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## INCREASING THE ACCESSIBILITY OF ASSISTIVE TECHNOLOGY AT SEVEN HILLS FOUNDATION

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## **ABSTRACT**

Finding the right assistive technology (AT) to best accommodate a person with a disability can be challenging. To help the staff at the Seven Hills Foundation assist their participants, we developed an AT database and an accompanying search tool. This was done through a stakeholder analysis to determine how to best meet the needs of the staff and through rigorous development cycles and testing. The database and web interface we developed is fully functional and includes a search function, an add solution form, and a solution of the day feature. We recommend further development of the database, including adding more solutions and fine tuning the search functionality. We also made additional recommendations to expand the use of existing AT at Seven Hills.

## **ACKNOWLEDGEMENTS**

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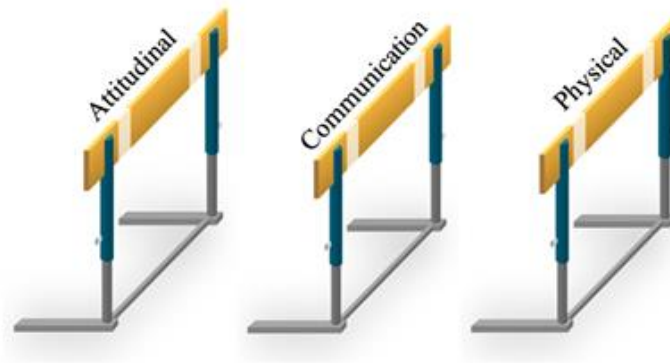
## EXECUTIVE SUMMARY

### Accessible AT Helps Individuals with Disabilities to Overcome Barriers



*Figure 1: Participants using Assistive Technology*

People with disabilities face many barriers that can prevent them from leading fully independent and fulfilling lives (Center for Disease Control and Prevention (CDC), 2015). Assistive technology (AT) includes “any item, piece of equipment or product system, whether acquired commercially or modified, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities” (Field & Jette, 2007, p. 186-187). AT can help people with disabilities overcome the different barriers, such as those shown in Figure 2, which they face in their daily lives. There is a wide range of AT devices that can help people with disabilities, including low-tech devices such as canes, walkers, magnifying glasses as well as high-tech devices including automatic wheelchairs and iPads. In order for assistive technology to best help the intended user, it needs to be accessible.



*Figure 2: Barriers Faced by Individuals with Disabilities (Center for Disease Control (CDC), 2015).*

Accessibility of assistive technology encompasses all the essential factors that contribute to the development of a successful device, such as availability and usability (Booth, 2012). Assistive technology is designed with accessibility in mind, but, oftentimes it is still difficult hard for users to find assistive technology that suits them. Additionally, there is a high abandonment rate among users of assistive technology. Abandonment is the discontinued use of an assistive technology that can lead to disillusionment with future technology (Kintsch & DePaula, 2002). “Assistive technology tools are expensive and the abandonment rate is an inefficient use of a finite service system that results in a loss of potential, freedom, and independence” (p. 2).

In order to increase both the availability and usability of assistive technology at the Seven Hills Foundation, our team of Worcester Polytechnic Institute student researchers, working through the Worcester Community Project Center, developed a database that catalogues both commercially available and do-it-yourself AT solutions that are available at Seven Hills.

### **Stakeholder Analysis and AT Kit Evaluation**

In order to ensure that the AT database would successfully assist staff in finding assistive technology solutions, we first conducted a stakeholder analysis. This included research regarding the care of the

participants at Seven Hills and the challenges they face, as well as working with the staff to discover their needs. We interviewed eight staff members at various Seven Hills' programs, surveyed forty-two staff members, and conducted participatory observation at various Seven Hills locations.

Over the course of this evaluation, we found that **the biggest detriment to the usage of assistive technology was time constraints of the staff.** Five of the nine staff members that were in charge of an existing low-tech assistive technology kit did not have time to search through Therese Willkomm's manual, *Assistive Technology in Minutes: Book 2*, included within the Kit to find solutions. A group of WPI student researchers developed the Kit, in March 2015, to provide the staff at Seven Hills the necessary tools to assemble a variety of low cost AT devices, suitable for a multitude of disabilities (Valley et al., 2015). The staff members also lacked the time to figure out how to assemble solutions from the Kit. An AT database would make it possible for the staff to quickly share AT solutions to all Seven Hills locations, facilitating a collaborative effort that promotes the growth of new ideas and the development of existing ideas. This research also helped us to develop features in the AT database that would be useful for the staff at Seven Hills.

Next, we evaluated the existing low-tech assistive technology kit that was being used at Seven Hills. We found various problems with the Kit. **Problems with the existing Kit include difficulty finding effective solutions, high cost of and lack of materials, and the short term nature of all solutions created by the Kit.** From these findings, we recommend that (1) Seven Hills give more information to their staff about how to replace materials in the Kit, and (2) design an expansion pack for the Kit containing materials that are used often.

## **Database Design and Implementation**

Next, we designed the AT database using **MySQL, a user-friendly, free, database management system (DBMS) that has a large capacity and can be easily accessed through a web application.** MySQL was an appropriate platform for the database because it is built on the relational model of database organization and our team members had previous experience working with it. MySQL is a powerful database management system that can hold large amounts of data and is designed to be used, accessed, and connected to by many users at once ("Top Reasons to Use MySQL", 2016). Additionally, it comes with its own server hosting software, making it easy to connect to the database with the interfacing application. We then referenced our interviews with Seven Hills' staff and experts in database creation; including Roger Donahue, WPI Database Administrator, Mohamed Eltabakh, Assistant Professor of Computer Science at WPI, and Andy Roberts, a data architect at Microsoft, to decide upon a list of entities, or objects, held in the database.

**We determined that the database needed to include the solution, material, category, and comment entities.** The solution and material entities would make it easy to find solutions and what materials were necessary to build the solution, while the categories would make the database easily searchable. Pictures would show staff members how a device is built and functions, and finally comments would make it easy for staff members to share information about the solutions they've built and modifications they have made to existing solutions. The solution page on our web interface

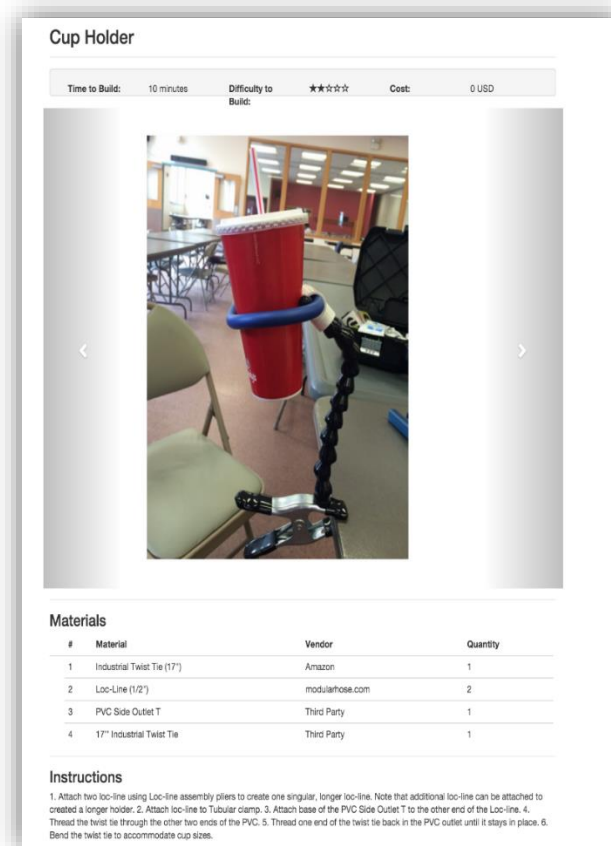


Figure 3: Example Solution Page

is shown in Figure 3. At first we believed that a rating system would help differentiate solutions. However, we learned from Benjamin Marshall, Case Manager at the Seven Hills Adult Day Health Program, that low rankings might act as a deterrent to using a solution, and a solution that did not work well for one individual might work well for another. These entities needed to be populated for the database to be useful for the staff at Seven Hills. In the time we had, we populated the database with approximately 76 solutions. Having additional solutions in the database will provide the staff at Seven Hills more options, and as a result, **we recommend that the staff at Seven Hills continue to populate the database with AT solutions.** Based on our research of various databases and our interviews with organizations such as Easter Seals, we learned about a number of useful sources to populate the database, such as, at4all.com, atsolutions.org, abledata.com, and instructables.com.



Discovering what tags/categories would best benefit the users of the database was a major part of the development process. As a result of the interviews we conducted with staff members at various Seven Hills locations, we learned that **AT solutions regarding activities of daily living and recreation were the most frequently used type of AT** (Alissa Rivard, Taylor Johnson, Benjamin Marshall, Hellen Bushard, & Joseph Plaisance, personal communications, March and April 2016). Therefore, we created *activities of daily living* and *recreation* activities as umbrella categories for the database.

Additionally, **in recognition of the individualized nature in identifying the appropriate AT solution for a participant, we developed categories related to functional abilities and limitations.** These included tagging whether a device required high mobility, or a light touch, etc. Finally, **we added a tag for whether a device was low or high cost, in order for the staff to easily search for solutions that met their budget.** The database also supports the functionality of users adding their own tag. One problem created by the *add categories* feature would be database clutter. If a user makes a typo, for example typing in “Recreation” instead of the already existing “Recreation” tag, both categories are now located in the database. To alleviate this problem, **we recommend implementing a dictionary check when submitting new tags to prevent duplication.**

### **Web-based Interface Design and Implementation**

According to Domenic Smarra, the Chief Technology Officer at Seven Hills, the staff at Seven Hills have various degrees of technical knowledge and may find it difficult accessing a database directly through SQL commands. Therefore, it was necessary for us to develop a web application that will convert graphical buttons and search functions into queries onto the database, allowing everyone to use and access the AT database.

In order to access this database, we built a web-based interface that would allow staff to search the AT database, add their own solutions, and comment on existing solutions. This interface used **MEAN which is a lightweight, fast and flexible web development framework**. MEAN stands for MongoDB or MySQL database, ExpressJS web framework, AngularJS participant-side framework, and NodeJS web server (Hightower, 2016). This website included a search bar for solutions, an add solution form, and a solution of the day feature.

The interface's search function worked through simple substrings, which means it looks for any keyword entered in either the solution name, description, or tags and returns any matching solutions. This solution is limited in searching power, as it limits users to their own keywords and can give bad results. For example, searching for "eating" might return a result that aids with "seating" because the word "seating" contains the word "eating". Thus, **we recommend improvements to the search functionality of the website, perhaps through the use of an established search engine**.

The add solution form allows users to add their own AT solutions to the database. It was necessary for the add solution form to include all the information we included in the database, so that there would not be any empty fields in the database. This also included usability testing of the interface in order to ensure it was easy to input complex forms such as materials, where there may be multiple new materials, all including a vendor and quantity (Duvall, Matyas, & Glover, 2007). Finally, **the "Solution of the Day" function allows the users of the database to find solutions that they originally may not have thought to search for**. This widens the availability of assistive technology by exposing users to additional solutions they are not aware of.

## **Training the Staff to Use the Database**

The final step in the creation of the AT database was training the staff at Seven Hills to use the database. We held two in-person training sessions at the Worcester Day Habilitation (WDH) and Adult Day Health (ADH) programs, as well as online Zoom Conference training sessions with the AT Super Users. We also developed **a brief, descriptive instruction manual to help the staff learn how to operate the database.** The staff involved in the training sessions enjoyed the ease with which they could find solutions, as well as the information provided on each solution. One staff member said, “I feel this will definitely help everyone find information easier,” and three individuals commented that they were looking forward to using the database (Survey of the Staff’s Level of Comfort and Exposure to Different Types of Technology, April 2016). **We recommend that Seven Hills conduct additional training sessions in the future, to share the database with other programs at Seven Hills.** In addition, follow-up sessions for those that request them, could be provided by the AT Super Users. Overall the staff at Seven Hills see the database as useful and are receptive to working with it.

## **Conclusion**

Individuals with disabilities face many obstacles, which can lead to reduced independence and quality of life. Assistive technology devices are tools that can be used to overcome the challenges people with disabilities face. Over the course of our project, we created a database and web application to increase the accessibility of assistive technology at the Seven Hills Foundation. This database, when in use, will increase both the availability and usability of assistive technology, which are the two main factors of accessibility. First, the availability of assistive technology will increase as more participants learn about the options available to them. The database will also increase the usability of AT Solutions, as the

instructions for building and using solutions will be easily available through the database. We hope that our project will better the lives of the participants at Seven Hills through increased independence and quality of life.

## KEY TERMS

**Availability:** *Whether an individual knows about, can access, and can afford assistive technology.*

**Usability:** *Pertains to the ability of an individual to make use of available assistive technology.*

**Developmental Disability:** *A disability that forms during childhood that can impair physical or mental ability, learning, or behavior.*

**Cognitive Disability:** *A disability that affects cognitive behavior; can be a subset of Developmental Disabilities.*

**Physical Disability:** *A disability that affects physical behavior; can be a subset of Developmental Disabilities.*

**Assistive Technology:** *Any item that can be used to increase or improve the functional capabilities of individuals with disabilities.*

**Seven Hills Foundation:** *A non-for profit organization that provides support for children and adults with disabilities.*

**Trialability:** *A measure of how capable of being tested something is, in our case, assistive technology.*

**Relative Advantage:** *A measure of the advantage of a piece of technology relative to the state in which the technology is not being used.*

**Uptake:** *The action of taking up or making use of an available AT device.*

**Technology Acceptance Model (TAM):** *Theory that models a user's acceptability of technology.*

**Entity Relationship Diagram (ERD):** *Graphical representation used to show the relationships between different types of entities contained within an information system.*

**Relational Model:** *Organizational method used to create a database that specifies data and queries.*

**Graphical User Interface (GUI):** *Uses visual indicators to interact with electronic devices.*

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## **1. INTRODUCTION**

According to the Center for Disease Control and Prevention, approximately nine percent of the United States population has some form of cognitive disability (CDC-Developmental Disabilities, 2014). People with cognitive disabilities experience problems related to attention, memory, judgment, reasoning, problem solving and comprehension (Valley et al., 2015, p. 4). They may also face learning challenges, such as a slower learning rate, less learned skills, an inability to learn through abstract concepts, and deficits in language, communication and relationships (Szymanski & Hanley-Maxwell, 1996). Forty-five percent of people with severe learning disabilities have hearing or visual impairments, and memory impairment is extremely common (Davies, 2008). These factors severely hinder an individual's ability to function on their own, and thus they have to rely on help from society.

A staff member at Seven Hills Foundation, a non-profit organization that provides support for children and adults with disabilities, stated, "We control the quality of life of these individuals, it is our job to give them a sense of choice and control to make their lives more meaningful and fulfilling" (Cynthia Greene, personal communication, April 2016).

Assistive technology (AT) is currently being used at numerous organizations in an attempt to help people with disabilities live more independent and fulfilling lives. Assistive technology is any item that can be used to increase or improve the functional capabilities of individuals with disabilities (Field & Jette, 2007). The Seven Hills Foundation is one such organization that utilizes AT in the rehabilitation and care of their participants. After hiring an AT Program Director in 2014, AT use has expanded and many Seven Hills programs have since implemented iPads and other AT devices to help individuals





Our project was intended to increase the accessibility of assistive technology at Seven Hills Foundation through the development of a database to act as an information resource to identify different assistive technology solutions for participants. We accomplished our goal by (1) Assessing the needs of the stakeholders at Seven Hills Foundation (2) Evaluating the status of the low-tech assistive technology kit (3) Researching AT solutions to include in the database (4) Developing a database to improve the accessibility of AT (5) Building a web-based data interface, and (6) Educating and training the Seven Hills staff to use the database.

This report chronicles how we accomplished our project goal. In the second chapter, our literature review, we provide important background information about the barriers faced by individuals with disabilities, the role and impact of assistive technology, how AT could be made more accessible, and finally, we address AT use at Seven Hills Foundation. In the third chapter, our methodology, we discuss how we accomplished our objectives. Finally, in the fourth and fifth chapter, we explain our project findings and recommendations in regards to the Kits and the development and implementation of the AT database and web application.

## 2. LITERATURE REVIEW

Assistive technology (AT) is “any item, piece of equipment or product system, whether acquired commercially or modified, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities” (Field & Jette, 2007, p. 186-187). Assistive technologies improve the quality of life and promote independence for people with developmental disabilities, whether cognitive, physical, or both. Figure 6 shows the major differences between these types of disabilities. Through the efforts of nonprofit organizations, like the Seven Hills Foundation, AT devices are reaching a wider array of individuals. Unfortunately, many AT devices are still inaccessible or unusable to the individuals that need them.

