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A. Importance of the Problem

Staff from the Institute for Human Development (IHD) at Northern Arizona University (NAU) are responding to the National Institute on Disability, Independent Living, and Rehabilitation Research Disability and Rehabilitation Research Projects (DRRP): Assistive Technology to Promote Independence and Community Living funding opportunity HHS-2020-ACL-NIDILRR-DPGE-0415. The proposal is a partnership with the University of Montana Rural Institute and Wisconsin Department of Health WisTech Project. The three partners all house their respective Assistive Technology Act Programs.

The existing problem is that individuals with disabilities (whether long-standing, acquired/age related) who are aging and live in rural, frontier, and tribal communities do not have knowledge of nor available access to assistive technology (AT). In addition, they have less access to AT when compared to their counterparts in more urban and suburban areas where services are more plentiful and in closer proximity to where people live. This reduced access leaves the individuals more vulnerable to reduced independence and quality of life as well as community living and engagement. AT use has been demonstrated to support individuals with disabilities to age in place and maintain independence beyond that experienced by individuals with disabilities who do not use AT (Hoppestad, 2013).

The proposed research is being submitted to the Intervention Development stage of the NIDILRR Disability and Rehabilitation Research Projects (DRRP) Program: Health and Function (Research). As an intervention development project, the goal of AT@Home is to develop and demonstrate an effective, useful, and appealing assistive technology (AT) application (“App”) to be used by individuals who are aging and have disabilities (inclusive of those with long-standing and acquired/age related disabilities) to identify AT solutions for

promoting independence. This includes all lived environments including ones' home and the community.

The project objectives focus on generating the AT@Home App intervention from conceptualization through prototype development. Results will be an Application (App) that can effectively be used by individuals with disabilities who are aging and walk them through the process of determining their assistive technology (AT) needs and thus solutions.

The App, when provided with information about the end user's challenges, needs and preferences, will use a decision-making process to identify AT options, strategies, and resources that support increased functional capabilities and independence. The user will be provided with recommendations for AT that will improve independence, quality of life, and community living including making the home safer and thus improving the chances of aging in place.

AT professionals across different disciplines are trained to approach AT decision-making by using a consideration process or framework that gathers information about and examines the interaction of three key factors (1) the person's abilities and limitations, (2) the tasks they need/want to accomplish and (3) the environments/contexts in which these tasks occur. Although several theoretical models such as the Student, Environment, Tasks and Tools (SETT) Framework and the Human, Activity, Assistive Technology (HAAT) Model among others, use variations of similar nomenclature to identify these factors: **Person**/Human/Student; **Tasks**/Activities/Occupations; **Environments**/Physical, Social, Cultural Contexts, they all recognize that AT decisions and interventions are most effective at meeting the individual's constellation of needs when a holistic data gathering model is used. These constructs will be used to guide and support the research and development of the AT@Home App.

The App will be developed and tested through a multisite research and development process

using a design-based research approach. The outcomes, of this three year project, will be a fully functional App with evidence to support its effectiveness/feasibility. The results (including data associated with development and the beta-test) from the proposed research will be used to inform the design of a study to test the efficacy of the AT@Home App intervention.

A. 1. Applicant clearly describes the need and target population.

The target population, of this research, is individuals who are aging (50 and older) and have disabilities (inclusive of those with long-standing and acquired/age related disabilities), living in rural, frontier, and tribal communities. As individuals age, the likelihood of acquiring a functional limitation or disability increases, and for persons aging with existing disabilities, there may be new challenges and functional impacts. Thus, by developing the App, with participation from individuals with disabilities who are age 50 and older, we are assuring that the App will be useable for individuals early on in the aging process and the recommended AT can also be used early on in the aging process and thus more likely to support aging in place.

As people age, they encounter access barriers and challenges to aging in place and often these are confounded by existing and acquired disabilities. In general, as people age, there are declines in hearing, visual acuity, mobility, balance, physical strength, coordination, and memory. People in rural, frontier, and tribal areas of the country face these barriers along with a decline in sense of belonging, sense of community, access to health care and social services. Addressing these barriers and challenges early on is more likely to result in acceptance and ongoing use of AT.

Adults with disabilities face disparities concerning education, employment (U.S. Census Bureau, 2014), and health. Health disparities are “...a significant disparity in the overall rate of disease incidence, prevalence, morbidity, mortality, and survival rates for adults with disabilities

as compared to the health status of the general population” (National Institute on Minority Health and Health Disparities [NIMHHD]). As an exemplar, one national survey found that adults with disabilities were more likely to be obese (2.0x, as compared to adults without disabilities) and more likely to lack emotional support (1.7x, as compared to adults without disabilities) (Havercamp & Scott, 2015).

Likewise, disparities associated with health exist for all individuals living in rural, frontier, and tribal communities but are even more pronounced for individuals with disabilities. Rural communities have higher rates of developmental and behavioral disorders in children (Kelleher & Gardner, 2017), and higher rates of incidence for the top five leading causes of death (heart disease, cancer, unintentional injury (including vehicle accidents & opioid overdoses), chronic lower respiratory disease, and stroke (Garcia et al., 2017). Fewer local doctors, poverty, and remote locations contribute to rural health disparities throughout the U.S. (Warshaw, 2017).

For individuals with disabilities these disparities are often more acute due in part to capabilities associated with their disability. For example, if a person has limited or no speech it is difficult for them to communicate pain or communicate about their emotional status. Likewise, as individuals with disabilities age they face additional barriers to health care and aging in place. For example, their caregivers (often parents) are also aging and may lose their ability to care for their adult child with a disability (e.g., the caregiver can no longer transfer their child from a bed to a chair) or may pass away. In addition, as individuals age we nearly always acquire disabilities (e.g., impaired vision & balance issues). This confounds the barriers for individuals with long-term disabilities while creating new barriers for individuals with acquired disabilities to remain in their homes and engage in community life.

Aligned with aging in place, researchers have investigated the use of possible solutions in rural communities. For example, research on rural women's perceptions of gerontechnologies (i.e., AT typically used by people who are aging) such as in-home monitoring and communication, concluded that older women in rural areas are open to the potential use of gerontechnologies/AT to extend their ability to age in place but are skeptical about their actual implementation (Bowman et al., 2013). In particular, access and reliability, cost, privacy, usability, a "use it or lose it" mentality and caregiver burden were identified as themes most relevant to the participants in the study (Bowman et al., 2013).

Similarly, survey-based research that compared services related to hearing impairments in rural and metropolitan areas of the United States, identified a lack of knowledge about possible interventions as a barrier to service provision for individuals living in rural areas. More practical issues of physical access to highly trained specialists and places to maintain and repair AT to aid in hearing were also identified (Sibon-Macarro et al., 2014).

There are many reasons why older adults with disabilities do not use AT. Factors include denial about loss of function and independence, the lack of awareness about and access to useful information and inability to take into consideration the constellation of decision-making factors that affect whether the AT will be useful and available to the person who needs it. In general, persons living in rural areas use AT less than their peers in urban and suburban areas for these very reasons while including the fact that they have less access to AT devices and services. This begins in the Pre-K through 12 educational system and continues into adulthood. This is exemplified in a study by Ault et al. (2013) in which rural zones/areas of the U.S. were found to have considerably less AT devices than in suburban and urban locations. In the same study it was found that when AT was available in schools in rural communities the AT was used primarily to

address functional limitations and not for accessing academics or to socialize. In addition, AT in the rural schools was typically not used to access the internet nor social media. Likewise, there was a greater desire for more training on available AT in rural locations than in urban/suburban (Ault et al., 2013). The Ault study is supported by a study conducted in Texas that concluded that school districts in rural areas reported having fewer AT devices available to them in comparison to suburban and urban school districts (Davis et al., 2013).

While these studies considered access to AT for all students with disabilities it is clear that individuals with the most significant disabilities, living in rural areas, are even more likely to not have access to AT. When considering the subpopulation of persons with intellectual and/or development disabilities (I/DD), one systematic literature search identified barriers for AT use that included high costs/lack of funding, a lack of awareness about AT in the I/DD community, and inadequate AT assessments for the I/DD community (Boot et al., 2018). Although high-tech AT may help persons with I/DD age in place and live safely and fully, another systematic literature search uncovered a dearth of research regarding the abilities of persons with severe developmental disabilities to access computers from which many high-tech AT devices are utilized (Hoppestad, 2013). Thus, the lack of access to a computer, both physically and the ability (e.g., cognitive ability) to effectively use one without AT, further limits access to AT (e.g., screen reading software) that is beneficial to individuals with the desire and or need to age in place. Due to the lack of research, similar to Hoppestad's, related to individuals with disabilities who are aging, the researchers are making the informed assumption that the same holds true for the targeted population – that is, if students in the Pre-K through 12 educational system do not have access to AT then older people in the same communities will likely not either.

While it is evident there are excessive disparities between access to AT in urban/suburban and rural communities across the U.S. it is also evident that AT can be an equalizer to quality of life, health access, and aging in place within these same communities (Wilson, et al., 2009).

A longitudinal study revealed that assistive technologies had significant results for adults aging with disabilities. The results showed a slower decline in function for participants in the treatment group and after two years, the treatment group was more likely to use equipment to maintain independence vs. personal assistance. This study supports the value of AT for adults aging with a disability and suggests that it be provided earlier in the aging process.

An intervention study, of aging persons with intellectual disabilities, saw significantly higher levels of function and satisfaction related to previously determined goals, when the individuals took part in an intervention of a consumer-directed approach to AT and environmental modification. These increases were reflected in both self-care goals and participation/environmental/systems-level goals (Mirza & Hammel, 2009).

This finding from these studies (Wilson, et al., 2009; Mirza & Hammel, 2009) closely align with the proposed research and development of the AT@Home App as the development will be supported by individuals with disabilities who are aging and living in rural, frontier, and tribal communities across the country. The project partners are located in Arizona, Montana, and Wisconsin. Each of these states has extensive rural and frontier areas as well as multiple tribal communities. In addition to recruiting participants from the partnering states, the staff from IHD will also recruit participants from New Mexico.

Each of the states, from which participants will be recruited, has a high percentage of individuals with disabilities at the age of 65 or older. While the target population for the research is individuals with disabilities who are 50 years of age or older, the U.S. Census Bureau and

many State Departments of Health, when collecting data, break out age ranges to the 65 and older grouping. Thus, individuals below the age of 65 are not accounted for. In addition, the method for calculating the number of individuals with disabilities living in rural, frontier, and tribal communities varies by state and county. For example, in Wisconsin the percentage of individuals with disabilities living in each county is computed by taking the rate of disability for 65+ population in Wisconsin (31.2%) and multiplying by the number of individuals age 65+ in each county. Thus, we lack information specific to individuals with disabilities age 50 and older, and there is inconsistency in how each state calculates the number. Additionally, based upon the knowledge and experience of the researchers, it is fair to assume that many people who are aging and have age-related disabilities do not identify nor report having a disability. Therefore, the available data per state are assumed to be low but are estimated, on the low end, as follows:

Arizona – Approximately 33% of individuals age 65 and over report having a disability (Employment and Disability Institute at the Cornell University ILR School, 2012). In La Paz County, one of Arizona’s many rural counties, it is estimated that upwards of 1,815 people age 65 and over (26%) have a disability (Western Arizona Council of Governments, 2017).

Montana – Approximately 34% of individuals age 65 and over report having a disability (Employment and Disability Institute at the Cornell University ILR School, 2014). In the United States, 35% of individuals age 65 and over have a disability; thus, Montana’s reported disability rate is consistent with the national average (Administration for Community Living, 2018).

However, in one of Montana’s rural counties (Lincoln), an approximated 41% of individuals age 65 and older report having a disability, which exceeds the national average (Lincoln County Health Department, 2017). This percentage equates to roughly 1,835 individuals. Other rural

counties may have similar rates of disability for this age group, but county-specific data are not available for all counties.

Wisconsin – Approximately 31.2% of individuals age 65 and over—or 924,695 people of this age group statewide—report having a disability (Wisconsin Department of Health Services, 2020). Information specific to rural counties in Wisconsin is not available.

New Mexico – Approximately 40.3% of individuals age 65 and over (112,020 individuals) report having a disability (New Mexico Aging and Long-Term Services Department, 2017). This rate of disability exceeds the national average of 35%.

Tribal communities located in rural areas face additional challenges in terms of aging in place for individuals with disabilities. In these communities, it is not desirable for elders to reside in institutions, because such institutions are often located far from the individual’s family and community. When outsiders take care of elders, the elders often feel a sense of shame (DeCourtney et al., 2003). Indeed, it is more culturally appropriate for the family and community to support aging in place (Department of Health and Human Services & Centers for Medicare & Medicaid Services, 2014). An additional challenge for these communities is a lack of long-term care services. Occupational therapy, speech therapy, short-term rehabilitation, respite care, assisted living, and other services are “rarely to never available,” in these rural tribal communities, in spite of a high need for such services (Jervis, Jackson, & Manson, 2002; Goins, Bogart, & Roubideaux, 2010). Available data suggests that rural tribal communities face higher than average rates of disability for aging populations, as detailed in the examples provided below:

Arizona – The Hualapai Reservation reports that 46% of individuals age 65 and over (85 individuals) have a disability, which exceeds the national average by 11%. Similarly, the

Colorado River Reservation reports a disability rate of 49% (792 individuals) for this age group (U.S. Census Bureau, 2017). On the Navajo Nation, which is situated in rural and metropolitan counties, 57% of individuals age 65 and over (11,633 individuals) have a disability while approximately 40% of individuals age 65 and over (443 individuals) report having a disability on the neighboring Hopi Reservation.

Montana – The Blackfoot and Fort Peck Reservations, both of which are located in rural counties, respectively have reported 32% and 40% of individuals, age 65 and over (311 and 404 individuals, respectively), as having a disability (U.S. Census Bureau, 2017).

