LIBERATE 2021 Workshop

May 14, 18, 21, and 26, 2021

Overview

As part of the National Science Foundation (NSF) Convergence Accelerator initiative, the LIBERATE 2021 - Living Better through Rehabilitative and Assistive Technologies - workshop series brought together 160+ individuals from diverse backgrounds and disciplines across multiple platforms to connect, reflect, discuss and ideate on an essential question: How can we reimagine tech accessibility and empowerment for people with disabilities? LIBERATE 2021 asked that daring question to help define a candidate research and development campaign that could lead to significant investment by the NSF in research and innovation for empowering people with disabilities. A series of live workshops was held on May 14, 18, 21, and 26 with the goal of identifying near-term, convergent opportunities to expand and advance the solution space of rehabilitative and assistive technologies for persons with disabilities or impairments. The "business unusual" approach of the Convergence Accelerator (and the workshop series) were timely and important, most notably by:

- Convening diverse stakeholders, many of whom are usually not brought into research and development efforts until much later in the process;
- Asking what they really want to see in the future development of assistive technologies.
- Creating a space for participants share, learn from and build on the diversity of perspectives

This report reviews why these discussions were important; who was here; what we learned from diverse perspectives shared via surveys, Slack, speaker videos, and 12+ hours of live online innovation workshops over four days; and how these helped shape the solicitation we have submitted to NSF.

Key References

Organizers	• Dr. Patricio Vela, Associate Professor, School of Electrical and Computer Engineering, Georgia Institute of Technology • Dr. Ted Conway, Professor & Head, Biomedical and Chemical Engineering and Sciences, Florida Institute of Technology • Dr. C. Aiden Downey, Lecturer, Alice Solomon University • Monica H. Kang, Founder & CEO, InnovatorsBox
Participants	• 160+ participants on Peripheral (survey & Slack) and Central (Zoom) • 31% being persons of disabilities (47 individuals) • 40+ speaker videos contributed during the event • 80+ participated live via Zoom during the workshops

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We invited everyone to get comfortable
diving into the unknown and ideating new possibilities.

Inclusion Intention and Strategy in the Experience

LIBERATE was designed to honor inclusion by making the whole experience a journey in which all participants felt welcome, able to engage, and safe to share their different perspectives.

While the live workshops were spread across four dates, the program design included multiple touch points through surveys, Slack engagement, and email updates to permit all stakeholders to continue to ideate, discuss, and share their thoughts throughout the full journey. This also permitted us to collect data, insights, and nuances that otherwise could have been lost.

Our strategy was to design the experience to:

- Maximize the depth and breadth of voices by offering multiple platforms, tools and ways to contribute and engage in an entirely virtual format;
- Provide a safe space with accessibility, diversity and inclusion at its core; and
- Model innovation / imperfection by asking people to step out out comfort zone and willingness to do the same (vs “playing it safe”).

"A real conversation always contains an invitation. You are inviting another person to reveal herself or himself to you, to tell you who they are or what they want." *- Poet, David Whyte*

As a result we were intentional throughout the engagement to encourage inclusion.

During the outreach process	To achieve broad diversity in participation, we were intentional in how we identified and sought out key experts and leaders in accessibility technology. In addition to personal contacts, we: ● Researched key leaders in accessibility and AT development and sent personalized invitations via direct email, LinkedIn, Facebook, and social media; ● Approached key organizations in AT and disability movements, sending personalized invitations via phone and email; ● Asked organizations in accessibility and disability movements to help us identify even broader experts, allies, and individuals and get the word out; ● Requested recommended researchers and leaders from our social networks and from those of the participants; and ● Scheduled weekly informational calls with any stakeholders who wanted to speak with us about the event more before committing to explain the context and intention of the event, why we wanted their insights, and specific ways their contribution would make a difference.
During the program	To ensure all participants felt welcome and encouraged to interact and share their different points of view, we offered multiple options as to: ● How they could participate: ○ As a peripheral participant via surveys and Slack; ○ As a central participant via the above and the live workshops;

	○ As a speaker who could contribute a video perspective and join as either central or peripheral participants; ● How they could communicate: ○ Live event audio/video/chat; ○ Speaker videos; ○ Slack; ○ Email; and ○ Surveys. ● How they could share feedback in real time throughout the live workshops - and ensuring that we would incorporate changes or recommendations into the program the next day. We focused on agility to ensure participants felt that their different points of view mattered. We also designed the experience to include: ● Norms and safe room policies to create a room where all participants felt safe, included and welcome; ● A professionally branded series with a logo, tagline, website, and Youtube channel that enhanced credibility and made it easier for participants to learn more about the workshops and how their contribution would make a difference; ● Regular and consistent email communication throughout the journey so that participants were familiar with what to expect before, during and after the workshops and could join and contribute any way they preferred while also priming deeper thinking; ● Opportunities to co-develop and co-design the room as we: ○ Constantly monitored the energy in the room; ○ Encouraged iterative growth (e.g., by sharing research insights from prior sessions); and ○ Shifted the focus to truly reflect where the research and themed discussion should be focused while encouraging an open and an experimental mindset.

The Program At a Glance

Divergent Thinking <	**Innovation** < >	**Convergent Thinking** >	**Convergent Thinking** >
Workshop Day 1 May 14, 2021 12:00 - 3:00 pm EST	Workshop Day 2 May 18, 2021 12:30 - 3:00 pm EST	Workshop Day 3 May 21, 2021 12:30 - 3:00 pm EST	Workshop Day 4 May 26, 2021 12:30 - 3:00 pm EST
Total participants: 81	Total participants: 71	Total participants: 68	Total participants: 64
7 main themes		4 main themes	3 main themes

How We Converged and What We Learned

Throughout the journey, we aggregated participants' real time feedback and insights to understand emergent themes and patterns that we then used to further focus and converge our inquiry.

1. Pre-event Surveys and Day 1 to Day 2

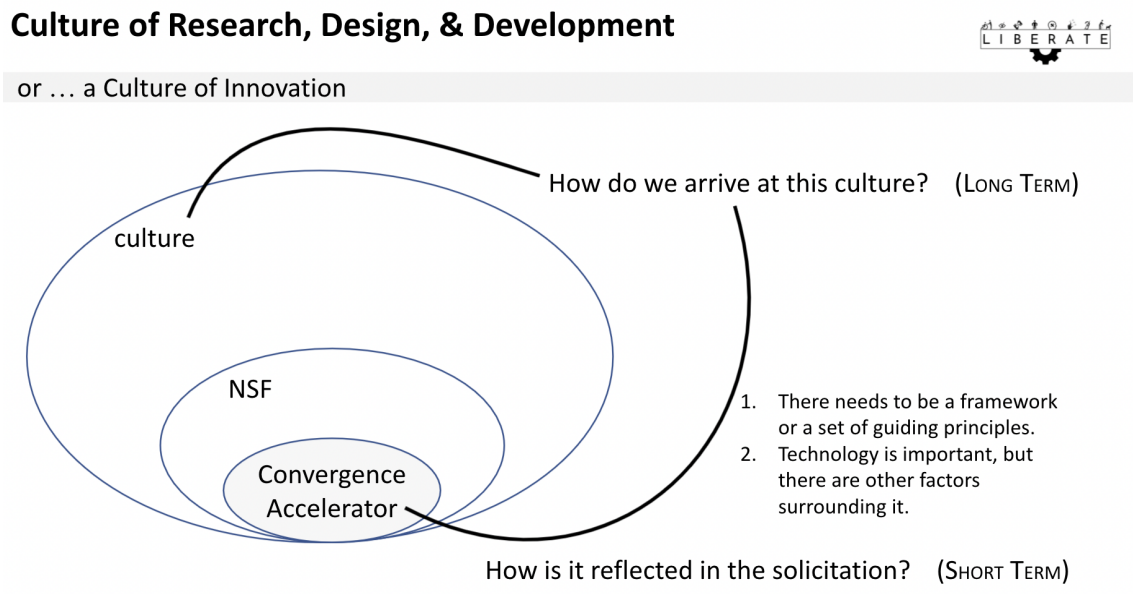
Analysis of data from the surveys, Slack conversations, and Day 1 of the workshop revealed the **seven themes** summarized below. More details about participant ideation are captured in the **google document** (also appended to this report). This activity revealed that for every issue or challenge raised, there was at least one participant directly working on a solution -- suggesting that the key obstacles might be less about what wasn't being done and more about the need for wider stakeholder engagement on what was already being considered.

1. Overarching Focus/Concern: "User Inclusion"	By far the most common theme among respondents was a firm commitment to including/listening to/involving "users in the entire process." Despite a commitment to including disabled people in all aspects of AT design and development, respondents spoke to the difficulty of actually realizing this in practice due to a lack of knowledge/support on how to do this as well as misaligned incentives. So as much as there was a call to include users, there was also a strong call to actually learn how to do this. Fortunately, there were people in this workshop who were already doing this (in pockets) and could share their expertise on how to do this and scale it out and up. ● What does "nothing about us without us" mean for research design, clinical trials, funding priorities, leadership, ect? ● How do we get "more disabled people involved in all levels of planning, community building, and research?"
2. Synergy with Societal Equity, Justice and Inclusion Efforts	Respondents referenced this historic moment and the critical importance of an effort to be committed to incorporating and advancing racial/social/economic/LGBTQ+ justice and equity for all people. Stressed in the responses was ***the importance of this being a dual movement in the sense of PWD being included in diversity, equity and inclusion (DEI) efforts and DEI efforts informing the design/implementation of assistive technologies.*** ● How do we center racially minoritized voices? ● How do we highlight intersectionality? ● How are contributions of participants to be credited and valued? ● Who is being paid for their expertise?"
3. Economic Accessibility	While also an equity and social justice issue, respondents spoke of the frustration of designing AT that most people either cannot afford or that insurance companies will not reimburse. Participants also spoke about the importance of designing for "bench to product" to satisfy users. ● How can we make technologies that help a person with disabilities more economically accessible to more people?

	● How do we “bridge the AT divide that expensive technologies create?”
4. Redesigning Design	As respondents spoke of including users, they referenced a panoply of design approaches - inclusive, universal, participatory, human-centered, user-centered, collaborative they discussed: ● If and how it might be worthwhile to find common ground on design principles; ● How to teach (and learn) these design approaches: ● How to keep the focus on human problems instead of technical solutions. Specifically: ● How do we “involve a person of disability in the earliest stages/entire process of design?” ● How do we “create interdisciplinary teams that can design in-situ researching techniques and other ways of analyzing end-user data while keeping the real-world struggles in mind to allow the development of devices with accelerated lab-to-market timelines and the development of entirely new, crossover research areas?” ● How do we “get technology to follow the person?”
5. Designing our way out of Fragmentation/ Silos	Respondents talked about the “pipeline” for the development of AT and how this separates designers from users and engineers from clinicians. It also creates silos that struggle to understand other perspectives and share knowledge. Participants hinted at an unspoken assembly line of sorts for AT that keeps people isolated from each other in the production and users at the “end.” Seen at scale, this results in a veritable Tower of Babel where stakeholders speak different languages, following different incentives, and unwittingly “holding” stakes that do not help and sometimes hinder innovations that change the lives of real people. ● How do we “fund the creation and maintenance of a well organized, indexed, searchable community knowledge base for assistive technologies that patients, families, caregivers, clinicians, and nonprofits can use and contribute to as a resource?” ● How do we “open traditional formation pipelines to other ways of creating and disseminating knowledge to include the epistemic richness of the disability community?”
6. Economic Incentive Systems	Many respondents identified the role that economic incentives (often funding) play in fostering and impeding high impact solutions for persons with disabilities. “How do we align research and development incentives and metrics with user value?” ● “Where are the funding mechanisms that encourage cross-disciplinary collaboration, that encourage application of one technology across multiple application areas or markets, that encourage decentralization of innovation resources, that focus on elevating entire fields rather than runaway success stories?”