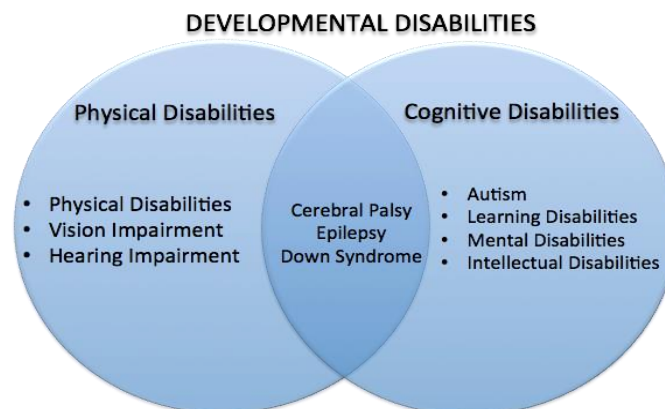


Figure 6: Venn Diagram of Developmental Disabilities (The Examiner, 2013)

This chapter examines the Barriers Faced by Individuals with Disabilities [\(2.1\)](#), as well as how those barriers can lead to reduced independence and quality of life. In [The Role and Impact of Assistive Technology \(2.2\)](#) we discuss how properly utilized assistive technology can help people with developmental disabilities overcome these barriers. Then we discuss the [Accessibility of Assistive Technology \(2.3\)](#), by exploring some of the factors involved in the usability and availability of AT devices, as well as the best practices for selecting AT. In [Successful Assistive Technology Programs \(2.4\)](#) we mention other organizations that have successfully utilized assistive technology in their

programs. Finally, we discuss the Seven Hills Foundation [\(2.5\)](#) and their efforts to address the accessibility of assistive technology.

## **2.1 Barriers Faced by Individuals with Developmental Disabilities**

People with disabilities face many barriers that can prevent them from leading fully independent and fulfilling lives (Center for Disease Control and Prevention (CDC), 2015). According to the Center for Disease Control & Prevention (2015), the three most common barriers to the inclusion of individuals with developmental disabilities are: *attitudinal barriers*, *communication barriers*, and *physical barriers*. *Attitudinal barriers* are both internal and external. They are created by another person's opinions, which includes discriminating against or stereotyping people with disabilities. As a result of external influences a person with disabilities may develop negative views about themselves. If a person does not believe that they can or should participate in society, they will not have the motivation to become a functioning member of society.

*Communication barriers* are encountered when someone's disability prevents them from hearing, speaking, reading, writing, and/or understanding normal discourse. These barriers can prevent people from understanding public health messages, getting a complete education, or effectively communicating with other people. *Physical barriers* hinder the mobility or access for people with disabilities. These barriers can be stairs or other obstacles that are impassable by someone using a wheelchair or a piece of health equipment that does not accommodate the needs of people with disabilities (Center for Disease Control and Prevention (CDC), 2015).

These *attitudinal, communication, and physical* barriers contribute to a reduced standard of living for people with disabilities. People with disabilities are at a much higher risk of leading unhealthy and unfulfilled lives. As illustrated in Figure 7, this may include, among other things, high unemployment rates, an increased risk of obesity, and a higher likelihood of being the victim of a violent crime

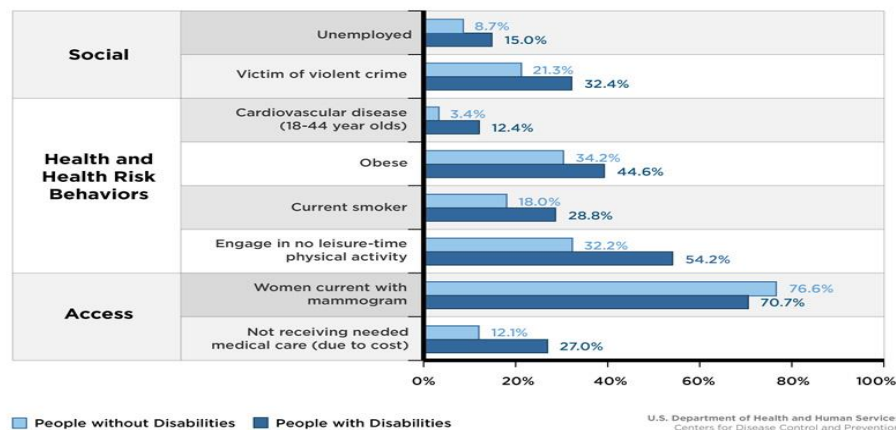


Figure 7: Factors Affecting the Health of People with Disabilities (Center for Disease Control & Prevention, 2015)

Associate Professors of Special Education at the University of New South Wales and The University of Sydney, respectively, Iva Strnadova and David Evans (2015), researched the foundation of these barriers. They proposed that discrimination of individuals with disabilities is a primary concern. According to Strnadova and Evans, stereotypes regarding the skills of people with disabilities are commonplace in the work environment. In addition to stereotyping, their research showed that the two main factors that limited the autonomy of individuals with disabilities were (1) individual factors that are difficult to change (health issues, implications of disability), and (2) environmental factors, such as living arrangements and difficulty managing finances (Strnadova & Evans, 2015).

Strnadova and Evans also researched challenges women with disabilities encounter, such as verbal harassment. One woman they interviewed discussed her brother-in-law, saying, “He’s not very nice to

me. He calls me a dummy because I've got a disability" (p. 14). Health problems were also an issue, especially for older people. When a disability is combined with something like arthritis, it can compound a person's ability to be mobile and independent. Additionally, mental health issues are more common in persons with cognitive disabilities. For example, Strnadova and Evans recorded an account of a woman who told them, "I've got depression. I can't work full-time because of my health. Two days is the maximum" (Strnadova & Evans, 2015, p. 14). These issues can cause people with disabilities to lose the will or the ability to seek out a career or job.

### 2.1.1 Career Development

Increasing the employability of people with developmental disabilities is critical to increasing their independence and quality of life. According to Edward Hall, Professor of Health and Social Sciences at Queen Mary Margaret University College, employment is a key indicator when measuring the social inclusion of people with learning disabilities (Hall, 2004). Addressing barriers to employment and career development is a key factor in helping individuals with disabilities to join and remain in the workforce.

According to a case study about the employment rates of individuals with disabilities in California performed by Patricia Yeager, CEO of The Independence Center in Colorado Springs, only 34.5 percent of 1,507 working-age respondents with cognitive disabilities had some form of employment. According to this study, people with disabilities found the top four barriers to employment to be: (1) the disability itself, (2) a lack of education, (3) problems with self-esteem, and (4) fear (Yeager et al., 2004).

Dr. Szymanski and Dr. Hanley-Maxwell, of the Department of Rehabilitation Psychology and Special Education at the University of Wisconsin-Madison, researched the career development of people with disabilities. Their research provided evidence that barriers to employment could be improved by addressing factors that affect the career development of people with developmental disabilities, which includes: the development of a 1) *work ethic*, 2) *formation of interests*, and 3) *the context of their environment* (Hanley-Maxwell & Szymanski, 1996).

For many people, *work ethic* is formed during their school years. Since most disabilities are present during early development, individuals with disabilities may be restricted from work opportunities, and may not develop these skills. Their disability could also reduce the quality of their experiences in early development which lead to the *formation of interests*, a crucial determinant in career development. The *context of the environment* of a person with disabilities can also affect career development (Hanley-Maxwell & Szymanski, 1996). For example, if an individual's family does not expect them to get a job, or their economic status does not allow access to the appropriate resources to gain employment, a person with disabilities will remain unemployed.

Assistive technology provides a way to overcome these barriers. Assistive technology also allows people with more severe disabilities to perform basic tasks. For people with less severe disabilities, assistive technology can allow individuals to integrate into the job market, allowing for greater independence. AT devices are also an essential part of the rehabilitation and care of individuals with disabilities.

## 2.2 The Role and Impact of Assistive Technology

There is a wide range of AT devices that can help people with disabilities. Technological breakthroughs are allowing for a new generation of high-tech AT devices, including automatic wheelchairs and iPads. These devices are impressive, but a low-tech device can oftentimes achieve the same effect as the high-tech version, and is often less expensive (Reichle, 2011). Examples of low-tech solutions include canes, walkers, magnifying glasses, and grab bars for toilets, as shown in Figure 8. These AT devices augment an individual's abilities or change the environment to best suit the individual's needs. Sometimes assistive technology involves a modification to an existing AT device. This form of technology is referred to as an "adaptive assistive device" (Field & Jette, 2007), and may include twist-tie modified marker grips, weighted utensils, and wheelchair attachments (Valley et al., 2015).



*Figure 8: Examples of Low-Tech Assistive Devices (clockwise from left): Toilet grab bars , magnifying glass, walker, pencil grip*

Adaptive assistive technology is useful in integrating individuals with disabilities into the workforce (Grott, 2015). For people with limited pinch grip or hand strength, handle and loop modifications to things such as brooms, files, and cabinets can allow people to more effectively perform their daily tasks. People with cognitive disabilities might benefit from AT solutions as simple as color coding files or using icons and pictures to represent tasks (Grott, 2015). According to Paul Gerber, Professor

of Dyslexia Studies at Virginia Commonwealth University, the adaptation of AT devices in the workplace may be done by analyzing the problem an individual faces, determining the simplest possible solution, and creating a prototype. The prototype then must undergo a trial and revision period. Finally, the user must be effectively trained on how to implement the device (Gerber, 2012).

For individuals with developmental disabilities, completing simple tasks and completely integrating into society can be extremely difficult. Individuals with disabilities often require assistive technologies to allow them to do normal tasks and to function independently. For example, a case study by David Goldsheyder et al. (2000), from the New York University School of Medicine, was conducted to find an AT solution to aid a 29-year old man with multiple, severe disabilities in using a toilet. In this study, the researchers identified that he struggled to use the toilet due to his posture and motor skills. Based on their findings, they designed and implemented a device that addressed his medical issues, allowing him to use the toilet more independently (Goldsheyder et al., 2000).

Assistive technology can lead to a better quality of life and reduced dependence on families and professional caregivers. Family caregivers may experience reduced physical and emotional stress, and less demanding caregiving responsibilities. This in turn can enable the caregiver to work outside the home, or to be more productive in their paid work. AT devices can allow children with disabilities to perform better educationally and can allow adults with disabilities to be more functional at work, which will benefit teachers, employers, and coworkers. Thus, the effective use of AT is a necessity that would benefit all aspects of society by reducing dependency and increasing productivity per worker and per member of society (Field & Jette, 2007).



## **2.3 Accessibility of Assistive Technology**

Accessible assistive technology encompasses all the essential factors that contribute to the development of a successful device such as availability and usability (Booth, 2012). Cost and lack of commercialization are the primary issues that affect the availability of AT devices. Assistive technology not designed with accessibility principles in mind are often abandoned by users. Currently, there is an alarmingly high abandonment rate among users of assistive technologies.

### 2.3.1 Availability of AT Solutions

The availability of assistive technology is one factor that determines its success. One aspect of availability, is market availability. According to Jerry Weisman, founder of Assistive Technology Solutions (ATS), “Due to the limited size of the assistive technology market, it is estimated that only five percent of devices developed for use by people with disabilities are commercialized and become available for purchase”(Weisman, 2014). There are many AT solutions being developed, but, many are custom-made and the information to construct the devices is not widely available (Weisman, 2014).

In addition to market availability, the current assistive technology industry sometimes overlooks the financial situation of its participants. Therefore it is important to examine the costs of different types of assistive technology to find the right AT solution for an individual. One study, performed by a Social Gerontology Professor at King’s Cross College and a Construction Management Professor at the University of Reading, examined the cost of modifications and AT solutions that would enable older people to remain in their homes. The study was performed to find areas of potential savings in formal care services. The primary finding was that there is a range of factors and costs to consider, and, at times, a more expensive option may promote better long-term savings in formal care services

(Tinker et al, 2005). Finding the right assistive technology is not just important from a financial perspective, usability and abandonment are also important considerations.

### 2.3.2 Usability and Abandonment of Assistive Technology

Abandonment is the discontinued use of an assistive technology that can lead to disillusionment with future technology (Kintsch & DePaula, 2002). Anja Kintsch and Rogerio DePaula (2002), members of the Interaction Design Foundation, claim that “Assistive technology tools are expensive and the abandonment rate is an inefficient use of a finite service system that results in a loss of potential, freedom, and independence” (p. 2).

The discontinuation of assistive technology devices is closely linked to dissatisfaction experienced by the user. Many AT experts, including Marti Riemer-Reiss, Counseling and Human Services Professor at Montana State University Billings, and Robbyn Wacker, Provost and Senior Vice President for the Division of Academic Affairs at the University of Northern Colorado have conducted studies to identify factors associated with assistive technology dissatisfaction and abandonment. Reiss and Wacker (2000) sampled 115 individuals with disabilities, who received 136 assistive technology devices to determine if factors such as the *relative advantage*, support, consumer involvement, *trialability*, changes in consumers, re-invention, and compatibility had a significant effect on determining abandonment. AT devices with a greater relative advantage, compatibility and trialability were most likely to be adopted and retained (Riemer-Reiss & Wacker, 2000, p. 45).

Additionally, one must fully understand the needs of the user in order to successfully implement and prevent the abandonment of an AT device. Many companies and organizations experience difficulty successfully integrating new technology due to the potential user’s perceived opinion of the usefulness

and usability of the proposed technology. The Technology Acceptance Model (TAM), shown in Figure 9 (Morris, 1997), is a popular model used to understand the reasoning behind a user's decision to accept or reject a new technology by graphically displaying the links between a user's perceived usefulness and ease of use (Marangunić & Granić, 2015). Using TAM may help companies to understand how they can best suit a user's needs and interests when introducing a new technology.

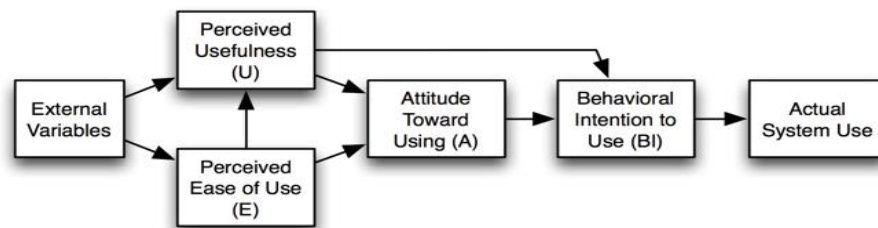


Figure 9: Process Diagram of the Technology Acceptance Model (TAM) ([https://en.wikipedia.org/wiki/Technology\\_acceptance\\_model](https://en.wikipedia.org/wiki/Technology_acceptance_model))

### 2.3.3 Success Factors in Implementing AT

In order to mitigate the high abandonment rates associated with assistive technology, many researchers have attempted to identify the underlying factors that would lead to successful implementation of AT. Ray Grott (2015), Director of Rehabilitation Engineering at San Francisco State University, suggests a stepwise implementation where you (1) identify the problem, (2) devise a solution (3) install and introduce the new device, (4) evaluate the success, and (5) make any necessary changes (Grott, 2015). The implementation process should be very thorough to promote the *uptake* of a new device.

Figure 10 shows a compilation of the most important success factors in promoting the *uptake* of a new AT device that will allow the developer to best suit the exact needs of a participant. By working together and developing good relationships between stakeholders, the designer can create a device that is more likely to succeed. By staying in contact with the user, the developer can make the user

aware of new, affordable technologies, while keeping the user's technologies current to enable them to better interface with technologies on the open market (Kintsch & DePaula, 2002).