Wisconsin – Approximately 40% of individuals age 65 and over (59 individuals) report having a disability on the Stockbridge-Munsee Reservation. On the Bad River Reservation, another rurally located reservation, 51% of individuals age 65 and over (101 individuals) report having a disability (U.S. Census Bureau, 2017).

New Mexico – Approximately 53% of individuals age 65 and over (135 individuals) report having a disability on the Jicarilla-Apache Reservation. The Zuni Reservation reports even higher rates of disability for this age group, with 63% of individuals age 65 and over (531 individuals) reporting a disability (U.S. Census Bureau, 2017).

The data indicate a high percentage of individuals living in rural areas and in Tribal Communities as having disabilities. Thus, it is evident that these communities need resources and tools to support their community members to age in place, safely and with dignity.

Assistive technologies address the varied needs of people with disabilities by augmenting, compensating for the loss of, or restoring function to improve performance.” (National Institute on Disability, Independent Living, and Rehabilitation Research [NIDILRR] Solicitation HHS-2020-ACL-NIDILRR-DPGE-0415). Following NIDILRR’s expanded definition of AT, the

proposed research team understands that addressing the AT needs of the target population requires an understanding of the functional abilities of the target population. While there are preliminary data about AT use by individuals with disabilities who are aging and living in rural, frontier, and tribal communities there are still significant areas in which very little is known, for example the types of technology they use on a daily basis and who are their primary support people. Thus, to support the development and testing of the AT@Home App the proposed researchers will obtain additional knowledge about the targeted audience which will help inform the development of the AT@Home App assuring the end product is user friendly in the targeted environments. This will begin with a systematic review of the literature followed by focus groups and observational/ethnographic data collection. The results will be used to inform development of the content of the AT@Home App as well as assess current use of technology and AT by people with disabilities who are aging.

A. 2. Extent proposed activities further the purposes of the Rehabilitation Act.

The Rehabilitation Act of 1973, as amended, states that “disability is a natural part of the human experience and in no way diminishes the right of individuals to live independently, enjoy self-determination, make choices, contribute to society, pursue meaningful careers, and enjoy full inclusion and integration in the economic, political, social, cultural, and educational mainstream of American society” (NIDILRR - 2018-2023 Long-Range Plan, 2020). Within this Act, NIDILRR was established with the purpose of generating new knowledge and promoting the use of new knowledge toward improving the abilities of individuals with disabilities to “perform activities of their choice in the community” (Administration for Community Living, n.d.).

For persons aging with disabilities in rural, frontier, and tribal communities, many of these rights, as well as the “performance of activities of their choice in the community” are impacted

by aspects of their lived environments. The right to live independently in rural locations could be affected by concerns about personal safety and living far from medical facilities or community centers. Research suggests that transportation solutions for aging adults are limited, and that poor infrastructure renders travel from rural areas to urban areas difficult (Averill, 2012). Individuals in rural communities often must travel long distances in order to access healthcare (Arcury, Preisser, Gesler, & Powers, 2005). The right to self-determine, make choices, and to perform activities of one's choice could be affected by a lack of knowledge of options about safe and accessible living environments. For individuals with all types of disabilities, these barriers to aging in place may exacerbate the need to relocate. In other words, aging individuals with disabilities may feel pressured to relocate to urban areas or seek residential care in congregate living facilities in an attempt to minimize the barriers. Our proposal furthers the Rehabilitation Act by facilitating enactment of the aforementioned rights for aging persons in rural, frontier, and tribal communities. The AT@Home App, and subsequently recommended AT resources, will support independent living, self-determined, and informed choices to a greater degree than what exists currently.

Section 504 of the Rehabilitation Act of 1973, as amended, states: "No otherwise qualified handicapped individual shall, solely by reason of his handicap, be excluded from the participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving federal financial assistance" (Rehabilitation Act of 1973, as amended). AT is a viable method to decrease the exclusion and discrimination against persons with disabilities. The continuum of low to high tech AT solutions are reasonable accommodations that provide access for persons with disabilities. Increased AT knowledge and increased AT use provided through

use of the AT@Home App will support the overall inclusion of persons with disabilities as required by the Rehabilitation Act.

Section 508 of the Rehabilitation Act of 1973, as amended, requires Federal Agencies to make accessible electronic and information technology to people with disabilities (Rehabilitation Act of 1973, as amended). AT can also serve a role in satisfying and complying with the digital accessibility standards from the Act and the AT@Home App will do just this. While the AT@Home App will be 508 compliant, the researchers will work to assure to the degree possible, that relevant AT solutions that are “recommended” by the App will also, when used, comply with Section 508 of the Rehab Act. This will be addressed and assessed throughout development and the beta testing of the App.

A. 3. Proposed project will have beneficial impact on the target population.

The proposed project will contribute to our understanding of the precise technology needs of aging persons with disabilities in rural, frontier, and tribal communities, as well as increase the knowledge around, access, and potential use of AT for this population.

This project will use a design-based research approach in which representatives of the target study population will be involved in both an advisory and research capacity. There are many benefits to research and the community when community members are involved as researchers, including building the skills of the community, collaborating with vulnerable populations, empowering a community and improving the external validity (Heffron et al., 2018; Holkup et al., 2004; St. John et al., 2018; Stack & McDonald, 2018; Wallerstein & Duran, 2006).

Through the provision of appropriate AT that addresses the functional limitations of individuals with disabilities as they age, more people will be able to maintain independence. As examples, AT use can impact the ability to participate in telemedicine through the use of AT

such as hearing aids and screen magnification. AT can positively impact mobility and by extension, socialization through the use of low tech walkers and high tech power wheelchair. AT can help a person stay in their home through the use of medication reminders and environmental controls. Thus, the AT@Home App has the potential to be extremely beneficial to the targeted audience and their capacity to age in place.

B. Design of Research Activities

B. 1. Literature review.

The goal of this project is to demonstrate an effective, useful, and appealing assistive technology (AT) application (“App”) to be used by individuals who are aging and have disabilities (inclusive of those with long-standing and acquired disabilities) to identify AT solutions that promote independence including in ones’ home and the community.

While this App will be useful for all individuals with disabilities who are aging, it will be designed with the challenges and barriers faced in rural, frontier and tribal community regions in mind and with an emphasis on assuring access for individuals with cognitive impairments. Through systematic and iterative research and development activities, the resulting App will be person-centered and designed to promote self-determination for successful aging through features for (a) increasing awareness and knowledge of readily available AT solutions matched to the individual’s needs, (b) providing a platform for configurations of individual/caregiver/provider interactions centered on AT solutions, and (c) connecting individuals with AT specialists and resources. [The *Design of Development Activities* section outlines the proposed features and functionalities of the App.]

Achieving the goal requires understanding (a) person-centered challenges in relation to tasks and environmental barriers to AT solutions experienced by individuals who are aging and have

disabilities in rural, frontier, and tribal areas, (b) taxonomy and anatomy of a decision-support tool/process for identifying AT solutions, and (c) functionalities and user interface that technologies can offer as a solution to identifying AT solutions.

Access challenges and barriers for aging individuals with disabilities – including for those residing in rural, frontier and tribal areas: As people age there are many barriers to aging in place and often these are confounded by existing and acquired disabilities. In general, as people age, there are declines in hearing, visual acuity, mobility and balance, strength, coordination and cognitive functions such as memory. People in rural, frontier, and tribal areas of the country face these barriers along with a decline in sense of belonging, sense of community and access to health care. They often have less access to AT resources due to scarcity and distance.

Existing AT assessment. Currently AT specialist use several tools when assessing an individual's AT needs. The researchers and developers will review and modify existing assessment process tools such as the Student, Environment, Tasks and Tools (SETT) Framework, the Human, Activity, Assistive Technology (HAAT) Model and the Person, Environment, Occupation Model that explore and use attributes of the person, task, and environment as a foundation for AT decision-making as they all recognize that AT decisions and interventions are most effective at meeting the individual's constellation of needs when a holistic data gathering approach is used.

Technology-based functionalities and user interface relevant for individuals aging with disabilities. The AT@Home App will be fully accessible to people with a broad range of disabilities. The App will be accessible through computer-based, web based and mobile digital platforms. The App will integrate with the accessibility features built into computers and mobile devices (such as auditory, visual aids, and touch systems) as well as contain App-specific

features to guide the user through the Apps menus and functionalities (such as App developed audio and visual prompts). By fully integrating the accessibility features built into the digital environments, the App can capitalize on these features as specific prompts and features are built for aging adults which includes cognitive prompts for novice technology users and user-specific prompts based on their personalized inventory of needs established when they build their profiles within the App. Additional information at existing tools can be found in section C. 2. – Current and related products.

B. 2. Research hypothesis and research questions are theoretically sound and based on current knowledge.

The guiding hypothesis for this study is “an App, with an embedded AT decision-support tool/process, can be developed and used to effectively identify AT solutions that safely support and promote independence in all ‘lived’ environments—in support of self-determined independence, high quality of life, and community engagement.” By accomplishing this, we are also furthering self-determined independence, quality of life, and community living and engagement of aging individuals with disabilities residing in rural, frontier, and tribal communities. Four research questions, that are informed by a strong theoretical foundation that supports the hypothesis, will be addressed using a design-based research approach.

Theoretical foundation

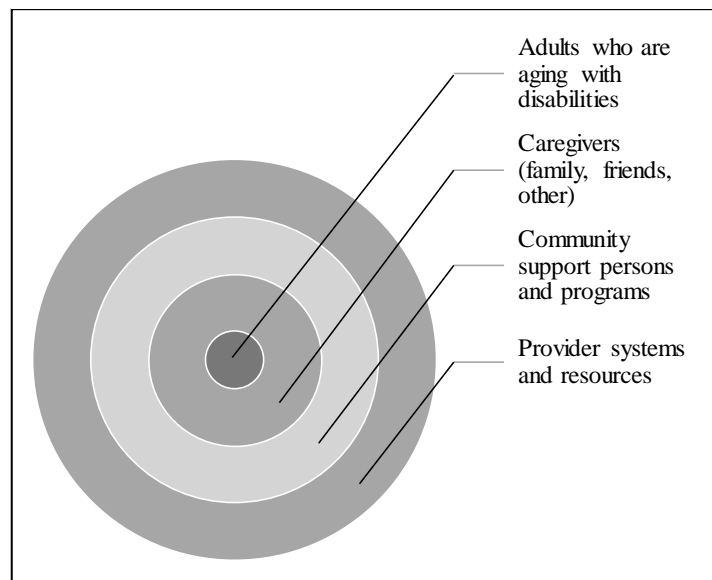
The primary theoretical foundation is self-determination theory (Deci & Ryan, 2012). Self-determination theory (SDT), in particular for aging adults, is based on factors of motivation and well-being within social and environmental contexts. Deci & Ryan (2012) identify three innate psychological needs for growth and personal well-being that influence self-determination: (a) autonomy associated with free will, having choice, and demonstrating responsibility; (b) feeling

empowered and the ability to achieve goals; and (c) feeling understood, cared for, and valued by significant others. Gerontology research has applied SDT extensively with identification and development of supports for active aging in-place (Dattilo et al, 2018)

Along with SDT, the socioecological perspective on the influences affecting the lives of and outcomes for people with disabilities (Walker et al, 2011) provides a foundation for the design of the App as well as the development and research processes. Building on the ecological model of human development (Bronfenbrenner, 1994; Sontag, 1996), the benefit of a social-ecological approach is the joint consideration for the influence of person-specific variables as well as the environment-specific variables and the interactions between levels of influence (Walker et al, 2011; Anderies et al., 2004; Stokols et al., 1996). Taking this approach increases the credibility of the findings as opposed to a “figure-ground” approach whereby the narrow focus obscures contributing effects from other significant factors (Wright & Lopez, 2002).

By using a social-ecological perspective, (see Figure 1) this project places adults who are aging with disabilities at the center of research and App development while recognizing the role of families and friends in supporting individuals to be independent. The subsequent layer represents community programs and persons who provide support and the outer layer represents service systems and resources. Figure 1 shows the nesting quality of influences while the central focus remains

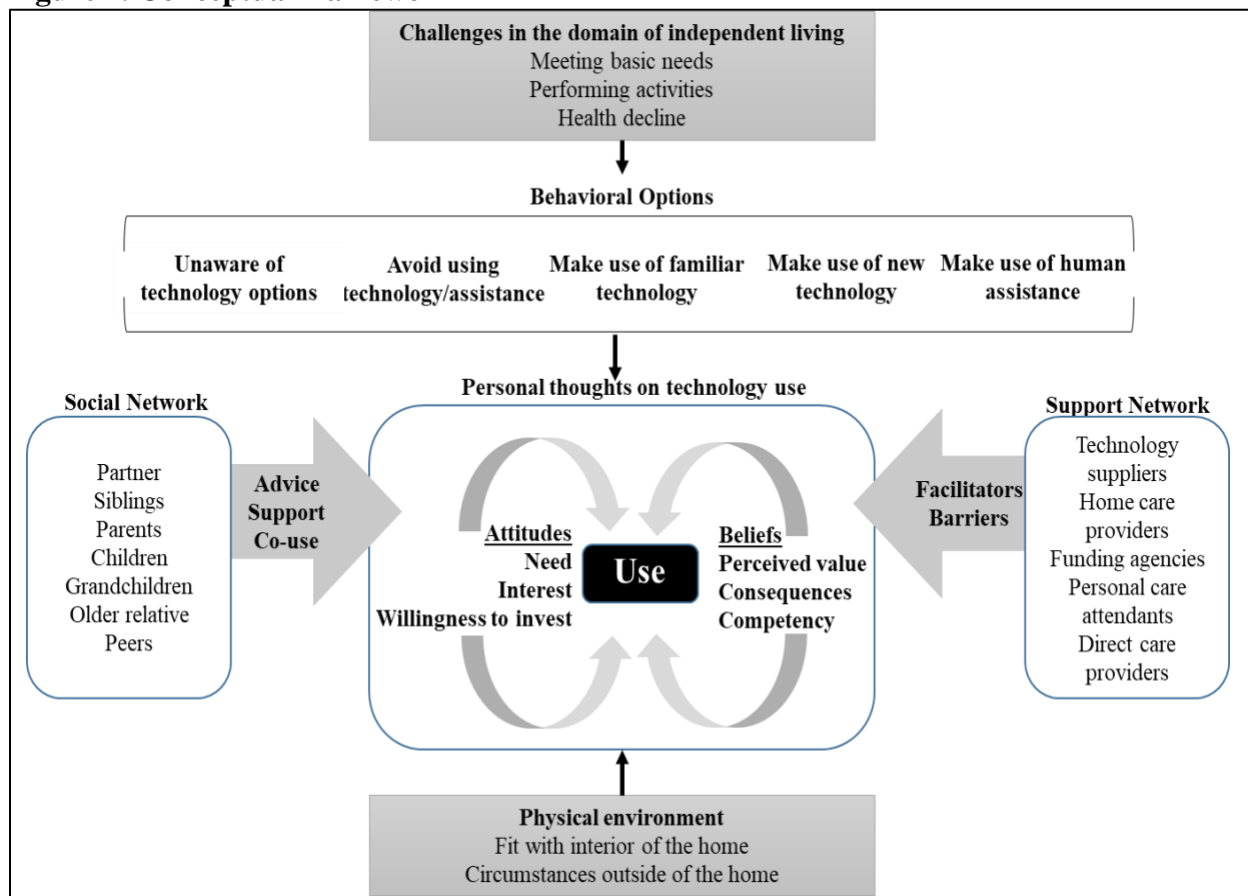
Figure 1. Socioecological perspective



on the individuals with a disability.