	• What factors – policy, economic, regulatory, equity, ect- would have to be in place to "ensure that all technology be "born accessible?" • How do we "seed grant funding (perhaps like Kickstarter or a VC fund) available to disabled entrepreneurs to develop assistive technologies that solve problems for disabled folks?"
7. Policy/ Advocacy	Respondents mentioned a multifaceted approach to AT development and the importance of understanding and advocating on realms- political, economic, societal- to ensure the technology can become accessible to people. • How do we advocate for disability awareness, the "ubiquity and importance of AT in everyone's life" and the "societal/economic benefits of universal access?" • "Until we get "technology researchers interested and invested in championing policy changes, much of AT research is, in practice, never going to meet a disabled person's body." How do we do this?

The question we kept coming back to was how do we shift the way we think of how we work, innovate and ideate for assistive technologies. The message that we are living in the confines of an old culture and way of doing while wanting to create a new way of working was emerging from the earlier discussions. **We wondered then what does a culture of innovation by and with people with disabilities look like? What must this culture of innovation include or consider?**



With these insights on Day 2, we dove deeper into five particular themes we agreed would resonate with the NSF solicitation. Three hours of ideation and discussion led to 34 pages of thoughts and reflection, and clearer findings that four themes in particular might merit additional exploration.

Different Groups

Framework from Survey Results so far

Group 1 | Human-Machine Systems (Physical)

Group 2 | Synergy with Societal Justice Equity Diversity and Inclusion (JEDI) Efforts

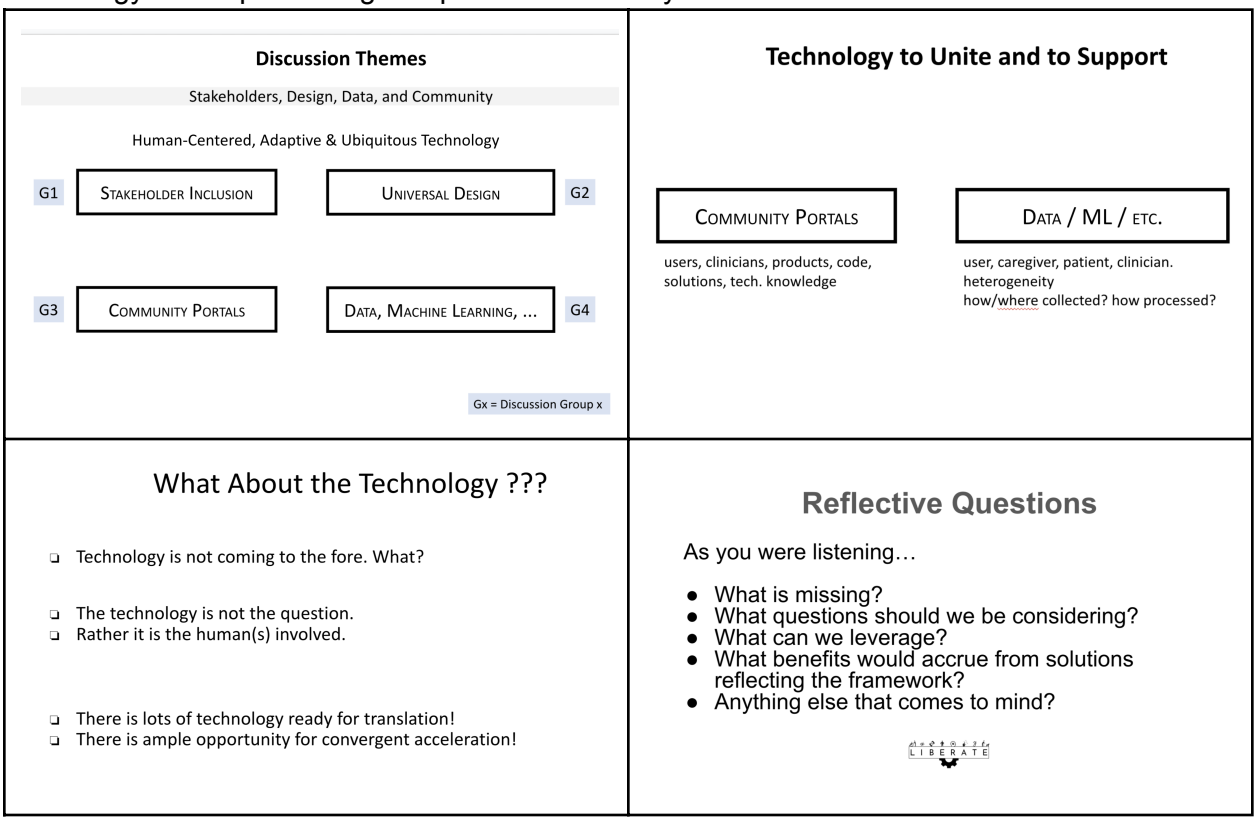
Group 3 | Economic Accessibility

Group 4 | Human-Machine Systems (Non-Physical)

Group 5 | Redesigning Design & User Inclusion

2. Day 3

Reviewing the data and discussions from Day 2, we discerned four themes that merited a deeper dive.. Interestingly, we noticed how the discussions on technology centered more on access and human involvement gaps and opportunities than on the technical aspects of technology development. For instance, while some useful AT already exists - the problem is that users cannot access or afford it, or educators often are not trained how to use it or prioritize using it, reinforcing a lack of user awareness and access. In fact, a more common observation was that low tech solutions were sometimes the best, but that no mechanism existed to support research and development into a product. This led us to delve into how so called 'low' technology development might improve accessibility for all.



On Day 3, participants self-selected into four themed conversations to crystallize their understanding of gaps and opportunities and explore more deeply where we should converge around the NSF solicitation.

1. Data / Machine Learning	How can we use data/machine learning to learn how to overcome barriers such as: ● Cost ● Customization ● Usability ● How can data be collected, processed, and used responsibly to capture all communities? What benefits accrue from diversity?

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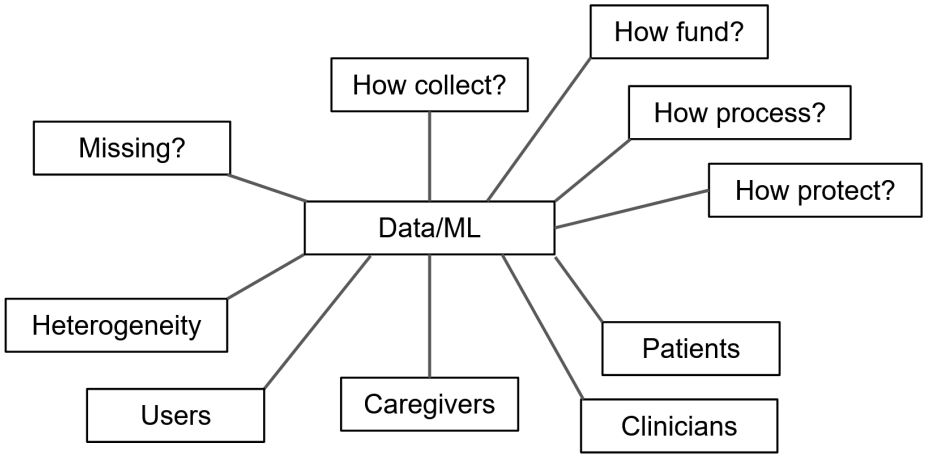
- What needs to be done to ensure equitable outcomes?



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<tr><td>2. Universal Design</td><td>

How can we engage universal design as an ongoing relational learning process that must be adapted to each particular situation?

- What are the overarching principles and how do we seed these?
- How can Universalizing Design empower marginalized or underserved communities? What benefits accrue?
- How should a given design approach be conceived as a temporal process?
- What metrics should be considered for evaluating success of the process (not necessarily the outcome)?

<table>
<tr><td>Born Accessible</td><td>Designed to be accessible and universal from the start.</td></tr>
<tr><td>Universalized Design</td><td>Designed for a subpopulation but with intent to serve all.</td></tr>
<tr><td>Empowering Design</td><td>Universally available technology adapted to a sub-population.</td></tr>
<tr><td>Adaptive Design</td><td>Designed for a subpopulation but adapted to serve all.</td></tr>
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<tr><td>3. Community Portals</td><td>

What would a community portal look like for different stakeholders?

- What could they offer and receive from it?
- How could it start and where could it go?
- Examples of functional portals, but possibly more limited in scope?
- How can a community portal serve or support marginalized or underserved communities? What benefits would accrue?

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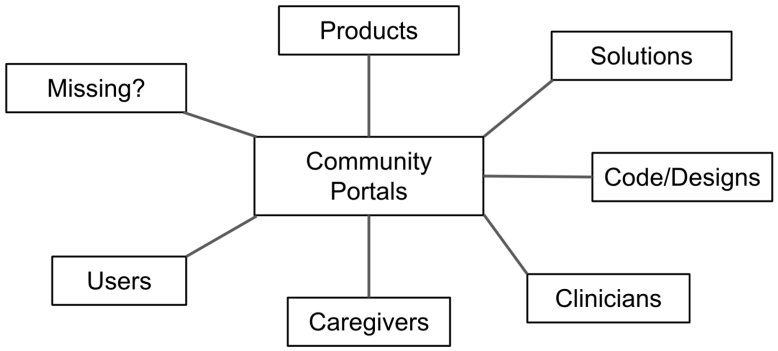
- How incorporated into research?



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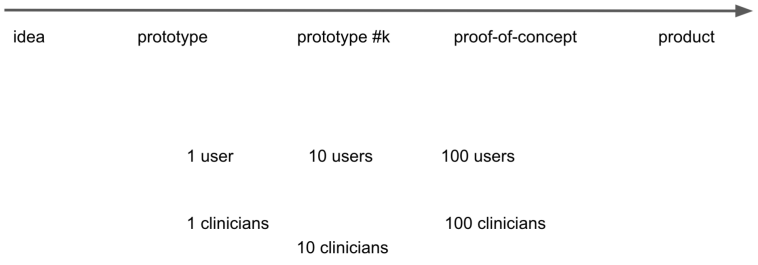
<tr><td>4. Stakeholder Inclusion</td><td>

What is a template for building relationships to ensure successful and sustained stakeholder inclusion?

- Principles for building relationships that involve persons from across the AT landscape?
- How do we align or create incentives to value this?
- Where is it already taking place?
- How can stakeholder inclusion address the needs of marginalized or historically underserved communities? What social benefits accrue?

Where should inclusion start? At what level? Which actors? For what purpose?
How can engineers and social scientists work together for richer outcomes?
How can we provide added value to the relationship for the user/clinician?