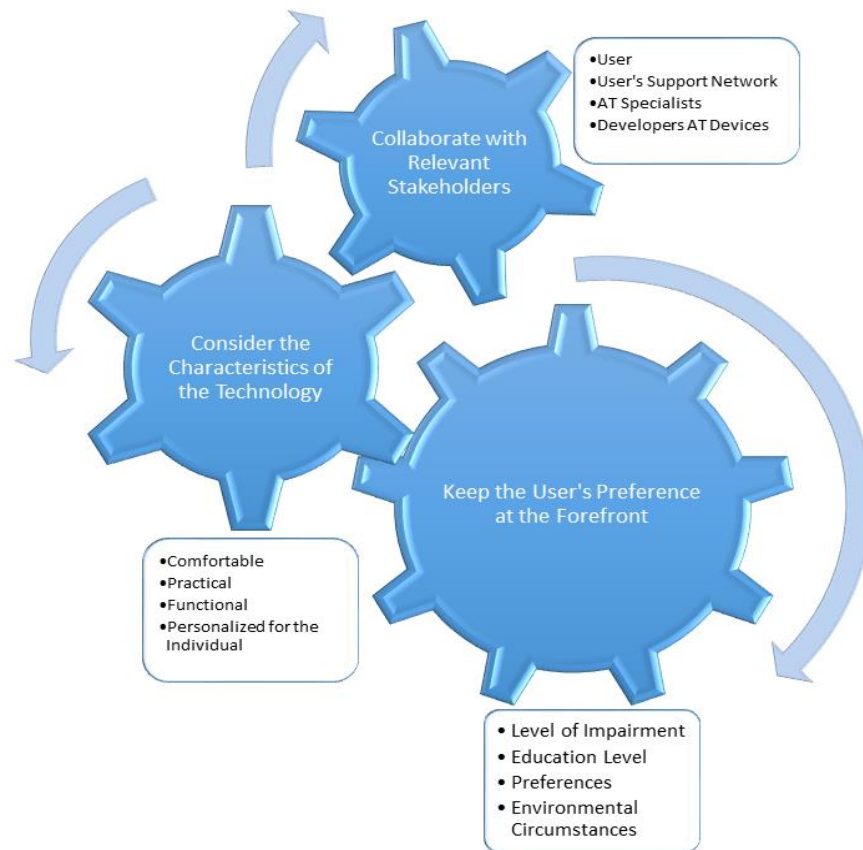


Figure 10: Components to Producing a Successful AT device (Kintsch & DePaula, 2002), (Field & Jette, 2007)

## 2.4 Successful Assistive Technology Programs

There are currently several organizations, such as Easter Seals and the Cotting School, that focus on finding solutions to match an individual's specific needs. These programs promote the *uptake* of new AT devices.

Easter Seals is a successful organization that can be used as a model for other assistive technology programs. Easter Seals works with individuals with disabilities to help them recognize their own skills

and interests, in the hopes of using technology to link their interests with their goals to become more independent. The different programs make a point to focus on the issues that interfere with their daily tasks and the skills that are necessary to succeed in the job force (Assistive Technology, 2016).

Due to the differing needs among individuals with disabilities, Easter Seals offers a Device Demonstration Program. The program allows participants or therapists to explore the different AT opportunities available and gives them the chance to test the equipment for up to four weeks. The program is free, which eliminates common financial barriers. Allowing individuals the opportunity to test equipment gives them an increased awareness about different AT devices and ensures participants purchase a device that meets their specific needs, eliminating the risk of buying a device that doesn't work (The Massachusetts Assistive Technology Loan Programs, 2016).

The Cotting School is another organization that effectively utilizes assistive technology. The Cotting School offers the Dorothy Pace Assistive Technology Assessment Center, which provides services to evaluate, test, and train participants in the use of AT devices. The Center helps each participant to identify which device would suit their needs most effectively. Staff members are also trained in the use of new AT devices in a large group followed by individualized training sessions for anyone who may benefit from the device; reducing the number of demo trainings and maximizing the benefits of new devices.

#### 2.5.1 Electronic Resources for Assistive Technology Programs in Massachusetts

One of the challenges faced by asset-based nonprofit organizations, such as the Cotting School, is the issue involving electronically accessing assistive technology solutions. There are numerous websites

and databases that are available to assist with the management of data regarding various materials, costs, solutions, or directions in relation to a particular assistive technology solution.

MassMatch, an initiative by the Commonwealth of Massachusetts, is one of the many state-level assistive technology programs partially funded by the federal government. MassMatch aims to promote the use of AT and to increase the independence of participants who use AT. "Through partnerships with community-based organizations, MassMatch is currently creating new AT programs and working to coordinate AT services throughout the Commonwealth" (MassMatch, 2016). The MassMatch website contains two functionalities meant to make finding assistive technology easier including an easy to use "Find Your AT" functionality, which allows users to test and borrow assistive technology through various loan and reuse programs, as well as a searchable database in order to find assistive technology solutions.

## **2.5 Seven Hills Foundation**

Seven Hills Foundation is a non-profit organization that is committed to helping individuals with disabilities or crippling ailments to succeed through the support of clinical, educational, and behavioral health services. Their programs emphasize the importance of life and career development skills in order to promote a higher degree of independence among individuals with disabilities. Assistive technology is essential to the success of these services and programs, and Seven Hills is working to expand their current assistive technology to help more individuals (Assistive Technology, 2015).

#### 2.4.2 The Future of Assistive Technology at Seven Hills

The future success of Seven Hills Foundation is demonstrated by their commitment to offer numerous programs that provide training, education, and various other resources. The staff at Seven Hills Foundation is so dedicated to increasing the accessibility and usability of AT solutions at Seven Hills, that in 2015, the AT Program Director, Jean Des Roches reached out to Worcester Polytechnic Institute's Worcester Community Project Center to collaborate on a project. The Worcester Polytechnic Institute students evaluated the need to promote the independence of individuals in various programs at Seven Hills through the use of assistive technology (Valley et al., 2015). In their project, the "Development of a Low-Tech Assistive Technology Kit", the group was able to identify the areas of Seven Hills that would be positively impacted by assistive technology solutions. Their project pursued a higher level of success in Seven Hill's career development and residential programs by providing more low-tech assistive technology to participants (Valley et al., 2015).

## **2.6 Summary**

Individuals with developmental disabilities face many different challenges in their daily lives. Assistive technology can help people overcome these challenges, but in order for assistive technology to be effective it needs to be accessible. Some nonprofit organizations have found success in making assistive technology more accessible by creating databases that make it easier to find solutions that match the specific needs of an individual. In 2016, Seven Hills Foundation reached out to Worcester Polytechnic Institute's Worcester Community Project Center for assistance in increasing the use of assistive technology in their organization by establishing a searchable database of available assistive technology solutions that can be accessed throughout the organization. Consequently, the goal of our project was to increase the accessibility of the current assistive technology kit at Seven Hills

Foundation through the development of a database which will act as a resource to find different assistive technology solutions for participants. We discuss our methodological approach to this project goal in the next chapter.



### 3. METHODS

Our project was intended to increase the accessibility of assistive technology at Seven Hills Foundation through the development of a database to act as an information resource to identify different assistive technology solutions. Our team worked with the Seven Hills Foundation in Worcester, Massachusetts from March 14, 2016 to May 3, 2016. In order to achieve our project goal, we completed the following objectives:

- **Objective 1:** Assessed the needs of the stakeholders at Seven Hills Foundation
- **Objective 2:** Evaluated the status of the low-tech assistive kit
- **Objective 3:** Researched AT solutions to include in the database
- **Objective 4:** Developed a database to improve the accessibility of AT
- **Objective 5:** Built a web-based data interface
- **Objective 6:** Educated and trained the Seven Hills staff to use the database

We begin by discussing our WPI Institutional Review Board Approval and our data storage and informed consent procedures. Afterwards, we describe our objectives and how we accomplished them. Our first objective was to assess the needs of the stakeholders, which we achieved by performing interviews and participatory observations. Then, we evaluated the status of the existing low-tech assistive kit by learning to use the Kit, evaluating the entry logs within the Kits, and interviewing the staff members working with the Kits. These first two objectives were necessary to validate the need for creating a database at Seven Hills. In the remaining sections, we describe how we developed the AT database and web-based data interface. We created the database by developing the appropriate platform and organizing the information to determine the right entities which allowed us to create design models. The web-based data interface was created using a Model-View-Controller design pattern. We began by developing a Graphical User Interface and implementing logistics, then we communicated with the database using a MySQL/NodeJS driver. Finally, we trained the staff to use

the database through an interactive demonstration in conjunction with an instruction manual we created, as shown in Appendix L.

### 3.1.1 WPI Institutional Review Board (IRB) Approval

The WPI Institutional Review Board (IRB) approved our research activity on March 14, 2016 by an expedited review according to the Code of Federal Regulation 45 (CFR45). All of the members in our team were also certified by the National Institute of Health's (NIH) web-based training course "Protecting Human Research Participants." While working at Seven Hills Foundation we followed all guidelines set forth by the IRB.

### 3.1.2 Data Storage

We protected all of the data we collected using Seven Hill's information encryption system. At the end of our research, we destroyed all records and data that were not collected anonymously.

### 3.1.3 Informed Consent

All research participants were fully informed, either verbally or in writing, of their ability to withdraw or decline from participation, or to keep their identity confidential in the interviews or surveys we conducted. We also asked the research participants to check this final report to verify that we accurately portrayed their thoughts and opinions (*Ethical Guidance for Research with People with Disabilities, 2009*).

## **Objective 1: Assessed Stakeholder Needs at Seven Hills Foundation**

Successful assistive technology relies on the context in which it is used (Grott, 2015). In order to establish the most usable AT database, we researched how the participants are cared for at Seven Hills and the challenges that they face. We also worked with the staff at Seven Hills to improve our research

and to better integrate the AT database into the Seven Hills community toward the end of our project timeframe (Kintsch & DePaula, 2002). To achieve this objective, we conducted interviews, distributed surveys, underwent an orientation process at Seven Hills, and conducted participatory observations of participants and staff. In addition to consulting and collaborating with the Seven Hills' staff and participants, we also interviewed organizations that have successfully implemented AT programs for individuals with disabilities.

#### Interview the Staff at Seven Hills

Acquiring input from the staff through interviews and surveys was an important step in the initial part of our project. In 2015, Worcester Polytechnic Institute students affiliated with the Melbourne, Australia Project Center, worked to improve AT for individuals with disabilities at the E.W. Tipping Foundation (deRito et al, 2015). They found that a semi-structured interview method was best suited to interview staff. According to Cohen and Crabtree (2006), from the Robert Wood Johnson Foundation, a semi-structured interview follows a list of questions and topics, but the interviewer can monitor the flow of the conversation and veer from the list when it is appropriate; which allows the interviewer to feel prepared and often provides reproducible qualitative data.

We interviewed eight staff members at various programs to learn their roles at Seven Hills, how the organization operates, as well as to gather feedback on the Kits. We provide an example of the staff interview questions in Appendix A. The staff members we interviewed included four Program Managers, two Occupational Supervisors, a Case Manager, and the Assistive Technology Director. All of the interviews we performed were semi-structured.

### Survey the Staff at Seven Hills

In order to understand the staff's level of comfort with and exposure to different types of technology, we developed a survey, which can be found in Appendix B. We distributed 34 paper copies of our survey to staff at the Worcester Day Habilitation (WDH) and Adult Day Health (ADH) Programs during staff meetings. In addition, we published an online version of the survey on the Seven Hills staff website and it was accessible to staff members from all departments and programs. We opened the survey to a wide variety of staff in order to develop an understanding of technology comfort level of everyone who could potentially use the AT database regardless of their position on the Seven Hill staff. We received 42 completed surveys.

### Participatory Observation

In order to triangulate our research, we also conducted participant observation to identify additional stakeholder needs. According to Barbara Kawulich (2005), professor of Educational Technology at the University of West Georgia, participant observation is “the process enabling researchers to learn about the activities of the people under study in a natural setting through observing and participating in those activities” (p. 2).

Participatory observation allowed us to understand the context in which the individuals at Seven Hills live. We chose to use the observer as participant stance, meaning that we participated in group activities when it was deemed appropriate (i.e. during leisure activities, with staff supervision, etc.). We completed three participatory observations at three different Seven Hills' locations including five participants at the Adult Day Health program, numerous individuals at the Pediatric Center, and one with the staff at a Group Home in Grafton. We conducted the observations with staff and a variety of participants from different age groups. While at these locations we observed varying disabilities and

types of assistive technology solutions that were used among the different groups. Prior to conducting the observation, we informed and received permission from the Seven Hills' participants and staff. Active participation improved our observations and gave us a better understanding of their situation. By performing participatory observations we were able to observe the context in which assistive technology is used, and how it affects the daily lives of the participants at Seven Hills.

#### Interviews of Other Organizations

In order to develop a broader understanding of the problems faced by organizations wishing to implement better assistive technology to help individuals with disabilities, we conducted semi-structured interviews with the Assistive Technology Directors of various organizations in Massachusetts. The organizations we reached out to were the Cotting School, Easter Seals, and MassMatch. The Cotting School works with individuals with disabilities, Easter Seals implements statewide assistive technology programs, and MassMatch provides an assistive technology device loan program. We focused on these organizations to understand how an informational database may supplement the staff's caretaking roles and improve the independence of participants at Seven Hills. Interview questions can be found in Appendix C.

#### **Objective 2: Evaluated the Status of the Low-Tech Kit**

In March 2015, a team of student researchers from WPI's Worcester Community Project Center developed a low-tech assistive technology kit for the participants at Seven Hills Foundation. The Kit was based on a manual by Therese Willkomm, the director of Assistive Technology at the University of New Hampshire. In order to understand the state of assistive technology at Seven Hills, our group evaluated this Kit. The Assistive Technology Director at Seven Hills provided us with a Kit to work

with throughout the duration of our project, as well as the prototype from the original project, which had additional components.

The purpose of this evaluation process was to understand the strengths and weaknesses of the Kit in order to make it accessible to the wide range of needs present amongst the individuals at Seven Hills Foundation. The Kit contains various materials that allows the Seven Hills staff to construct their own assistive technology devices, as well as an entry log for the staff to catalog their experience in creating these devices. A copy of the entry log is shown in Appendix D.

In order to fulfill these goals, we accomplished the following tasks:

1. Familiarized ourselves with the Kit to understand its different components
2. Constructed various solutions
3. Interviewed the staff about their experience with the Kits and obtained entry logs
4. Provided a list of recommendations to improve the Kit

#### Familiarization with the Kit

We each read through Therese Willkomm's manual, *Assistive Technology in Minutes II: Ordinary Items, Extraordinary Solutions* (2015), looked through the Kit that was provided to us, and cataloged all of the materials within it. We then identified which solutions could be assembled using the materials that were present and worked to construct them. We also compared the prototype to the piloted Kits.

#### Solution Construction

After we identified the materials and solutions that were present, we created solutions using components from the Kit. *Assistive Technology in Minutes* instructions were used to construct some of the solutions. However, the majority of the solutions that we constructed were adaptations of those

present in the Kit and they were constructed without the aid of instructions from the book. For these new solutions, we recorded instructions and photo documented the steps taken to construct the AT solution. We constructed eight solutions.

#### Staff Interviews and Entry Logs

We conducted semi-structured interviews with five of the nine staff members that were part of the initial piloting of the Kit at Seven Hills to discuss how they currently use assistive technology. We used their feedback to analyze how the Kits worked and to identify and address any areas where assistive technology usage could be improved within the organization. These interviews also helped us to determine improvements that could be made to the Kit. Our interview questions can be found in Appendix A.

In addition to various materials that can be used to create low-tech AT solutions, each Kit contains an entry log. We reviewed three of the entry logs from active Kits and compiled the information into one document, which can be found in Appendix E, to make observations and to identify any major trends. Each entry log recorded information such as the solution, the assembly difficulty, the success of the project, and its benefits for the participants. Using this data, we were able to see the different AT solutions that the Kit users constructed and the effectiveness of the solutions. Finally, we used all of this information to provide a list of future recommendations for the Kit.

#### **Objective 3: Researched AT Solutions to Include in the AT Database**

In order to develop a large and comprehensive AT database, we researched AT solutions that exist beyond the scope of the current Kit. We expanded our research to provide the staff with an outlet to

help participants find the right assistive technology solutions to help improve their independence and quality of life.

We researched assistive technology databases, websites, and YouTube to build up the AT database and to identify various resources for the staff at Seven Hills Foundation to use in conjunction with the AT database we created. We reached out to other organizations, such as Easter Seals and the Cotting School, to see what resources they currently worked with. We also used keywords such as “assistive technology database” and “DIY assistive technology devices” to search for solutions on Google and YouTube. On YouTube we identified a number of stations, such as, *Temple OT Assistive Technology Videos*, that were dedicated to low-tech assistive technology solutions and we incorporated all of the solutions we thought would benefit Seven Hills. We also used some AT solutions that a previous WPI project team compiled for Seven Hills. In January 2016, this group of WPI student researchers compiled a catalog of high and low tech AT devices, with the goal of further ingraining AT at Seven Hills. In order to further this cause, we incorporated this catalog into the database we created (Hackett et al., 2016).

The online databases sources we discovered were at4all.com, abledata.com, instructables.com, and atsolutions.org. The databases that contained useful information that could benefit the staff were used to search for AT solutions to incorporate into the Seven Hills database. We also used feedback from our staff interviews to search for AT solutions that addressed specific solutions the staff requested. Any database that we thought would be beneficial for the staff in conjunction with the AT database we created, were shared with the Assistive Technology Director, Jean Des Roches, to see if she wanted to put it on the staff website at Seven Hills to make it directly accessible to the staff.



#### **Objective 4: Developed a Database to Improve Accessibility of AT**

In order to develop a database that organized AT solutions in a useful manner, we conducted interviews with Domenic Smarra, Chief Information Officer at Seven Hills, Roger Donahue, Senior Database Administrator at WPI, and Andy Roberts, a data architect at Microsoft to accomplish the following tasks:

1. Determine an appropriate platform for the database based on types and features.
2. Figure out the necessary entities to be included in the database
3. Create an Entity Relationship Diagram and Relational Model
4. Create SQL CREATE TABLE statements to create the database
5. Incorporate the database into the current operations at Seven Hills.