Prior research on the adoption of technologies among older adults has resulted in a conceptual framework that aligns with SDT and the socioecological perspective, thus providing a foundation for this project (Peek et al, 2016). This conceptual framework, developed from direct data collection with older adults, illustrates multiple factors for considerations and the relationship between factors. For the proposed project, Peek's framework (see Figure 2) has been adapted to address disability factors such as functional limitations. Figure 2 represents the adapted conceptual framework used to inform this project. As shown in this framework, there are considerations, for example, contextual factors and social and support network factors, for how technology is perceived and received by aging adults with disabilities.

Figure 2. Conceptual framework



Hypothesis and Research Questions

The guiding hypothesis for this study is “an App, with an embedded AT decision-support tool/process, can be developed and used to effectively identify AT solutions that safely support and promote independence in all ‘lived’ environments—in support of self-determined independence, high quality of life, and community engagement.”

By focusing on the following four research questions, aligned to the socioecological model (Figure 1) and guided by the theoretical model (Figure 2), this hypothesis will be addressed using a quasi-experimental method consistent with design based research.

RQ1. What types of technologies do persons with disabilities who are aging use?

- What platforms and operating systems?
- What types of interface and functionalities?
- For what purposes do they use technologies of any kind?

RQ2. What is the essential content necessary for addressing AT solutions promoting independence in the home and how can the content be presented and organized in order to facilitate ease of interpretation and navigation in the App?

RQ3. What are the essential components and attributes (functionalities, content, and user interface) of the AT@Home App that result in accessible, efficient, and intuitive use for people with varied abilities, caregivers, and service providers?

RQ4. To what extent do the results of beta-testing the prototype of the App (with individuals with disabilities who are aging, caregivers, and service providers) (a) show an increased knowledge of AT solutions, (b) increase the reported likelihood of applying AT solutions in the home, and (c) increase initiation of contact with a AT resource

specialist?

B. 3. Methodologies, sample, and analyses.

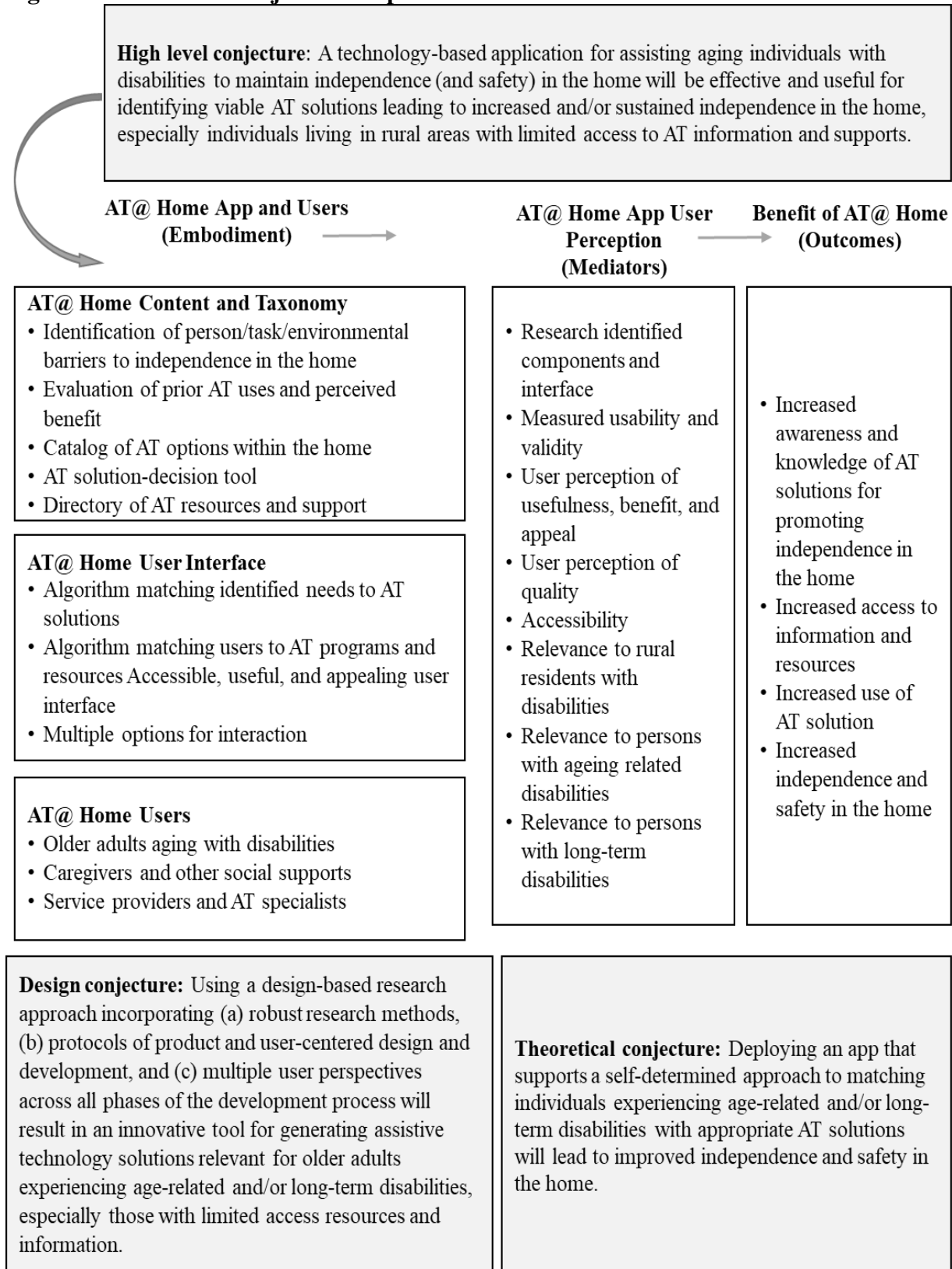
The following pages describe the sample, research methodologies, and analyses proposed for use in addressing the research questions.

Research methods: This project aligns theory and design; thus, a design-based research approach is a good fit. Design-based studies focus on research and learning in the naturalistic context using vetted theory and improvements to develop new theories or practices that can be generalized (Barab & Squire, 2004). In application to AT@Home, a design-based research approach will assure that (a) initial iterations of the App are grounded in theory, (b) research is targeted to identify essential components and interfaces that are informed by broad stakeholder perspective and undergo scrutiny through testing, and (c) further iterations integrate research findings to result in a valid and more refined product. Conjecture mapping, as outlined by Sandoval (2014), provides a structure for the design-based research. Conjecture mapping assumes that each stage of design, beginning with theoretical underpinning and leading to desired outcomes, is a series of conjectures (assumptions and suppositions) as to how design and implementation should work. The logic of a conjecture map starts with high-level conjectures (theories giving rationale for the work), which inform the embodiment (design conjectures accounting for mediating processes), which lead to desired outcomes providing confirmation or leading to revision of original conjectures. Figure 3 illustrates the project launch conjecture map.

RQ1. What types of technologies do persons with disabilities who are aging use?

A survey approach will be used to address this first research question. In the first year of the project, surveys will be distributed nationally in collaboration with State AT Programs, with a specific recruitment plan for assuring rural, frontier, and tribal representation in

Figure 3. AT@Home conjecture map



the survey. Four surveys, designed for specific populations will be distributed to the following participant groups, targeting representation in rural, frontier, and tribal areas:

- individuals with disabilities who are aging (age 50 or older),
- caregivers/social supports for individuals with disabilities who are aging,
- community service/resource support providers, and
- AT specialists working at State AT Act programs and other AT programs (e.g., occupational and physical therapy centers).

The surveys will be developed in the first 2 months of the project to be included in the IRB protocol. Anticipated distribution will be months 4-6 of the project. These results are critical to the design of the App content, functionalities, and user interface. The surveys will specifically address (a) the scope of familiarity, comfort, and confidence in using technologies in daily life and (b) barriers and challenges in the home environment that are suited for addressing with AT solutions (see description below regarding RQ2). The survey questions will focus on how individuals with disabilities who are aging use technologies and their challenges with being safely independent. This means that caregivers, providers, and AT specialists will answer questions based on their direct experience working with older adults with disabilities. Survey questions will also include demographic information, quantitative items (i.e. frequency of use, ranking confidence of use, and rating agreement with benefit) and qualitative items in the forms of describing needs. Analysis of the surveys will primarily entail descriptive statistics and themes to identify consensus and gaps and comparison of means between participants residing in rural/frontier/tribal versus suburban/urban areas. Because participants will note their location of residence, comparison between availability of AT resources in rural/frontier/tribal versus urban/suburban areas will be made. However, in order to assure representation of our targeted

population and thus be positioned to make valid statistical comparisons, a purposeful effort will be made to assure rural, frontier and Tribal participation in the survey. See the description of recruitment for details.

RQ2. What is the essential content necessary for addressing AT solutions promoting independence in the home and how can the content be presented and organized in order to facilitate ease of interpretation and navigation in the App?

This question will be answered by survey items (building on the above mentioned surveys) and through a systematic review of the literature. Included within the surveys described above are the mentioned questions about barriers, challenges, and AT solutions. AT specialists will be asked about AT solutions they have experienced to be most frequently used, be most effective, and their process for matching AT solutions with individual needs. Individuals, caregivers, and providers will be asked about functional limitations experienced or observed, their access and independent needs in the home and if they have used strategies for reducing these barriers. These questions will consist of both quantitative and qualitative items, similar to the description of the survey above. Likewise, the analysis will be similar. In addition to a survey, a systematic review of the literature will begin once the project is awarded. The purpose of this review is to inform development of the content as well as assess current use of AT for people with disabilities who are aging. This review will include published research and evaluation articles focused on the development and use of tools for assessing needs for and deriving AT solutions for promoting independence and safety in the home for individuals with disabilities who are aging. The systematic review method will follow the Preferred Reporting Items for Systematic Reviews and Meta-analysis (PRISMA) protocols for determining breadth and depth of literature appropriate

for identifying suitable articles for review as well as conducting the systematic review (Moher, et al, 2009).

Upon completion of the systematic review and development of the App content taxonomy and decision-tree, a draft will be distributed to the State Assistive Technology Program for their feedback on content and construct validity (See Description of Development section for timeline and process for developing the App.) This feedback will be gathered in a structured format that measures agreement with key components as well as open-ended questions for sharing additional comments and ideas. This feedback will be analyzed for consensus and themes, then shared with the advisory panel/workgroup members for further input.

RQ3. What are the essential components and attributes (functionalities, content, and user interface) of the AT@Home App that result in accessible, efficient, and intuitive use for people with varied abilities, caregivers, and service providers?

Answering this third research question will entail conducting focus groups, starting at the end of the first year of the project and continuing into the second year, in which aging individuals with disabilities, caregivers, and service providers are able to test simulations of key components of the App and provide feedback. Focus groups will be held in rural and frontier regions and in tribal communities in Arizona, New Mexico, Montana, and Wisconsin. Each focus group will include 12 people inclusive of four participant dyads: an aging individual with a disability paired with either a caregiver or a provider. *(Note - caregivers are considered inclusive of natural/social/familial supports, including friends, and service providers are considered paid positions, e.g., care attendants and therapists).* There will be two parts to a focus group, led by a facilitator with assistants. The one part will be led by the facilitator who will pose questions and prompt discussion – this will occur at the opening and closing of the focus group. In the middle

of the focus group, participants will interact with simulations of the App. During the simulations, the facilitator and the assistants will be matched with a participant dyad to answer questions and observe their interactions with the App. During this time, the nature of the questions and observation of ease and difficulties with using the simulated components will be recorded using a structure form designed by the research team. Analysis will involve identifying themes from the discussion and aggregation of the recorded observation data.

RQ4. To what extent do the results of beta-testing the prototype of the App (with individuals with disabilities who are aging, caregivers, and service providers) show an (a) increase in knowledge of AT solutions, (b) increase the reported likelihood of applying AT solutions in the home, and (c) increase initiation of contact with a AT resource specialist in their region or state?