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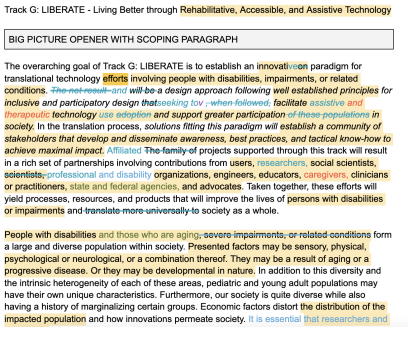
3. Day 4

It is important to note that up until to this point the report has focused on generating powerful questions more so than coming up with specific answers. We see these questions as critical to defining the essential elements of the NSF solicitation and as such the solution pathway. We discovered that while many of the participants had developed unique solutions to particular problems, the solicitation should focus on creating a framework that supports teams working together to come up with viable solutions. The collaborative nature of the Convergence Accelerator cohort and the



Track G: LIBERATE - Living Better through Rehabilitative, Accessible, and Assistive Technology

BIG PICTURE OPENER WITH SCOPING PARAGRAPH

The overarching goal of Track G: LIBERATE is to establish an innovativeon paradigm for translational technology efforts involving people with disabilities, impairments, or related conditions. ~~The net result~~ and ~~will be~~ a design approach following well established principles for inclusive and participatory design that~~seeking to~~ ~~, when followed,~~ facilitate assistive and therapeutic technology use adoption and support greater participation ~~of these populations~~ in society. In the translation process, solutions fitting this paradigm will establish a community of stakeholders that develop and disseminate awareness, best practices, and tactical know-how to achieve maximal impact. Affiliated ~~The family of~~ projects supported through this track will result in a rich set of partnerships involving contributions from users, researchers, social scientists, ~~scientists,~~ professional and disability organizations, engineers, educators, caregivers, clinicians or practitioners, state and federal agencies, and advocates. Taken together, these efforts will yield processes, resources, and products that will improve the lives of persons with disabilities or impairments and ~~translate more universally to~~ society as a whole.

People with disabilities and those who are aging, ~~severe impairments, or related conditions~~ form a large and diverse population within society. Presented factors may be sensory, physical, psychological or neurological, or a combination thereof. They may be a result of aging or a progressive disease. Or they may be developmental in nature. In addition to this diversity and the intrinsic heterogeneity of each of these areas, pediatric and young adult populations may have their own unique characteristics. Furthermore, our society is quite diverse while also having a history of marginalizing certain groups. Economic factors distort the distribution of the impacted population and how innovations permeate society. It is essential that researchers and

diversity of solutions tackled by selected teams would help to develop a framework for successful research into--and translation of--technology for better living by people with disabilities. If approached in this manner, the benefits of the Convergence Accelerator would be two-fold. First, the translated technology would contribute to society in the form of products that improve living. Second, the successful instances of translated technology would inform the creation of a framework for research and translation of technology where the needs of people with disabilities are central to the problem being solved.

Thanks to our participants' active engagement and feedback, we started Day 4 with a preliminary draft of the solicitation and detailed questions and feedback that had already been contributed. The process fleshed out further details and identified patterns for convergence towards the final candidate solicitation draft.

During this day's discussion a number of patterns emerged:

- **Explicit Calls and Clear Language Matter**: Many raised how a person of disability should be not only actively involved from the beginning of a solicitation, research or tech development process but also across areas of responsibility (i.e, not just as the voice of an end-user but also as that of reviewer, grant decision maker, and technologist, among others.) Including the recommendation that the solicitation explicitly lay out requirements for involvement by people with disabilities.

- **Active Stakeholder Engagement is Important**: Many raised how active stakeholder engagement throughout the full research and development process is key. They shared that how intentional a solicitation is in how stakeholders are engaged, can engage, and are invited to engage will make a difference in what findings researchers will identify and what they will ultimately be able to design.

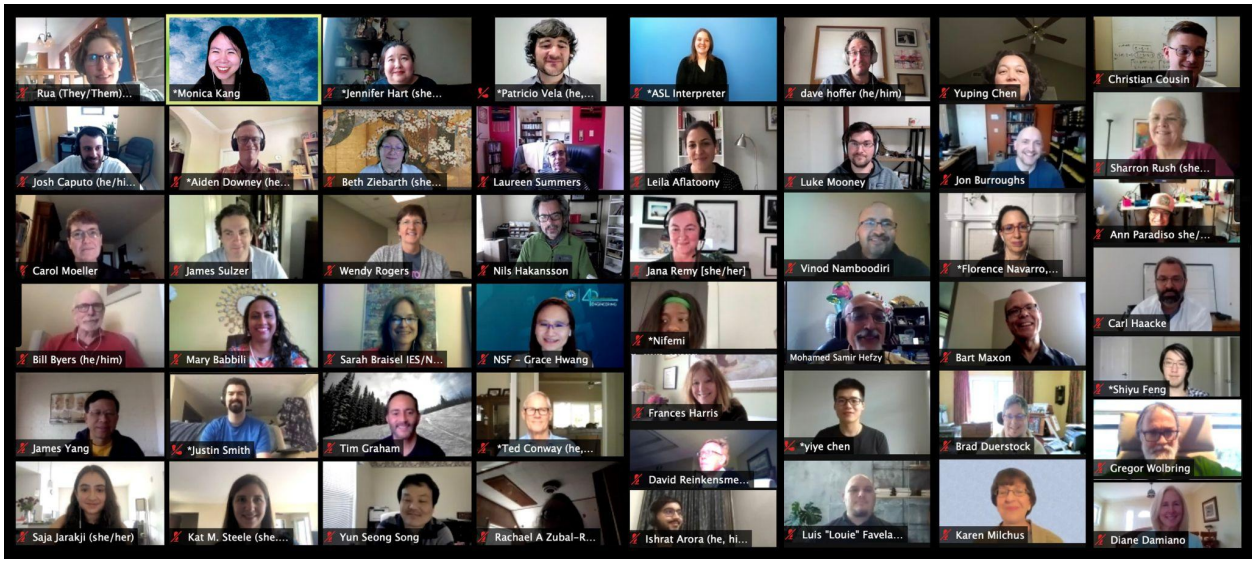
- **Advocating for Marginalized Voices**: While research on majority needs may seem the best way to help the most, some shared how advocating for extreme marginalized populations can be a way not only of finding truly innovative technology solutions, but also of helping advance causes for many more who are in between those stages. Because a person with disabilities's needs are different, when we focus only on short term pain points, we may not be able to solve for the longer run majority who are facing crucial life conditions that could benefit from better lifeware AT design.

- **Power of Storytelling**: Participants also spoke of the importance of storytelling. How can we ensure more useful AT is accessibly used? Anecdotal storytelling is a powerful way for new users to learn why they should adapt to a new way of using a tool, or even want to use a new tool. Are there training and information opportunities for better storytelling and technologies elaborating upon the importance of how what they build would be used by those who need it?

Workshop Conclusion

Remarks

The power of reframing was a constant reminder. Instead of focusing on “what new technology should be developed” participants brought our attention to “how technology development actually occurs” or “how technology is used” present some of the greatest barriers to AT accessibility. While emphasizing the importance of universal design, participants also reminded us that overgeneralization would prevent the most marginalized audiences from benefiting from AT development. Each conversation reminded us how advancements in AT have the potential to impact and transform real lives, which is why this work is so important . . . and so urgent. Timing . . . and intention . . . are both of the essence. It’s important to remember that today’s stakeholders are demanding that more thoughtful transformation be made not just in technology but first and foremost in how it’s designed, developed, marketed and accessed. In short, the shift in focus towards developing a better process to develop authentically useful and impactful AT products has reaffirmed why NSF’s involvement and investment could have a wide impact where it matters most.



The Team is thankful to all the workshop participants who have shared insightful perspectives!!

Draft Solicitation

The final workshop solicitation, arrived at through the workshop discussions and a crowdsourced revision and discussion process, is located below. To assist in understanding the focus of the solicitation draft, we identified two candidate titles for the solicitation topic:

Track X: Technology for Better Living by People with Disabilities
Track X: Living Better Through Rehabilitative, Accessible, and Assistive Technology

The overarching goal of *Track X: Technology for Better Living by People with Disabilities* is to establish an innovative translational technology paradigm that will yield technologies which directly impact and improve the lives of people with disabilities. Projects supported through this track will be expected to embrace participatory design principles that center people with disabilities in all aspects of the technology development. Collectively, Track X affiliated projects will embrace collaborative partnerships between persons with disabilities, caregivers, researchers, social scientists, scientists, professional and disability organizations, engineers, educators, clinicians or practitioners, state and federal agencies, as well as policymakers and advocates. Within three years, projects will be expected to deliver tangible products, resources, or processes that empower a diverse population of persons with disabilities to live better and more fully participate in and contribute to society.

Background. The *Americans with Disabilities Act* (ADA) defines a disability as a mental or physical impairment that prevents an individual from performing one or more major life activities such as the ability to care for oneself, work, walk, run, speak, think, and interact with others [1]. A disability can be permanent or temporary, congenital or acquired, and evolve over one's lifetime. Despite the various categories of disabilities, each person experiences it as a singular and unique challenge mediated by their life circumstances. Factors such as race, ethnicity, gender, socioeconomic and LGBTQ+ status, and societal and cultural attitudes impact the ability of persons to adequately address and overcome disabilities.

People with disabilities constitute a large, fluid, and diverse population in our society. Currently, one in five persons in the United States lives with some form of disability [2], as defined by the ADA. Recent demographic shifts in the United States towards an aging and older population is expected to increase the number of people experiencing a disability [3]. Finding ways for people with disabilities to fully participate in all activities of daily living (ADL) and in society will have a myriad of positive outcomes for both individuals and the larger society. Most importantly, identifying and removing all barriers to full participation will empower people with disabilities to exercise their inalienable right to self-determination. These barriers deprive society of their skills and talents, as evidenced by the fact that two thirds of people with disabilities do not currently participate in the workforce.

Beyond the obvious personal, societal, and economic benefits of enabling twenty percent of our population to fully participate in society, there is a larger societal incentive for designing technology addressing the full range of human needs. Engaging people with disabilities in the design and development of emergent technologies will translate into products that are accessible and useful to more people regardless of their ability status. Indeed, their inclusion or leadership in the development and deployment of technologies will avoid building inadequate technologies.

Convergent Teams, Participatory Research and Translation. Track X necessarily involves convergent, multidisciplinary teams including the active participation of persons with disabilities focused on the accelerated translation of high-impact use-inspired technologies for a substantial and diverse population of people with disabilities. The successful translation of these technologies requires the buy-in and participation of additional stakeholders, including

caregivers, practitioners, educators, employers, advocates, and policymakers. Therefore, teams will be required to enlist persons from across pertinent stakeholder groups. In addition, technologies that become effective products with broad user adoption require empirical or clinical evidence of efficacy. To do this will require the engagement of researchers, clinicians, businesses, manufacturers, and other relevant stakeholders in the implementation process. The overarching goal of Track X is to create templates for successful participatory innovation that produce tangible and impactful technologies for better living by people with disabilities and that also positively impact society.

Considered projects will embrace some form of participatory design and participatory action research throughout the design and translation efforts. Projects must demonstrate significant and meaningful participation of people with disabilities as well as, wherever possible, leadership by people with disabilities. Technology awareness and adoption does not permeate/proliferate through society at equal rates, thus intersectional considerations related to diversity and equity are needed, such as inclusion of diverse participants who collectively reflect distinct user bases for the technology, application of best practice to ensure sensitive or fair inclusion, attention to privacy, and efforts to understand any unique opportunities or barriers for the different user bases.