##### Determine the Appropriate Platform for the Database

The database had to address each stakeholder's needs, and had to be simple enough to be used by all the members of the staff. Additionally, we had to ensure that any database we created would be compatible with the existing infrastructure at Seven Hills. In order to determine the platform for the AT database we created it was necessary to look over our stakeholder analysis, carefully examining the surveys and interviews that were done. This allowed us to determine the necessary features for the AT database at Seven Hills Foundation. Using these features, various database platforms were researched to determine the best fit for the Seven Hills Foundation.

##### Organize the Database

Using the information from our stakeholder analysis, we determined the necessary entities that would need to be included in the AT database we created. Using these entities as a base, we determined the information these entities would contain and the relationships between them. This information was

then compiled into our design models, which graphically displays the design layout for the AT database. These models allowed us to effectively determine the organization of the AT database.

### Create Design Models

Creating design models are important in developing the layout of the database. In similar fashion to writing a paper, it is necessary to begin with an outline so that you know the direction you are taking. Building a database without the proper design models will most likely lead to a poorly designed database that will not function well. Mohamed Eltabakh, Assistant Professor of Computer Science at WPI, cites three main reasons for the creations of database modeling. First, it allows the developers to better understand the requirements of the database. Second, it helps to communicate that the developers and designers understand the application. Finally, it allows the designers to easily come up with the best design possible (Mohamed Eltabakh, personal communication, March 2016).

The first design model we created was an *Entity Relationship Diagram (ERD)*. The ERD shows the different types of entities that will be contained in the database, as well as their relationships. An ERD shows three different key components that are necessary when thinking about how a database will work: entities, their attributes, and the relationships between entities. In an ERD, entities are represented by squares, attributes by circles and the relations between entities are represented by diamonds (Mohamed Eltabakh, personal communication, March 2016).

Afterwards, we designed a *relational model* for the AT database we developed. The *relational model* contains every entity and its attributes, even those which might not be represented in the ERD. These models and diagrams allowed us to write the code that would create the AT database.

## **Objective 5: Built a Web-Based Database Interface**

After the database framework was completed, we built a web-based interface to enable users to interact and conduct searches within the database without extensive technical knowledge.

### The Model-View-Controller Design Pattern

According to Matthias Veit, Senior Software Engineer at Mesosphere, Inc., and Stephan Herrmann, Programming Languages and Software Engineering Professor at the Technical University Berlin, the Model-View-Controller design pattern, or MVC, is a software design architecture, popular for designing web applications due to its clear design which separates different responsibilities within a web-based application (Veit & Herrmann, 2003). The MVC pattern divides a web application into three parts: the model, the view, and the controller. This allowed us to keep the code for the server logic, such as searching the database, and the user interface separate. This will keep our code base much more organized in the long run. It is important to properly organize and manage the codebase while designing a medium-to-large sized application.

**The Model** manages the data, logic and fundamental behaviors of the application. It can respond to different action and instructions, and update the appropriate views when the data changes. **The View** provides the user with an interface to the application. This renders the data from the Model and presents it to the user in a meaningful way that the user will understand. **The Controller** receives user input and makes changes to the Model and the View accordingly. All in all, these three components work together to create the three basic components of the MVC (Veit & Herrmann, 2003).

### The Graphical User Interface

We started by constructing mock-ups of the *Graphical User Interface*, or GUI, to best decide which features would be included in the website and to help us make the layout as user-friendly as possible. According to James Landay and Brad Myers, Professors of Computer Science at Carnegie Mellon University, it is important to draw rough sketches of the screen to develop the layout and structure of the components to aid in the development process (Landay & Myers, 1994). We aimed to keep the User Interaction (UI) as simple as possible, drawing inspiration from notable websites such as Google and Wikipedia. We then translated the mockup design into a functional web interface with the help of Bootstrap, a framework for creating responsive web pages. This GUI is considered to be the View according to the MVC, or what the end user experiences. The GUI mockup can be found in Appendix J.

### Implement Logistics

The application logic, or the Model and Controller, as stated above, influences how the application behaved. We used AngularJS, a popular user interface framework for building a web application that performs and scales well as needs grow. Then, the application logistics was built to handle user action, such as searching the database, adding new solutions, or adding new components to said solutions. These actions make changes to the data, and would be changed accordingly in the database. This was all done on top of ExpressJS, a server framework for lightweight hybrid web applications.

### Communicate with the Database

After we established the application, complete with the MVC architecture, it needed to be able to access the information stored inside the database. This was done by using a MySQL/NodeJS driver, which established a connection to the database and translated server command to database search

terms, and return database search results in a Javascript Object Notation, a format the server could easily understand.

### **Objective 6: Educated and Trained the Staff to Use the Database**

After completing the database and web-based interface, we developed and held various sessions to train the staff to use these new resources. The different areas of training and education that we focused on were: the components of the database, how to use the database, how the database could replace old methods of obtaining information, and how the database could be utilized to help a participant. Education and training was meant to instill the users with confidence, allowing them to see the database as a valuable resource that they want to use. The training included a walkthrough of the database, followed by a question and answer period. We held a training session at WDH for eleven individuals and one training session at the ADH for seventeen individuals. The individuals that attended were of varying positions, and most use AT with participants in their daily work. A short survey was given to the staff after each session to allow them to share any suggestions or information that could improve the usability of the database. The survey was brief to encourage the staff to answer every question. We received 28 total survey responses. The Survey is included in Appendix K.

We also used Zoom Conference technology to conduct an online training with three AT Super Users at various Seven Hills programs. We used “show my screen” to explain the different components in the database and then we answered any questions and requested feedback. We trained the AT Super Users so that they could serve as a resource to other members of the Seven Hills staff who may have questions about the database. We also developed an instructional manual to assist the staff in using the database. We provided a PDF of the manual in the help section of the AT database. A copy of the database instruction manual can be found in Appendix L.

In this chapter we detailed the methods we used to accomplish the objectives of our project. We first gauged the current use of AT at Seven Hills, by assessing the need of the stakeholders and evaluating the Low-Tech Kit. We then developed a database populated with various AT solutions, as well as a web application to interface with it. Finally, we educated and trained the staff on how to use the AT database we developed, to better familiarize them with the AT available at Seven Hills. In the next chapter, we discuss our findings and recommendations.

## 4. FINDINGS AND RECOMMENDATIONS

In this chapter we discuss the findings we obtained as we completed the objectives of our project. We identified some key areas, and have broken down our findings into these specific groups. First, we discuss our findings from the evaluation of AT use among Seven Hills staff members and the Kit. We then give evidence supporting the role and importance of implementing a database at Seven Hills Foundation. Next, we outline how we used our findings and research to develop an AT database and an interfacing web application; including some of the design models we used. We then discuss our findings from the surveys we conducted. Finally, we discuss the training sessions we held to familiarize the staff with the Kit.

### 4.1 Comprehensive Analysis of the Staff's Ability to Identify and Utilize AT Solutions at Seven Hills

#### Staff Need

**The staff currently does not have enough available time to search for or to learn to construct AT devices at Seven Hills.**

Time constraints were one of the biggest issues we found regarding the staff's usage of assistive technology. More specifically, we interviewed five of the nine staff members, from various Seven Hills programs, that were part of the initial piloting of the Kit at Seven Hills, and all five **lacked adequate time to search through Therese Willkomm's manual, *Assistive Technology Solutions in Minutes***. The manual is located within the Kit created by a previous team of WPI student researchers working through the Worcester Community Project Center. Alissa Rivard, an occupational therapist and Joseph Plaisance, the Senior Service Coordinator, at the Seven Hills Foundation Worcester Day Habilitation and T.W.O programs, explained that they did not use the Kits because they did not have enough time to look through the manual for solutions (Alissa Rivard & Joseph Plaisance, personal communication, March 2016). Benjamin Marshall, Case Manager at Adult Day Health (ADH), has

made several solutions, but he has not made as many as he would like due to time constraints (Benjamin Marshall, personal communication, March 2016). In addition, **several of the staff members at various programs had trouble finding creative AT solutions.** For example, staff members at the Pediatric Center said that they were continually looking for new recreational solutions for the kids in their program. However, they had trouble finding creative AT devices that were effective and affordable by searching the internet (Cynthia Greene & Brian Heath, personal communication, April 2016). At the Grafton Group Homes, where the staff primarily focus on early morning and late night care, the staff rarely use assistive technology and had difficulty determining how to use the Kits to develop AT solutions to assist their participants (Hellen Bushard, personal communication, April 2016).

We reached out to five of the nine staff members that were part of the initial piloting of the Kit at Seven Hills, and four, **lacked adequate time to figure out how to assemble solutions from the Kit.** Several members of the staff had difficulty assembling the devices once they had found a solution that fit their participant's needs. For example, Hellen Bushard, a medical staff member at a Group Home in Grafton, said that she has not made many solutions from the Kit because she does not have time to figure out how to build solutions that she is already aware of, such as a cup holder attachment (Hellen Bushard, personal communication, April 2016).

The inability to build AT solutions may deter the staff from using the Kit to construct AT solutions. The combination of not being aware of available AT and not being able to assemble AT solutions greatly inhibits the use of AT at Seven Hills.



### Kit Evaluation

#### **Finding 1: The staff had difficulty identifying the appropriate Kit solutions that would address their participant's specific needs.**

Although there are many useful materials present in the Kit, which can be used to assemble numerous AT solutions, it is difficult for the staff to find solutions for their participants. The book, *Assistive Technology Solutions in Minutes II: Ordinary Items, Extraordinary Solutions*, accompanied each Kit and was meant to act as an instruction manual for the Kit. However, this manual was not written with this purpose in mind, and is intended to “be viewed as an idea book to inspire individuals to think creatively in solving unique challenges through the application of assistive technology solutions” (Willkomm, 2013, p. 4).

For instance, the manual showed numerous ways to use a variety of materials, but had very few actual instructions to create specific solutions. For this reason, it was somewhat difficult for staff members to find solutions to assemble from the Kit using the manual alone. Hellen Bushard, a member of the medical staff at the group homes in Grafton said that she hadn't made any solutions from the initial training session with the Kit because she found that it was hard to read the manual and was unsure how to construct new AT devices using the Kit components (Hellen Bushard, personal communication, April 2016). She said it would be very helpful if there was an easier way to navigate the Kit.

This was the general consensus, and was corroborated by Benjamin Marshall, a Case Manager at the ADH, who enjoyed skimming the manual to learn about new ideas but oftentimes developed his own solutions without using the instructions from the manual. He agreed that it would be beneficial to have an easier way to navigate the Kits (Benjamin Marshall, personal communication, March 2016).

**Finding 2: The use of AT involves much trial and error before finding practical solutions.**

We found that effectively utilizing solutions from the Kit required much trial and error. This can be attributed to the varying circumstances of each individual. Each individual has a unique challenge that they need to accommodate and the Kit solutions may not initially suit that person's need. From interviews with staff members that had the Kits, personal experience in working with the Kits, and from firsthand experience in participatory observations with participants at Seven Hills, we found that **modifying the solutions in the Kit to work more efficiently is often required.**

For example, one woman always carried around a heavy purse, but after an accident, the purse was difficult to carry while using a walker. Benjamin Marshall, Case Manager at the ADH Program, attempted to improve her mobility by attaching her purse to her walker (Benjamin Marshall, personal communication, March 2016). He first tried taping a PVC hook to her walker, which broke easily. He then attempted to screw the PVC into the walker which was also ineffective, finally he succeeded in using metal hooks to secure the purse to the walker, as shown in Figure 11.



*Figure 11: Low Tech Walker Attachment for Purse*

During the participatory observations of the participants at the ADH, we found that many of the devices we fabricated needed some form of modification to suit a particular individual. The cup holder we created could have used copper wire in the loc-line to strengthen it to allow the individual to hold a heavier drink (refer to Figure 4). Benjamin Marshall, found that using the metal from old political signs can strengthen the loc-line just as effectively as copper wire (Benjamin Marshall, personal communication, April 2016). The modified stylus we made with an industrial twist tie needed a firmer end on the stylus because it needed to be pushed into the screen to work which was difficult for the individual to do without assistance (refer to Figure 18). The need for modifications in a number of the Kit instructions limits their effectiveness in allowing the staff to fabricate new AT solutions for their participants.

In order to take advantage of the trial and error nature of the Kit, **we recommend that Seven Hills find volunteers or students to work with the Kits to discover ways to overcome different issues in constructing AT solutions by working to develop improved versions of the solutions in the Kits.** This person (or people) should work to create solutions for the participants at Seven Hills and they should document any adjustments they make in constructing the AT device, so that the information can be added to the AT database. This would improve the efficacy of the AT kits and it would also teach the individual valuable lessons about developing AT devices which they could share with others.

**Finding 3: The cost of materials and lack of certain materials inhibits the effectiveness of the Kit.**

Currently, there are three Kits that are in active use at Seven Hills Foundation, they are operated by Taylor Johnson, the Expressive Arts Coordinator at Worcester Day Habilitation (WDH), Benjamin Marshall, a Case Manager at ADH, and Hellen Bushard, a member of the Medical Staff at the group homes in Grafton. During interviews with each of these individuals we learned that supply of certain materials and the cost necessary in replacing them also prohibited the use of the Kits.

In an interview with Benjamin Marshall, Case Manager at ADH, we learned that there was only a single supply of some materials, such as the loc-line clamp, present within the Kits. Unlike the loc-line, PVC, and industrial twist ties which are reasonably priced and easily purchased, loc-line clamps were too expensive and were not replenished (Benjamin Marshall, personal communication, March 2016). Loc-line clamps are required for many different wheelchair and walker attachments, which are meant for everyday use. This meant that if one solution was being used by an individual, then other solutions that needed that material could not be made, and as a result, only a few solutions were made with the Kits. The solutions that were constructed and written down in the entry logs, can be found in Appendix E. In our interview with Hellen Bushard, at the Group Home in Grafton, she found the cup holder to be a very useful device but she could only make one because there was only a single loc-line clamp in the Kit (Hellen Bushard, personal communication, April 2016).

Therefore we recommend that **the staff at Seven Hills be given information about how to replace materials in the Kits.** The original plan was that each program had funds for replacement materials and an individual just needed to request materials from their program manager. These funds are still available, however people aren't aware that there is a system in place to replace the Kit materials. In order to make this a more common occurrence, **we recommend Seven Hills develop an order**

form or a monthly email to send out to each Program Manager inquiring which individuals need new components for their Kits.

At the beginning of our project, we also examined the Kit and its prototype to determine solutions that could be assembled from the Kit components. **We found that there were some critical materials, in the prototype, that were useful in creating a number of solutions, but were not in the Kits currently being used.** These items were removed to lower the production cost of the Kit. However, this meant that many of the solutions from the book could not be made by the staff who had received the Kits. Figure 12 details the materials that were in the prototype but did not make it into the actual Kits that were given to the different programs at Seven Hills.

Prototype	Quantity	Cost	Vendor
BB Bullets	400	\$0.63	Walmart
Carpet Tape	1 ft	\$0.33	Home Depot
Loc-Line (3/4")*	2 ft	\$17.06	<a href="http://modularhose.com">modularhose.com</a>
Loc-Line Pliers (3/4")	1	\$14.33	<a href="http://modularhose.com">modularhose.com</a>
Magnum Steel Epoxy Putty	2 oz	\$6.00	Amazon
Mini Flashlights	2	\$0.90	Amazon
Mounting Disk*	1	\$11.39	<a href="http://modularhose.com">modularhose.com</a>
Spring Clamp (3/4")*	1	\$7.63	<a href="http://modularhose.com">modularhose.com</a>
Swiffer Duster Handle	1	\$8.97	Home Depot
Table-cloth Spring Clamps	4	\$1.99	Amazon
Tubular wheelchair clamp*	1	45.46	<a href="http://modularhose.com">modularhose.com</a>

Figure 12: Absent Prototype Materials (\*items deemed vital to numerous solutions)

For example, the mounting disk, as shown in Figure 13, is important in creating many different types of wheelchair or table attachments using loc-line. Using a single mounting disc, with velcro attached,

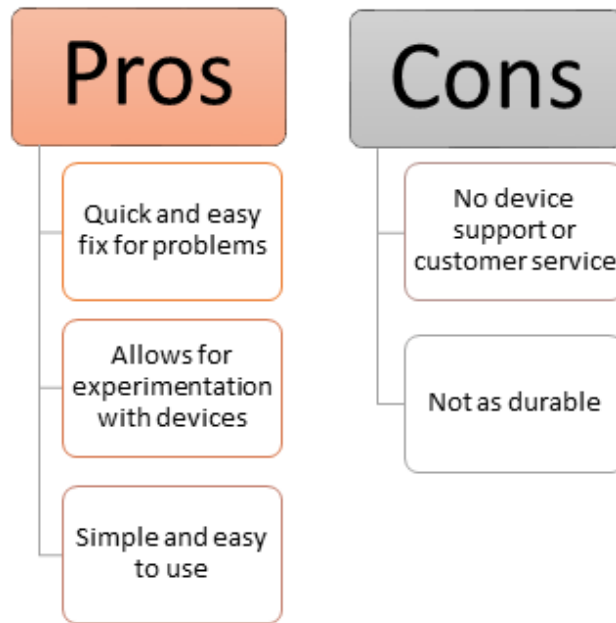
a cup holder could be changed to an iPad stand within seconds. Another vital material that was absent from the Kit was the tubular wheelchair clamp, as shown in Figure 13, which could fasten numerous different solutions to a wheelchair.