At the end of the second year of the project, coinciding with the start of the fall academic year, a complete prototype of the AT@Home App will be built based on the findings of the research. Upon completion of the prototype in the spring of the third year, beta-testing will occur. The research processes associated with beta-testing will follow the same structure as the focus group format mentioned for RQ3 with facilitated led portions and observed interactions between the participants and the App. The focus group questions and prompts as well as the observation recording form will be different in order to align with the finalized features and content of the App. Participants may or may not be the same as the focus group participants under RQ3. Because responding to simulated components of the App is dramatically different than responding to the full prototype of the App and there will be nearly a year time lapse between, there is no concern for bias. However, to the greatest extent possible in the rural, frontier, and tribal regions of participating states, involving new participants will be a priority and when not possible, the research will formally note this. Analysis of the beta-testing results

will be used to identify necessary refinements to the App and develop the user manual.

In addition to focus groups, field based consultants with AT expertise and AT specialists across the network of State Assistive Technology Programs will be asked to provide formalized feedback on the App. Program leaders agreeing to participate will receive access to the App along with a structure format for beta-testing and providing feedback on their own. This process will gather insight into necessary information to be included in the user manual, identify strengths and weaknesses in the App content and design, and provide ideas for widespread dissemination and use of the App to inform the technology transfer processes and next steps of development. This process will provide for analyzing aggregating responses through structure response options as well as themes through open-ended feedback.

Participants. The target population is aging adults age 50 or over, with a disability who live in rural, frontier, and tribal areas of the country. A sampling of this population will participate in the research processes testing the technology and as members of the advisory panel/workgroup who provide feedback and guide the development process. Other participants include caregivers and service providers who support aging individuals with disabilities. A sampling of this population will also participate in the research as well as in the advisory panel/workgroup. The last group of participants are field-based consultants with AT expertise and AT specialists who are part of the national network of State Assistive Technology Programs. A sample from this population will participate in the research by completing the needs assessment survey and by reviewing the App and providing feedback on validity, usefulness, benefit, and appeal.

Sampling. Tables 1 and 2 provide an overview of the number of participants, location, and type of participation associated with the respective RQs. A purposive sampling approach will be used in order to strategically gather national perspective of AT leaders as well as targeted

perspective from participants living and working in rural, frontier, and tribal areas. Leahy (2013) notes that purposive sampling, and in particular the use of targeted focus groups early in the design processes is ideal for developing new products with direct input from the product's target population. Additionally, consistent with the socioecological perspective, the research and development processes are designed to gather perspectives across types of stakeholders.

Table 1. RQ1 and RQ2 participants

Method	Participants	Sample Size	Location
Survey	Aging individuals with disabilities (age 50 or older)	176 total with 88 representing rural, frontier, and tribal zip codes ¹	
	Caregivers/social supports for aging individuals with disabilities	176 total with 88 representing rural, frontier, and tribal zip codes ¹	National distribution through AT program
Survey	Community service/resource support providers	176 total with 88 representing rural, frontier, and tribal zip codes ¹	network and project collaborators
	AT specialists at State AT programs and field-based consultants	20	
Total = 548			

¹A priori power analysis for t-test calculation of difference in means=.95.

Table 2. RQ3 and RQ4 participants

Focus groups and beta-testing	Dyads: Aging individuals with disabilities (age 50 or older) with caregiver or service provider	3 focus groups, 4	Rural, Frontier,
		dyad participants	Tribal,
		each=12 participants	Arizona
		3 focus groups, 4	Rural, Frontier,
		dyad participants	Tribal,
		each=12 participants	New Mexico
		3 focus groups, 4	Rural, Frontier,
		dyad participants	Tribal,
		each=12 participants	Wisconsin
		6 focus groups, 4	Rural, Frontier,
dyad participants	Tribal,		
each=24 participants	Montana		
Focus Group Total =		60	
Beta-testing Total =		60	

Recruitment. Project collaborators from a University Center for Excellence in Developmental Disabilities (Montana Rural Institute) and The Wisconsin State AT Act Program, who specialize in research relevant to individuals with disabilities and implementers of the State AT Act Programs will assist the research team from Northern Arizona University with recruitment. Letters of commitment are included in this proposal from the two

collaborating sites— The Rural Institute at the University of Montana (UM) and the Wisconsin Department of Health WisTech Project. The partners agree to assist the research team in recruiting participants across their states. Staff from these collaborators will screen potential participants for inclusion and exclusion criteria and will assist the project staff in obtaining informed consent. Additionally, through established relationships across the network of State Assistive Technology Programs, recruitment information will be distributed.

Recruitment strategies may vary among the three sites and will be informed by our collaborating partners. Recruitment of participants for IHD will be through community partners in Northern Arizona and other rural areas of Arizona including tribal communities of Navajo, Hopi, White Mountain Apache and Tohono O'odham Nation among others. IHD staff will also recruit in New Mexico by working with long-term partners from that state such the current and former AT Act State Program directors. Within Arizona, partners may include the Division of Developmental Disabilities (DDD), the Arizona State Rehabilitation Administration, the Arc of Arizona, the Arizona Department of Aging and Adult Services, and Ability360 Independent Living Center.

Multistep recruitment across all collaborating partners will include (1) dissemination of a flyer invitation to potential participants through organization websites or listservs; (2) requesting that organization representatives such as DDD service coordinators share the flyer with individuals with disabilities and their caregivers; and (3) using snowball (e.g., word of mouth) sampling to recruit additional participants. These strategies will also be employed throughout Montana and Wisconsin, and will be guided by our collaborating partners to leverage their established relationships with statewide partners.

As noted in the sampling plan for administering the survey, recruitment will target

representation from rural, frontier, and tribal areas as well as urban and suburban areas. Project collaborators, along with the project advisory panel/workgroup members, will develop a plan for saturating rural, frontier, and tribal areas with recruitment information. This plan will involve multiple approaches such as providing multiple options for participation (i.e., online, survey read aloud in person or virtually, and printed mailer). The budget is designed to allow for these varied approaches. The research team will monitor the survey responses received by reported zip codes in order to determine the need for continued recruitment or revisions to the recruitment approach. The revisions will be made as indicated in the data.

B. 4. Data and the data collection methods are appropriate to address the proposed hypotheses or research questions and to support the proposed data analysis methods.

As indicated, the sources of data are surveys, focus groups, structured observation forms, and structured feedback forms. In order to maximize accessibility of participation, there will be multiple options for participation in the research activities. When signing up to participate in a focus group or beta-testing, needs for alternative formats or supports will be solicited and provided. With the leaders of the groups being connected to AT programs, the facilitators will have ready access to a full range of tools for assuring accessibility. The sampling plan is consistent with recommendation in product development research as well as statistical rigor where it applies. The range of types of data collected and targeted participants will provide multiple perspectives for informing the design and final prototype of AT@Home App.

B. 5. The data analysis methods are appropriate.

The analysis methods match the types of data collected. Qualitative data will be analyzed using the thematic analysis in NVivo. Quantitative data will be analyzed using descriptive

statistics and t-test approach to compare data between rural and non-rural responses. Each data component aligns to a research question, which informs the development process. Adhering to the protocol of design-based research, as data are analyzed, the conjecture map will be refined thus providing clarity and focus to the development process leading to an App that effectively addresses the AT needs of individuals with disabilities who are aging. By employing a mixed methods approach, this project benefits from the strengths of both quantitative and qualitative methods of providing in-depth information to fill the gap when moving from research through development to implementation to results (Green et al., 2015).

B. 6. The applicant identifies and justifies the stage of research being proposed and the research methods associated with the stage.

Being that there are no apps available to assist in acquiring AT recommendations, the proposed project is highly relevant and justifiable and likely to be beneficial to the targeted population. This project aligns with the NIDILRR research stage of Intervention Development at the development stage of Proof of Concept. Consistent with the definition of Intervention Development, this project focuses on developing and testing a specific intervention (AT@Home App) designed to promote independence in the home for individual with disabilities who are aging. The research questions and development processes address the key components of this stage by (a) identifying essential components; (b) utilizing targeted research methods and measures to iteratively inform the development of the App; and (c) testing the components as well as the full App with intended users. As a research and development project at the proof of concept stage of development, the research and development activities are designed to (a) involve multiple voices and perspectives across all aspects of the project, (b) verify requirements of the AT@Home App essential for achieving desired results, (c) systematically test the components as well

as the overall App in order to identify and resolve technical challenges, and (d) lead into a technology transfer plan for licensing and further refinement of the App.

B. 7. Input of individuals with disabilities and other key stakeholders is used to shape the proposed research activities.

Consistent with the socioecological perspective, multiple stakeholder types are involved in the project. Additionally, there are multiple ways to be involved. The surveys are designed to serve as a needs assessment and thus gather information pertaining to the needs of individuals with disabilities who are aging from their perspectives as well as the perspectives of caregivers, service providers, and AT specialists. The simulation testing as well as the beta-testing will gather perspective from intended users of aging individuals with disabilities, caregivers, and providers in a focus group manner and from AT specialists in a structure self-guided manner. In addition to these direct forms of providing data in response to the research questions, the advisory panel/workgroup will be an opportunity for stakeholder participation. The advisory panel/workgroup is explained in more detail in the design of development activities section. In summary, this group will include representation across the mentioned stakeholders and will meet regularly to share in interpretation of data, participate in the evaluation of the development process, and inform the development of the AT@Home App.

C. Design of Development Activities

C. 1. Target population.

As mentioned, the primary target population is individuals with disabilities who are aging (50 years of age and older & inclusive of those with long-standing and acquired disabilities) and have limited/unequal access to AT information and resources due to living in rural, frontier, and tribal areas. Other expected users are caregivers (inclusive of natural/social/familial supports),

service providers (e.g., paid care attendants & therapists), and AT specialists who may provide assistance to the individuals with disabilities and therefore will use the App alongside the target population. The design of research section describes how these multiple users will be involved as participants in the research. Additionally, representatives of these populations will be members of the advisory panel/workgroup who will also be involved in the development processes. This step in the research aligns with best practices as supported by Lindenberger et al. (2008) who indicate that technologies for adults who are aging with disabilities require recognizing that cognitive and sensorimotor factors are key to the construction of assistive technologies. Technologies co-constructed by researchers, behavioral scientists, engineers, AT specialists, and aging individuals, offers great promise for improving both the transition from middle adulthood to old age and the degree of autonomy in old age in present and future generations (Lindenberger et al., 2008).

C. 2. Current and related products.

Aging individuals with disabilities are accessing and using technology in various ways. Some forms of technology are readily available while others are more customized. Applications on Android and iOS constitute a number of the more readily available technologies. Individuals with disabilities who are aging can use apps that track blood pressure, remind them to take medications, and assist in reading small print (Frederick, 2019). To facilitate social relationships, apps such as Simple Social provide a user-friendly option for using Facebook and Twitter, thereby minimizing navigational task difficulties (Cosmopolitan Retirement Living, 2020). A company called Generation on Line developed an application to support individuals who are aging in using tablets and other computer technology. For those unfamiliar with technology, this free app allows users to learn via large type, plain-language instruction.

In addition to applications, individuals with disabilities who are aging also use other forms of technology. Smart lighting gives individuals the ability to automate their home lighting. Best Buy sells hearing devices, diabetes monitoring tools, and even robotic companion pets for individuals who are aging with disabilities (Best Buy, n.d.).

More recently, customizable AT, using artificial intelligence (AI) has been developed. Microsoft developed the Seeing AI app, which allows users to point their cell phones at objects or people to identify them. Other companies have developed hearing aids that tune into the user's brainwaves to determine what they would like to hear, AI to convert sign language to text or voice, and apps to improve communication skills in individuals with disabilities (Magic Software Inc., 2019). Available to Israeli persons with disabilities, Atvisor, a digital platform, uses AI to suggest AT based on the user's specific needs. The platform provides recommendations for aids and assistive technologies as well as contact information for specialists who can provide further assistance in Israel (Atvisor, n.d.). While this platform provides insight for forming the vision of AT@Home, the proposed App will differ substantially in scope, audience, and legal parameters pertaining to terms of service.

C. 3. Concepts, components, and systems.

By using an engaging and accessible graphical interface, the AT@Home App will serve as a self-guiding, decision-making tool and allow the user to input his or her information to identify daily living tasks and environmental elements that are difficult/unsafe to carry out or areas within the home that are not accessible due to intrinsic or extrinsic factors. The initial development will be targeted for use on computer-based, web based, and mobile digital platforms (e.g., Smartphones & tablets). The App will then suggest AT options to mitigate those challenges. The App will be designed to process the information inputted and pose clarifying questions in order

to meet the following purposes:

1. Identify AT needs related to a functional impairment of concern to the end user (e.g. vision or hearing loss, limited mobility or memory impairment) affecting specific daily living activities that typically occur in the context of rooms in a home (a) kitchen (food preparation/storage, eating), (b) bathroom (toileting, bathing, hygiene/grooming), (c) bedroom (dressing, getting in/out of bed), (d) home entrance/exits, and (e) non-specified locations where other critical activities take place such as communication/social engagement, leisure activities and medication management. Note – in most instances one functional impairment will be entered and “processed” at a time.
2. Match, align, and organize the end user’s identified AT needs with AT options offering features and compensatory strategies to address and mitigate the identified functional limitations, thus increasing capabilities.
3. Provide the end user with additional AT and community resources including contact information for State Assistive Technology Act Programs and Aging and Disability Resource Centers as a next step.

The images presented in Figures 4 and 5 represent initial thinking for the how the App interface may look to users. The sample home page (Figure 4) shows an image representing spaces in the home. A user would select a room which then would lead to an image of that space (Figure 5). This sample content page represents a kitchen and shows a range of AT solutions and strategies.