Projects should address how the proposed technology can become more universally adopted and thus impactful to a wide and diverse population of persons both with and without disabilities. There are several ways to achieve this. Examples include, but are not limited to, designing technology that is

- accessible and usable to as many as possible from conception
- for a specific user group with the idea that doing so will lead to improved usability for all
- based on available, widely adopted technology with adaptations to a group
- based on a target group but with adaptive elements that improve usability for all
- applicable to a specific group with quickly derived parallel products that generalize to other groups.

In doing so, these assistive technologies become accessible to more people with disabilities and for that matter people without disabilities.

Technologies should be designed with awareness of the commercialization path and barriers to adoption such as insurability, government regulations, cost, employer constraints, needs for empirical validation of benefits, etc. Team composition and considerations will depend on the predominant factors influencing adoption of the proposed technology. For example, in the process of solving one need, an assistive mobility technology might introduce secondary health problems. Addressing design issues to prevent those consequences should lead to a better product, which might also be more affordable or insurable. Similarly, validated efficacy of a technology might provide the justification needed to support employer coverage. If cost is a factor, partnering with a company that has a large consumer base could take advantage of economies of scale.

Convergence Research, Deliverables, and Diversity and Inclusion. Track X focuses on use-inspired, translational research generated through stakeholder inclusion during the entire pathway, where persons with disabilities are active participants in all aspects of the process. Projects must embody a culture of inclusive innovation, coordination, and collaboration across various disciplines, and engage relevant organizational or corporate partners. Projects must define at least one tangible deliverable that will translate research into practice with measurable outcomes and impacts within the timespan of the Convergence Accelerator track (9 months for Phase I and 24 months for Phase II). Additionally, deliverables must have a demonstrable or convincingly realizable pathway to widespread adoption or provide generalizable insights for future innovations in the same domain. To promote creation of knowledge communities around the innovations, each project should incorporate community engagement and include an education or training component. Projects that focus on community building, engagement and education are also encouraged. All submissions should explicitly address how larger issues of diversity, equity, and inclusion will be integral to the project.

Projects fitting this track are anticipated to span a diverse range of topics related to how people with disabilities can use technology to enhance their lives. Broad categories of solution approaches include rehabilitative, accessible, and assistive technologies. Rehabilitative technologies help to recover or improve function after developing a disability [4]; assist children with disabilities in meeting developmental goals; or delay the progression of a disability. Accessible technology refers to technology whose design permits use by users with a wide range of abilities [5]. As a general term, assistive technologies include “any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities [6].” Increasingly, advanced technology incorporates software modules based on data-driven modeling. There is an opportunity to collect data to generate and/or provide such models so that technology may suit and be adapted to diverse groups of people with disabilities, in a manner that respects privacy. Acceptable projects might include scalable efforts to build community portals to improve public participation in STEM and technology development, awareness of technologies that support the needs of people with disabilities, and education.

[1] Americans with Disabilities Act of 1990. 42 U.S Code §12101.
[2] “Regulations To Implement the Equal Employment Provisions of the Americans With Disabilities Act, as Amended.” 76 FR 16977, 2011.
[3] World Health Organization. “Ageing and health.” https://www.who.int/news-room/fact-sheets/detail/ageing-and-health
[4] National Institute of Child Health and Human Development. “How does rehabilitative technology benefit people with disabilities?” https://www.nichd.nih.gov/health/topics/rehabtech/conditioninfo/help
[5] Partnership on Employment and Accessible Technology. “Get Started: Why Accessible Technology Matters.” https://www.peatworks.org/get-started-why-accessible-technology-matters/
[6] Assistive Technology Act of 2004. Public Law No: 108-364.

Solicitation Specific Criteria

The project centers the experiences of people with disabilities in defining the proposed work and engages them as partners or leaders.

The technology has a pathway to widespread adoption and use, or can be used in adjacent domains and/or with similar technologies to solve other problems.

The project gathers a diverse team spanning all relevant domains/populations throughout the entire process.

Workshop Findings

To address the NSF Convergence Accelerator needs, several questions were asked by the NSF program managers. These questions help to justify the rationale for creating a topic with the proposed theme.

How is the translational research use-inspired?

The theme of the LIBERATE workshop was summarized as Living Better through Rehabilitative and Assistive Technology, with the anticipated user base of the technologies being people with disabilities. By definition, a disability is a mental or physical impairment that prevents an individual from performing one or more major life activities; it can be permanent or temporary, congenital or acquired, and evolve over one's lifetime. Technology designed to address the needs arising from a disability is necessarily use-inspired: its purpose is for the individual to recover or enhance, as much as possible, their functional capabilities when the technology used. The prevailing point communicated by all participants is how *technology needed to go beyond being use-inspired but needed user-involvement. User-involvement in the entire process would be the best insurance against the design and production of a technology that is effectively inaccessible to a wide swath of the target population.* Furthermore, a corollary point was stressed that the technology could not succeed without direct and constant involvement of users. There can be no stronger notion of use inspired than technology whose creation and design directly derives from the needs of, and input from, its intended users.

The workshop's technology focus was on rehabilitative, accessible, and assistive technologies. *Rehabilitative technologies* help to recover or improve function after developing a disability; assist children with disabilities in meeting developmental goals; or delay the progression of a disability. *Accessible technology* refers to technology whose design permits use by users with a wide range of abilities. As a general term, *assistive technology* includes technology used to increase, maintain, or improve functional capabilities of individuals with disabilities. All these technologies have at least one user: the person with disability who is the primary user. Many of them often involve another person or secondary user, who might be a caregiver, practitioner (physical therapist, occupational therapist, etc.), instructor, or other professional. For the technology to successfully translate and be adopted, the primary user and the secondary user, as applicable, both need to see the value in the technology. Regardless of the type of

technology translated, including people with disabilities in all aspects of the process ensures that the translational research is not only use inspired but perhaps more importantly useful to and usable by people with disabilities.

Why is it needed?

There are two main arguments for why translational research on rehabilitative, accessible, and assistive technologies is needed. The first is regarding the untapped potential of people with disabilities and the societal gains associated with improving their ability to participate fully in and contribute to society. The second is due to spillover benefits of the technology that would be experienced by everyone.

People with disabilities are a diverse population in our society. Currently, one in five persons in the United States lives with some form of disability, as defined by the Americans with Disabilities Act of 1990. Further, recent demographic shifts in the United States towards an aging and older population is expected to increase the number of people experiencing a disability, since many conditions associated with aging fall under the definition of a disability. Establishing the means for people with disabilities to fully participate in major life activities will lead to positive outcomes for the individuals, for their caregivers or family, and for society. Foremost, identifying and removing barriers to full participation in life and society empowers people with disabilities to exercise self-determination and reduces stressors in the lives of their caregivers or family members. There is an opportunity to enrich the lives of people with disabilities and those near to them. Second, barriers to self-determination deprive society of the skills and talents of people with disabilities, as seen by the fact that two thirds do not participate in the workforce.

In addition to the direct benefits to people with disabilities, there is a larger societal incentive for designing technology addressing the full range of human needs. Engaging people with disabilities in the design and development of emergent technologies translates into products that are accessible and useful to more people regardless of their ability status. Including affordances based on disabilities into the design considerations of products increases their user bases and enhances their utility or usability. The inclusion of—or leadership by—people with disabilities in the development and deployment of technologies helps to avoid the creation of inadequate technology. In essence, there is the powerful argument that a large fraction of technologies expected to result from the NSF solicitation would have parallel implementations for the wider general population. They might be integrated into existing technology, or establish wholly new products for the marketplace. These potential products would span a rich set of application domains based on the diversity of technology needs for people with disabilities. What these technologies might be is still to be determined, but if the current examples of socially adopted accessible designs are any indication of their utility, then we can expect for the outcomes to have a profound impact on all of our lives.. Implemented with fidelity, Technology for Better Living by People with Disabilities will naturally lead to technology that has the potential to improve the lives of everyone.

What are the convergent themes?

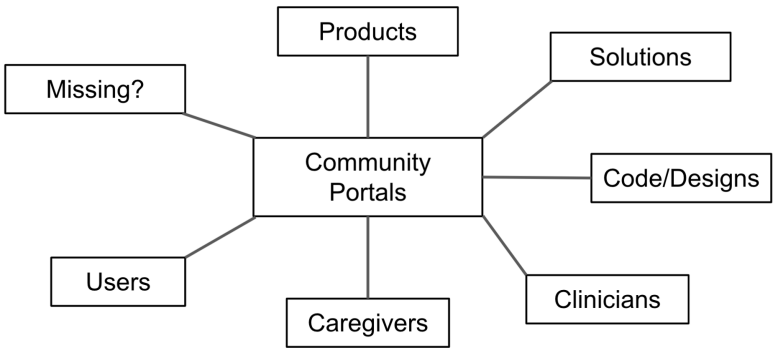
The definition of disability results in an umbrella term for a broad spectrum of conditions that collectively require different technologies and solutions. Rather than focus on specific technologies, workshop participants converged around the imperative of including a diverse group of people with disabilities in all aspects of the translational research process. The reluctance to explicitly identify specific solutions was due to the fact that while disabilities are often lumped into easily discernable categories, people's experience of being disabled is unique and singular.,.In fact, people identified as having a specific disability class can have less in common with each other than people in a different disability class. Furthermore, when someone acquires a disability, it may evolve over time and therefore require evolving and emergent solutions.

A second factor related to the diversity endemic to disabilities is that it shifts the technological solution space away from singular solutions and towards more evolving and contextual approaches. Many of the participants agreed that basic or low research value technology could provide excellent solutions to important problems, just as much as maturing high research value technology could to the same problems. Technology is not the impediment, rather the ecosystem surrounding the solution and its development is.

These observations converged around the need for truly interdisciplinary teams to examine the technology from multiple diverse perspectives to ensure that the technology addresses the actual needs of real people with a given disability. For example, the imprecise definition of disability leads to a heterogeneous population with variable use needs, which is further demarcated by intersectional factors such as gender, race or ethnicity, class, and sexual orientation. Successful creation of the technology is much more likely to take place when people with disabilities converge with multidisciplinary teams as co-contributors in the translational process. Equally important is the involvement of other stakeholders such as physical therapists, doctors, caregivers, service technicians, etc. Only through interdisciplinary teams can all barriers to development and adoption of a technological solution be addressed.

Community Involvement

Two major considerations about the technology surfaced from the discussions. They were (1) the role of community sourced data in supporting customized or adaptive solutions, and (2) the importance of creating community portals for improved education and dissemination of information about rehabilitative, accessible, and assistive technologies in support of living or working better.



Depicted in the figure to the right is a visual anchor used for discussion during the workshop. It indicates

the multiple ways to foster community around technology for better living. The more informed, connected and vested these different groups or communities are, the more likely the technology will achieve the levels of adoption required to succeed. Thus, the recruitment of people from these communities, outreach to organizations, and targeted dissemination to them is essential. Communities that revolve around solutions or code/designs exist to normalize and create anticipation for the technology. They also exist to share best practice and common solutions that could be reused or modularized, thereby extending the reach of the solutions.

In a similar vein, the increasing use of machine learning and artificial intelligence to provide adaptive or customized solutions fundamentally relies on data. Data collection, curation, and use require developing community outreach that is sensitive to the needs of the community. As our participants stressed over and over, creating more connected communities would go a long way towards removing barriers to technology adoption such as lack of information.