*Figure 13: Mounting Base (left) and Tubular Wheelchair Clamp (right).*

In order to provide the staff with these necessary materials, as well as an extra amount of certain Kit materials, which were not included in the final product or that there was only one of, **we recommend that Seven Hills create an “expansion pack” of some sort, to supplement the Kits.** This could be a set of materials deemed to be vital, or a fund that allows users to supplement the Kit with materials they feel are necessary. Benjamin Marshall, Case Manager at the ADH, suggested screws and nails and other basic tools as cheap additions to adjust the AT solutions described in Therese Willkomm’s manual (Benjamin Marshall, personal communication, April 2016).

**Finding 4: All the AT devices that the Kit creates are short term solutions.**



*Figure 14: Pros/Cons of Low-Tech Kit*

**All of the Kit solutions are not meant to be a permanent solutions to a problem an individual is facing.** There are a number of pros and cons associated with the short term nature of the Kit solutions as illustrated in Figure 14. This can be a benefit, because it allows the staff members in various programs and positions at Seven Hills that are working with the Kits to find quick and creative ways to address challenges their participants face. These short term solutions are great at providing temporary fixes until Seven Hills can obtain a more permanent solution. The Kit also generates interest in assistive technology because it is simple and easy to use. However, there are drawbacks to temporary AT devices. The AT devices are not just short-lived, they also lack support and customer service. Jerry Weisman, Founder of Assistive Technology Solutions, informed us that this can make them less cost-effective in the long term (Jerry Weisman, personal communication, April 2016). His reasoning was that when a short term solution breaks it can be difficult and cost prohibitive to fix. Commercial versions of the AT devices in the Kit can often be purchased from a website or tested for free using

a device-loan program. If these break, it is often easy to contact customer support or replace the device through warranty.

**We recommend that Seven Hills implement a Kit at the Pediatric Center.**

When our team toured the Pediatric Center we learned that their program currently does not have a Kit, but many of the staff members at the Pediatric Center create low-tech AT devices and could benefit from the components currently present within the Kits. The AT staff at the Pediatric Center make palm guards out of foam and velcro, which aids individuals with clenched grips, and they would benefit from having a Kit with Velcro present that could be easily accessed by all members of the staff. Currently, when an individual's palm guard breaks staff members need to call an AT staff member to assist them. Loc-line would also be extremely beneficial because all of the participants are wheelchair-bound and non-verbal and need any device they have to be safely secured to their wheelchair. The staff members and participants at the Pediatric Center could also benefit from the switch components that are only present in the Kit prototypes. By providing a Kit to the Pediatric Center their AT staff would be more productive in their work and would have more time to help a larger number of individuals. The AT staff are aware of the Kits and could easily request a custom Kit that would have only the supplies that would be most useful.

**We recommend that Seven Hills spread awareness to encourage more staff members to develop AT solutions using the Kits.**

There are currently only nine "Super Users" who have the Kit. Expanding the use of the Kit to include a wider range of staff members would expand assistive technology use dramatically. The Kits were designed with a train the trainer model, and the use of the Kits should have branched out to include a large portion of the staff. Unfortunately, this did not occur because the Kit holders took full



responsibility for the Kits and the other staff members directed all of their assistive technology ideas and requests to the individuals that were in charge of the Kits.

By reaching out to the Program Managers and Supervisors to determine why this occurred and by encouraging the staff to work with the Kits by incorporating a promotional video, which espouses how easy it is to work with AT and how much it helps the participants at Seven Hills into the staff's training period, the usage of the Kit should spread. Additionally, if those who currently have the Kits encourage their colleagues to use the Kit, it may reduce staff members' reliance on those who currently oversee the Kits.

Seven Hills participants would benefit from a comprehensive database of AT solutions.

Our assessment of the Kit and the staff interviews we conducted at Seven Hills revealed useful information. We learned that many of the barriers associated with making AT more accessible at Seven Hills could be improved through the creation of an AT database. For example, time constraints hinder staff members' ability to search for, construct, and implement new AT devices. Benjamin Marshall, Case Manager at the ADH Program, said that a database of AT solutions would allow him to find Kit solutions easier, and that would allow him to spend less time looking for solutions and more time building and experimenting with different solutions (Benjamin Marshall, personal communication, March 2016).

Current successes with AT devices at Seven Hills Foundation could also be augmented through the implementation of a database. We learned from various interviews with staff members, including staff at the Pediatric Center, ADH, WDH, and the AT Director, that there are a handful of staff members

at Seven Hills developing their own AT solutions as well as students from nearby schools currently collaborating with Seven Hills to produce assistive technology devices (Jean Des Roches, Cynthia Greene, Bryan Heath, Benjamin Marshall, Sarah Tree, & Taylor Johnson, etc., personal communications, March and April 2016). Information about new AT devices are discussed at weekly staff meetings of each Seven Hills department, including Adult Day Health and Worcester Day Habilitation, and monthly at AT Super User meetings. The AT Super User meetings are meetings with Service Coordinators from various Seven Hills locations. Unfortunately, there is not time at those meetings to spread every new AT idea to every program. **A Seven Hills AT database would make it possible for the staff to quickly share AT solutions to all Seven Hills locations, facilitating a collaborative effort that promotes the growth of new ideas and the development of existing ideas.**

A database could also aid Seven Hills in their current efforts to achieve a higher level of assistive technology use across their organization. At a meeting, the Seven Hill's AT Director, Jean Des Roches, discussed her overarching goal to provide better AT assessments for new participants at Seven Hills, and the new AT database and the resources it provides could supply the necessary information to assist this process (Jean Des Roches, meeting, March 2016). In order for the database to be successful in achieving this endeavor it needed to be larger and more comprehensive than the current Kit to allow Seven Hills to produce an AT database to help participants for the rest of their lives. As a result, we researched solutions that did not use the Kit components and included them in the AT database we developed.

**There are a number of useful databases, with different collections of AT solutions, available online.** In researching AT solutions outside the Kit we found a number of useful databases such as **at4all.com, atsolutions.org, abledata.com, and instructables.com.** Some of these databases, such as atsolutions.org, contained only commercial AT devices, and thus, provided links to the manufacturer’s website. In Appendix M, there is a comparative table of the different features on each website. Meanwhile, other databases included instructions on how to build the AT device, such as Instructables.com. We analyzed these databases to determine the best search setup to promote the ease of use of the AT database we developed. Abledata.com has thousands of solutions including many do-it yourself options, the site also has video links and pictures of the devices which reinforced the need for images and other visuals which were suggested by staff members at Worcester Day Habilitation and the Adult Day Health Program. The atsolutions.org database tags their AT devices and instructions with sorting features such as the cost, skill level, time needed, various functional abilities and limitations such as incoordination and complete loss of sight. The atsolutions.org database also had categories including “aids for daily living” and “education.” As a result of our staff interviews we found that similar tags would be beneficial for the staff at Seven Hills to easily find AT solutions. This research helped us to develop what features we wanted to include in the AT database. We also researched various database management systems, which we will discuss in the next section.

## **4.2 Comprehensive Analysis of the Creation, Implementation and Benefits of an AT Database for the Staff at Seven Hills Foundation.**

### Database Management System

To begin building the AT database for Seven Hills, we needed to determine the appropriate database platform on which to build the database. Choosing the right platform is critical, as it is the foundation

for all the software that builds on it. We interviewed Domenic Smarra, the CTO at Seven Hills, and we learned that a database of AT solutions would be separate from any existing database infrastructure due to security and privacy concerns (Domenic Smarra, personal communication, March 2016). This allowed us complete freedom in choosing the database management software (DBMS).

**Finding 1: MySQL is user-friendly, free, has a large capacity and can be easily accessed through a web application.**

The AT database we created for Seven Hills had to be fairly complex to allow it to hold a large amount of data. However, since the staff at Seven Hills are busy, as evidenced by the time constraints faced by many of the staff members working with the Kits, it had to be easy to use and efficient. In order to choose the right DBMS for Seven Hills, we developed a comparative figure of various DBMSs, as shown in Figure 15. This figure analyzed several factors, including cost, the type of database and what operating systems it supported. We chose the following DBMS as a result of our interview with Worcester Polytechnic Institute Information Technology (IT) staff member, Roger Donahue, and our own research on various databases.

### Database Management System Comparison Chart

DBMS	Cost	Relational?	OS Support
MySQL	Free	✓	Windows, Linux, UNIX
SQL Server	~\$8592+	✓	Windows Server
Oracle	~\$22000+	✓	Windows, Linux, Mac
Amazon <u>SimpleDB</u>	~Free+	✗	Cloud-Based

Figure 15: Database Management System Comparison Chart

All these databases would meet the needs of Seven Hills, as they support most of the same SQL functions. This meant cost was the main concern, and restricted our choice to either Amazon SimpleDB or MySQL. However, a database built on the relational model would work better for Seven Hills as it allows us to better connect our entities by placing our information into tables. The relational model of database organization splits information into relations (tables) and attributes (columns/fields). This ruled out Amazon SimpleDB and left us with the best choice of MySQL. MySQL is powerful: it is designed to be used, accessed, and connected to by many users at once and can hold large amounts of data ("Top Reasons to Use MySQL", 2016). Additionally, it comes with its own server hosting software, which made it easy for us to connect to the database with our interfacing application.

#### Database Entities

After choosing the appropriate database management system, we referenced our interviews with both the staff who would be using the database as well as experts in database creation to decide upon a list of entities that would be held in the database (Domenic Smarra, Roger Donahue, Andy Roberts, etc.,

personal communications, March and April 2016). As a reminder, the entities are the objects that the database keeps track of. For example, a database tracking a school might have entities representing students, classes, and professors. The obvious entities held in the AT database we developed were each AT solution and the materials required to build those solutions.

We included a ‘Vendor’ property within the material entity, so the staff could spend less time searching various vendors for the most affordable place to buy materials. Additionally, many of the staff members we interviewed at Seven Hills suggested that pictures would make it much easier for them to see how the solution is built and functions. As a result, we developed an image upload option and an instruction box where links to video instructions can be placed in the instruction box (pictured in Figure 16).



*Figure 16: AT Database Instruction Box*

We also found that it was difficult for the staff members to share information about the solutions that they built and modifications they made to the solutions. As mentioned earlier, building AT solutions requires much trial and error. In order to make it easier to communicate about how solutions were modified to meet an individual’s need, we included a comments section for each solution (Pictured in Figure 17). Additionally, these comments will allow staff to explain why a solution did or did not work for a participant. At first we believed that a rating system would help differentiate solutions, however, low rankings might act as a deterrent to using a solution, and a solution that did not work well for one individual might work well for another.

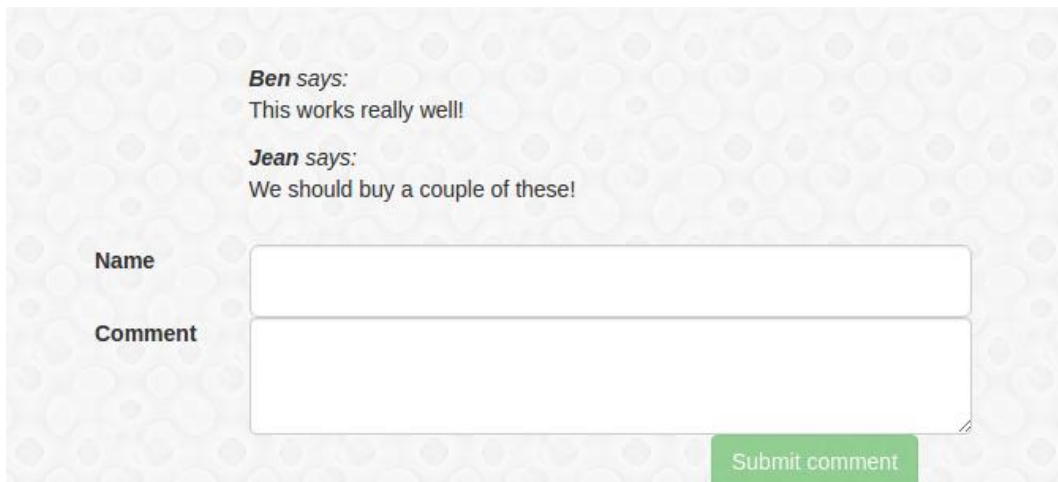


Figure 17: AT Database Comment Section

These entities needed to be populated, and in our time at Seven Hills we populated the database with 76 solutions. However, more solutions in the database is always better. Thus, we recommend that the staff at Seven Hills **continue to populate the database with assistive technology solutions**. Based on our findings, we know that the staff is very busy with everyday tasks. As a result, they do not have time to dedicate to creating, finding, and implementing new AT devices. We **recommend that Seven Hills find an outside source to help them continue to populate the database with additional AT solutions**. The individual would need to be on the Seven Hills network to add solutions and therefore it would be beneficial to hire a summer intern, or if that is cost prohibitive, we recommend that they find a volunteer that would be interested in searching for additional AT solutions.

**If Seven Hills does not wish to pursue an outside source, the task could be divided amongst the AT Super Users.** Each AT Super User should be assigned a specific type of solution to prevent an overlap in searches. Dividing the solutions would be done most efficiently by giving each AT Super User a specific site or resource and having them search for solutions they think would be beneficial to add to the database. They would be responsible for providing a small number of solutions each month,

which they could delegate to other members of their program to separate the level of responsibility and time commitment. Both options encourage the use and development of the database.

Finally, in order to allow for easier searching and browsing of the database, we included a system that would allow users to tag solutions with various categories. Categories are useful because they help staff members at Seven Hills to find solutions relating to specific activities, functional abilities and limitations, as well as features of the AT solutions, such as cost, build time, and how the device will aid an individual (ex. seating/positioning aid). In the interviews we conducted with the current Kit holders, (Alissa Rivard, Taylor Johnson, Benjamin Marshall, Hellen Bushard, & Joseph Plaisance, personal communications, March and April 2016), all believed that categories would improve their ability to find appropriate AT solutions, and suggested various categories that they believed would be most useful for them. In the next section, we explain how we determined which categories should be included in the database.

#### Database Categories Personalize AT Device Searches

We developed categories regarding common activities that individuals with disabilities often have difficulty performing, included recreation activities and activities of daily living. In addition to categories regarding activities, we also developed categories relating to functional abilities and limitations. Together these categories could allow staff members to help individuals with particular limitations to find devices to aid them in performing a specific activity. Finally, we developed categories relating to the features of the specific technology, which included the cost, to allow staff members to find solutions that are right for the individual and also within their price range and other specifications. Together these categories will help staff members to find devices that are accessible, meet the needs of the participant, and are specific to a particular activity.