For each user, there will be an inventory that they complete when setting up their profile which then, through a programmed algorithm, the best matches of AT solutions will be visible as an icon on the room display, corresponding to the area representing the barrier or challenge.

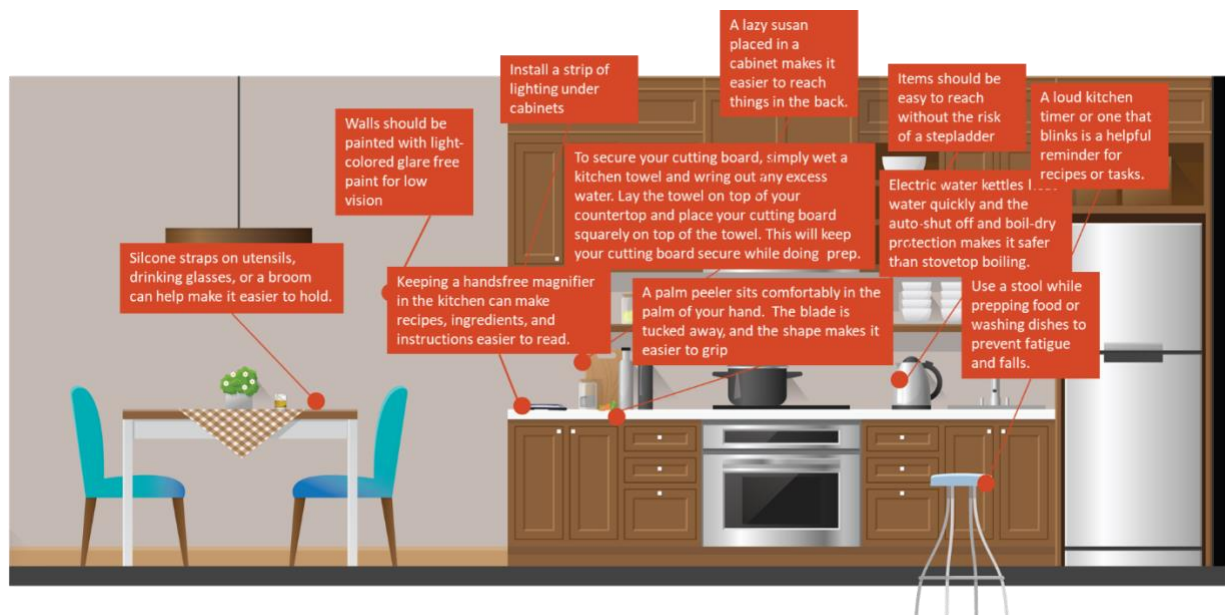
When selecting the icon, the description box will show. Note that not all of the options and supportive strategies displayed in Figure 5 will be visible to a user because that would be overwhelming and difficult to read. These are shown in the figure to represent some of the types of examples that will be suggested as AT solutions. There are multiple pathways from the user profile inventory to the ultimate set of recommendations and these pathways will be tested throughout the research and development process.

Figure 4. Sample home page



A development team, with expertise in accessible graphic design and computer programming/App development, is onboard and will work closely with the research team, the AT content design team, and the advisory panel/workgroup members.

Figure 5. Sample content page



C. 4. Appropriate samples in tests and development activities.

Through an iterative process, components of the technology will be developed and tested in order to inform the AT@Home App development. Simulations of App features will be tested in a focus group format in the second year and beta-testing of the complete App will occur in the third year. The specific steps, environment, and participants are described in detail in the design of research section. In summary, the sampling of participants is consistent with product development and usability testing for this proof of concept phase of development. Additionally, the samples involve participants across multiple states in order to give consideration to varying contexts of state services and support systems, availability of resources, and potential cultural differences. The research activities are intertwined with the development activities such that the development process occurs in response to stakeholder provided research results.

C. 5. Development activities occur in an appropriate environment.

Leadership for development activities involves two State Assistive Technology Act Programs, housed within two University Centers for Excellence in Disability with long histories

of working with rural populations; The Wisconsin Department of Health which houses WisTech, the Wisconsin State AT Act Program; and the NAU Computer Science Department. All leaders are part of a national networks that provide for easy facilitation of the involvement of national experts at key stages of the research (see Design of Research section). Additionally, because of this team's expertise in disability services and assistive technologies, necessary supports for facilitating accessible participation will be readily available for all participants of the research and development activities.

The NAU Computer Science Department has a long-standing mechanism for generating proof of concept technologies. Specific to the involvement of intended users, the use of a focus group format for the simulation testing and beta-testing will take an ethnographic approach (Rosenbaum & Chisnell, 2000) wherein the researcher observes the user with the technology and collects observational data, in addition to data from typical focus group type questions and discussions about the technology. This approach has established credibility in development of technology products (Leahy, 2013) and usability testing (Rosenbaum & Chisnell, 2000).

C. 6. Input from individuals with disabilities and other key stakeholders.

At the beginning of the project, the advisory panel/workgroup will be established. This group will consist of 10 members who meet three times per year. At the onset of each year, membership on the advisory panel/workgroup may adjust to accommodate diverse perspectives. There will be five core members who agree to participate all three years. The remaining five members will be representatives of the intended users of the App (individuals with disabilities who are aging – 50 + years of age, caregivers, service providers, and AT specialists) (see description of target population).

Because the research and development activities are intertwined, please refer to the research section for specificity on the participants. Intended users and stakeholders will be involved across development activities, including simulation testing of components and beta-testing of the complete App. The development process will also involve experts in research, assistive technology, accessible design, and computer programming. This team will collaborate across all phases of development to assure the development of an accessible, useable, and appealing App focused on the purpose verified in the needs assessment (RQ1). Structured feedback processes are integrated into the research activities. The project team, in collaboration with the advisory panel/workgroup, will review data and development progress at critical junctions, thus allowing for timely course correction as needed. This cross-stakeholder involvement across project development phases is designed to result in an App that is both content and context valid; thus, increasing the likelihood of broad usability across older adults with disabilities and in preparation for further larger-scale testing.

C. 7. Stages and phases of development.

The development approach (a) aligns with the design-based research approach, (b) incorporates the research activities as a mechanism for informing the development, and (c) includes the advisory panel/workgroup members as key to providing expertise and context to the development process as well as functioning in a formative evaluation role. To reiterate, the goal of this project is to demonstrate an effective, useful, and appealing assistive technology (AT) application (“App”) to be used by individuals experiencing age-related or longstanding disabilities to identify AT solutions for promoting safety and independence in daily living activities including in ones’ home and the community. There are four objectives that structure the development process leading to reaching the goal:

Objective 1: Assess and determine what technologies the targeted population is currently using.

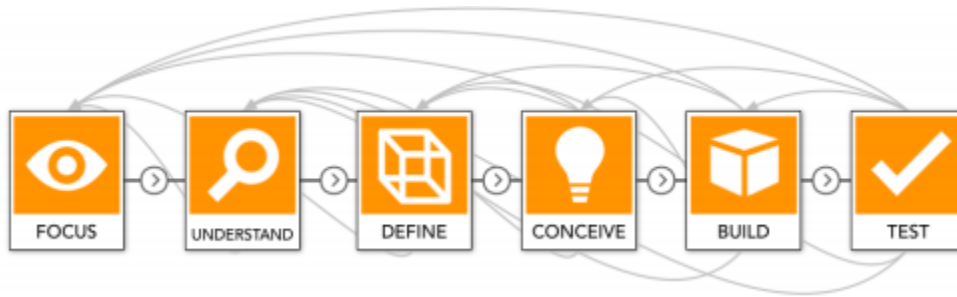
Objective 2: Assess and determine what key components need to be included in the AT@Home App decision tool/process to make it accessible, useful, and efficient.

Objective 3: Develop the AT@Home App

Objective 4: Develop technology transfer plan and disseminate lessons learned.

The first two objectives focus on identifying the technologies, content, and components of the App. The third objective focuses on developing the full prototype of the App and the final objective focuses on dissemination and technology transfer. Addressing each objective will entail a development process containing 6 iterative phases consistent with design based research (Easterday, Lewis, & Gerber, 2014). As shown in Figure 6, the phases are sequential yet incorporate feedback loops.

Figure 6. Iterative phases of design based research used for product development



The list of phases and defining attributes of each are as follows.

1. Focus: The audience, topic, and scope of the project are confirmed and there is consensus among the development team.
2. Understand: Research is conducted to understand the range of users, contexts, existing solutions, and feasibility of proposed solutions.

3. **Define:** Product designers establish goals, parameters, taxonomies, and indicators of effectiveness.
4. **Conceive:** Components are simulated and tested.
5. **Build:** Prototype is built using the results of the simulation testing.
6. **Test:** Prototype is tested with intended users.

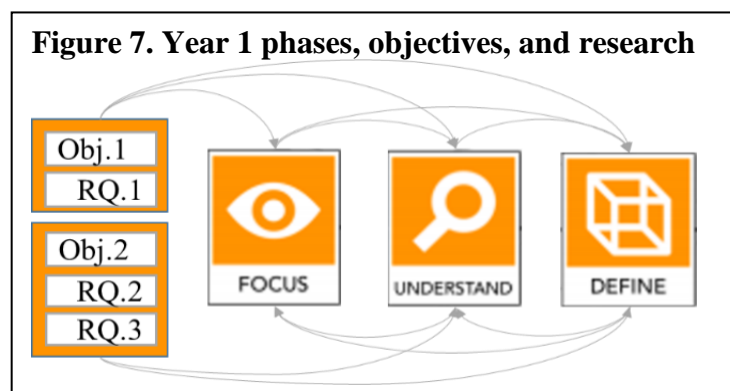
These phases will occur across the three years of the project.

Evaluation. At the end of each year, the advisory panel/workgroup, facilitated by the data manager/analyst, will conduct a formative evaluation of project adherence to the development plan. Using an evaluation survey administered to the advisory panel/workgroup, the project team will gather feedback on perceptions of adherence to the development plan and research protocols, extent to which multiple viewpoints were considered and valued, the extent to which the development process accurately incorporates findings from the research, and a status check on the perceived potential value and quality of the App as it is being developed.

The remainder of this section describes the development process by project year and phase. The Plan of Operation section contains a work plan organized by objective providing a detailed list of development, research, and project management activities, responsibilities, and timelines.

Year 1: October 2020-September 2021 [Phases: Focus, Understand, and Define]

As Year 1 focuses on the development phases of focus, understand, and define, objectives 1 and 2 and research questions 1, 2, and 3 will be addressed. Figure 7 displays how the objectives, research questions, and development phases



for the first year are interrelated. Development activities in this year include the following.

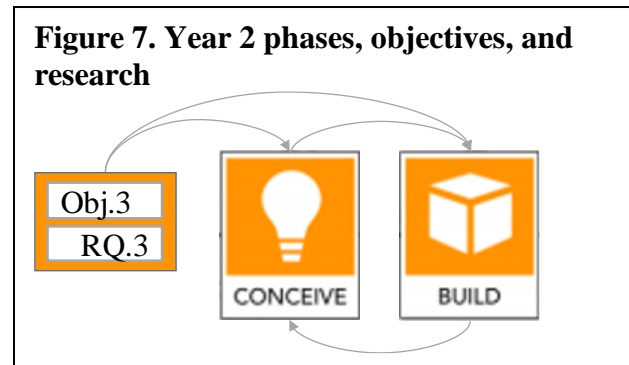
- Establish the advisory panel/workgroup and convene an inaugural meeting to arrive at consensus on focus, as well provide orientation to group responsibilities and the research and development processes.
- Conduct the research to address RQ1 and Objective 1.
- Hold advisory panel/workgroup meeting to review results of RQ1 research.
- Use the results of the RQ1 research to refine focus, document understanding, and start to define elements of the AT@Home App.
- Conduct the research to address RQ2, prepare for RQ3 and Objective 2.
- Hold an advisory panel/workgroup meeting to review results of RQ2 research, prepare for RQ3 research, prepare for year 2 activities, and conduct a formative evaluation of Year 1.
- Use the results of the RQ2 and RQ3 research to refine understanding and further define the taxonomy of the AT@Home App.

Year 2: October 2021-September 2022 [Phases: Conceive and Build]

The focus of Year 2 is on the phases of conceive and build. The third objective and RQ3 address these phases. Note that preparation for RQ3 research will occur in Year 1 and the research activities in Year 2; therefore, RQ3 research activities bridge these phases (conceive and build) and the Year 1 phases. Through the development and simulation testing that will occur as part of RQ3, elements of the App will be defined, conceived as functionalities of the App and built for simulation. Development activities in this year are as follows.

- Using the research-defined taxonomy, develop simulated components for focus group simulations to partially address Objective 3 (see Year 3 for continued Objective 3 activities).

- Conduct research to address RQ3.
- At mid-point of progress in conducting RQ3 focus group simulations, hold advisor group meeting to review data to determine needs for changing the simulations or keeping the course.



- Hold advisory panel/workgroup meeting to review results of RQ3 research, generate solutions to technical challenges, and formulate requirements for supporting materials (i.e., user manual, marketing materials, research briefs) (see Dissemination plan).
- Develop a full simulation of the App (to be completed in Year 3) and package for the programming team.
- Hold initial meetings with the programming team to review research results, outline vision and parameters of the App, and share the simulated materials.
- Hold end of Year 2 advisory panel/workgroup meeting to conduct a formative evaluation of Year 2.