Make a case that they are not only convergent but ready for acceleration.

The need for diverse, multidisciplinary teams inclusive on all levels of people with disabilities is ready for realization. Right now, many translational efforts go fast but miss the mark in terms of producing assistive technologies that positively impact the lives of a wide swath of people living with disabilities. The consensus is that acceleration happens when the core components for the technology are sufficiently mature, there is a compelling commercialization pathway, and the team has the right composition for the target use-case. Importantly, the team must place at the center of all considerations the actual user of the technology.. Given the diversity of technologies and the diversity of and within disabilities, there are many candidate application domains ready for convergent acceleration. Example domains noted by the speakers include but are not limited to:

- Rehabilitation
- Wayfinding and Situational Awareness
- Assistive Robotics: Smart Devices
- Prosthetics
- Non-Invasive Interfaces
- Wearables.

What limits progress in these domains is the scarcity of well-coordinated multidisciplinary and team efforts. In addition, ‘progress’ needs to be reframed as the uptake and use of a particular technology within a disability community. Selection by the Convergence Accelerator would provide the mechanism to unite the right configuration of people around common objectives in line with the candidate theme.

Who would likely be involved in providing?

This resounding answer to this question is multidisciplinary teams made up of a wide range of stakeholders and inclusive of people with disabilities. Our workshop found a strong need to learn, use and develop participatory design and participatory action research methodologies.

Furthermore, to fully address the intent behind participatory action research, teams must include persons adept at addressing societal, equity, and diversity aspects, and of capturing the experiences of people with disabilities. In many cases, it will be equally important to include clinicians, therapists, educators, or other health professionals, so that the technology can be validated for efficacy regarding its intended use.

Connecting with industry partners is essential. Partnering with large corporations permits leveraging economies of scale to lower costs. Partnering with smaller companies or startups provides mechanisms to target multiple application domains outside of technologies for people with disabilities. In addition, coordinating with advocacy, policy, non-profit, or non-governmental organizations leads to more feedback and community interaction, and wider awareness and dissemination of the proposed technology. In short, a good team includes the myriad of stakeholders connected to the technology from its inception to its ultimate adoption and use.

The need for a team providing broad expertise across a range of domains was emphasized by participants who:

1. Worked on multi-disciplinary efforts and observed their value
2. Realized that their own efforts could not gain traction without bringing in additional expertise
3. or have led such efforts (for example, a PI of an NSF BRAIN Center).

All of them noted that without the team there would be a knowledge gap that would undermine or halt progress. Likewise, they commented on the importance of reaching out to non-research organizations for improved understanding of the social context of the research, as well as for expanding and diversifying participation of persons with disabilities in the research activities. These needs are on top of the value that such organizations play in terms of enabling participatory design,

Companies communicated the value of teams in a different manner. Larger companies expressed the desire to explore fresh new ideas with researchers to push advances in their design space, while themselves being able to contribute through advanced mass fabrication techniques, economies of scale, and improved awareness based on brand name recognition, so that products could be more readily adopted and produced for commercial use. Smaller companies, on the other hand, had contacts within the niche areas they were commercializing and had viable technological demonstrations, but needed to be part of larger and more diverse teams to push through the remaining troublespots. These troublespots related to translational clinical research, to enhancing the robustness or generalization of the technology in collaboration with research groups, and to maximizing outreach efforts, all of which require coordinating efforts as part of a multidisciplinary team. Technology generalization is a critical achievement for smaller companies since it permits them to explore tangential markets from a single base product.

What are possible tangible outcomes (< 3 years)?

The most tangible outcome will be a viable model for engaging diverse, multidisciplinary teams in the translation of rehabilitative, accessible, or assistive technologies that positively impact a diverse and substantive population of people living with disabilities. The model will then accelerate the translation of such technologies in many areas, including:

Rehabilitation. The state-of-research in this area indicates that successful rehabilitation lies with the user and requires successfully motivating them and understanding neural processing of sensorimotor loops. The right team would design intrinsically motivating rehabilitation regimes and products that address the neurophysiological sources of injury and tailor rehabilitation to the user. Low-cost, widely deployed devices with the ability to safely and anonymously collect data would generate a rich trove of user and progress data to support the generation of generalizable models with customization capabilities that would best predict and bring about the rehabilitation needs and trajectories of individual users.

Wayfinding and Situational Awareness for the Blind. Advances in robot localization and visual recognition algorithms, such as those used in autonomous vehicles, have the potential to support sensory substitution devices that would provide enhanced awareness for the blind or visually impaired. The outcome would be a robust, adaptive visual assistant for interpreting one's immediate environment. Creating communities around such devices, especially if an open standard for maps and wayfaring were created, would facilitate widespread mapping and sharing of map information so that visual support could be available anywhere another person a visual assistant has been, which would be quite valuable to all stakeholders.

Assistive Robotics. Leveraging recent advances in navigation, manipulation, and low-cost robot design with understanding of human factors and user interface design could lead to the creation of an easily trained and highly capable assistive robot for people with upper body paralysis or muscular deficiency. This thread brings together small companies with innovative assistive robot designs and researchers whose effort in perception, planning, and human-robot interaction could provide compelling and easy to operate assistive robots for the home. Importantly, these devices can achieve universality quite easily given the overlap of this application domain with flexible manufacturing and flexible automation. Both applications need easy programming through human demonstration, combined with advanced perception and manipulation algorithms. Major advances in robotics over the past few years, along with the number of robotics startups targeting industry, is a strong indication that this topic is ready for translation.

Smart Devices. An example in this domain includes smart wheelchairs, whose design and functional components would exploit many of the same advances informing assistive robots, while permitting the use of commercially available smartphone or tablet devices, or other interfaces, as accessible interfaces. Miniaturized technology, both on the sensor and compute hardware fronts, means that many smart assistive devices are in the realm of possibility. Furthermore, several startups are exploring the retrofit of these technologies onto existing

non-smart devices, while advances in automated processing enhanced through machine learning support increased robustness of smart devices in real-world use cases.

Prosthetics. Rapid and custom manufacturing techniques could provide personalized prosthetics with favorable mechanical properties that avoid or mitigate secondary health problems typically associated with poorly fit or improperly used prosthetics. Much like smart devices trackrosthetics have benefitted from miniaturized technology as well as advanced fabrication methods. Major needs involve assembling multidisciplinary teams to consider the holistic properties of prosthetics, from custom fitting and fabrication, to training, to adaptive use over time as the user's needs evolve.

Non-Invasive Interfaces. Novel, non-invasive human-machine interfaces would permit more natural and efficient interaction with assistive and computing technologies. Techniques from the data sciences and machine learning would specialize sensory signal interpretation to the specific properties of the user. The ability to provide limited control of complex devices has been demonstrated in the past few years. This technology is ready for a bigger push to evaluate it on larger, more diverse populations, especially since many techniques involve data-driven machine learning methods. Connection to industry, whether startups or established, could lead to scalable techniques for interfacing smart devices or computational hardware through alternative, non-invasive interfaces. There are a variety of industry needs whereby a worker's hands are used but the worker needs to interface with another technology or device, but where traditional hands-off or hands-free interfaces do not apply (e.g., voice recognition does not work well in noisy or loud environments). Successful deployment for people with disabilities would provide the proof of concept needed to seriously consider the same technology's translation to industrial use cases where the alternative interface would increasingly risk the operator's health and/or task success.

Wearables. Miniature, low-cost, networked sensors placed on the body would promote more frequent monitoring and analysis of human movement. Widespread deployment would improve our understanding of population and group level norms for better tracking development or progression of movement-based disabilities for users of all ages. Most importantly, light-weight, low cost wearables would go a long way towards providing richer information to physical therapists for enhanced intervention. The richer data could also be collected on a larger scale to better understand the course of rehabilitation, training, or learning. Interactions between users and clinicians could be virtualized based on the higher fidelity information safely and privately sent to clinical practitioners. This technology has several pathways to greater adoption, most especially for health monitoring and training of workers. Many physically demanding jobs require correct posture or interaction with heavy or bulky hardware. Wearables are excellent platforms for better understanding physical movement for targeted corrective training by instructors, or for identifying when to intervene to correct posture for workers.

Interconnected benefits of a diverse, inclusive, multidisciplinary and user-informed approach to the design, development, and adoption of Assistive Technologies

The intent behind the technology is to support major life activities, which cover the activities of daily living, work, creative pursuits, etc. By definition, a disability impedes someone from performing a major life activity, which in turn diminishes their participation in society. By providing a means to achieve fuller participation, the person's life experience improves as does their ability to contribute to society. Furthermore, in instances where the person relies on caregivers, the increased independence frees up the time—and possibly lowers the stress—of the caregivers. However, to do so requires for the technology to be usable and attainable by all people with disabilities, including women, minorities, and other underserved groups. Excluding these voices from the design and development phases may shrink the candidate user base due to their lack of adoption, and negatively impact the commercial viability of the technology. Following a more inclusive process could result in the opposite outcome, increased adoption and enhanced commercial viability.

Technologies better tailored to the actual needs of people with disabilities translate into increased ability to fully participate and contribute to society. Participants contributed examples where technology did not adequately address the needs of women resulted in solutions that did not apply to them (e.g., prosthetics), and from which they could thereby not derive any benefits. Similar outcomes apply to underrepresented minorities and people from marginalized or economically disadvantaged communities. These same technologies that prevent participation in society also impact participation in work or creative activities. The contributions from talented and motivated persons (20% of population) that right now are either struggling to or unable to gain access to many of the societal means for employment, advancement, etc. form a significant population of untapped contributors. Likewise, those who are employed could increase their productivity with the right employer supported resources. On the employer side, increased awareness of, and pathways to provide, such technologies would facilitate compliance with ADA regulations. Given that the aging population exhibit symptoms that resemble disabilities, these same technologies would permit them to remain gainfully employed for as long as they wished to be. Or, more generally, would allow older people to be more productive, independent and to live fuller, more engaged lives.

More broadly, many of the anticipated technological solutions directly translate to products that serve or benefit the general population. In effect, they have more universal application and can result in products with a significantly larger user base, possibly everyone. The products would thereby improve the abilities of many more people to perform a given activity, while also contributing to the economy by opening new markets or creating new niches within an existing market. Continuing on this idea, the adoption of technologies designed for particular disabilities by the general population may enable the users to achieve something that is not possible today but of societal value.

Appendix

How participants have engaged

PRE WORKSHOP ENGAGEMENT	LIVE WORKSHOPS				SOLICITATION FINALIZATION	SUSTAINED ENGAGEMENT
4/1/21- 5/16/21	5/13/21	5/18/21	5/21/21	5/26/21	5/24-6/9	ONGOING

Central participants who attended the live workshops	Total of 104 participants engaged with at least one live workshop. More than 40 participants attended all four sessions including organizers and volunteers.
Slack Engagement	93 Active users. 56 started conversations in introductions. 1,600 messages were exchanged during May 2021.
Speaker Video contribution	48 individuals listed on website 40+ videos uploaded with captions on our Youtube channel 2 Summary Videos created from selective speaker videos

	Total Participants	Guests	Organizers & Staff	Volunteers
Day 1	81	68	9	4
Day 2	71	56	9	6
Day 3	68	56	8	4
Day 4	64	52	9	3

Participants

Out of 160 participants…Central and Peripheral Participants

- 30.6% are a person of disability (44 individuals)
- 18-19% are organizations (26-28 individuals)
- 11% are caregivers (16 individuals)
- 51% are Central participants (73 expressed interest)
- Over 40+ speakers are contributed via video submissions

Participants have walked away with:

1. New connections and friendships
2. New insights and ideas across industries.
3. New opportunities for collaboration. Possible followup collaborations include: co-writing papers; collaborating on grant proposals.

