implemented on government Web sites there was no strategy to make them accessible. Web developers were instructed to create interactive Web applications which included user log on and authentication but were not given guidance or tools to make them accessible.

26. At the same time Canada, through its Industry Canada, funded participation in IMS Global Learning Consortium and through its participation in ISO JTC1 SC36 was actively developing tools, guidelines, specifications and standards to make interactive Web applications (especially applications involving user log on or identification) accessible. Canada also participated in the W3C Accessible Rich Internet Applications (ARIA) working group to create guidelines and necessary interoperability specifications to make rich internet applications accessible (information about the W3C's ARIA work is attached as **exhibit "16"**).

27. The CLF 2.0 does not adequately prepare or equip government Web developers to create accessible interactive Web applications although it was known that these would continue to proliferate and would be used to deliver essential government services. Canada was aware and participated in creating guidelines and standards that would address these challenges. Although some of these guidelines and standards were in draft form some were stable and in final form. The IMS Global Learning Consortium 'Access ForAll' standards were in recommendation form. The ISO 24751 multipart standard was in Final Draft International Standard (past committee review and balloting, meaning the only revisions are editorial and translation). The Authoring Tool Accessibility Guidelines 1.0 were in final form.

28. Despite problems of non-compliance and recognition by government groups tasked with accessible design that there were major systemic problems in creating accessible Web sites, CLF 2.0 did not require or recommend the use of authoring tools that support the creation of accessible Web sites and are accessible to consumers with disabilities (in compliance with ATAG 1.0). This would have addressed accessibility as an integrated part of authoring any Web content. At the time that CLF 2.0 was authored Moxie Code offered an ATAG compliant open source content management plug-in, called TinyMCE, which could have been implemented in government content management systems.

31. While the CLF 2.0 addresses some of the concerns with CLF 1.0 it does not address the systemic problems of lack of knowledge regarding accessible Web design, lack of integration of accessibility into the design, development, implementation, update and maintenance process of the government Web space at a local and distributed level, and the attitude that accessibility is counter to innovation and improvement of service. CLF 2.0 also ignores the issue of interactive Web applications making it inevitable that these increasingly implemented technologies will be inaccessible.

Federated Architecture Structure

29. Many of the problems/deficiencies with the CLF standards (old and new) could have been addressed through the Federated Architecture Program (see 'Federated Architecture Program' attached as **exhibit "17"**). In 2000, the TBS created the Program to achieve a common government-wide approach to planning, designing and implementing the Government's strategic IM/IT infrastructure.

30. I, and other experts in accessible design such as Gregg Vanderheiden of the Trace Centre at the University or Wisconsin advised the government on the creation of an architecture that would integrate accessible design in from the ground up and would greatly reduce the effort and time required to make the government Web space accessible to individuals with disabilities. The accessibility work within this effort seems to have come to a halt. Contracts and RFPs related to this effort, specifically contracts related to security, did not address accessibility and the deliverables are counter to accessibility and create significant barriers to people with disabilities.

Conclusion

31. Accessibility experts within the government are aware of the necessary systemic changes required to make the government's online presence not only more accessible to Canadians with disabilities but also more usable for all Canadians. The Treasury Board has received a number of expert reports and participated in the creation of reports setting out in detail the kinds of changes required to government Web material, and how those changes could be easily implemented, yet it has not implemented or made use of these resources to make online services accessible. This is despite the fact that designing new Web material or even existing Web material to be accessible does not add significant cost and often leads to direct and indirect costs savings. It is well known that inclusive design supports greater longevity, better interoperability, easier localization and better device independence (see, e.g. W3C 'Developing a Web Accessibility Business Case for Your Organization' attached as **exhibit "18"**).

32. Canada is known worldwide as an inclusive nation. It distresses me that we lack the concerted commitment to inclusion to implement the lasting, systemic changes needed to make our online presence accessible to all visitors. The costs of not doing this hugely outweigh the costs of implementing a coordinated accessibility strategy.

AFFIRMED BEFORE ME at the City of
Toronto, on June 27, 2007.

_____   _____

Sarah Godwin   Jutta Treviranus

Commissioner for Taking Affidavits

Court File No.: T-1190-07

BETWEEN:

DONNA JODHAN Applicant - and - ATTORNEY GENERAL OF CANADA Respondents

AFF!DAV!T 2 OF JUTTA TREVIRANUS
(Affirmed February 21,

2009) I, Jutta Treviranus, of the City of Toronto, AFFIRM

that:

1. I affirmed an affidavit dated June 27, 2007 that was filed in support of an application of Donna Jodhan concerning the inaccessibility of federal government websites.

2. In November 2008, seventeen months after I affirmed my original affidavit, the Attorney General of Canada filed twelve affidavits. This affidavit contains a response to the following issues raised in those affidavits: (1) Constraints Imposed By Meeting the Needs of Users; (2) External Reviews of Federal Government Websites; (3) Security As a Priority Impeding Access; (4) Commercial Products for Addressing Interactive Websites; (5) Costs of Accessibility; (6) Decentralization of Responsibility for Access; and (7) Archival Policies for Websites.

Constraints Imposed By Meeting the Needs of Users

3. As is noted by Ken Cochrane in his affidavit, at paragraph 39, the government of Canada has assumed an obligation to meet the needs of a diverse group of users. He refers to the Communications Policy of the Government of Canada ("the Policy") which is appended as Exhibit G to the affidavit of Wendy Berkinsaw Malo.

4. The Policy explicitly provides (1) that Canadians of diverse perceptual and physical abilities are to be accommodated, (2) government information must be available in multiple formats and (3) "All means of communication - from traditional methods to

new technologies -   must be used to reach and communicate with Canadians wherever they may reside."

5. More particularly, Treasury Board's CLF 2.0 Guidelines for the Internet, found at http://www.tbs-sct.gc.ca/clf2-nsi2/clfs-nnsi/clfs-nnsi-2-eng.asp, and appended as **Exhibit A** to my affidavit provides:

> Canadians have the right to obtain information and services from the Government of Canada websites regardless of the technologies they use and in the official language of their choice.

6. The same CLF 2.0 Guideline goes on to state:

> The institution ensures that content can be easily accessed by the general public, including persons with disabilities, by complying with the accessibility provisions of the World Wide Web Consortium's Web Content Accessibility Guidelines (WCAG) 1.0 and Common Look and Feel.

7. In her affidavit at paragraph 65, Cynthia Waddell states that IBM screen reader called "Home Page Reader" is not commonly used, is not a good reader and is no longer supported by IBM. In paragraphs 67 and 68 she states Internet Explorer 6.0 and earlier versions were problematic. She suggests that a user, such as Donna Jodhan, who uses "Home Page Reader", is using an outmoded and deficient technology, and that problems she encountered accessing federal government websites could be attributed to the technology she used and her lack of technical proficiency.