Year 3: October 2022-September 2023: [Phases: Build and Test]

In the third year, work toward achieving Objective 3 will continue, RQ4 research will occur, and Objective 4 tasks will be completed. Beginning at the end of Year 2, but mostly occurring in the third year is the development of the App by a team of programmers under the leadership of

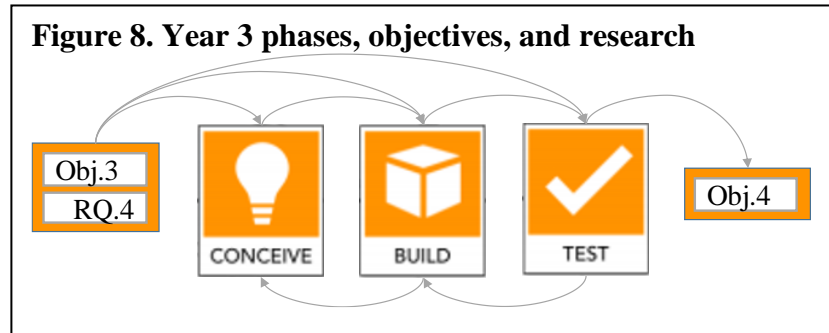
senior computer science faculty with expertise in user-centered technologies, Dr. Eck Doerry. Dr. Doerry, will be a collaborator across all project years so he will be well-grounded in all aspects of the intended users, vision for the AT@Home App, and the research results. Dr. Doerry leads a computer science capstone course that has yielded many ready for market technologies. Under his direction and with persistent involvement of the project team, a team of computer science students will develop the AT@Home App as their capstone assignment. The App will be completed near the end of the spring semester (May 2023). At that point, Dr. Doerry will make any additional adjustments in preparation for beta-testing.

Also in the third year, the technology transfer process will begin. NAU Innovations will collaborate with the researchers and their collaborators to contribute to the protection and potential commercialization of the new technology which may include filing new patents and copyrights as needed. NAU Innovations will assist in (a) forming connections between various potential partners in industry and university settings for the project and the intellectual properties that have been developed from opportunities provided by the grant; (b) evaluating the commercial potential of any intellectual properties developed from opportunities provided by the grant; (c) helping to protect and commercialize the intellectual properties that have been developed from opportunities provided by the grant; and (d) providing the governmental reporting for the intellectual properties. With this scope of work with NAU Innovations will be detailing disclaimers, liabilities, and indemnity for product use.

The third year development activities include the following.

- Meet every two weeks with the programming team
- Prepare supplemental materials to accompany the App (see Dissemination plan)

- Convene advisory panel/workgroup meeting to provide an update on the programming team's



progress and formulate a concrete plan for recruiting beta-testing participation.

- At critical junctures of the programming team's progress, the project team tests components and provides feedback.
- Conduct beta-testing research to address RQ4.
- Convene advisory panel/workgroup meeting to review the results of beta-testing (RQ4), generate solutions to technical challenges, and identify market opportunities
- Form a plan for continued refinement of the App.
- Develop and initiate a technology transfer plan with the office of NAU Innovations.
- Finalize supplemental materials based on beta-testing results.
- Hold final advisory panel/workgroup meeting to conduct a formative evaluation of Year 2 and gather cumulative reflections.

D. Design of Dissemination Activities

D. 1. Materials to be disseminated are likely to be effective and usable, including consideration of their quality, clarity, variety, and format.

The AT@Home's dissemination activities will effectively present, translate, and share learned knowledge regarding the outcomes and usefulness of the App as a tool for individuals who are aging to identify AT solutions for promoting independence. Project materials and products will be developed and disseminated in formats appropriate and accessible to multiple

audience stakeholders including adults with disabilities age 50 or older in rural, frontier and tribal communities, caregivers, disability services providers, assistive technology professionals including users and designers, policy makers, and researchers.

Sharing and translating the research findings, outcomes and associated products for dissemination to multiple audiences in a variety of clear, high quality formats is a strength of the NAU IHD. Staff at the NAU IHD have developed expertise in creating accessible formats for research translation applicable to both professionals and consumer audiences. A range of materials and products will be produced and disseminated to inform stakeholders about the AT@Home project's research efforts and results, including supplemental materials, progress toward the App's development and its deployment and overall outcomes.

Dissemination products will include summaries of research findings for the target population and other key stakeholders. Research highlights offering summaries of research findings applicable to the various audiences, but especially for adults aging with disabilities and caregivers will be developed to include infographics and fact sheets. The AT@Home website (discussed in more detail below), will be the public site for project information.

The researchers across the collaborating institutions as well as in partnership with the methodology experts, have agreed to co-author materials for peer review publications as well as other forms of results sharing including the application of the methodology with persons with disabilities. Research publications will include manuscripts for peer review publications, white papers, research briefs, and other descriptive documents describing outcomes and innovative application of the methodologies. Publications will adhere to the ACL Public Access Policy by either publishing in journals with PubMed Central's full participation status or through the National Institutes of Health Manuscript Submission Systems (NIHMS).

Project leadership and researchers will present findings at conferences for disability professionals, health professionals, self-advocate and disability specific organizations, and older adult-focused organizations.

D. 2. Methods for dissemination are of sufficient quality, intensity, and duration.

In Year 1, the dissemination activities will focus on the development of recruitment materials for project participants and the development of an accessible, Section 508 compliant, independent project website. The AT@Home website will serve two key project functions: (1) provide a repository to house comprehensive program information such as fact sheets, infographics, instructions, additional assistive technology resources for stakeholders for immediate use and next steps in the AT access and acquisition process; and, (2) serve as a dynamic, interactive site for interfacing with the computer-friendly version of the App. To ensure accessibility across audiences, information presented in video or webinar formats will contain embedded captions and audio descriptions. Documents will be uploaded in accessible formats and plain language will be used for sharing information as appropriate to specific audiences.

Beginning in Year 2, the research team will expand the development and production of dissemination materials. A Research-to-Practice brief will feature a synopsis of the research conducted in order to develop a valid and reliable App. Infographics developed in conformance with accessibility standards will accompany research-to-practice briefs providing a graphical representation of the research process. In Year 3, manuscripts for peer-review publications will feature (a) specific findings applicable to unique settings, age groups, and disability types, and (b) data informed recommendations for use of the App. The research team will also submit conference proposals to present research results that informed the App development process and

final product, implementation results and user outcomes at national and state professional conferences across the stakeholder audiences: the Assistive Technology Industry Association (ATIA) and RESNA conferences attract on AT professionals, researchers and disabilities services providers. Many states including Arizona hold their own AT and/or disability conferences that highlight evidence-based practices. The AUCD annual conference addresses a wide scope of issues including use of AT pertinent to persons with Intellectual/Developmental Disabilities (I/DD) and other disability populations and AT is featured prominently at the American Occupational Therapy Association Annual Conference (AOTA).

D. 3. Materials and information to be disseminated and the methods for dissemination are appropriate to the target population.

Project materials and products will be developed and disseminated in different formats appropriate and accessible to multiple audience stakeholders including adults with disabilities age 50 or older in rural, frontier, and tribal communities, caregivers, disability service providers, AT professionals including users and designers, policy makers, and researchers. Given the diversity of the stakeholder groups discussed earlier in this section, dissemination methods and products will be equally diverse and tailored to these populations' specific interests and needs.

Dissemination materials (flyers, fact sheets, print and E-newsletter articles, in-person presentations, live and archived webinars, etc.) targeted to adults aging with disabilities and those in their immediate support network (family members and caregivers) will emphasize the benefits of AT to support aging in place while maintaining or improving safe independence and reducing caregiver responsibilities. These materials and products will be developed in consumer friendly, accessible and culturally relevant, plain language formats.

To reach this population, dissemination materials will be shared by IHD and project

collaborators with organizations that provide consumer support or direct services across state disability, health and aging networks. The agencies will include state disability and aging agencies such as the Aging and Disability Resource Centers (ADRCs), Area Agencies on Aging, senior centers in rural communities, Centers for Independent Living and state Associations of Providers for People with Disabilities (APPD).

Because the AT@Home App will be relevant to the other populations described previously, focused dissemination efforts will also target those stakeholders, building upon project partners' existing relationships and connections with state Aging and Developmental Disability networks as well as national organizations. To reach a broader national audience of service providers, the Association of University Centers on Disabilities (AUCD) network will be used. IHD and the Rural Institute at the University of Montana belong to the Association of University Centers on Disabilities (AUCD) networks which are part of a larger national network of University Centers for Excellence in Developmental Disabilities (UCEDDs). Through this network, products and materials will be widely shared via platforms such as AUCD 360, listservs, councils, and special interest groups. Additionally, all collaborating institutions will share and will also post links to the project website on their Center websites. Since all three collaborators (IHD, the Rural Institute and WisTech) are designated AT Act Programs, there are direct opportunities to broadly share lessons learned through The AT Act Programs' Technical Assistance Center (AT3). IHD will also rely on its internal resources for developing and delivering virtual presentations through live and archived webinars.

Underpinning the project's foundational approach to dissemination are the Seven Principles for Universal Design: equitable use, flexibility in use, simple and intuitive use, perceptible information, tolerance for error, low physical effort, size and space for approach and use.

<https://www.udll.com/media-room/articles/>. These principles, as adapted to this project, will guide its dissemination activities.

Additionally, Northern Arizona University ensures equal access in compliance with Section 504 of the Rehabilitation Act of 1973, as amended. The Act prohibits disability discrimination in any program or activity that receives Federal funds or is conducted by an executive agency.

Northern Arizona University (NAU) actively strives to ensure that persons with disabilities have access to all of its programs, services, activities, and information comparable to the access provided to persons without disabilities. Accordingly, all materials created for this project will adhere to University communication standards and protocols. IHD adheres to Information and Communication technology accessibility standards under Section 508 of the Act which are therefore also applied to development and launching of dissemination activities and products.

The dissemination team at IHD is prepared to develop and deploy content through available learning management systems at NAU or other enterprise solutions that may fit the project. The Dissemination Coordinator will work closely with project staff in the design, development, and implementation of the project website and dissemination and recruitment materials. He will ensure the proper storage and retrieval of data developed on the project as well as ensuring the proper alignment with federal access standards of materials developed and disseminated.

E. Design of Utilization Activities

E. 1. Utilization strategies are likely to be effective.

Almost anyone with a computer, or mobile device and internet service can do a Google search for a technology related item, but to what end? If purchased, it may not meet the person's needs and thus, money and time are wasted, the product will likely be abandoned, and the individual is no better off. The AT@Home App will not be designed to yield an unlimited

amount of AT information. Instead, its purpose is to be a decision-making tool focusing on identifying AT options that address the interplay involving a person's functional limitations impacting performance of daily living activities within environmental contexts and constraints. Data about and analysis of three key elements - person, tasks and environments- provides the basis for making decisions about which AT options offer features aligning with these elements.

Ultimately, the goal is to have the AT@Home App be useful on multiple levels. For some users, the App will provide enough information (i.e., targeted AT options - cost, vendors, etc.) so the AT can be purchased to immediately addresses their AT needs. However, for individuals with more complex needs across the person-task-environment triad, the information outputs will likely provide AT options plus contact information for additional resources to facilitate connections between the individual (or someone on their behalf) with other, more comprehensive service driven resources such as the designated AT Act Programs available in all states and territories. As part of their core services, AT Act Programs provide device specific information and demonstrate and lend out devices which may be the next appropriate, no risk, cost effective step in the AT decision-making process for the individual. AT Act Programs also provide information about funding sources to assist with offsetting the cost of purchasing AT including lower cost Re-use options and some even offer affordable, low interest financial loan programs.

E. 2. Extent to which the potential new users of the information or technology have a practical use for the information and are likely to adopt the practices or use the information or technology, including new devices.

As discussed previously in this proposal, there are many reasons that older adults with disabilities do not use AT. Factors include denial about loss of function and independence, the lack of awareness about and useful access to such information and inability to take into

consideration the constellation of decision-making factors that affect whether the AT will be useful and available to the person who needs it.

AT@Home's engaging and familiar interface will stimulate more natural conversations and thought processes centering on how the person functions at home in a pragmatic, organic manner that is designed to be less intimidating to the person. The AT options and suggested strategies will align with the specific challenges the person is experiencing in their home during the performance of daily activities and will lead to the recommendation of additional resources. For example, when discussing daily activities that take place in the bathroom, the older adult may be encouraged to acknowledge problems with showering as a result of balance and mobility issues - specifically, she can't lift her legs over the tub ledge without losing her balance. The App will provide AT solutions such as a tub transfer bench, grab bars, and hand-held shower nozzle recommendations and where they can be obtained and strategies for safely using the equipment: (e.g., sit on the bench, then bring your legs over the tub ledge, etc.).

E. 3. Information or technology is likely to be of use in other settings.

The AT@Home App will be designed to be accessible and useful to older adults using it independently or as a dyad consisting of the older adult and someone within their natural support system such as a caregiver or service provider. However, the App and the resources embedded in it will have broader applicability to healthcare and rehabilitation professionals, Centers for Independent Living and community-based Senior Centers. For example, an occupational therapist providing home health services could use the App during a home visit to engage the patient in a meaningful discussion of functional limitations within the home and then proceed to identify AT options for supporting a higher level of independence in specific daily living activities. A discharge planner, working in an acute care hospital or rehabilitation center, could

use the App to guide decisions about what AT should be considered and obtained to maximize safety and independence upon discharge.

According to the National Council on Independent Living Centers (NCIL) Every Center for Independent Living across the United States is required to provide five core services: advocacy, information and referral, independent living skills, peer support and mentoring, and transition.

<https://ncil.org/about/aboutil/>. The AT@Home App can be used within these centers by staff and peer mentors to directly support independent living. For persons with disabilities living at home, but encountering new or progressing challenges with independence, or for individuals transitioning from nursing homes or assistive living facilities to less restrictive environments under the intent of the Olmstead Act, the App can be used to identify needed AT and serve as a link to additional resources - both would be particularly valuable to people in rural, underserved areas.

In a similar vein, staff and volunteers at community-based senior centers, especially those in rural areas, could be trained to use the App to guide center members and visitors through AT options when conversations come up about the challenges and concerns with losing independence and the desire to age in place.