Youtube Videos

Total Videos: 44
Breakdown: 2 Instructional, 2 Insights Summary, 3 Welcome/Introduction, 36 Speaker perspectives (live) 1 Speaker perspective (pending final approval)

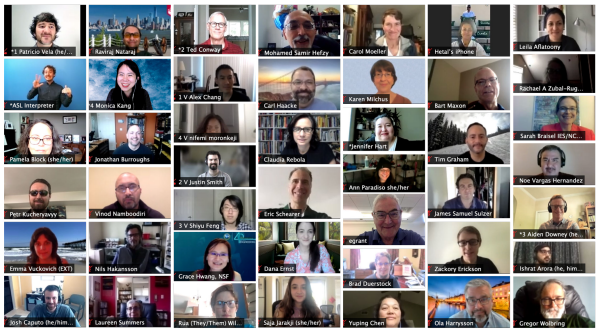
	VIDEOS		
	Speaker(s)	**Topic**	**Length**
1	Mary Babbili	Accessibility is for Everybody	6:56
2	Dr. Phillip Beatty	Problems/ Solutions Supported by NIDILRR	12:54
3	Dr. Pamela Block	The Interaction of Assistive Technology with Human Support	4:40
4	Dr. Sarah Brasiel	Funding Opportunities at IES	12:22
5	Bill Byers	My Journey to the Right Assistive Devices	13:00
6	Dr. Jose 'Pepe' Contreras-Vidal	Neurotechnologies: Challenges and Opportunities	10:31
7	Dr. Ted Conway	Activities of Daily Living Using Assistive Technologies	19:37
8	Dr. Rory Cooper	Participatory Action Design and Engineering: Forging a New Freedom!	28:46
9	Dr. Theresa Cruz	NIH Support for Assistive Technology	17:42
10	Dr. Diane Damiano	Integrating Neuroengineering, Neuroscience, & Physical Therapy to Improve Gait in Cerebral Palsy	16:44
11	Dr. Brad Duerstock	Machine Learning for AT Development	15:06
12	Dr. Luis Favela	Rethinking Underlying Commitments of Assistive Technologies	21:45
13	Larry Goldberg	Born Accessible	10:06
14	Dr. Edward Grant	Smart Wheelchairs for People with Rare Diseases	21:41
15	Dr. Ola Harrysson	Role of Additive Manufacturing in Rehabilitation and for Persons w/ Disabilities	21:44
16	Dave Hoffer	The Power of Design in Accessibility	6:11
17	Xian Horn	Why Thinking of the End-User Matters	18:33
18	Dr. Ayanna Howard	Every Engineer Can Make a Difference	19:10
19	Dr. Grace Hwang	Creating Universal, Accessible, and Affordable Solutions Through Convergence and Acceleration	5:40

20	Dr. Terry Jackson & Dr. Tara Courchaine	Technology for Children with Disabilities	13:51
21	Becky Kekula	How workplaces can be designed to be disability-inclusive	24:17
22	Dr. Charlie Kemp	Progress Toward a New Kind of Assistive Robot	19:14
23	Petr Kucheryavyy	Why Universal Design Matters	6:15
24	Dr. Maja Matarić	Socially Assistive Robotics for User Empowerment	9:33
25	Dr. Don McMahon	Emerging Technologies that Support Students with Disabilities	6:49
26	Dr. Nathan Moon	Inclusive Wireless Technologies for Independence and Participation	14:02
27	Dr. Vinod Namboodiri	A Convergent and Universal Design Approach to Assistive Technology	18:37
28	Dr. Raviraj Nataraj	The Need to Personalize Assistive and Rehabilitative Technologies	8:14
29	Hetal & Nish Parikh	Workforce Strategies for Accessible and Inclusive Workplaces	17:15
30	Dr. David Reinkensmeyer	People, Practice, Plasticity	13:46
31	Dr. Wendy Rogers	Designing for People Aging into and Aging with Disabilities	10:17
32	Dr. Kat Steele	Making Inclusion Work	12:42
33	Dr. Simone Stumpf	5 Things You Should Consider When Bringing AI to Accessibility	21:31
34	Dr. James Sulzer	A Rehabilitation Engineer's View on Care for His Daughter's Traumatic Brain Injury	20:20
35	Laureen Summers	Why Strengthening Inclusive STEM Education & Careers Matters	17:28
36	Dr. Rua Williams	The Critical Importance of Distinctions	3:59
37	Organizing Team	Welcome to Liberate 2021	19:54
38	Organizing Team	Liberate 2021: Setting the Stage - What the Survey Results Are Telling Us	15:10
39	MULTIPLE	Introduction to the NSF Convergence Accelerator, LIBERATE and DARE	1:11:44
40	MULTIPLE	Insights 1: Assistive Tech and Universal Design	3:00
41	MULTIPLE	Insights 2: Inclusivity and Integration	3:01

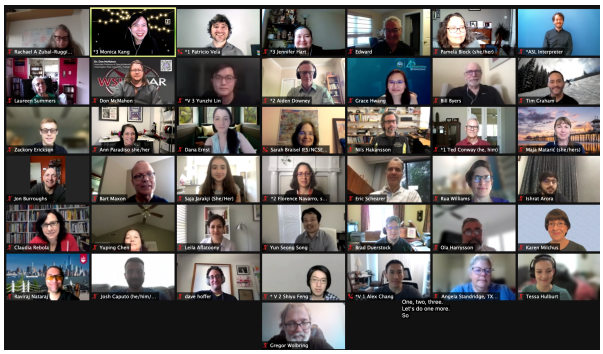
42	Instructional	How to Use Slack	13:11
43	Instructional	How to Use Miro	7:33
44	Tim Graham	"How Engineers Can Design For Accessibility" Interview with Tim Graham (pending final approval)	22:49

Group Photos

Day 2 - May 18, 2021 - 71 participants

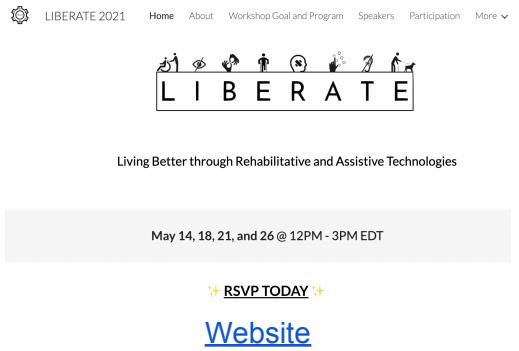


Day 3 - May 21, 2021 - 68 participants



Day 4 - May 26, 2021 - 64 participants

Links to core documents



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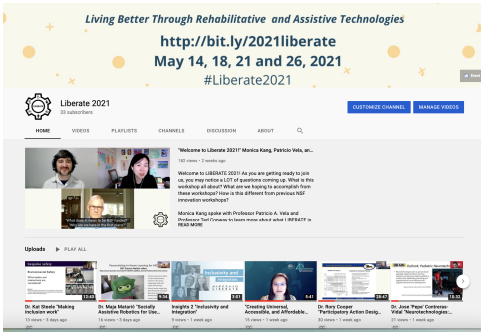
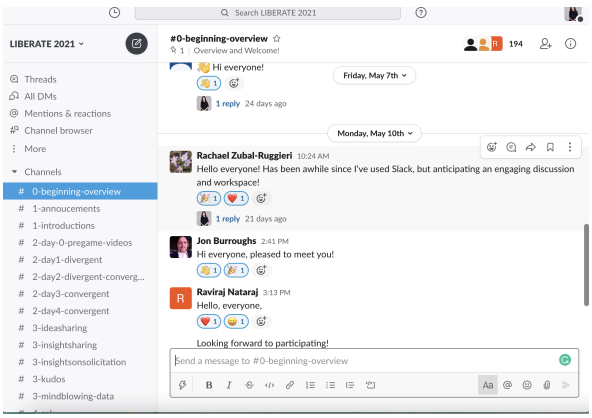
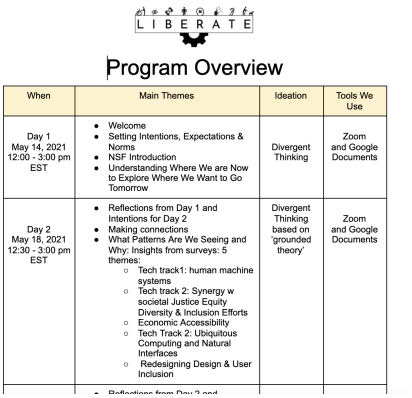


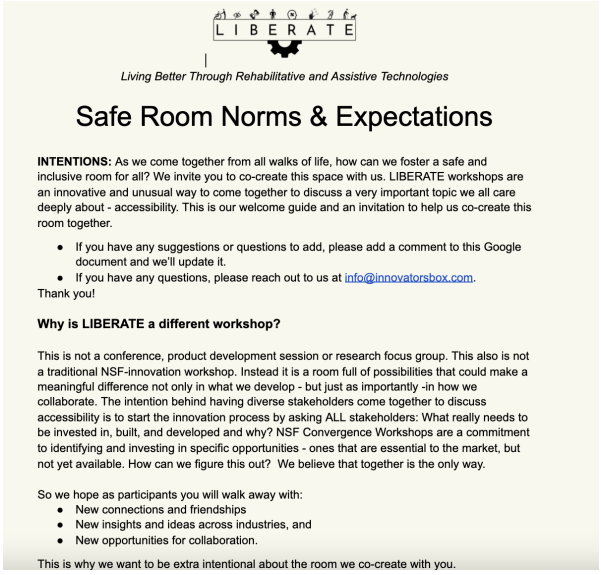
[Youtube Site]



[Slack site]

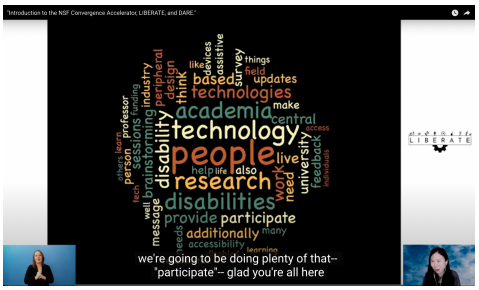


[Program Overview]



[Participant Norm Guide]

As part of being intentional in designing for accessibility, we surveyed participants for their specific accessibility needs and offered live captioning and ASL interpretation at each live event. **Here** is an example from our first day.



Survey Insights from LIBERATE 2021

Last updated May 17, 2021

Dear participants,

The first pass at the survey results established several important themes that will be explored during the second workshop meeting (Tuesday, May 18, 2021). These themes are given their own section in the document below. In addition to the themes are de-identified paraphrases from the survey results, with some reframed as questions. Quoted text indicates the original text. Bold and underline was added for emphasis.

If you have any questions please reach out to us. We appreciate you being part of this journey with us. Thank you Dr. Aiden Downey and Dr. Patricio Vela for sharing these. You are welcome to leave comments and questions in the document as well as Slack.