8. Most screen readers are made to work with a full range of software applications. For example they must work with word processors, spreadsheets, email programs as well as browsers and Web applications. This frequently implies that they are not optimized for any one purpose as they must provide general functionality and compatibility. One of the major motivations behind Home Page Reader was to create a screen reading application that is optimized for the Web and Web Browsers. At the time that Donna was using Home Page Reader it can be said that it was an

application that was better able to read Web pages than more generic Screen Readers. Home Page Reader had numerous strategies to deal with access barriers that stumped other Screen Reading programs. It was also much more affordable and therefore available to a greater percentage of the Canadian population than generic multi-purpose Screen Readers. Part of the motivation for discontinuing the development of Home Page Reader was the fact that generic Screen Readers added Web specific functionality, in some cases borrowed from Home Page Reader. As indicated in my June 27, 2007 affidavit, I have expertise in the operation of computers and am conversant with the requirements WCAG 1.0, and by necessary implications with CLF 1.0 and 2.0, which are based upon it, WCAG 1.0 and therefore the government's CLF Guidelines require that government webpages work with

technologies which are less than cutting edge. To say that a government website could not be accessed using Home Page Reader would be to acknowledge that that particular website was not in compliance with the government's own accessibility guidelines.

9. In a study prepared for the federal government by IBM Business Consulting Services entitled 'Census Internet Access for Visually Impaired Respondents', which can be found at Exhibit D appended to the affidavit of Anil Arora in the Affidavits of the Respondents, IBM Home Page Reader 3.04, is identified as a "popular screen reader" along with JAWS. Thus Home Page Reader was identified by consultants and retained by the federal government as a widely used screen reader. It is neither obscure nor fundamentally flawed. It is precisely the type of screen reader which the government has committed itself to serving with its website.

10. Donna Jodhan, amongst other technologies, operated IBM Home Page Reader 3.04. In her affidavit at paragraphs 65 through 72, Cynthia Waddell suggests, without saying so, that Ms. Jodhan's difficulty in accessing federal government websites can be attributed to her use of IBM Home Page Reader. In my opinion there is no evidence whatsoever to support such a conclusion. Ms. Jodhan possesses above average computer skills and was using a screen reader to which the government has committed itself to providing access.

Decentralization of Administration of Government Websites

11. Ken Cochrane indicates at paragraph 55 of his affidavit that "Defining a [web]site itself is a complex issue". By this he is suggesting that it is a difficult task identifying which websites are the government's responsibility to ensure accessibility. However, I note that the Communications Policy of the Government of Canada, which can be found as Exhibit G to the affidavit of Wendy Berkinshaw Malo, clearly defines its "Application and Authority" as extending to "all institutions of the Government of Canada identified in Schedules I, I.I and II" of the *Financial Administration Act,* which is precisely the same list of institutions as is subject to Treasury Boards Common Look and Feel Standards for the Internet 2.0, which can be found at Exhibit H to Ms. Berkinshaw Mala's affidavit. Thus while the scope may be

comprehensive, it would not be fair to say that it is unclear or indefinable.

12. Mr. Cochrane speaks at paragraph 62 of his affidavit of the organizational challenges government departments face when applying what he calls a "decentralized governance structure". Nevertheless, both the <u>Communication Policy of the Government of Canada</u> and Treasury Board's Common Look and Feel Standards for the Internet establish accessibility policies governing the accessibility of government websites. Thus while a "decentralized governance structure" may be in place, it is recognised that a government-wide standard is required and must be adhered to.

13. This same decentralized governance structure is able to meet its commitments to bilingual content.

14. It is precisely because of this decentralized governance structure that the government should develop accessibility supports that can be integrated into the local workflow, are consistent and supportive of local goals and require less central oversight and policing. These accessibility supports would include a) the provision of content management systems and authoring tools that either produce or promote the production of accessible content, b) guidelines and regulations that acknowledge the use of current and innovative Web technologies, and c) the provision of Web application toolkits that make available accessible components that can be reused. This approach would engender a more positive and cooperative attitude to Web accessibility compliance on the part of decentralized Web developers within the government.

15. While the accessibility of the HTML component of the Services Canada Web sites have improved significantly over the past year, the accessibility of the interactive functions is still a major issue. Unfortunately it is exactly these interactive components that are so critical to most citizens. For example an individual who is blind (and who is also fortunate to have the latest Jaws screen reader) and wishes to apply for a passport, can navigate the downloadable form but cannot read the form field labels (the labels such as name, address, etc. that indicate what to put in the spaces), and therefore cannot "complete the form interactively" as stated on the site (<u>http://www.ppt.gc.ca/cdn/form.aspx?lang=eng&region=Canada),</u> which is attached as **Exhibit B.** An unfortunate side effect of inaccessible Web based services is that individuals with disabilities cease to trust that they can access government services online. As Ms. Jodhan indicates, if a person is working on what purports to be an accessible website and the person encounters an inaccessible matter that represents a violation of the governnment's applicable CLF Guideline, the person will over time learn that the frustrating loss of time and effort that results has become endemic and the person will conclude that he or she can no longer rely upon direct access to the internet in a manner comparable to that enjoyed by non-disabled persons.

16. The guidance given to government Webmasters on creating accessible HTML is comprehensive and exemplary, the guidance on creating accessible interactivity is lacking, incomplete or outdated, leaving even well-intentioned government Webmasters at a loss. The Treasury Board has responsibility to provide accessibility advice within the government. This should apply even to complex, challenging issues such as Web interactivity. Not acknowledging that Web developers within the government will be compelled to develop interactive Web sites (and thereby avail themselves of current interactive Web methods and components) as part of their duties in bringing government of Canada services online and not providing guidance on the latest accessibility strategies is a disservice to government Web developers and citizens with disabilities. This has resulted in an ever widening gap between the level of access given to citizens with disabilities and their peers without disabilities. It

has also led to a great deal of frustration with accessibility requirements on the part of government Web developers.

17. It is also precisely because of this decentralization that proactive measures to embed accessible design elements into the Web architecture and Web applications are so critical. The cost of retrofitting is accentuated in a decentralized structure. Thus the government needs to assess the risks and benefits of recommending the implementation of evolving but widely accepted standards (such as ARIA which should be applied when first building a Web application or interactive script, or WCAG 2.0) rather than waiting until the guidelines are completely stabilized. The Web is an evolving environment requiring more than reliance on static prescriptions for accessibility. The goal of accessibility support within government should be to create a culture of inclusive design among Web developers. The support measures should recruit and harness the creative, innovative talents of Web developers toward addressing the challenges of Web accessibility. This requires discussion of new technologies and strategies to make them accessible. This also requires a greater investment in personnel to address accessibility in government and integration of these accessibility staff into the relevant decision making structures within the government.

18. In 2000 the Treasury Board Secretariat initiated the Federated Architecture Program which is described in Exhibit 17 to my June 27, 2007 affidavit. In particular I note that the Program was intended to be a "flexible approach" to allowing for groups or departments "to interconnect with the common infrastructure as appropriate". Rather than allowing departments to operate in complete isolation from each other, it ensured "the most effective and economical way" was followed to "ensure the alignment of IM/IT architecture with Government of Canada goals and objectives," including ensuring the accessibility of the government's websites in compliance with the Common Look and Feel Guidelines for the Internet.