F. Plan of Operation

Tables 3, 4, 5, and 6 provide information on the adequacy of the plan of operation to achieve the objectives of the proposed project on time and within budget, including clearly defined responsibilities, and timelines, presented by quarter, for accomplishing project tasks.

The following legend provides the working title for key roles and associated acronyms.

Legend for Lead Persons - Principal Investigator = PI, Project Director-AT Content Lead = PD, AT Team Lead = ATL, Research & Tech Lead = RTL, Graphic & Visual Design

Specialist = GDS, Dissemination Coordinator = DC, Research Administrator = RA, Data Manager and Analyst = DMA, Field Based Consultants = FBC, Advisory Panel/Workgroup = AP, Collaborator-MT= CMT, Collaborator-WI = CWI, App Development Consultant = ADC

F. 1. Adequacy of plan of operation.

Table 3. Objective 1 Work Plan

Objective 1: Assess & determine what technologies the targeted population is currently using.													
Activities	Lead Persons	Year 1				Year 2				Year 3			
		Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Establish advisory panel/workgroup	PI, PD												
Create project website	DC, PD												
Advisory panel/workgroup orientation meeting	PI, PD												
Develop surveys	PI, RTL, RA												
Develop focus group protocols and procedures	PI, RTL												
Develop recruitment materials	PD, CMT, CWI, GDS												
Finalize recruitment strategy	PD, CMT, CWI,												
Provide training to focus group and beta-testing	RTL, CMT, CWI, GDS												

Objective 1: Assess & determine what technologies the targeted population is currently using.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
facilitators													
Secure IRB approval	PI												
Conduct RQ1 data collection	DMA, RA												
Conduct RQ1 analysis	DMA, RA												
Conduct RQ2 data collection	DMA, RA												
Conduct RQ2 systematic review	RTL												
Conduct RQ2 analysis	DMA												
Prepare simulations to address RQ3 research	RTL												
Prepare supplemental materials for RQ3 simulation testing.	RTL, PD, ATL, CMT, CWI, FBC												
Draft taxonomy	PD, ATL, CMT, CWI, FBC												
Draft functionalities	PD, ATL, CMT, CWI,												

Objective 1: Assess & determine what technologies the targeted population is currently using.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
	FBC												
Draft graphics	GDS												
Conduct formative evaluation with advisory panel/workgroup	RTL, DP, RA, AP												
Advisory panel/workgroup data review	RTL, DMA, RA												
Outputs: IRB protocol, recruitment materials, training materials, focus group materials, surveys, project website													
Outcomes: Identification of taxonomy, functionalities, and graphics for simulation testing; Identification of barriers and solutions, particular in rural areas; Identification of research-based features to include in App.; year 1 activities evaluated to be consistent with plan and adjustments appropriately justified													

Table 4. Objective 2 work plan

Objective 2: Assess & determine what key components need to be included in the AT@HOME App decision tool/process to make it accessible, useful, and efficient.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Finalize simulations for RQ3	RTL, PD,												

Objective 2: Assess & determine what key components need to be included in the AT@HOME App decision tool/process to make it accessible, useful, and efficient.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
research	ATL												
Renew IRB approval	PI												
Conduct RQ3 focus groups	CWI, CMT												
At mid-point of conducting focus groups, hold advisory panel/workgroup meeting to review focus group progress and response to simulations	RTL, PD, CWI, CMT, AP												
Revise simulation materials as results require based on advisory panel/workgroup progress-check meeting	RTL, PD, ATL, CMT, CWI, FBC												
Finish focus groups	CWI, CMT												
Analyze focus group data	RTL/DMA												
Develop full simulation for illustrating the vision with the programming team	RTL, GDS, PD, ATL, ADC												
Refine supplemental materials	PD, ATL, CWI, CMT												

Objective 2: Assess & determine what key components need to be included in the AT@HOME App decision tool/process to make it accessible, useful, and efficient.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Hold initial meeting with the programming team (NAU)	PI, RTL, ADC												
Conduct formative evaluation w/advisory panel/workgroup members	RTL, PD												
Maintain website for sharing results and as a portal for simulation materials	DC												
Outputs: Simulation materials, supplemental materials													
Outcomes: Identification of the essential components and attributes of the App; Validity, accessibility, usability, and appeal of simulation materials for inclusion in the App, year 2 activities evaluated to be consistent with plan and adjustments appropriately justified													

Table 5. Objective 3 work plan

Objective 3: Develop the AT@Home App.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Meet bi-weekly with the programming team	RTL, ADC, PD												

Objective 3: Develop the AT@Home App.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Renew IRB approval	PI												
Finalize supplemental materials	PD, ATL												
Hold advisory panel/workgroup meeting to share progress on App development and finalize beta-testing plan	PD, RTL												
Project team runs internal tests of App in stages of programming development	PD, RTL, ADC												
Conduct beta-testing to address RQ4	CWI, CMT												
Analyze results of beta-testing	RTL, DMA,												
Hold advisory panel/work group meeting to review results of beta-testing and form a plan for continued refinement and distribution of the App	PI, RTL, PD												
Maintain website for sharing results and as a portal for beta-	DC, PD												

Objective 3: Develop the AT@Home App.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
testing materials													
Conduct formative evaluation with advisory group	RTL												
Outputs: App for beta-testing													
Outcomes: Validity, accessibility, usability, and appeal of App; reported increase in knowledge of AT solutions, reporting increase in the likelihood of applying AT solutions; increased initiation of contact with AT specialist; year 3 activities evaluated to be consistent with plan and adjustments appropriately justified													

Table 6. Objective 4 work plan

Objective 4: Develop technology transfer plan and disseminate lessons learned.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Work with NAU innovations to develop a technology transfer plan	PI, RTL, RA												
Submit license and copyright forms	PI, RTL												
Finalize briefs and reports	PI, RTL												
Author and submit manuscripts for peer review publication	PI, RTL, PD												

Objective 4: Develop technology transfer plan and disseminate lessons learned.													
Activities	Lead	Year 1				Year 2				Year 3			
	Persons	Q1	2	3	4	Q1	2	3	4	Q1	2	3	4
Author and submit proposal for sharing results through professional presentations	PI, RTL, PD												
Finalize supplemental materials	DP, ATL												
Draft marketing materials highlighting the apps features and benefits	PD, GDS												
Outputs: Technology transfer plan; licensing/copyright forms; briefs, reports, manuscripts, and presentation proposals													
Outcomes: Lessons learned disseminated, license forms filed													

G. Project Staff

Key staff of the AT@Home project have extensive experience that is highly relevant to the proposed research. This includes over 100 combined years of working in the AT field (all partners), 100 combined years of conducting research (Roberts, Jenson, Lee, Blair, & Doerry), 60 combined years of developing computer/technology applications (Doerry, Jenson, & Roberts). A snapshot of this experience and roles, as defined for the proposed project, follow.

Principal Investigator

Kelly D. Roberts, PhD, PI/Executive Director and Professor, IHD (Y1, 10%, Y2, 10%, Y3,10%). Dr. Roberts will direct project activities across the three partnering sites and advisory panel and participants. Dr. Roberts is the Executive Director of the Institute for Human

Development and a Professor of Education at Northern Arizona University (NAU). She has over 24 years of experience working in higher education as a researcher, evaluator, instructor, curricula developer, and administrator. In addition, she has over 25 years of experience working in the AT field having started this aspect of her career in the late 1980s in a k-12 school district (using Apple II GSs) and becoming a RESNA Certified AT Practitioner in the late 1990s. In addition, her dissertation was on the use of Voice Recognition software and she has conducted extensive research on the use of text-to-speech software. She has also assisted in the development of curricula-based applications associated with Teen Health Education. Her knowledge, skills, and background make her highly qualified to guide implementation and completion of the proposed project activities. Dr. Roberts has served as PI on over 15 research and demonstration grants targeting traditionally underrepresented groups including Hawaiians, Pacific Islanders, and Native Americans. She has served as Chair of the Association of University Centers on Disabilities Council of Research and Evaluation and on its Board of Directors.

Dr. Roberts is currently the Principal Investigator (PI) of the State of Arizona Technology Act Project – Arizona Technology Access Program (AzTAP). At the PI she oversees the operations and annual work scope. She supports the extensive work the AzTAP team performs across the state and is working to extend internet/virtually based activities across the state. Dr. Roberts is also the PI for the Office of Special Education and Rehabilitative Services, U.S. Department of Education Rehabilitation Services Administration funded cooperative agreement entitled – American Indian Vocational Rehabilitation Training and Technical Assistance Center (AIVRTTAC). Leading this project has provided greater understanding of the barriers faced by Native American across the country. It has also expanded Dr. Roberts' network of national

collaborators which will be leverage to recruit participants and support dissemination. In addition to other roles Dr. Roberts is the PI on the University Centers on Excellence in Developmental Disabilities and thus has access to the vast network on 67 such centers which will be leveraged for recruitment and dissemination.

Project Director/AT Content Lead

Jill S. Pleasant, MA, OTR/L, IHD (Y1, 50%, Y2, 50%, Y3, 50%). Ms. Pleasant will direct project activities at IHD and will provide oversight and coordination of the AT content development components. Ms. Pleasant is the Associate Director for the Institute for Human Development (IHD) at Northern Arizona University – a University Center for Excellence in Developmental Disabilities. She has provided 17 years of leadership, oversight and fiscal management for IHD’s AT related programs. These initiatives include the Arizona Technology Access Program (Arizona’s designated AT Act program), and management of AT contracts with state agencies including the Arizona Department of Education, the Division of Developmental Disabilities and Rehabilitation Services Administration. She has also successfully designed and implemented grant projects funded by private foundations including the Christopher and Dana Reeve Foundation. She has been responsible for successfully coordinating 18 statewide AT conferences.

Ms. Pleasant has a BS in Occupational Therapy from New York University, an MA in Educational Leadership from the University of Central Florida and a Certificate in Assistive Technology Applications from California State University, Northridge. She is an Arizona licensed occupational therapist (OT), providing OT and AT services to persons in diverse environments across the age and disability spectrum. She has presented on a range of AT topics at local, regional and national conferences in the US and in Asia and the Pacific Basin. She is the

co-author of a chapter in Helal, A; Mokhtari, M; Abdulrazak, B., The engineering handbook of smart technology for aging, disability and Independence (2008) Wiley. Ms. Pleasant is an appointed member of the Arizona State Rehabilitation Council (SRC) and a Commissioner for the Phoenix Mayor's Commission on Disability Issues.

Research and Technology/App Development Lead

Ronda Jenson, PhD, Associate Professor, IHD (Summer: Y1, 55%, Y2, 40%, Y3, 40%). Dr. Jenson is an Associate Professor with appointments in Psychological Sciences and Education Specialties at Northern Arizona University (NAU). She is also the Research Director at the NAU Institute for Human Development (NAU-IHD). Additionally, Dr. Jenson is currently the Chair of the Association of University Centers of Excellence in Disabilities (AUCD) Council on Research and Evaluation (CORE) and an AUCD Board member. Her professional background is in the field of special education, implementation science, accessible data visualization, and evaluation of systems and collective impact. As a leader in research and evaluation, she has experience developing technologies that bridge research to practice by providing interactive platforms for assessing needs, identifying solutions for improving practice, and integrating opportunities for accessing resources and support. Examples include using the robust features of readily available software (Adobe, Excel, and embedded macros) as well as working with programmers who use web-based technologies to build new software such as the Self-Assessment Practice Profile platform that is currently undergoing the licensing process in collaboration with NAU Innovations.

AT Team Field Lead

Clayton Guffey, MSW, CRC, ATP, CEAC, IHD (Y1, 25%, Y2, 25%, Y3, 10%). Mr. Guffey will support Dr. Roberts, Ms. Pleasant, and the project team in the identification of AT resources

as aligned with disability type and function, tasks, and environments. He will also assist with field-based data collection.

Mr. Guffey is the Interim Program Director for AzTAP and has been an Assistive Technology Specialist at AzTAP since 2007. He has more than 25 years of direct experience working with persons with disabilities of all types and ages on the assessment and implementation across the broad range of AT. He brings a vast amount of content expertise related to AT device selection, implementation, and funding strategies. He is an experienced group trainer on AT devices and its role in the lives of persons with disabilities and their families. He developed and implemented AzTAP's AT Demonstration and Loan programs, the Arizona Durable Medical Equipment & AT Reuse Coalition website and spearheaded major revisions to the Arizona AT Exchange website. Mr. Guffey has established strong working relationships with many community-based disability and service provider organizations. He has an MSW, is a RESNA credentialed AT Professional (ATP), a Certified Rehabilitation Counselor (CRC) and is also a Certified Environmental Access Consultant (CEAC).

Data Manager and Analyst

Michele Lee, M.A., IHD (Y1, 40%, Y2, 40%, Y3, 40%). Ms. Lee is a Research Associate, Senior at the NAU-IHD. Ms. Lee holds a master's degree in Psychological Sciences and professional strengths in the areas of statistics, social networks and modeling, as well as collaborative projects spanning multiple universities. Ms. Lee will be responsible for the ongoing data collection and facilitating the formative evaluation with the Advisory Group.

App Development Consultant

Eckehard Doerry, PhD, Professor, NAU (Summer: Y1, 15%, Y2, 15%, Y3, 15%). Dr. Doerry is a Professor of Computer Science, School of Informatics, Computing and Cyber Systems

College of Engineering, Informatics, and Applied Sciences at Northern Arizona University. He has served in this capacity since 1999. His primary Research Areas include Task-oriented Online Communities, Research Informatics, Health Informatics, Internationalized STEM education, and User Interface Design and Evaluation. Additional research interests (see publications in CV) address knowledge-based tutoring systems, artificial intelligence, interface construction tools and techniques, and software engineering and object-oriented languages. His academic background includes his PhD in Computer and Information Sciences, University of Oregon, an M.S. in Computer Science, University of Oregon, B.S. in Computer Science and Engineering and B.S. Mathematics, Northern Arizona University.