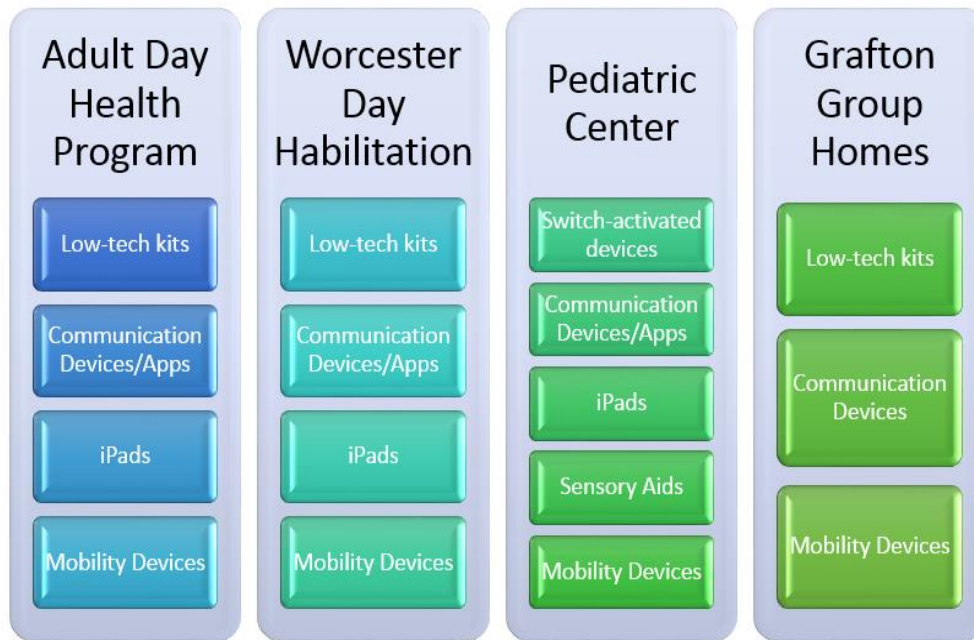
**Finding 2: The staff searches for AT solutions in the areas of Recreation and Activities of Daily Living most frequently.**

As a result of the interviews we conducted with staff members at various Seven Hills locations we learned that AT solutions regarding activities of daily living and recreation were the most frequently used type of AT. Programs such as WDH, ADH, and the Pediatric Center work with participants throughout the day and would benefit from devices that fall into both the recreation and daily living categories. Benjamin Marshall, Case Manager at ADH, reported that he, “believed that entertainment was one of the primary uses of AT at Seven Hills” (Benjamin Marshall, personal communication, March 2016). Examples of assistive technology use for entertainment at Seven Hills includes, iPads, switch-activated bowling, and modified styluses to draw using an iPad, as shown in Figure 18.



*Figure 18: Switch Activated Bowling (left to right), iPad Stand, Adapted Stylus Grip*

Programs which have fewer assistive technology outlets, such as the group homes in Grafton, use AT solutions primarily for activities of daily living because the staff's main role is to provide evening and early morning care (Hellen Bushard, personal communication, April 2016). A breakdown of the different types of AT currently being used at each location can be found in Figure 19.



*Figure 19: Common AT Devices used at various Seven Hills programs*

The Low-tech kits (Kits), which are present at the ADH, WDH, and Grafton Group Homes, include many attachments that serve as positioning aids, as well as a variety of other simple solutions such as weighted utensils. A communication device, which can be found at all four locations, is any assistive technology device that allows an individual to speak, write, or use alternative methods to convey information (Wendt, Quist, & Lloyd, 2011). Communication Devices and Apps, vary widely and can be found at all four locations. Examples of communication devices and apps include the TOBY eye gaze system, communication boards, and AAC (Augmentative and Alternative Communication) apps, such as ProLoQuo2Go. iPads have numerous apps and features which are primarily used for entertainment and educational purposes, according to staff members at the Adult Day Health Program and Worcester Day Habilitation (Benjamin Marshall, Jean Des Roches, etc., personal communication, March 2016). A mobility device is used to promote an individual's ability to move freely, this can include the range of motion in their arms, legs, and other extremities (Wendt, Quist, & Lloyd, 2011).

Mobility devices include canes, motorized/electric wheelchairs, and long-handled hair brushes. Sensory devices, found at the Pediatric Center, are meant to stimulate or to improve the functional abilities of those who are visually impaired, hearing impaired, or have impairments in their sense of touch/feeling (Cynthia Greene, personal communication, April 2016). Sensory devices include adapted rocking chairs, decorated ceiling lights, and weighted blankets. Switch-activated devices are primarily used to adapt existing devices for individuals with limited mobility. For example, a switch-activated measuring cup could help a person with limited mobility to use a measuring cup. All of these devices can be used to assist individuals in a number of activities.

During each interview, staff members were asked about what categories would be the most useful to include in the database. **Activities of daily living was the number one response from five of the seven interviewees. The two staff members at the Pediatric Center were primarily interested in a recreation category.** The Pediatric Center primarily works with children that are wheelchair-bound and nonverbal. In order for these children to play games and participate in recreation activities the staff needs to modify these activities to be switch-activated or otherwise adapted to meet the needs of each individual. The primary recreation activities at the Pediatric Center were board games, sports, music, and art. According to an AT survey, administered by the Seven Hills AT Director in 2014, movies (84%), gaming (52%), and photography (48%) were the primary recreation activities the participants at various Seven Hills programs enjoyed. The blue bars in Figure 20 show a more detailed breakdown of the recreation activities of different participants.

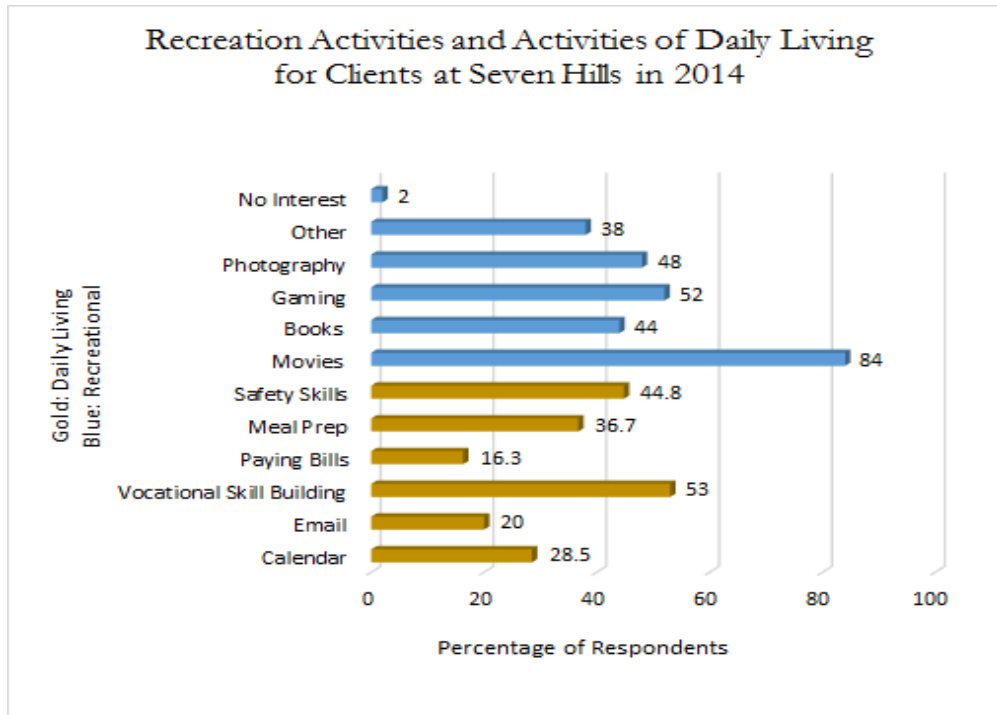


Figure 20: AT Survey (2014) Responses. There were 50 participant responses from various Seven Hills programs.

**In regards to activities of daily living, the most common activities mentioned by the staff involved cooking, eating, vocational skills, and hygiene.** For, example, at the group homes in Grafton, the staff requested access to assistive technology solutions that could allow their participants to participate in meal preparation (Hellen Bushard, personal communication, April 2016). According to the 2014 survey, graphically represented by the gold bars in Figure 20, AT is most often used at Seven Hills in activities of daily living with respect to developing safety and vocational skills. As a result of this information, we chose *activities of daily living* and *recreation activities* as umbrella categories for the database. Both categories are easily identifiable by the staff which will make it easy for the staff to find categories when adding new solutions and to search for existing solutions.

**Finding 3: Many of the individuals at Seven Hills have varying limitations and functional abilities which can alter the efficacy of an AT device.**

According to the 2014 survey by the Assistive Technology Director, Jean Des Roches, participants at various Seven Hills locations have difficulty accessing AT devices due to problems related to hearing (14%), vision (30%), physical (30%), and other issues (42%). For example, the Pediatric Center uses light boxes to help children with limited vision to more clearly see their hands while learning grasping techniques. Another individual may have difficulty learning grasping techniques due to low grip strength and would benefit from modified hand grips. Each individual would benefit from having an array of different devices that could achieve the same purpose, as some devices might work better for one individual than another. In recognition of the individualized nature in identifying the appropriate AT solution for a participant, we developed categories related to functional abilities and limitations.

**High and low mobility user, low vision, and weak grip strength are example categories we created that will allow the staff to find solutions that address the specific needs of the participants at Seven Hills Foundation.**

We came up with these categories because the Assistive Technology Solutions (ATS) database, founded by Jerry Weisman, features similar categories to better personalize AT searches, including severe loss of sight and incoordination. We developed our exact categories from information we learned in staff interviews with seven staff members from various Seven Hills programs. The categories we came up with included high mobility user vs. low mobility user, low vision, and weak grip strength. These categories will better personalize an AT search which should lower the time the staff will spend searching for a device. Ideally, quicker searches will provide the staff with added time to construct more complicated devices.

**Finding 4: The ability to add multiple tags to a device will help staff members to find more personalized AT devices faster.**

In order for the multiple categories to be effective, we developed the AT database with the ability to tag an AT device with multiple categories. This can allow the user to search the limitation, such as “low mobility” and an activity such as “recreation” to come up with devices that are relevant to both. This is extremely beneficial in the solution input aspect as well as in searching a device. Many AT devices are versatile and can address multiple needs and can serve different purposes which makes it difficult to sort the device into any one category.

**Finding 5: Cost of an AT solution impacts the participant’s ability to access and benefit from an AT device.**

In an interview with Patti Salmonson, the Director of Technology at the Cotting School, we learned that after an individual turns 22 years old and moves to an adult care program, they lose a lot of financial support and resources that were previously available (Patti Salmonson, personal communication, March 2016). **Do it yourself (DIY) AT devices provide cheaper options that help individuals but are often not sustainable, long term solutions.** According to Jerry Weisman, founder of Assistive Technology Solutions, commercial items are more robust solutions that have customer support and warranties to ensure proper maintenance of a new device (Jerry Weisman, personal communication, April 2016). **Commercial items have varying types and price ranges, and although funding is limited, a more expensive option may be worthwhile.** According to the Seven Hills “AT Super User” meeting that we attended, grant funding for new assistive technology is heavily reliant on the publication of success stories. For example, Jean Des Roches, the Assistive Technology Director at Seven Hills showed us a success story of how the Liftware spoon helped a man with a bad hand tremor to eat Cheerios more effectively (Jean Des Roches, personal communication, March 2016). This device is over \$100 but it worked so efficiently it made the

purchase worthwhile by greatly promoting the independence and self-confidence of the individual. We determined that **in addition to labeling the price of the device in the description we should provide categories that rate the cost as low (under \$25), medium (\$25-\$50) and high (over \$50)**. These categories would allow the staff member to search for a device in their desired price range.

**Finding 6: There are many AT solutions currently used at Seven Hills and many more are being developed and purchased.**

During a conference call with Jean Des Roches, the AT Director at Seven Hills, we learned that there are currently **15-20 AT devices that are being developed at Seven Hills with the assistance of students** from Massachusetts Institute for Science and Math, University of Massachusetts Lowell, Clark University, and Worcester Polytechnic Institute (Jean Des Roches, personal communication, April 2016). **Staff are also developing solutions to better aid their participants.** For instance, at the Pediatric Center they have developed weighted blankets to replace more expensive commercial versions. Another staff member, Brian Heath, developed his own hook and Velcro system for feeding pumps to avoid cumbersome IV bag holders which make the individual look sicker than they actually are (Brian Heath, personal communication, April 2016). Benjamin Marshall, Case Manager at the ADH, developed a device with cardboard that had the spacing of a full chord in the key of C to allow a musician with limited dexterity to play his guitar (Benjamin Marshall, personal communication, March 2016). In addition to devices created at Seven Hills, **there is an even larger number of devices that are being purchased for individuals, and that are available for purchase or demonstration through the Device Loan Program at MassMatch** (Catherine Bly, personal communication, March 2016). In order to find the right devices, the staff inputting each new solution into the database can either choose from pre-made categories or they can create their own category to be added by the website administrator. **Categories that help to specify a search should be created**

**if they improve a person’s ability to find the appropriate AT solution.** The *add categories* feature can also be used to add better categories to tag an existing device. This could be done by finding new uses for an existing device, labeling what functional abilities and limitations are best suited by the device, features of the device itself, and anything else that would help to characterize the device and the individual it is designed to help. This will allow the database to continue to grow and expand to create a comprehensive, personalized way to sort and search for AT devices.

One problem created by the *add categories* feature would be database clutter. If a user makes a typo, for example typing in “Recreation” instead of the already existing “Recreation” tag, both categories are now located in the database. To alleviate this problem, **we recommend implementing a dictionary check when submitting new tags to prevent duplication.**

#### Database Models

After learning the necessary components that we would need to include in the AT database, we began to construct the framework for the AT database. We constructed an Entity Relationship Diagram and a Relational Model for the AT database; shown below in Figures 21-22, respectively. These diagrams were necessary to construct the AT database for the reasons discussed in our methods (refer to Ch.3, pg. 50-51).



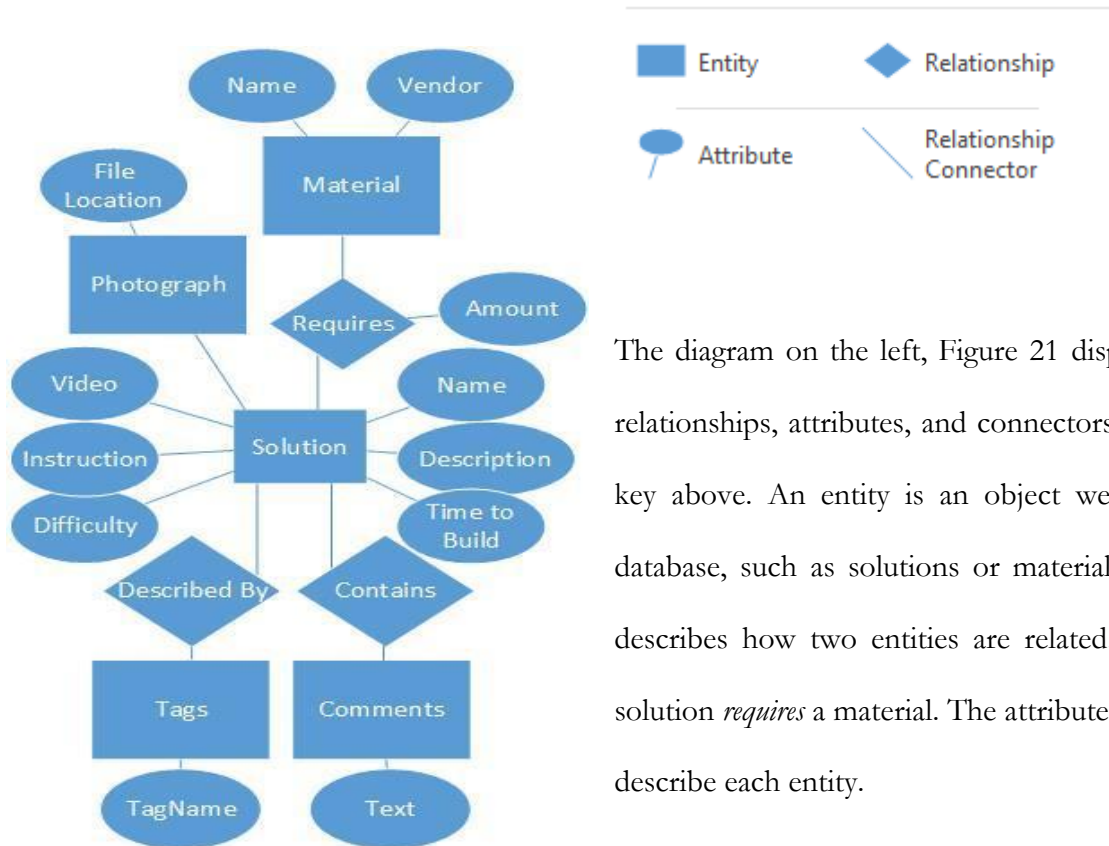


Figure 21: Entity Relationship Diagram

The diagram on the left, Figure 21 displays the entities, relationships, attributes, and connectors as shown in the key above. An entity is an object we included in the database, such as solutions or materials. A relationship describes how two entities are related. For example, a solution *requires* a material. The attributes are necessary to describe each entity.

Solution	<u>SolutionID</u> , SolutionName, Description, Time, Difficulty, Instruction
Material	<u>MaterialID</u> , MaterialName, Vendor
Requirement	<u>SolutionID</u> , <u>MaterialID</u> , Amount
Tag	<u>TagName</u>
SolutionTag	<u>SolutionID</u> , <u>TagName</u>
Comment	<u>SolutionID</u> , <u>CommentText</u> , Name

Figure 22: Relational Model

The relational model above describes the database in more detail by providing a concrete list of entities in the database, including relational entities, as well as all fields that describe the entities. This was used as the blueprint for constructing the database by visually communicating how the database was to be

built. Underlined fields are *primary keys*, which means that they are used to describe an individual entity within the database. For one SolutionID, there exists only one Solution to match it.