19. It is unfortunate that the government abandoned this initiative as it integrated

accessibility into the design, development and implementation workflow of ICT systems and embedded accessibility at a foundational level into the underlying architecture of the enterprise systems applied in government. The small amount of money saved by cutting this Program will be spent many times over adding accessibility as a special, non-integrated component of government information systems. I return to this issue in my discussion of "Costs as a Barrier to Accessibility" below.

20. Ms. Berkinshaw Malo at paragraphs 6 to 11 of her affidavit discusses the under resourced and virtually vestigial role of the Common Look and Feel Office ("CLF Office") within the Treasury Board Secretariat. It is very unfortunate that the Government of Canada chose to reduce the level of accessibility support to government of Canada Webmasters at a time when Web accessibility challenges were becoming much more complex and the government of Canada was moving

very aggressively toward offering essential government services online through interactive systems.

21. Ms. Berkinshaw Malo describes the CLF procurement clause at paragraph 10 of her affidavit. In actual fact the government is no longer consistently including CLF compliance in its Requests for Proposals. Attached as **Exhibit C** to my affidavit is a RFP containing such a clause from 2002, and attached as **Exhibit D,** is a RFP from 2007, which does not contain such a clause.

The Erroneous Assumption That Security Precludes Access

22. Mr. Cochrane, at paragraphs 33 through 36 of his affidavit, refers to the way the implementation of government policies regarding security and privacy "impeded" the fulfilling of government commitments concerning accessibility of its websites, including compliance with its own Common Look and Feel Guidelines.

23. This is an example where the government did not comply with the CLF procurement clause described by Ms. Berkinshaw Malo at paragraph 10 of her affidavit. As a consequence, Treasury Board implemented ePass/Secure Channel, and only after access has been impeded for persons with disabilities is it working "with departments and the Secure Panel Service Provider, to evolve effective service that meets the CLF 2.0 standards"

24. As was proposed under the Federated Architecture Program, the most cost effective and effective way to address issues of accessibility/CLF 2.0 compliance would have been when the RFP was issued by the government to procure software to enable it to comply with its security and privacy obligations. Prevention is always more cost effective and comprehensive than correction on an *ad hoc* basis.

25. The federal government is by no means unique in its need to address privacy and security issues in a manner that is compatible with its obligation to ensure its websites are accessible. Websites such as those operated by the major Canadian banks safeguard the privacy and security of personal information disclosed online. They maintain accessibility for comparably large numbers of applicants for employment and otherservices.

Cost As a Barrier to Accessibility

26. At paragraphs 65 through 71 of his affidavit, Mr. Cochrane addresses the resource implications of converting federal government web pages and documents currently available online to a format that ensures accessibility to persons with disabilities.

27. Leaving aside the issue of the limitations of CLF 2.0 Guidelines, which I address below, the issue Mr. Cochrane addresses is the cost of having the federal government bring itself into compliance with its own guidelines

28. As discussed above there are strategies and tools that can be implemented to greatly reduce or even eliminate the cost of creating accessible Websites. The most important strategy is to create an accessible site from the start rather than attempt to retrofit the site after the fact. This requires that tools and resources that are capable of producing compliance with the government's own standard and promote accessibility as part of webmaster's routine workflow. Authoring tools modelled after the Authoring Tool Accessibility Guidelines and software development kits that contain accessible reusable components will greatly decrease the incremental costs of creating accessible Websites.

29. In her affidavit at paragraph 34, Cynthia Waddell references the W3C Web Authoring Tool Accessibility Guidelines. I agree with her statement of the purpose of the Guidelines. I note that the Guidelines based on the W3C's WCAG 1.0 standard are referred to as ATAG 1.0. These Guidelines were available in final form months before the CLF 1.0 Guideline was issued by Treasury Board, however it was not made part of the government's CLF 1.0 Guideline. Moreover, in all the subsequent years, the use of authoring tools based on the ATAG 1.0 Guideline has not been included in either CLF 1.0 or CLF 2.0. Consequently content management systems procured or developed by the government have failed to provide support for developing accessible content, leaving accessibility largely to an evaluation or gatekeeping process at the end of the development cycle. This is more costly and less likely to garner the enthusiastic cooperation and creative talents of Webmasters towards accessibility goals.

30. Mr. Cochrane's general comment at paragraph 65 of his affidavit about the cost of bringing federal websites into compliance is sufficiently vague ("it is almost impossible to estimate the resources that may be required") as to be inarguable in any specific or reasoned manner. What can be said with certainty is that the

systematic use of authoring tools modelled on ATAG 1.0 or 2.0 would massively reduce the ongoing creation of new or changed web sites which are inaccessible. This would represent substantial and ongoing cost savings to the government in achieving the accessibility standards it has imposed upon itself. I suppose it could be said that giving up on making federal government websites accessible would be cheaper than making them accessible. I do not understand this to be Mr. Cochrane's point. It is also true that the use of monitoring instruments such as Web accessibility evaluation and repair tools would expedite the identification of non-compliant websites so that conversion takes place, and continuing, deepening non-compliance can be avoided. My point is that the government, by not mandating the use of these tools, is imposing *ex post facto* costs upon itself that would have been easily avoidable.

Availability of Commercial Products for Making Interactive Websites Accessible

31. Steve Buell, at paragraph 36 of his affidavit, states that "Commercial Products to produce 'downloadable forms' have only recently included the ability to produce forms with Adaptive Technology support". Cynthia Waddell references the United

States Electronic and Information Technology Standards ("Section 508") at paragraph 37 through 41 of her affidavit. At paragraph 6 of her affidavit, Ms. Waddell addresses the adequacy of Canada's CLF Guidelines and in particular their adoption of the W3C WCAG 1.0 guideline. She states "CLF has adopted a best practice for providing accessibility to all in Canada with disabilities".

32. WCAG 1.0 became a final recommendation of the W3C in 1999. Almost immediately, the W3C began work on WCAG 2.0, which became a recommendation in 2008. A major area of website access not covered in WCAG 1.0, was interactive websites designed to resemble desktop applications, currently also referred to as "rich internet applications". Examples in the federal government context would be websites through which citizens can apply online for government jobs, apply for passports and social benefits such as those available through the Canada Pension Plan. For citizens in general, Canada's willingness to make such applications available online has been a major convenience and cost saver; speeding the submission of applications which formerly had to be sent by mail. For persons with disabilities, being able to directly deal with government over the internet is more than just a matter of efficiency and reliability. For many of them, functioning independently in a print world was impossible and electric forms of communication, such as are available over the internet are nothing short of a lifeline.