Project Support Team

Providing support to the project is a collaborative team of individuals with targeted expertise. Jodi Arnold, UX Designer, brings to the project her training and experience in graphic design, data visualization, website design and accessible design. Additionally, as a parent of an adult son with disabilities who uses assistive technologies, she brings experience as an advocate for and user of technologies to the project.

John McDermott supports the project through his experience as Dissemination Coordinator and web master for IHD. He is well-versed in multiple forms of and platforms for dissemination. He is also highly skilled in making all products accessible and meeting all ADA and 508 standards for electronic media accessibility.

Nicholas Blum will provide day-to-day coordination of project activities. As a keen writer, communicator, and a person who is highly knowledgeable of NAU policies and practices, he will assure project activities occur seamlessly across the multiple collaborating sites.

Collaborators

Marty Blair, PhD, Executive Director, Rural Institute for Inclusive Communities, University of Montana. Dr. Blair is well versed in both AT and research. He will lead the recruitment and data collection throughout Montana. He will work closely with the project team to assure that data collected are relevant to the development and usefulness of the App. Dr. Blair is the Executive Director of the University of the Montana Rural Institute at the University of Montana in Missoula. He has been in this role since 2013. He is also an Associate Professor in the Department of Teaching and Learning, Phyllis J. Washington College of Education and Human Development at the University of Montana, Missoula.

His past leadership activities include: Program Director of the Utah Assistive Technology Program, from 1996-2011; and Associate Director of the Center for Technical Assistance for Excellence in Special Education (TAESE), Center for Persons with Disabilities, College of Education and Human Services, at Utah State University, Logan, UT. From 2008 to 2013. Presently he is a Member At-Large of the Board of Directors for the Association of University Centers on Disabilities, Silver Spring, MD. And Co-Chair of the Public Policy Committee of the AUCD, and Member, Montana Council on Developmental Disabilities, Helena, MT. He is also a Member, Editorial Board for Assistive Technology, RESNA, Washington, DC.

Molly Kimmel, MOT, OTR/L, Program Director, MonTECH, Rural Institute for Inclusive Communities, University of Montana. Ms. Kimmel will work closely with Dr. Blair on recruitment and data collection activities in Montana and serve on the Advisory Group. Aligned with her expertise she will also assist with AT identification associated with disability types and functional needs. As the MonTECH Program Director, Ms. Kimmel oversees the provision of AT support and services that focus on improving the quality of life for individuals with disabilities across the state. She is also the Montana State Coordinator and Occupational Therapy

Core Faculty for URLEND (Utah Regional Leadership and Education in Neurodevelopmental Disabilities) where she facilitates interdisciplinary, family-centered, evidence-based training for healthcare and education graduate students and professionals. As an Occupational therapist, she has nine years' experience developing and carrying out treatment plans, connecting clients and families with AT and community resources, and is a certified Stroke Rehabilitation Specialist.

Laura E. Plummer, MA, CRC, ATP, Program Coordinator, WisTech (Wisconsin's AT Act Program). Ms. Plummer will be the primary contact and lead the recruitment of participants and the conduct of data collection throughout Wisconsin. She will also assist with AT identification associated with disability types and functional needs. Ms. Plummer is the Assistive Technology Program Coordinator for the WisTech (Wisconsin's AT Act Program), Wisloan, and ICanConnect programs administered through the Wisconsin Department of Health Services. She provides project management, oversight, and program collaboration and development to build statewide capacity for AT services. She also facilitates and provides statewide AT trainings. She has 15 years' experience as Resource Coordinator for the Center for Independent Living for Western Wisconsin where she was responsible for providing independent living services for a cross disability caseload, serving as specialist in deafness, hearing loss, and deaf-blindness and had extensive experience with community awareness and public education trainings.

Additionally, she organized and implemented the Universal Service Fund Non-Profit Access Grant for three years. More recently, she developed, implemented and coordinated technology solutions for students, teachers, and families throughout Wisconsin's K-12 public education system. She has consulted with IHD on several AT projects. Her undergraduate and master's degrees are in Communicative Disorders with emphasis on Deafness Rehabilitation Counseling. She holds certifications as an AT Practitioner (ATP) and Certified Rehabilitation Counselor

(CRC). She is also an Adjunct Professor, University of Wisconsin Stout – Rehabilitation and Counseling Department.

Advisory Panel/Workgroup

AT@Home will rely on input from its Advisory Panel/Workgroup members to guide the work of the project team and ensure that activities and products accurately reflect the needs of the target population while integrating best practices and state of the art AT information. In addition to the previously identified staff and consultants with subject matter expertise, Letters of Commitment to serve on the Advisory Panel/Workgroup are provided from: Kathy Laurin, Ph.D., Cheryl Belitsky, PT, MSc, Jodi Lindstrom, OTR/L. These individuals, respectively, bring subject matter expertise and clinical experience in AT leadership; rural service delivery; technical assistance and rehabilitation counseling (Laurin); physical therapy and AT leadership (Belitsky); and occupational therapy and AT implementation in home health settings for older adults (Lindstrom). As a value-added component, they will bring personal/family member perspectives on aging to the process.

Other organizations and individuals who have agreed to serve as advisors include representatives from Arizona's Department of Aging and Adult Services, the Arizona Division of Developmental Disabilities, and Ability360, Arizona's largest and most comprehensive Center for Independent Living. Scott Lindbloom, a disability advocate and an individual with a developmental disability residing in rural, northern Arizona, will also participate on the Advisory Panel/Workgroup. Project collaborators have agreed to recruit additional rotating members in Arizona, New Mexico, Montana, and Wisconsin.

Inclusion of Traditionally Underrepresented Groups

NAU does not discriminate on the basis of sex, race, color, age, national origin, religion, sexual orientation, disability, veteran status, gender identity, or other protected status. NAU is committed to affirmative action (<https://in.nau.edu/eao>). The Northern Arizona University, Institute for Human Development is committed to employing, and advancing in employment, individuals with disabilities and persons from traditionally underrepresented groups. As an example, one NAU-IHD employee/lecturer has severe cerebral palsy and uses a wheelchair and other AT. NAU-IHD has a history of employing persons with disabilities and/or those from culturally diverse backgrounds. Out of NAU-IHD's current employees, many are people with (visible and non-visible) disabilities and/or people of color. In addition, there are numerous employees who have family members with disabilities. AT@Home will make positive efforts to employ, and advance in employment, qualified individuals with disabilities.

In addition, the proposed project specifically includes individuals with disabilities and individuals from tribal communities, both of which are traditionally underrepresented groups in terms of access to AT and infrastructure that supports technology (e.g., funding).

H. Adequacy and Accessibility of Resources

H. 1. Applicant is committed to provide adequate facilities, equipment, other resources, including administrative support, and laboratories.

Lead: Northern Arizona University-Institute for Human Development (NAU-IHD)

The Northern Arizona University-Institute for Human Development (NAU-IHD) is a University Center of Excellence in Developmental Disabilities (UCEDD), one of two in the state of Arizona. IHD has more than sixty faculty and staff. It is an interdisciplinary unit working across a range of university departments, research institutes, community agencies, consumer advocacy groups, and state departments on projects that impact the delivery of services and

supports to persons with disabilities. IHD has two labs/clinic –the Genetic and Developmental Disabilities Research Lab, and the AT Lab.

NAU-IHD leaders are committed to providing adequate facilities, equipment, administrative assistance, and other resources to ensure the success of the proposed project. The IHD occupies over 18,000 square feet of space located on the campus of NAU with satellite program sites in Phoenix and Tucson. This space is dedicated to IHD for instructional, research, training, and dissemination activities and is used primarily for housing faculty, staff, and trainees. The facility is fully accessible to individuals with disabilities, including accessible doors and restrooms, a TTY line, and accessible workstations and computers. IHD faculty, staff, and trainees have offices, computer workstations, e-mail and Internet access. In addition, web sites maintained by IHD meet government and industry standards for accessibility.

NAU provides 24-hour a day computer information and technical (IT) support services. The NAU Cline Library provides access to research databases and materials. NAU also provides statistical software packages. The NAU Disability Resources Office supports the full inclusion of persons with disabilities in the NAU community. IHD personnel work with Disability Resources Office to promote a universally designed environment and full accessibility for the benefit of students, faculty, staff, and the campus community. The Equity and Access Office works with members of the NAU community to ensure that the university is meeting the letter and spirit of its legal obligations including obligations to persons with disabilities.

Laboratory: The Institute for Human Development (IHD) provides its staff with a clinic room with two additional observation rooms. The clinic is equipped with state-of-the-art video and audio recording and storage capabilities. In addition, the IHD has a large classroom and two conference rooms available.

Computer: Northern Arizona University (NAU) has completely networked computer systems that are available to all personnel for scientific writing, editing, email, data storage, data analyses and graphics visualizations. Computers used for data storage and analysis are secured through server security measures as well as computer-based security measures. Computers are equipped with appropriate software for statistical analyses. All personnel have access to online literature databases via internet connection.

Office: All personnel have individual and fully furnished offices.

Assistive Technology Program: The Arizona Technology Access Program (AzTAP) a constituent program of IHD since 1994 is Arizona's Governor-designated Assistive Technology Act Program. Physically located in Phoenix, but providing statewide AT services, the fully accessible AzTAP office consists of more than 5,500 square feet of space and has nine staff members who bring AT expertise, credentials and perspectives across different health and human services disciplines. AzTAP delivers robust AT activities consistent with the core services required under the AT Act: Information and Assistance, Device Demonstrations, Short term Device loans, Equipment Reuse Initiatives, State Funding Activities, and Training and Technical Assistance. AzTAP maintains and continually updates its inventory of more than 7500 AT devices and products. While AzTAP's services have traditionally been offered through in-person, email and phone options, due to recent events, AzTAP along with other IHD programs, has successfully navigated the transition to delivering virtual services through telepresence formats when appropriate. Although AzTAP services are available to stakeholders across the age and disability spectrum, AzTAP consumers often include older adults and adults who are aging with longstanding disabilities and the family members who support them.

Other: NAU is a four-year, public, primarily residential university located in Flagstaff, Arizona. It is an R2: Doctoral Universities – High Research Activity institution, under the Carnegie Classification of Institutions of Higher Education (Basic Classification, 2018). It is accredited by the Higher Learning Commission and has 21 sites across the state or online. NAU is an Associate Member of the Hispanic Association of Colleges and Universities, as well as having the Yuma branch designated as a Hispanic-Serving Institution (HIS).

In the Fall of 2019, NAU enrolled 22,390 students at the Flagstaff Mountain campus and 8,346 students off campus at satellite sites and online. There are currently 17 Doctorate programs, 62 Masters programs, 34 graduate Certificates, 44 undergraduate Certificates and 94 Baccalaureate programs. In addition to the above resources, NAU offers the full range of educational resources typical of many well-equipped universities, such as an extensive library, computer labs, instructional technology services, curriculum library, and facilities for conducting workshops and training.

Collaborator: University of Montana, Rural Institute

Since 1978, The Rural Institute has functioned as a research unit under the University of Montana Vice President for Research and Creative Scholarship. As one of 67 University Centers for Excellence in Developmental Disabilities Education, Research and Services or UCEDDs, the Rural Institute's current fiscal year budget is just over \$5 million, with half dedicated to regional and national research initiatives. The Rural Institute engages in research, provides education and interdisciplinary training, and develops model services that improve the skills, abilities, quality of life and satisfaction of people with disabilities in rural communities nationwide, their families and those who support and partner with them. Approximately 50 projects and programs are administered by interdisciplinary research faculty and staff.

The Rural Institute is undergirded by the following values: (a) respectful partnership, (b) informed leadership and (c) evidence-based agenda-setting. The Institute relies on three advisory bodies to ensure consumer responsiveness of its projects and programs: a self-advocate-majority Consumer Advisory Council, an Academic Advisory Council comprised of several University of Montana deans, and the governor-appointed Montana Developmental Disabilities Council. This project is consistent with recent federally-funded research conducted by the Institute's Research and Training Center on Disability in Rural Communities, or RTC: Rural.

Collaborator: Wisconsin

WisTech, Wisconsin's statewide AT program, was established in 1991 following passage of the Assistive Technology Act. The program is managed within the Department of Health Services, Bureau on Aging and Disability Resources, and the Office for the Promotion of Independent Living. WisTech subcontracts with the eight Independent Living Centers, the University of Wisconsin – Madison, and the Department of Corrections for the state level activities of the AT Act. These include device demonstration, device loan, device reutilization, and alternative financing. Staff from DHS also manage additional programs such as the iCanConnect National Deafblind Equipment Distribution, the AT Kit program with the Aging and Disability Resource Centers and serves as the designated state entity for independent living services funded under the Administration for Community Living. The structure of the Bureau on Aging and Disability Resources ensures collaboration among federal and state funded programs for people with disabilities and senior citizens.

H. 2. Facilities, equipment, and other resources are appropriately accessible to individuals with disabilities who may use the facilities, equipment, and other resources of the project.

As an institute that focuses on disabilities IHD personnel make it a high priority to assure that all facilities, equipment, and other resources are fully accessible to individuals with disabilities. The IHD office has automatic doors and ramps alongside all stairs making it fully accessible to individuals with mobility impairments. Other examples of accessibility features that are continually provided include live captioning and American Sign Language interpreters for live webinars, materials available in multiple formats (large print, Braille), website accessibility, and of course more customized AT available for those who need it. In addition, when looking to hold events in locations other than NAU or IHD, venue personnel are fully aware and educated as to the needs to assure that all facilities and activities are accessible.