### Interfacing Web App

According to Domenic Smarra, the Chief Technology Officer at Seven Hills, the staff at Seven Hills have various degrees of technical knowledge (Domenic Smarra, personal communication, March 2016). Accessing a database directly through SQL commands requires specific technical knowledge that not all of the staff at Seven Hills will have. Therefore, it was necessary for us to develop a web application that will convert graphical buttons and search functions into queries onto the AT database, allowing everyone at Seven Hills to use and access the AT database.

### Choosing a Web Application Toolkit

#### **Finding 1: MEAN is a lightweight, fast and flexible web development framework.**

There are many ways in which one could build a program, or in this case, a web-based application (or web app for short). A traditional toolkit to build a website is LAMP, which stands for Linux operating system, Apache web server, MySQL database, and PHP programming language.

LAMP is a set of free, open source components, also known as a stack. It is used to build both dynamic and static web pages. However, using the LAMP stack locks the available operating systems to Linux, which makes it harder to develop and deploy on Windows machines. Additionally, Apache, the web server tool is not optimized for performance, and can break down during intensive traffic. PHP, the main programming language used in a LAMP stack also proves difficult to use and to write modular software with (Rosebrock & Filson, 2006).

In recent years, there has been a shift in the web programming paradigm, namely the emergence of the MEAN stack. MEAN stands for MongoDB (or in this project, MySQL) database, ExpressJS web framework, AngularJS participant-side framework, and NodeJS web server. While users of the LAMP stack have to be proficient in multiple programming languages, including PHP, MEAN stack only requires extensive knowledge of one programming language: Javascript. Moreover, each component of the stack is built on top of existing frameworks, which means there are more features that allow developers to write less code while improving productivity (Hightower, 2016). Furthermore, since some of our team members have already worked on projects built using the MEAN stack, our group opted to use this toolkit.

#### Continuous Integration and Testing

#### **Finding 2: A good product requires vigorous testing.**

As the project grew from a simple set of web pages to a functional, responsive, event-driven web application, we started noticing bugs, or unintended behaviors in the program. Thus, we felt the need to be able to detect problems as soon as possible and fix them before deployment. To achieve this, we utilized a software development technique called “Continuous Integration.” During this process, the codebase was modified and checked into a shared repository daily, where it was evaluated and tested automatically by a build system, and any errors were reported immediately (Duvall, Matyas, & Glover, 2007).

To set up a continuous integration environment, we wrote a variety of tests on different components to confirm that they behaved as intended. This led us to six different tests: Functionality, Usability, Interface, Compatibility, Performance, and Security. **Functionality tests** check for database connection, form submission, and links. **Usability tests** check for navigation within the web page,

and page content, for spelling and lexical error. **Interface tests** check for incorrectly handled interactions between the User Interface, Web Server and the Database. **Compatibility tests** handle compatibility between browsers, operating systems, and mobile devices. **Performance tests** check the website under heavy load and stress levels. And lastly, **Security tests** make sure users with malign intentions would not have access to view or modify vital information in the system (Duvall, Matyas, & Glover, 2007).

After setting up tests to cover all major cases, we chose an automated build system to test the application every time we made changes to the codebase. For this purpose, we chose Travis-CI, one of the two main continuous integration services, with the other being a service called Jenkins. Jenkins and Travis-CI have very similar functions. We settled on Travis-CI because a majority of projects on GitHub, a code sharing and publishing service, are configured using Travis-CI (206 out of 223 projects, or 92.3%), which means that there is a large source of open code available which helped us to learn how to set up and run Travis-CI (Vasilescu, Van Schuylenburg, Wulms, Serebrenik & van den Brand, 2015).

### **Finding 3: A search bar allows users to easily find AT Solutions**

In order to allow the Seven Hills staff to easily find the solutions that would best suit them, we implemented a search bar that queried the database based on entered keywords. The search function was based on a simple substring query. This means that it looks for any keyword entered in the search bar in either the solution name, description or tags and returns any solution that has a match with any of the entered keywords.

However, this solution is limited in terms of searching power, as it limits users to their own keywords. One way to improve upon this is by using “fuzzy search”, a feature that searches for a relevant solution, rather than an exact match. Thus, we recommend **improvements to the search functionality of the website**, perhaps through the use of an established search engine. An improved search functionality would make it even easier for the staff to find solutions that work well for them and their participants. Both Elasticsearch and Sphinx are open source search engines that are fast, however they take time to set up and will not be used in our project due to time constraints.

## Add a Solution

**Solution Name**

**Description**

**Category**

**Materials**  **Vendor** **N/A** **Quantity**

#	Material	Vendor	Quantity
---	----------	--------	----------

**Time to Build**  **minutes**

**Difficulty** ☆☆☆☆☆

**Cost**  **USD**

**Upload Images**  No file chosen

**Instructions**

Figure 23: Add a Solution View

### Finding 4: Add solution form allows users to add their own AT solutions into the database

In order to allow the Seven Hills staff to continue to populate the database and add any solutions that they develop on a day-to-day basis, we implemented an add solution form to the web interface. This

add solution form included all the information necessary to describe a solution, which includes the instructions, materials, categories, time to build, difficulty, upload images feature, solution name and description, as shown in Figure 24. We implemented a five star difficulty rating based on the type of assembly required to fabricate a device, as shown in Figure 24, to allow a staff member to determine if construction of a particular AT device is within their skill level. This was different than a rating system based on the helpfulness of the device, which we deemed would be unhelpful due to the varied needs of each individual.

<b>Difficulty</b>	<b>Description</b>	<b>Example</b>
1	Store bought, no assembly required	<u>Lifeware</u> Spoon
2	No assembly, only manipulating (bending, twisting, etc.) materials.	Writing Grip
3	Some assembly required, no alteration (cutting, burning, etc.) of materials.	Cup Holder
4	Some alterations required	Foot Stool
5	Much alterations required	Acrylic solutions

*Figure 24: Difficulty Rating System for AT Database*

An upload images option was developed to allow staff members to add step by step pictures depicting how to construct a device, or simply upload a picture of the final product. In various staff interviews, we learned that images would aid device construction” (Alissa Rivard, Joseph Plaisance, Jean Des Roches, Benjamin Marshall, Brian Heath, & Cynthia Greene, personal communications, March and April 2016).

The materials section allows a staff member to input the amount of a particular material, the vendor, and where a material can be purchased. Any existing materials will appear as a drop down option. During a demonstration of the AT database we developed, Jean Des Roches, the AT Director at Seven Hills, found the material list to be useful because the drop down menu will quicken the time it takes for a staff member to add solutions to the database (Jean Des Roches, personal communication, March 2016). The vendor option will also speed up searching by saving the staff from having to discover where a material can be purchased.

The time to build feature will allow staff members to find an AT device that is in a time frame they believe is reasonable to build a device. The solution name, description, and instructions provide the information to find a device in a search and the information to construct the device. Finally, the categories were developed for a number of different reasons, intended to better personalize device searches as described in Database Categories Personalize AT Device Searches (Pgs. 75-83). To learn more about the different components in the add solution form, visit the Database Instruction Manual in Appendix L.

**Finding 5: A Solution of the day will expose staff to a new possible solution for a current obstacle a participant is facing.**

In an interview early in our project timeframe, we met with Benjamin Marshall, Case Manager at the ADH program (Benjamin Marshall, personal communication, March 2016). During this meeting, he suggested a “Random Solution” button. The reason for this, was that Mr. Marshall had difficulty finding AT solutions for the participants in his program because he sees many of the “problems” these individuals face as characteristics of who they are. In meetings with the Assistive Technology Director, Jean Des Roches, and our advisors, we learned that the term “Random Solution” is not very

intuitive, so we decided to develop a “Solution of the Day” button (Jean Des Roches, personal communication, March 2016). A “Solution of the Day” button will help the staff to find AT solutions they might not consider searching for but could be beneficial to a participant. This feature is useful because it can be used to find answers to existing problems without the need to find proper search terms and can be used to match a device to an individual that it could help.

Many of the staff members at Seven Hills have difficulty identifying the appropriate AT solutions for reasons such as lack of time, difficulty searching through online information, and not knowing how to best help the participants in their programs. The “Solution of the Day” button, will aid the staff in better helping an individual, and it is a great way to get them using the database, so that they will be more comfortable using other features later on. A solution will be generated at the beginning of the day, and will change every 24 hours. We believed that this will be a long enough window of time to allow an individual to see the device and possibly build it, and at the same time will not overwhelm them with multiple AT devices.

Seven Hills Staff Members of Varying Technological Abilities Want to Learn to Use the AT Database.

**Finding 1: When training staff members to use the AT database it would be beneficial to allow individuals to work with the device they are most comfortable with, because our web-based application will work on smartphones, iPads, and computers.**

The statistics gathered also supported the need for staff training as many individuals who want to work with an AT database do not have the technological background for success. The raw data from these responses including the different positions surveyed, can be found in Appendix B. According to the survey we administered to Seven Hills staff members of various positions at the WDH and ADH programs, in order to assess the technological capabilities of the staff, we learned that the staff members least comfortable with AT were nurses and those that chose not to list their position. As



shown in Figure 25, approximately 56.1% of all 42 individuals surveyed use high-tech AT everyday with participants and 95.1% had used high-tech AT with participants in the last month. In regards to low-tech AT, Figure 25 shows that 47.6% of the staff members surveyed used low-tech AT every day with participants and 92.9% had used low-tech AT with participants in the last month (Survey of the Staff's Level of Comfort and Exposure to Different Types of Technology, April 2016). This data reflects that **the majority of staff do work with AT regularly and could benefit from being aware of new AT devices that could help the participants.**

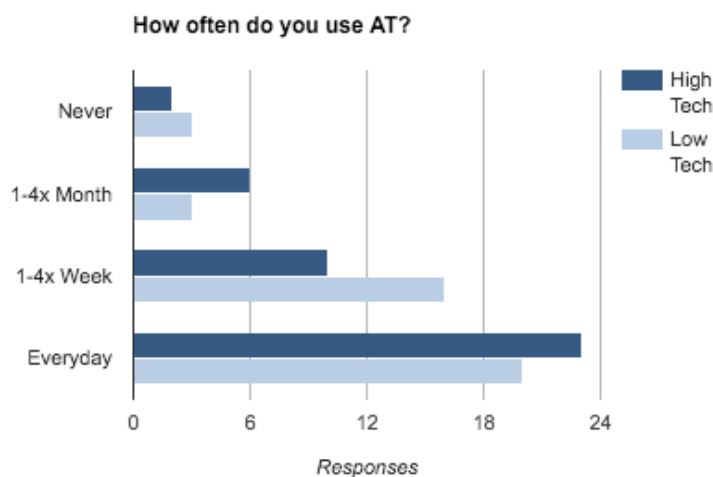


Figure 25: "How often do you use AT?" Survey of 42 staff members at Seven Hills Foundation (2016).

The staff are also receptive to the idea of being more knowledgeable about AT. One individual wrote, that they, **“look forward to having a place to find information.”** Another staff member said, **“I really want to know more so I can do more”** (Survey of the Staff's Level of Comfort and Exposure to Different Types of Technology, April 2016). Of the staff members surveyed, 90.5% said that a database would be helpful for using AT in their work, as shown in Figure 26. Of the four staff members who were opposed to an AT database; two staff members were in programs that did not use

AT often, one was not comfortable working with any form of technology, and one individual did not provide any feedback.

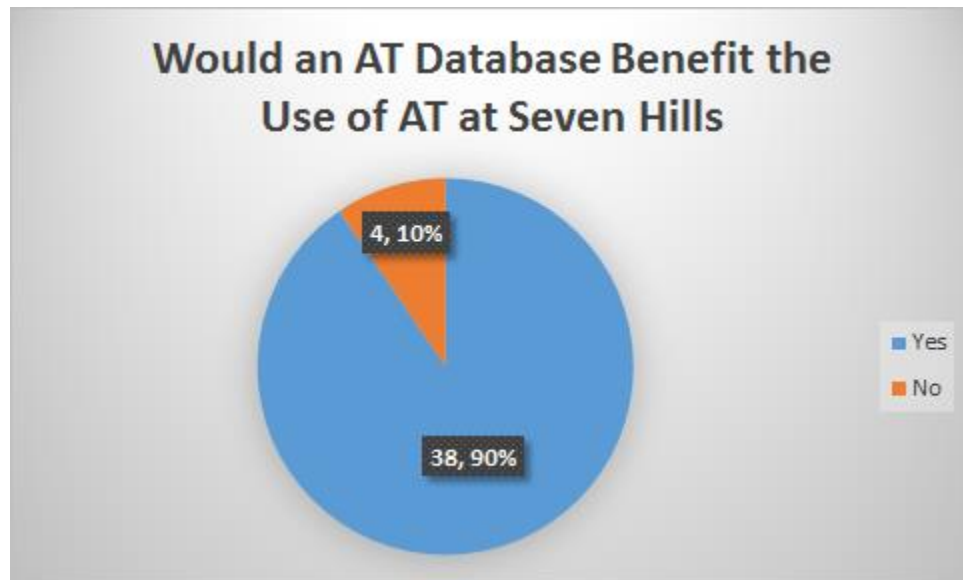


Figure 26: "Would a database benefit your use of AT at work?" Survey of 42 staff members at Seven Hills Foundation (2016)

In order to anticipate concerns with the database, we gauged staff comfort with various technologies. We learned that the staff members were most comfortable (score of 5) using phones (31 people or 73.8%) and somewhat comfortable using iPads (19 people or 45.2%), and computers (18 people or 42.9%). Figure 27 shows a graphical representation of this data.

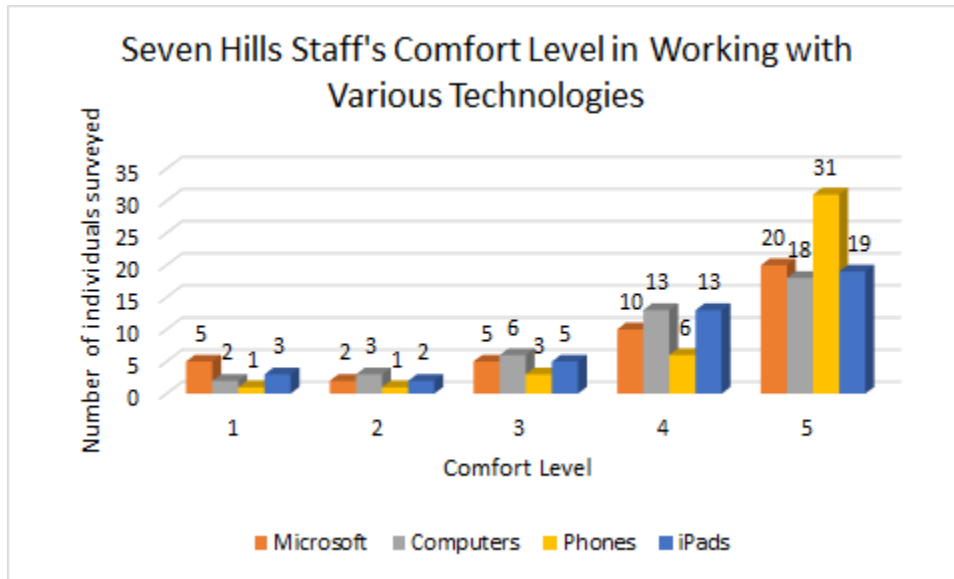


Figure 27: Comfort level using Microsoft Word, computers, phones, and iPads . Survey of 42 staff members at Seven Hills Foundation (2016). One is least comfortable and five is most comfortable.

Training the Seven Hills Staff to use the AT Database will Increase the Accessibility of AT.

**Finding 1: Conducting training sessions during staff meetings allowed us to teach nurses, Activities Specialists, and other staff members with varying AT experience to operate the AT database.** We conducted short, concise training sessions during the staff meetings at WDH and the ADH to teach the staff how to operate the AT database. The staff present at these meetings had varying technological abilities. In order to help individuals with varying technological abilities we used a live demonstration of the database where we answered questions throughout. We followed the Technology Acceptance Model (TAM) by stressing ease of use and how useful the database is (refer to Ch. 2, pg.36-37). At the end of the training sessions we conducted a post-training survey, as shown in Appendix K. We asked them how they would describe the training session, whether or not they would feel comfortable using the database after the presentation, and if there were any features they would like to see in the AT database. As shown in Figure 28, 54% of the staff described our presentation as helpful and the remaining 46% found the training session to be informative.