33. It is significant to note that Rehab 508, attached as **Exhibit E,** which was enacted in 2001 mirrored WCAG 1.0 in all but the guidelines, referring to interactive elements including scripts and applets. There was recognition even at this early stage that Web

authors would be compelled to use scripts and applets and a more flexible strategy would be required to address accessibility issues with respect to these functions. Moreover, since 2004 the United States government has been working on revised standards, referred to as "Section 508 refresh", attached as **Exhibit F,** which are based upon WCAG 2.0 standards. No comparable action has occurred in Canada, even for the federal government's websites.

34. WCAG 2.0 is now a W3C recommendation. It did not change significantly during the candidate recommendation phase or during the last call phase. Notwithstanding Ms. Waddell's focus on WCAG 2.0, it is not the only mechanism and guidance available for achieving equal access for persons with disabilities. ARIA or ISO 24751 or other techniques exist to provide equal access. The government isn't required to adhere to WCAG standards, a fact of which it is very much aware. If one refers to Exhibit A to the affidavit of Ms. Berkinshaw Malo at Appendix A, Part 2, it is evident the government did not adopt WCAG 1.0 Guidelines without modification or limitation. Thus where the federal government has reservations about WCAG 2.0 not going far enough to establish web accessibility, as indicated in her affidavit at paragraph 42 and Exhibit K to her affidavit, it is very much aware there is nothing preventing it from modifying standards to address whatever reservations it may have. The point is that they failed to do so. ARIA and ISO 24751 and other documents would have provided helpful advice to government of Canada webmasters faced with current tools, the current Web development environment, demands for advanced

interactivity but guidelines that were developed almost a decade ago. As a result federal government websites have moved further and further from granting persons with disabilities equal access comparable to that afforded to non-disabled persons. The limiting factor was not the availability of suitable technology but the will to keep accessibility standards current and in line with important advances in how the government uses the internet to communicate with its citizens.

35. The Web is a quickly evolving environment. To provide effective and realistic advice and support, the CLF support group must address the current realities of the Web developers it is assisting. Objections, such as those attached as Exhibit K to the affidavit of Ms. Berkinshaw Malo, amount to a statement that WCAG 2.0 does not go far enough to address the accessibility needs of persons with disabilities. As was done with WCAG 1.0, this could easily have been addressed by augmenting or modifying portions of WCAG 2.0 to meet the government's desired goals. Other jurisdictions such as Australia participated in the candidate recommendation phase of WCAG 2.0 and implemented the standard before it became a recommendation. See (http://www.w3.org/WAI/GL/WCAG20/implementation-report/). Attached as **Exhibit G** is a list of individuals and government agencies which were applying WCAG 2.0 standards before they became a final W3C recommendation.

Canada's Declining Record on Web Accessibility

35. In paragraphs 23 and 24 of Mr. Cochrane's affidavit, he makes selective reference to two reports concerning E-Government Readiness. He cites a 2005 *United Nations Report* based on 2004 data and a 2005 *Accenture Report.* My reading of the literature, based on audits of Canada's web accessibility, leads me to the conclusion that (1) there is a big gap between the government's policies and its actual performance, and (2) while Canada could at one time have legitimately claimed pre-eminence in web accessibility, its performance is now mediocre at best and declining, in relative terms.

36. In the *United Nations E-Government Survey 2008,* attached as **Exhibit H,** at p. 99-100 a methodology based on actual consumer experience with web accessibility is surveyed, (as opposed to relying exclusively on statements of accessibility policy and automated tests). The Survey bases its conclusions, in part on a 2007 *Accenture Survey* research methodology. Based on its application of this survey instrument, Accenture concluded that "a gap between the government's promise and its practice" exists in Canada. It further noted that "less than half the [Canadian] respondents believe the service has improved compared to three years ago".

37. The authors of the UN Report reach the following conclusion for Canada's poor and declining performance:

> A particular concern pertaining to ongoing political ambivalence about the mission, mandate and formal governance structures of the lead sevice entity (Service Canada) reinforces a point made earlier on [sic] this report-namely the

> importance of political leadership (a key driver of Canada's earlier early success and emergence as an e-government leader).

38. The UN Report then cites another source as supporting its conclusion that Canada's accessibility performance is declining:

> Accenture's findings are echoed to some degree by Canada's slipping performance in the *Economist Intelligence Unit's e-readiness rankings* where Canada dropped from 9th to 13th place in 2007.

39. While other sources could be cited to support a conclusion that Canada is no longer an accessibility leader and is declining year after year, I will simply add The *2006 United Nations Global Audit of Web Accessibility,* attached as **Exhibit** I, which surveyed 100 actual websites, both public and private, from 20 countries from around the world. The Canadian government website surveyed (The Prime Minister's Office) did not achieve Single-A accessibility, unlike the central government websites of Germany, Spain and the United Kingdom. The report specific to Canada, starting at p. 29, indicates the Prime Minister's website falls below the accessibility of many Canadian private sector websites and does not compare favourably to central government websites in many of the other countries surveyed.

AFFIRMED BEFORE ME at the

City of Toronto in the Province
of Ontario on this 9-Is;--day of
2009.

Jutta Treviranus

Cammi for Taking Affidavits

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Appendix G: IDRC Canada-Ireland Knowledge-Building

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"Evaluating CO-CREARIA: Model for the Co-Creation of Inclusive and Accessible OER" Full author list: Silivia Margarita Baldiris Navarro, Ph.D in Technology; Cecilia Avila Garzón, MSc in informatics, PhD student; Levinton José Licona Suárez, MSc in ICT; Jorge Luis Bacca Acosta, MSc in informatics, PhD student; Ramon Fabregat Gesa, PhD in information technology; Yurgos Politis, PhD in Education; Jutta Treviranus, PhD in Education; Lizbeth Goodman, PhD in Education

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Adding Feeling,
Sound and
Equal Access
to Distance
Education