Email: Dr. Patricio Vela (pvela@gatech.edu) and Monica Kang (info@innovatorsbox.com)

Table of Contents

1. Overarching Focus/Concern: "User Inclusion"

By far the most common theme among respondents is a firm commitment to including/listening to/involving "users" in the entire process"

- How do we get "more disabled people **involved in all levels** of planning, community building, and research?"
- What does "**nothing about us without us**" mean for research design, clinical trials, funding priorities, leadership, ect?
- How do we "**include** the individuals from a particular demographic for subject matter **expertise during EVERY step of the process**? "
- **"How we design technologies is as important as what we design**. The **inclusion** of people with disabilities in technology development and application in the **research/development process in itself is a recognition of their expertise and essential role**. In addition, the collaborative relationship between researchers and people with disabilities provides a perspective and insight that academic or industry cannot find on their own."

Despite a firm commitment to including disabled people in all aspects of AT design and development, respondents spoke to the difficulty of actually realizing this in practice due to a lack of knowledge/support and misaligned incentives. *So as much as there is a call to include users there is also a desire to learn how to do this.* Fortunately, there are people at this workshop who are doing this (in pockets) and *can share their expertise on how to do this and scale it out and up*.

2. Synergy with Societal Equity, Justice and Inclusion Efforts

Respondents referenced this historic moment and the critical importance of an effort to be committed to incorporating and advancing racial/social/economic/LGBTQ+ justice and equity for all people. *Stressed in the responses was the importance of this being a dual movement in the sense of PWD being included in diversity, equity and inclusion (DEI) efforts and DEI efforts informing the design/implementation of assistive technologies.*

- How do we **leverage the "increased awareness of racial, ethnic, LGBTQ+ rights"** to foster the "sense of urgency that serving people with disabilities is the absolute right thing to do?"
- "How do we **center racially minoritized voices**? How do we highlight intersectionality? **How are contributions of participants to be credited and valued**? **Who is being paid for their expertise**?"

3. Economic Accessibility

While also an equity and social justice issue, respondents spoke of the frustration of designing AT that most people either cannot afford or insurance companies will not reimburse for.

- How do we "**build on mainstream technologies** (e.g., mobile apps, wearables, voice assistants) that, when designed to be accessible, have assistive applications, the support and **pricing advantages of a large user's market**, and don't present a stigma when used?"

- "How can we make technologies that help a person with disabilities more **economically accessible** to more people?" How do we "**bridge the AT divide that expensive technologies create?"**

- How do we address "the **outsized role insurance companies play" in PWD's access to AT?**

  >> Bench to product to satisfied user

4. Re-designing Design

As I poured over the responses again it struck me that the concept and question of design was everywhere. As respondents spoke of including users, they referenced a whole panoply of design approaches- *inclusive, universal, participatory, human-centered, user-centered, collaborative*- that made me wonder if and how it might be worthwhile to find common ground on design principles? Alongside the question of how to do this, is how **to teach and learn** these design approaches?

- "I work on inclusive research with a group of adults with intellectual disabilities. One of our challenges is **to genuinely involve this group** with the research objectives, passing insights and deciding together which next steps to take, according to their felt priorities." How do we do this?

- **How do we "involve PWD in the earliest stages/entire process of design**?"

- How do we "**teach people** - designers, developers, project managers, product owners, content creators, educators, purchasing agents, funders, HR departments,

and management at every level- the philosophy and specific techniques of disability inclusion **and inclusive design so that technology does not continue to disable millions of people by bad design**?"

- How do we "create **interdisciplinary teams** that can **design in-situ researching techniques** and other ways of analyzing end-user data while keeping the real-world struggles in mind to allow the development of devices with **accelerated lab-to-market timelines** and the development of **entirely new, crossover research areas**?"

- How do we "**leverage the relationship between big data and individual data to create customized solutions and more universalized design**?"

Finally, there was a concern for designing ways to keep the focus on human problems instead of technical solutions:

- How do we "**focus on human problems** and foster genuine concern for understanding what people need/want, their aspirations and goals, feeling the pull rather than making a push, so that our efforts are more immediately helpful to more people?

- How do we "get **technology to follow the person**?"

5. Designing our way out of Fragmentation/Silos

Respondents talked about the "pipeline" for the development of AT and how this separates designers from users and engineers from clinicians. It also creates silos that struggle to understand other perspectives and share knowledge. I get a sense that there is an unspoken assembly line of sorts for AT keeps people isolated from each other in the production and users at the "end." Seen at scale, this results in a veritable Tower of Babel where stakeholders speak different languages, following different incentives, and unwittingly "holding" stakes that do not help and sometimes hinder innovations that change the lives of real people.

- How do we "fund the creation and maintenance of a well organized, indexed, searchable **community** knowledge base for assistive technologies that patients,

families, caregivers, clinicians, and nonprofits can use and contribute to as a resource?"

- **How do we get rid of/out of the "silos"** that are hampering our efforts to collaborate with other fields, disciplines and end-users? What incentives/systems/structures support the silos and how can we shift them to increase collaboration?

- How do we "**open traditional formation pipelines to other ways of creating and disseminating knowledge** to include the epistemic richness of the disability community?"

6. Economic Incentive Systems

Many respondents identified the role that economic incentives (often funding) play in fostering and impeding high impact solutions for persons with disabilities.

- **"How do we fund solutions** that could have high social impact for real people in need but not necessarily generate huge investment returns?"

- **How do we get companies to "produce cheaper, user friendly, and simplified (low tech) technologies that have high social impact** but limited economic return?"

- "Many innovators must "follow the money," so **if we want to see a paradigm shift in how disability issues get addressed we need to figure out a way to shift the way innovation is funded**." How do we do this?

- **"Where are the funding mechanisms that encourage cross-disciplinary collaboration**, that encourage application of one technology across multiple application areas or markets, that encourage decentralization of innovation resources, that focus on elevating entire fields rather than runaway success stories?"

- What factors – policy, economic, regulatory, equity, ect- would have to be in place to "**ensure that all technology be "born accessible**?"

- "How do we align research and development incentives and metrics with **user value**?" [Framework? A whole new culture. How to accelerate?]

- "I want to **include** people with disabilities into the research process in a more meaningful way. **This is a challenge for funding agencies, experts, industry, and other researchers** (myself included) because that means **we are forced to question the very norms and measurement systems that define ""disability"" in our society**."

- How do we "**fund low tech inspired by real user needs that keeps costs down, has more universal availability" and has high impact?**

- How can we "support and **fund the design and implementation of affordable, low-tech, high impact AT?"**

- How do we "**seed grant funding** (perhaps like Kickstarter or a VC fund) available to **disabled entrepreneurs** to develop assistive technologies that solve problems for disabled folks?"

I would also add that one respondent put their finger on the fact that we are caught in these very same incentive alignment

- "What are the criteria by which the workshop and its outcomes will be assessed or judged by the NSF in order to "win the gold" (which we all would love to have happen for our larger community)? **How perhaps do these criteria overlap with the "measures" of success for the folks who will benefit from these ideas and developments, and if they do not, how can we creatively interpret and reinterpret the criteria so there is greater convergence?"**

That is our million-dollar question :)

We are living in the confines of an old culture, while trying to create a new one. What does a culture of innovation by and with people with disabilities look like? What must that culture of innovation include/consider?

7. Policy/Advocacy

Respondents mentioned a multi-facets approach to AT development and the importance of understanding and advocating on other landscapes to ensure the technology can get access to people.

- "Until we get "**technology researchers interested and invested in championing policy changes**, much of AT research is, in practice, never going to meet a disabled person's body." How do we do this?

- "There are few "technology complete" problems but lots of "**technology + policy"** kinds of problems. **How do we synchronize technology development/commercialization and the legal/regulatory environment** could allow advances that aren't possible with either alone?"

- How do we advocate for disability awareness, the "**ubiquity and importance of AT in everyone's life" and the "societal/economic benefits of universal access?"**

Team has to go all the way to the end. Bench to product to user.
Can we design a culture? Or cultivate it?

Conclusion

These findings should serve as a starting point for real discussion and innovation. For every single issue/problem raised in the surveys there is at least one participant- often more- who is working directly on that issue and has often created solutions. Amongst the participants, there are those who are including the target users, who are working on universal design, who are using technologies like assistive manufacturing and machine learning to make AT more affordable, who are advocating on the policy arena and engaging insurance companies to rethink their reimbursement schemas. There are people here who are working on including marginalized communities. The way forward will be found in and between the people that are at the workshop!

First Name	Last Name	Affiliation	Acad.	Gvmt	Ind.	Caregiver	PwD	Fund.	Org.	Other	Participation
David	Miller	Program Officer / NSF	Y				Y	Y			Peripheral
Zackory	Erickson	Georgia Institute of Technology	Y								Peripheral
Antonia	Escudero	Escuela de Arquitectura y DiseÃ±o PUCV (Chile)	Y								Peripheral
Noe	Vargas Hernandez	University of Texas Rio Grande Valley	Y								Central
Fatima	Nabavian	Coordinator of Accessibility and Related Programs							Y		Peripheral
Jennifer	Singh	Associate Professor at Georgia Tech								Y	Central
Bob	Amelio	Accessibility Support Coordinator					Y		Y		Peripheral
Tawnay	Henderson	VR Specialist II OKDRS		Y					Y		Other
Alexander	Leonessa	Virginia Tech	Y								Other
Matthew	Wangeman	Universisty Instructor of Disability Studies at Northern Arizona University	Y				Y				Other
Ann	Paradiso	Principal Research Designer, Enable Group, Microsoft Research			Y	Y	Y				Central
rolando	garza	BIND					Y				Peripheral
Ishrat	Arora	Graduate Student - Georgia Tech	Y		Y		Y	Y			Central
Josh	Caputo	Humotech	Y		Y						Central
Jose	Contreras-Vidal	Cullen Distinguished Professor and Director, NSF IUCRC BRAIN Center at the University of Houston	Y								Central
Susann	Keohane	IBM			Y						Peripheral
Yisvi	Aroche	Mechanical Engineer at Dell Technologies			Y				Y		Peripheral
Herbert	Spencer	Full time professor, e[ad] PUCV, Chile	Y								Peripheral
Saja	Jarakji	Recent Graduate from the Georgia Institute of Technology	Y	Y	Y	Y	Y	Y	Y		Central
Andres	Aparicio	Associate Researcher at Millenium Institute for Caregiving Research (MICARE)	Y						Y		Peripheral
carol	moeller	Associate Professor of Philosophy, Faculty Scholar in Diversity, Equity, and Inclusion, Moravian College	Y				Y		Y		Central
Jana	Remy	Director, Educational Technology at Chapman University	Y				Y				Central
Maya	Chupkov	Director of Strategic Communications & Outreach/Public Advocates Office		Y			Y				Peripheral
Rory	Cooper	Executive Director of Human Engineering Research Laboratories	Y				Y		Y		Peripheral
Ola	Harrysson	Professor, Director of Center for Additive Manufacturing and Logistics, North Carolina State University	Y								Central
Lewis	Wheaton	Associate Professor, Georgia Tech	Y	Y					Y		Peripheral
Leila	Aflatoony	Georgia Tech	Y								Central
Daniel	Engber	Senior Editor, The Atlantic								Y	Other
Jon	Burroughs	Founder/CEO Benevolent Robotics			Y						Central
Siddhartha	Chaturvedi	Microsoft							Y		Peripheral
Nils	Hakansson	Associate Professor, Biomedical Engineering, Wichita State University	Y				Y				Central
Terry	Jackson	Senior Education Program Specialist/US DOE/OSEP		Y				Y			Peripheral
Bernice	You	Microsoft					Y				Peripheral
Tara	Courchaine	Education Program Specialist/Office of SpEd Programs		Y							Central
Bart	Maxon	DOW			Y		Y		Y		Central
Tapomayukh	Bhattacharjee	Assistant Professor, Cornell University	Y								Peripheral
Jacqueline	Lopez	Blind/Deaf AT (CPRT) ILS							Y		Peripheral
M	Wu	Graduate Student / Emory University and Georgia Institute of Technology	Y								Peripheral
David	Jones	Director, AoD/ACL		Y							Peripheral
Vinod	Namboodiri	Professor, Wichita State University	Y				Y				Central
Ray	Browning	Biomotum, Inc.	Y		Y						Peripheral
Jesse	Byers	Physical therapist-American Physical Therapy Association (APTA)			Y						Peripheral