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ATRC
University of Toronto
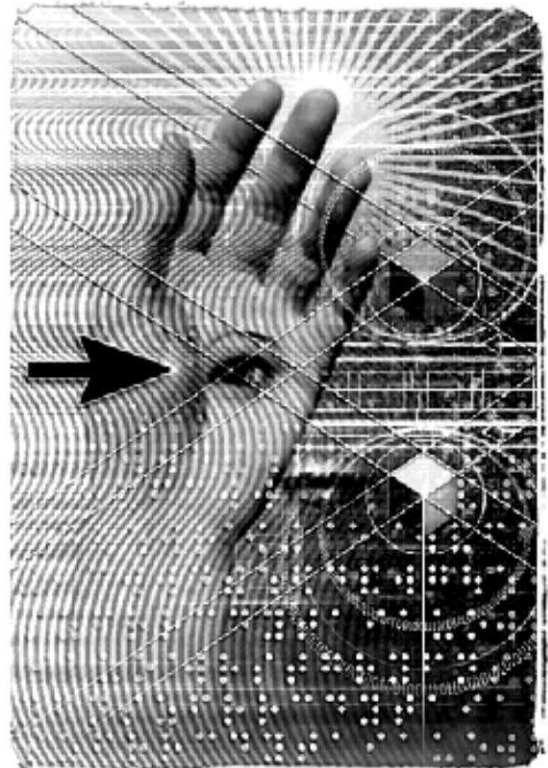
Paul Watson/National Post
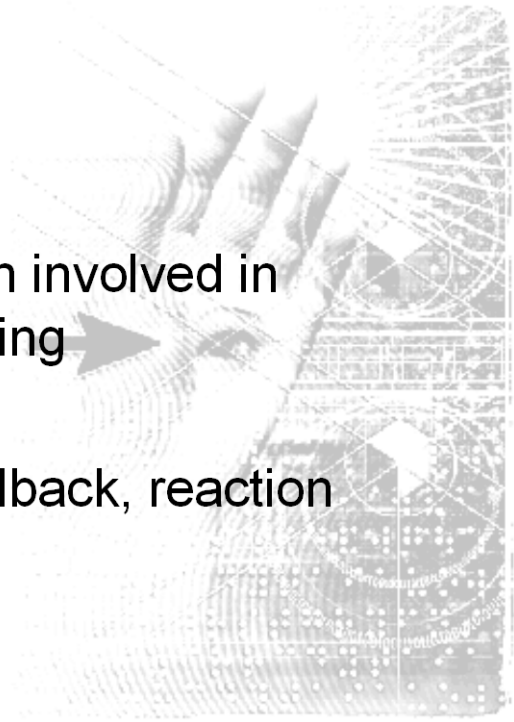
The Need

⌘How can you learn without touching?

The Need

" Let me see that"

Haptics

- Both sensing and action involved in touching and manipulating
- Active and interactive
- Continuous action, feedback, reaction loop

Subjects that require hands-on experience

⌘ Tasks that require sensorimotor skills, skilled manual tasks

⌘ Advantages of computer simulation:

⬒ Students can practice in a risk free environment

⬒ Students can obtain objective simultaneous feedback regarding their actions

Learning Styles

⌘ Some students learn better when their tactile and kinesthetic senses are engaged

Learning disabilities

⌘ Some students may be restricted to one learning style when they are integrating new concepts or processing information

Curriculum for Students who are blind

⌘ Increased use of graphics in education

⌘ Challenge of teaching subjects that involve spatial concepts or physical properties

⌘ Dependence on physical models or tactile graphics

Tactile Graphics or Models

- ⌘ Costly to produce
- ⌘ Costly to store and ship
- ⌘ Fragile, easily damaged
- ⌘ Not easy to share or duplicate
- ⌘ Not easily updated
- ⌘ Not dynamic or flexible
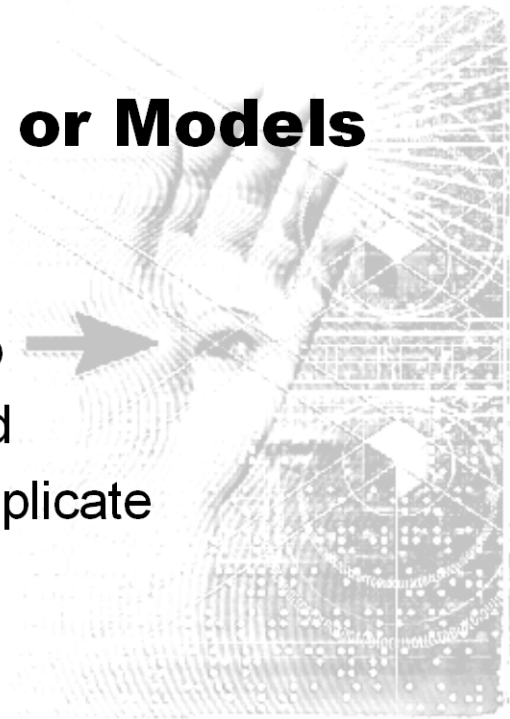
Virtual Reality Modeling Language (VRML)

- ⌘ Description language for 3D objects
- ⌘ ISO standard
- ⌘ Relatively compact
- ⌘ Transmission of virtual 3D objects or environments over the Web
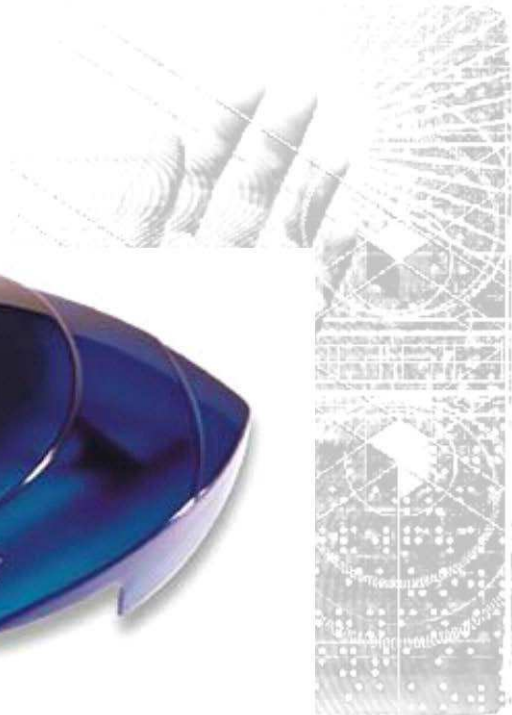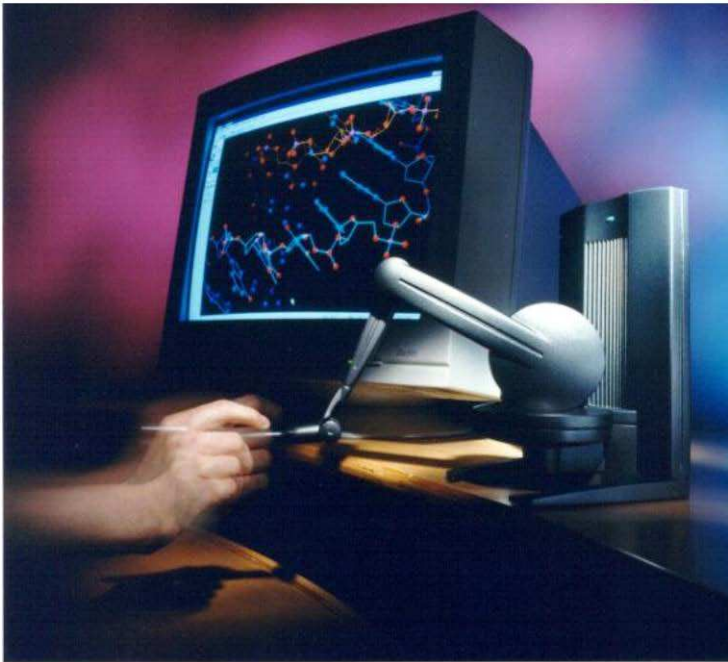- ⌘ Presently no provisions for haptic rendering
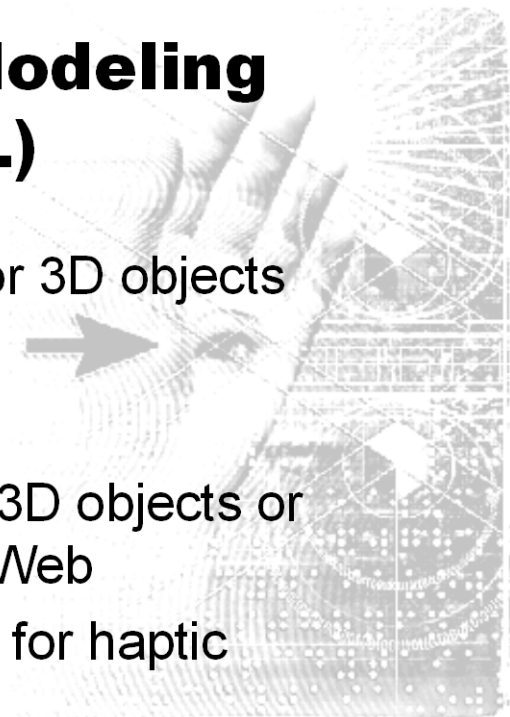
Haptic Technology

⌘ Computer peripherals combining display and control

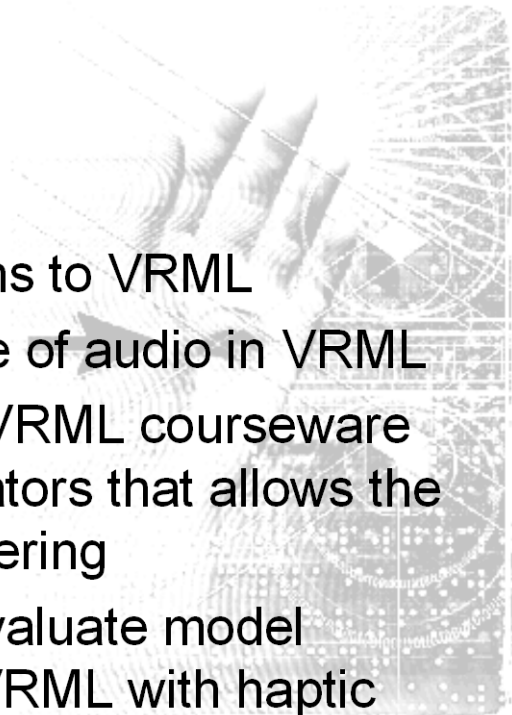⌘ Simulating forces and tactile feedback
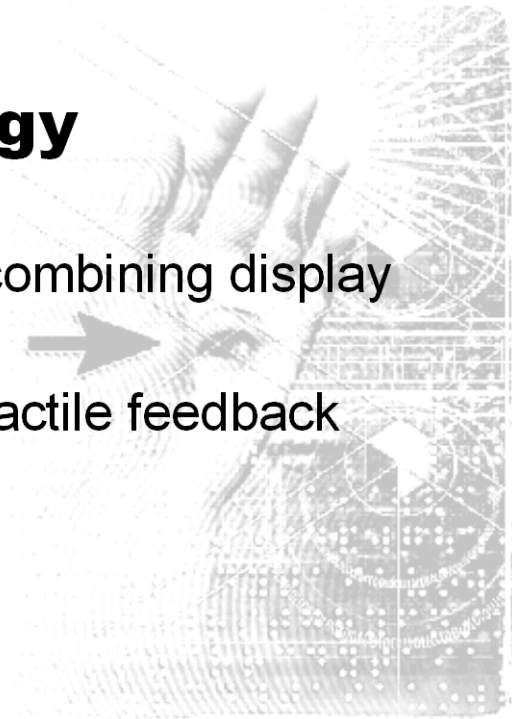
Pencat

Phantom

The Project

- ⌘ Create haptic extensions to VRML
- ⌘ Further develop the use of audio in VRML
- ⌘ Design and develop a VRML courseware authoring tool for educators that allows the inclusion of haptic rendering
- ⌘ Design, develop and evaluate model courseware that uses VRML with haptic and multi-modal extensions

Extensions to VRML

- Method of specifying haptic properties:
  - Friction, damping, texture, vibration
- Group, position and orient multimodal information
- Representation of haptic device
- Specify interaction between haptic device and VRML objects

Courseware Authoring Tool

- User interface shell
- Easy to use front end to collection of necessary utilities
- Libraries of VRML objects, template lesson plans, interactive exercises

Geography Courseware Module

⌘ Grade 4 geography curriculum

⌘ Multimodal rendering

⌘ Access both map information and large index of spatially indexed information
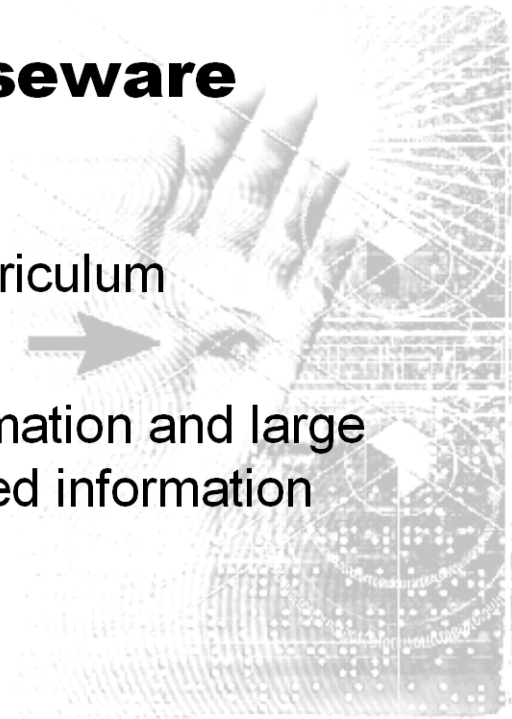
Rendering Palette

⌘ Speech

⌘ Non-speech Audio

⌘ Haptics

◻ 3D shapes as artifacts

◻ Topography

◻ Curtain

◻ Elastic

Role of Modality

⌘<u>Non-speech Audio</u>: context or ambiance

⌘<u>Speech</u>: Identify element, provide additional information

⌘<u>Haptic</u>: Spatially orient

Example Rendering:

| Cities	Proximity	Busy City Street Sound, cars honking, people talking, traffic		Slight gravity well around sphere
	Over or touching	Increase volume upon entering zone, interrupted by speech	Name of City spoken	1/2 sphere
	Mouse Click		City and Population Size spoken	
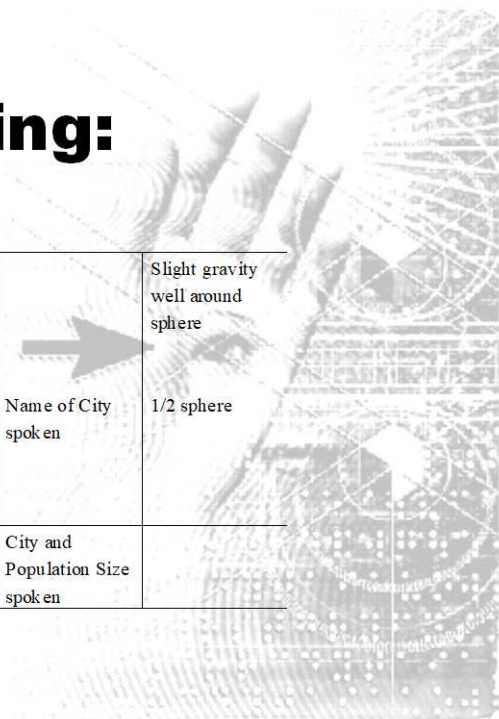
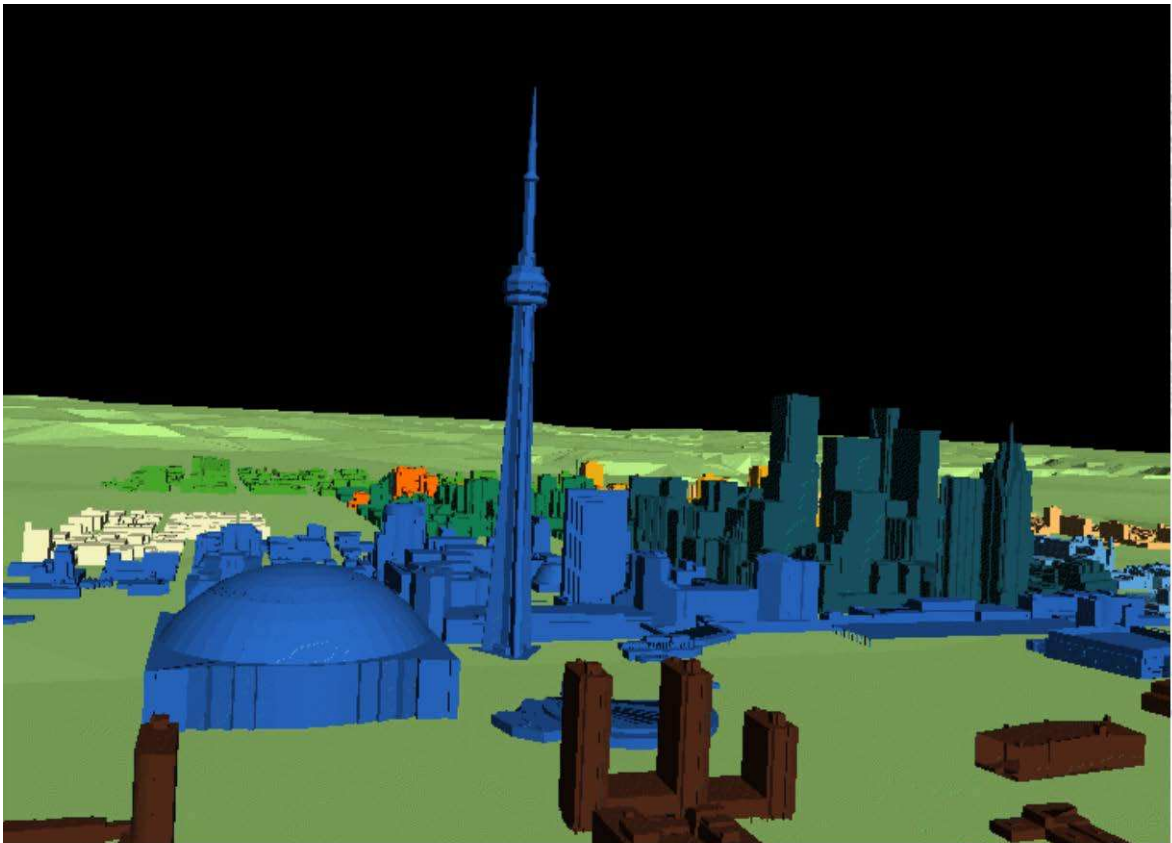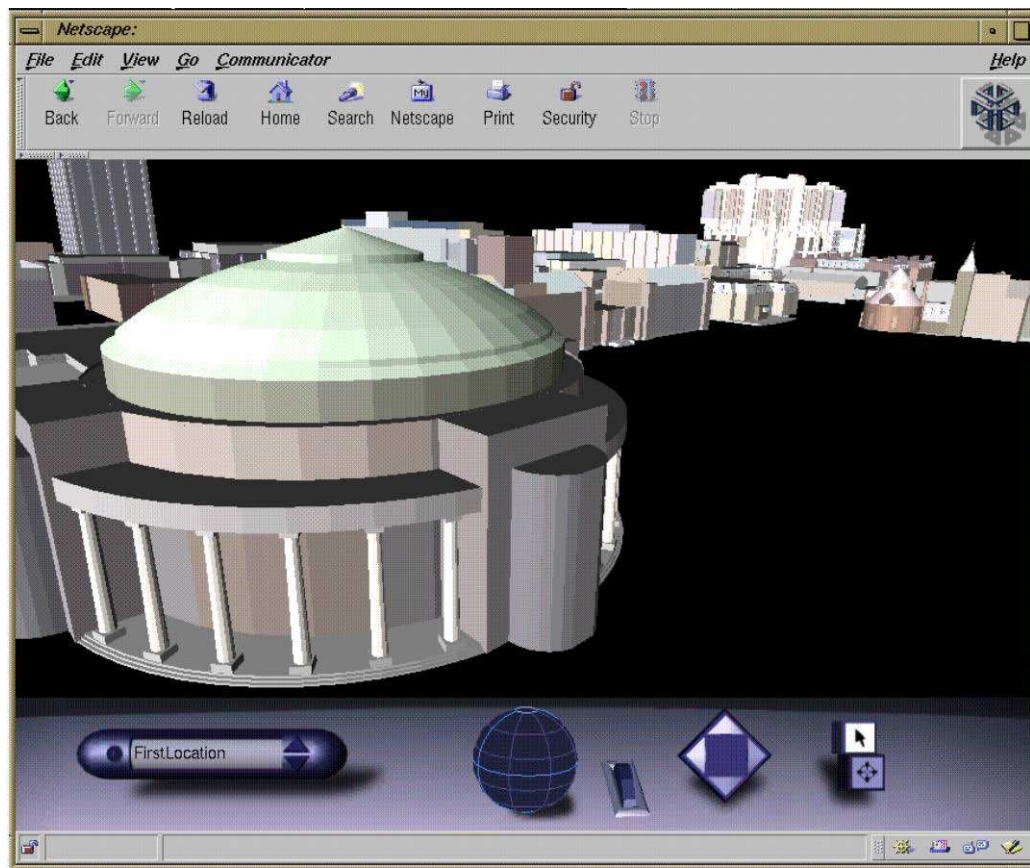# Additional Effects