Karen	Milchus	Senior Research Engineer, Center for Inclusive Design and Innovation (CIDI), Georgia Institute of Technology	Y									Central
Carolyn	Phillips	Co-Director Center for Inclusive Design & Innovation (CIDI) Georgia Tech	Y			Y	Y					Peripheral
Dana	Ernst	Ph.D. Student in Anthropology and Pre-Doctoral Fellow, UC Berkeley Disability Lab	Y		Y	Y	Y					Other
Ruturaj	Patil	Georgia Institute of Technology	Y									Peripheral
Frances	Harris	Research Scientist, Georgia Institute of Technology	Y									Central
Zerrin	Ondin	Research Scientist / Georgia Tech	Y									Peripheral
Rua	Williams	Assistant Professor Purdue University	Y			Y	Y					Central
Nathan	Moon	Senior Research Scientist/Director of Research, Center for Advanced Communications Policy, Georgia Institute of Technology	Y									Central
Angela	Standridge	Texas Technology Access Program (Texas' state AT program)		Y					Y			Central
Stephen	Kuusisto	Syracuse University					Y					Peripheral
Rachael	Zubal-Ruggieri	Administrative Asst/Burton Blatt Institute	Y			Y	Y					Central
Gregor	Wolbring	Associate Professor University of Calgary	Y				Y					Central
Ahad	Behboodi	National Institutes of Health (NIH)	Y		Y							Central
Tom	Corfman	NIDILRR	Y	Y				Y				Peripheral
Maria	Kett	Associate Professor, UCL	Y									Peripheral
Herbert	Muyinda	Lecturer Makerere University	Y	Y			Y	Y	Y			Central
Brad	Duerstock	Associate Professor of Practice, Purdue University	Y				Y					Central
Megan	Moodie	Associate Professor of Anthropology, University of California, Santa Cruz	Y				Y					Peripheral
Kim	Fernandes	PhD Candidate, University of Pennsylvania	Y			Y	Y					Central
Timothy	Loh	PhD student, MIT	Y									Central
Pamela	Block	Western University	Y									Peripheral
Qingyu	Geng	Ph.D. Student/ NC. State University	Y									Central
DEVVA	KASNITZ	SOCIETY for Disability Studies, CUNY	Y				Y		Y			Other
Bill	Byers	Retired Chemical Engineer					Y					Central
James	Sulzer	University of Texas at Austin	Y			Y						Central
Joon-Hyuk	Park	University of Central Florida	Y									Central
Paul Amadeus	Lane	Abilities Expo Ambassador			Y		Y					Central
Mary	Babbili	President, LaSaRa Hi-Tech Consulting Inc./Accessibility SME	Y	Y			Y		Y			Other
Sarah	Brasiel	Education Research Analyst, Institute of Education Sciences, National Center for Special Education Research						Y				Central
Grace	Hwang	NSF						Y				Central
Ahmed	Ramadan	University of Maryland, Baltimore	Y									Peripheral
Gregory	Sawicki	Associate Professor--MechEng +BioSci--Georgia Tech	Y									Central
Grace	Kim	Assistant Professor, NYU	Y									Peripheral
Tessa	Hulburt	PhD Candidate, Wake Forest School of Medicine	Y				Y					Peripheral
David	Reinkensmeyer	Professor, Mechanical and Aerospace Engineering, Anatomy and Neurobiology, University of California at Irvine	Y		Y	Y						Central
Rich	Simpson	Duquesne University	Y									Peripheral
Erica	Hedrick	Doctoral Research Assistant	Y									Peripheral
Xianlian	Zhou	New Jersey Institute of Technology	Y									Peripheral
Vinutha	Sampaath	Research fellow , Defence Bioengineering and Electromedical laboratory(DEBEL), DRDO , Ministry of Defence , Govt of India									Y	Central

Margrit R.	Meier	Consultant / SAHB (a Swiss company providing consultation service for assistive technologies)		Y					Y		Peripheral
Dave	Hoffer	Managing Director, Design at PwC								Y	Central
Troy	Nagle	Professor, NC State University	Y								Peripheral
Carl	Haacke	CEO, Skylight Lab			Y	Y					Central
Li	Li	Research Professor, Georgia Southern University	Y								Peripheral
Debbie	Espy	Associate Professor, DPT Program, Cleveland State University	Y			Y					Peripheral
Melissa	Malzkuhn	Founder & Creative Director of Motion Light Lab at Gallaudet University	Y		Y		Y		Y		Other
Patricio	Vela	Associate Professor/Georgia Tech	Y								Central
Nick	LaRoche	Klaviyo					Y		Y		Peripheral
Maja	MatariÄ‡	University of Southern California	Y								Central
Sharron	Rush	CoFounder, Executive Director, Knowbility							Y		Other
Laureen	Summers	Project Director, Entry Point! American Association for the Advancement of Science					Y		Y		Central
Luis (Louie)	Favela	Assistant Professor of Philosophy and Cognitive Sciences, University of Central Florida	Y								Central
Becky	Curran Kekula	Director, Disability Equality Index, Disability:IN					Y				Peripheral
Xiumin	Diao	Purdue University	Y								Peripheral
Prabaha	Sikder	Cleveland State University	Y								Central
Yuping	Chen	Associate Professor, Department of Physical Therapy, Georgia State University	Y								Central
Hala	Osman	Cleveland state University					Y		Y		Peripheral
Larry	Goldberg	Head of Accessibility, Verizon Media			Y		Y	Y	Y		Peripheral
Mohamed	Abdelhady	Student, Cleveland State University	Y								Central
Eric	Schearer	Associate Professor Cleveland State University	Y								Central
Betty	Troy	Accessibility Auditor/Applause			Y						Peripheral
David	Quintero	Assistant Professor / San Francisco State University	Y	Y					Y		Central
Alok	Doshi	University of Texas at Austin					Y				Peripheral
Betty	Siegel	Director, Access and VSA, The John F. Kennedy Center for the Performing Arts			Y				Y		Peripheral
Luis (Louie)	Favela	Assistant Professor of Philosophy and Cognitive Sciences, University of Central Florida	Y								Central
Claudia	Rebola	Associate Dean for Research, University of Cincinnati	Y								Central
Molly	Millians	Clinical Education Specialist/Senior Associate of Research Faculty, Emory University School of Medicine	Y								Peripheral
Beth	Ziebarth	Director, Access Smithsonian, Smithsonian Institution		Y			Y				Central
Li	Liu	California State University Northridge	Y								Peripheral
Wendy	Rogers	Khan Professor of Applied Health Sciences University of Illinois Urbana-Champaign	Y								Central
Joshua	Josa	USAID Disability Inclusive Education specialist		Y		Y	Y	Y	Y		Peripheral
Raymond	Huml	Vice President of Medical & Scientific Strategy			Y	Y		Y	Y		Peripheral
Giacinto	Barresi	Postdoc - Rehab Technologies, Istituto Italiano di Tecnologia	Y								Central
Matteo	Laffranchi	Istituto Italiano di Tecnologia		Y	Y				Y		Peripheral
Hamed	Mohammadbagherpoor	Nc state university	Y								Peripheral
Edward	Grant	Professor ECE & BME, North Carolina State University	Y								Central
Diane	Damiano	Senior Scientist, National Institutes of Health	Y	Y					Y		Central

Dario	Martelli	Assistant Professor at the University of Alabama				Y	Y				Peripheral
Emily	Porter	Assistant Professor, University of Texas at Austin	Y								Central
Sunil	Agrawal	Professor, Columbia Univ.	Y								Central
In Hong	Yang	University of North Carolina, Charlotte	Y								Central
Diane	Collins	Associate Professor, Dept. of Occupational Therapy, Univ. of Texas Medical Branch	Y			Y	Y				Central
Jason S.	DiSanto	Senior Engineer, GE Gas Power					Y				Peripheral
Stephen	Sprigle	Professor, Georgia Tech	Y								Central
Kat	Steele	University of Washington	Y								Central
Roger O.	Smith	Professor, Occupational Sciences and Technology; Director, R2D2 (Rehabilitation Research Design & Disability) Center	Y								Peripheral
Yun Seong	Song	Assistant Professor / Missouri University of Science and Technology	Y								Central
Bart	Maxon	Co-Leader Dow Disability Employees Network/Dow			Y		Y				Peripheral
Don	McMahon	Washington State University	Y								Central
Mahanth	Gowda	Penn State University	Y								Peripheral
Ramana	Vinjamuri	Assistant Professor in University of Maryland Baltimore County	Y	Y	Y	Y	Y	Y	Y		Central
Maria	Kyrarini	Postdoctoral researcher/UTA	Y								Central
Christian	Cousin	Assistant Professor, University of Alabama	Y								Central
Luke	Mooney	Dephy, Inc.			Y						Central
James	Weiland	Professor, University of Michigan	Y								Central
Pei-Chun	Kao	University of Massachusetts Lowell	Y								Peripheral
Zach	Lerner	Assistant Professor/Northern Arizona University; CTO/Biomotum Inc	Y		Y						Peripheral
Raviraj	Nataraj	Assistant Professor, Stevens Institute of Technology	Y								Peripheral
Emel	Demircan	California State University Long Beach	Y								Peripheral
Wenlong	Zhang	Arizona State University	Y								Central
James	Yang	Professor, Texas Tech University	Y								Central
Hongyu	An	Michigan Technological University	Y								Peripheral
Tse Nga	Ng	University of California San Diego	Y								Peripheral
Sameer	Sonkusale	Tufts University	Y								Peripheral
Mohamed Sar	Hefzy	Professor at the University of Toledo	Y								Central
Chun-An	Chou	Northeastern University	Y								Central
Ted	Conway	Professor, Florida Institute of Technology	Y	Y			Y				Central
Karthik	Balasubramanian	Professor, Howard University	Y				Y				Peripheral
Will	Durfee	Professor, University of Minnesota	Y								Peripheral
Hetal	Parikh	President & Co-Founder, Rangam Consultants Inc.			Y				Y		Central
152			105	19	26	16	46	12	31	4	
			Acad.	**Gvmt**	**Ind.**	**Caregiver**	**PwD**	**Fund.**	**Org.**	**Other**	
			69%	13%	17%	11%	30%	8%	20%	3%	
											Participation
									75	49%	**Central**
									68	45%	**Peripheral**
									9	6%	**Other**