⌘Region as raised shape
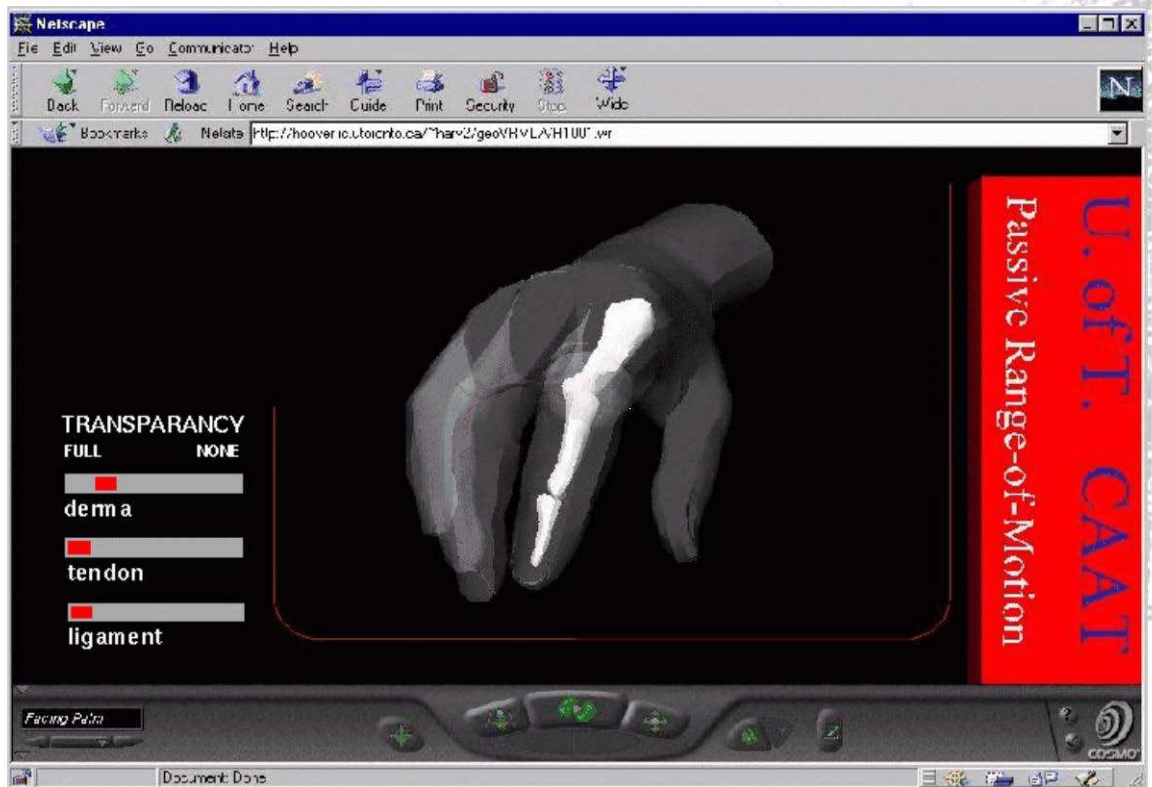⌘Latitude and Longitude elastics
⌘Compass

Shape of Province
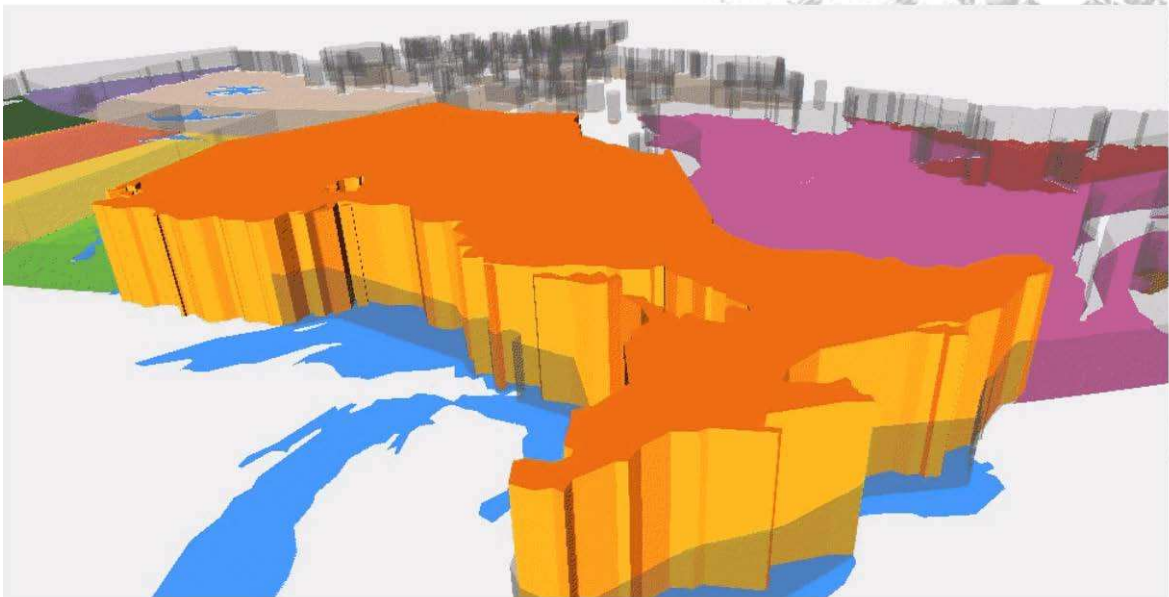
Rehabilitation Medicine Courseware Module

- ⌘PIP passive range of motion
- ⌘End feel- normal and pathological
- ⌘Objectively monitor actions and provide feedback

Netscape: Hard End-Feel

File Edit View Go Bookmarks Communicator Help

Back | Forward | Reload | Home | Search | Netscape | Images | Print | Security | Stop

Location: http://www.bmc.med.utoronto.ca/haptic/Pages/HardEF.html

Haptic Passive Range of Motion Test

Choose an end-feel modality:

Hard end-feel   Soft end-feel   Firm end-feel

To experience the end feel of the PIP joint in flexion, move the haptic device to firmly and maximally flex the PIP joint on the monitor at the same speed that was just demonstrated.

Notice the sensation of an abrupt, hard stop to the movement and observe on the monitor that the bone of the middle phalanx is making contact with the bone of the proximal phalanx. Try it a few more times. This sensation is called a hard, or bony, end feel and occurs when bone contacts bone.

Home | Introduction | End-Feel | Hard End-Feel | Soft End-Feel | Firm End-Feel

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Netscape

File Edit View Go Communicator Help

Back | Forward | Reload | Home | Search | Guide | Print | Security | Stop | Wide

Bookmarks | Netsite: http://hoover.ic.utoronto.ca/~harv2/geoVRHVLAVH1UU.wrl

TRANSPARANCY
FULL   NONE

derma

tendon

ligament

Facing Palm

Passive Range-of-Motion

U. of T. CAAT

Document: Done

Evaluation

⌘Grade 4 students- sighted and blind
⌘Expert clinicians
⌘Questionnaire

Conclusion

⌘More work needed
  ⬆Rendering conventions
  ⬆Multi-modal assignment
  ⬆Hardware improvements
  ⬆Rendering tools

⌘Please Touch the Merchandise