No staff members thought that the AT database we developed was confusing. Using the database through the web application we created is user friendly, and the staff didn't have any questions about operating it. After the training session, 75% of the staff we surveyed felt comfortable using the AT database as shown in Figure 28 (Post-Training Survey, April 2016). Several people asked about how they could access it and when it would be operational, which showed their enthusiasm and readiness to use the database. The staff really seemed to enjoy the ease with which they could find solutions, as well as the information that was provided on each solution. One staff member said, "I feel this will definitely help everyone find information easier," and three individuals commented that they were looking forward to using this tool (Post-Training Survey, April 2016). They also seemed really excited about the comment section, in which they could share their experiences with the AT devices. **We recommend that there should be training sessions in the future, to share the database with other programs at Seven Hills as well as to provide follow-up sessions for those that request**

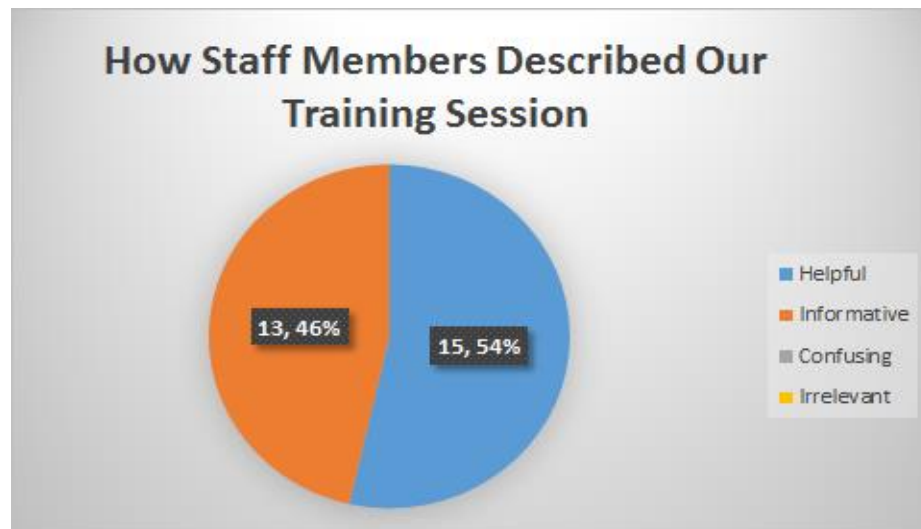


Figure 28: Post Training Survey Feedback

**them.** As shown in Figure 29, one individual felt uncomfortable using the database after our training

session and 21.4% of staff stated that they would like more training after our presentation. The staff also said that instructional videos or photos would be helpful.

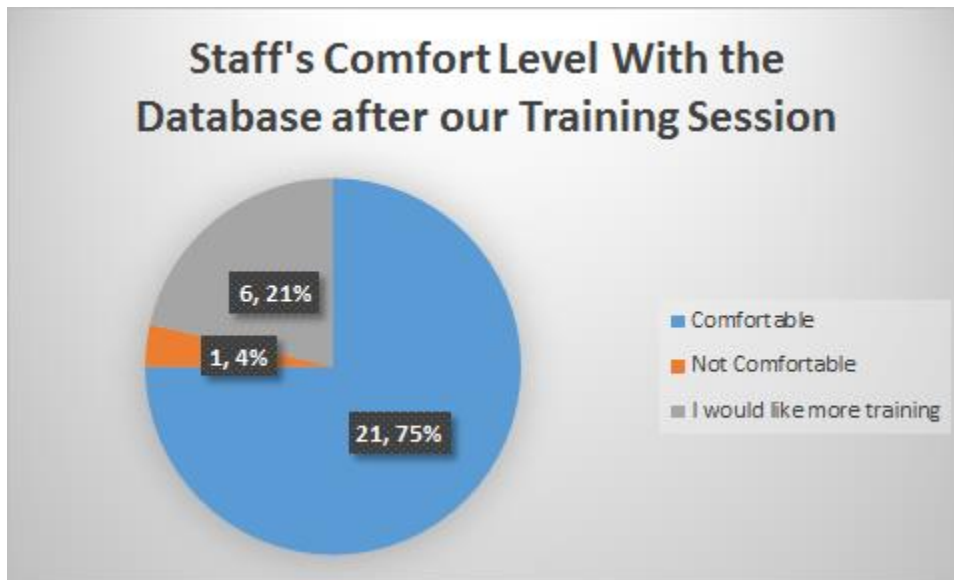


Figure 29: Post Training Survey Feedback- Comfort Level

**Finding 2: Conducting a training session with the AT Super Users will train staff experienced in the use of AT, who will be able to teach individuals at their respective programs how to operate the database.**

In an interview with the Assistive Technology Director of the Cotting School, we learned that they train their staff and students to use a new AT device by first providing a demonstration to teachers who will then train the students to use a new AT device (Patti Salmonson, personal communication, March 2016). She stated that a large training session followed by various individual training sessions has proven to be most impactful when introducing new technologies. Therefore our aim in teaching AT Super Users, was to provide a source of skilled individuals that can provide individual training to all of the staff members from the staff meetings that may still have unanswered questions.

The training sessions we conducted were through Zoom Conference which limited our ability to send out a post-training survey. Thomas Carey, Service Coordinator of Media at Seven Hills, informed us

that he thinks the database is very helpful (Thomas Carey, AT Super User training session, April 2016). Fedna Laurent, from the Milford, ASPIRE program, agreed, but, informed us that she would like a follow-up training session in the future (Fedna Laurent, AT Super User training session, April 2016). Jean Des Roches plans to explain how to use the AT database at an upcoming AT Super User meeting which should train the remainder of the AT Super Users.

**Finding 3: A brief, descriptive instruction manual will help the staff learn how to operate the database.**

The instruction manual made the database more accessible by enhancing staff knowledge in conjunction with the training sessions. The staff thought that the database training session was fairly simplistic but and they requested an instruction manual to help them if they had questions after the training sessions. We focused on the various features of the database, including the add a solution page, the search results page, and the solution page. We also discuss the importance of the database and how it could be used to augment AT use at Seven Hills. The instruction manual included concise instructions in addition to screenshots, aimed to make the directions easier to follow. The instruction manual can be found in Appendix L.

**Finding 4: A technical manual for the database and web-based application will aid Seven Hills in improving and maintaining the upkeep of the database and the web-based application.**

From our interviews and interactions with the IT staff at Seven Hills, we learned that they are extremely busy, and the rest of the staff has no experience in working with MySQL or web-based applications. As a result, we created this manual to allow a future team of students with experience in working with databases to pick up our work where we left off. We also created the manual to ensure that if something went wrong and Seven Hills needed to call an IT Specialist, they would be able to address the problem. The technical manual can be found in Appendix F.

### **4.3 Collaborating with Other Organizations**

**Finding 1: ATS is a useful database that should be used as a resource for the staff at Seven Hills in conjunction with the AT database we developed.**

As our team researched various existing AT databases we found many useful resources that would be beneficial for the staff to use in conjunction with the AT database. One organization we reached out to was Assistive Technology Solutions (ATS). The founder, Jerry Weisman, created a database that promotes the sharing of AT designs that are not commercially available. There is also a platform similar to Etsy which allows individuals to sell a product they have developed. If the product is very successful, ATS collaborates with the Center for Translation of Rehabilitation Engineering Advances and Technology (TREAT), which has a National Institute of Health (NIH) grant to help individuals to commercialize the AT devices they develop.

Our team reached out to Mr. Weisman for help in developing our own database and he advised us to have Seven Hills Foundation collaborate with his website. As a result of a conference call with various individuals at Seven Hills along with Mr. Weisman, we agreed that Seven Hills would use the site as a resource (Jerry Weisman, conference call, April 2016). Students working at Seven Hills to develop AT devices will be encouraged to publish the products they develop on the website along with a Seven Hills tag. During the conference call, we also learned that Mr. Weisman is the task president of the Rehabilitation Engineering and Assistive Technology Society of North America (RESNA). Mr. Weisman agreed that he would assist Seven Hills in further RESNA-certifying staff. Expanding RESNA-certification at Seven Hills will further improve the assistive technology competence of the staff (Jerry Weisman, personal communication, April 2016). This connection was useful and will help to expand the accessibility of assistive technology at and beyond Seven Hills Foundation. ‘

**We recommend that Seven Hills provide a webpage of additional AT resources on the Seven Hills staff website.**

While researching information to include in the AT database we encountered many other resources, besides Assistive Technology Solutions, that staff members were not aware of but would be helpful to use in conjunction with the AT database.. The database at4all.com is a companion website for the Easter Seals device loan program and it could be used to help staff test new, more expensive AT options with participants before purchasing them. Instructables.com and abledata.com also have many useful AT solutions. The database, abledata.com, allows a person to search for AT devices by product maker/seller, resource type such as state and local resources, by a specific disability, or by product. These different search methods could produce very specific devices if a staff member knew exactly what type of device they wanted to purchase for a particular participant. **If all of these resources were posted on the staff page in conjunction with the link to the Seven Hills AT database, it would improve the overall accessibility of assistive technology at Seven Hills Foundation.**



## **5. SUMMARY OF RECOMMENDATIONS**

We listed ten recommendations for the Seven Hills Foundation throughout the last two chapters, and in order to summarize these recommendations we have created two finalized lists of recommendations, ordered by what we believe to be the highest priority for Seven Hills. We split the recommendations into two lists as the recommendations came in two categories: recommendations to better utilize the Low-Tech Kit and recommendations to increase the capabilities of the assistive technology database.

### **5.1 Recommendations for Utilizing the Low-Tech Kit**

1. Spread Kit Awareness (pg. 64)
2. Educate staff on how to purchase materials (pg. 60)
3. Develop an expansion pack for the Kit (pg. 62)
4. Find volunteers/students to develop improved versions of the solutions in the Kit (Pg. 59)
5. Implement a Kit at the Pediatric Center (Pg. 64)

### **5.2 Recommendations for the AT Database/Website**

1. Continue to populate the database (pg. 71)
2. Increase the search functionality of the website (pg. 85)
3. Implement a dictionary check for categories (pg. 80)
4. Create a webpage of additional AT Resources (pg. 96)
5. Hold additional training sessions (pg. 91)

## **6. Conclusion**

Individuals with disabilities face many difficulties in life, which can lead to reduced independence and quality of life. Assistive technology devices are tools that can be used to overcome the challenges people with disabilities face. Over the course of our project, we created a database and web application in order to increase the accessibility of the assistive technology at the Seven Hills Foundation. This database, when in use, will increase both the availability and usability of assistive technology, which are the two main factors of accessibility. First, the availability of assistive technology will increase as more participants learn about the options available to them. The database will also increase the usability of the Kit and other solutions outside the Kit, as the instructions for building solutions will be easily available through the database. We hope that our project will better the lives of the participants at Seven Hills through increased independence and quality of life.

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Figure 18 Images:

Toilet Grab Bars: <https://i.ytimg.com/vi/Ew4tVqtE3Ec/maxresdefault.jpg>

Magnifying Glass: <https://www.flickr.com/photos/katerha/7071545621>

Walker:

[https://he.wikipedia.org/wiki//media/File:Chair\\_and\\_walker\\_easier\\_to\\_sit\\_down\\_and\\_rise.jpg](https://he.wikipedia.org/wiki//media/File:Chair_and_walker_easier_to_sit_down_and_rise.jpg)

Hand grip:

<https://s-media-cacheak0.pinimg.com/736x/50/69/ae/5069ae3bcd001b0708ae5a2e511d17b4.jpg>



## Appendix A: Semi-Structured Interview Questions for Staff

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting an interview of the staff members to develop a better understanding of the current assistive technology at Seven Hills. We strongly believe this kind of research will ultimately improve the accessibility of assistive technology at Seven Hills Foundation. Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will appear on the questionnaires or in any of the project reports or publications.

This is a collaborative project between Seven Hills Foundation and WPI, and your participation is greatly appreciated. If you are interested, a copy of our results can be provided at the conclusion of the study.

- Can you tell us a little bit about your experience here at Seven Hills?
- Can you describe your role within the organization?
- Can you tell us a little bit more about the role of AT at Seven Hills?
  - How are you involved with the assistive technology at Seven Hills?
- Can you tell us about your experience with the low-tech AT Kits?
  - Have they been effective in increasing the independence of participants?
  - Do you and the users like them?
  - How many Kits?
  - About how many people are using the Kits?
- Who is using the Kits (Therapists, caretakers, etc.)
  - What have you heard about people using the Kits?
  - Is there anything you think that could be improved about the Kits or its components?
- Can you explain the dairies that are located in each Kit?
  - What information has been recorded?
  - Where they effective in recording the Kit activities?
- We are developing a database for the Kit. Is there anything you would like to see included in it?
  - Categories?
  - Solutions?
- Is there anyone else we could talk to about assistive technology or the Kits? Caretakers? Staff?
- Is there anyone in another organization that we should talk to?

# Appendix B: Survey of the Staff’s Level of Comfort with and Exposure to Different Types of Technology

## Survey Format:

### Assistive Technology Survey

We are a group of WPI students working to create a database to act as a search engine for different assistive technology solutions. In order to do so, we feel it is important to gain a better understanding regarding the level of technology acceptance among staff, as well as the level of assistive technology use among staff members. Thank you for participating.

Position at Seven Hills?

Your answer \_\_\_\_\_

How often do you use HIGH-TECH assistive technology with your clients? (ie. ipad, automatic wheelchair, apps)

- Everyday
- 1-4 times a Week
- 1-4 times a Month
- Never

How often do you use LOW-TECH assistive technology with your clients? (ie. magnifiers, grips, weighted utensils)

- Everyday
- 1-4 times a Week
- 1-4 times a Month
- Never

How comfortable are you with using the following technologies? (1 being not at all and 5 being very)

	1	2	3	4	5
Microsoft Word	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Phones	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Computers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
iPads	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would a search engine for assistive technology (AT) solutions encourage the use of AT in your everyday work?

- Yes
- No

Additional comments or concerns...

Your answer \_\_\_\_\_

## Survey Results:

Position at Seven Hills?	How often do you use HI	How often do you use L	How comfortable are you with using the following technologies? (1 being not at all and 5 being very)			
	Everyday	Everyday	4	4	4	4
Director of ADH	1-4 times a Week	1-4 times a Week	4	4	4	3
Program Aid	1-4 times a Week	Everyday	5	5	4	4
Senior Program Aid	1-4 times a Week	1-4 times a Week	5	5	5	5
Activity Coordinator	1-4 times a Month	1-4 times a Week	5	5	4	5
Activity Specialist	1-4 times a Month	Never	5	5	5	5
Program Aid	1-4 times a Month	Everyday	5	4	5	5
	Never	1-4 times a Week	1	1	1	1
Activity Director	Everyday	1-4 times a Week	3	3	4	3
Service Coordinator		1-4 times a Week	5	5	5	5
Registered Nurse	1-4 times a Week	Everyday	5	5	5	5
Program Aid	1-4 times a Week	1-4 times a Week	3	3	5	4
Program Nurse	1-4 times a Week	1-4 times a Month	4	5	5	4
Program Manager	Everyday	1-4 times a Week	4	4	4	4
	Everyday	Everyday	4	5	4	4
	Everyday	1-4 times a Month	4	5	3	3
Family Support Speciali	1-4 times a Month	Never	5	5	5	5
	1-4 times a Week	Everyday	5	5	5	2
	1-4 times a Week	Everyday	5	5	5	5
Provider	Everyday	1-4 times a Week	5	5	5	5
Assistant Vice President	1-4 times a Month	1-4 times a Month	5	5	5	5
Service Coordinator	Everyday	1-4 times a Week	5	5	5	5
Nurse	1-4 times a Week	1-4 times a Week	2	2	3	1
Activity Specialist	Everyday	Everyday	1	5	3	5
Media Specialist	Everyday	Everyday	1	4	1	3
Activity Specialist	Everyday	Everyday	4	4	4	4
Service Coordinator	Everyday	Everyday	5	5	5	4
Expressive Arts Coordin	Everyday	1-4 times a Week	4	5	5	5
Nurse	Never	Never	3	5	2	1
Activity Specialist	Everyday	Everyday	1	5	2	2
Activity Specialist	Everyday	Everyday	1	5	2	5
Case Manager	Everyday	Everyday	5	5	5	5
Activity Specialist	Everyday	1-4 times a Week	4	5	4	5
Physical Therapist Aid	Everyday	Everyday	5	5	5	5
Case Manager	Everyday	Everyday	5	5	4	4
Service Coordinator	Everyday	Everyday	3	3	3	4
Activity Specialist	Everyday	1-4 times a Week	5	5	4	5
Activity Specialist	Everyday	Everyday	4	5	3	4
Activity Specialist	Everyday	1-4 times a Week	2	5	3	3
Intern	Everyday	Everyday	5	5	5	5
Program Coordinator	1-4 times a Month	1-4 times a Week	5	5	4	4
Service Coordinator	1-4 times a Week	Everyday	3	5	4	4

## **Appendix C: Semi-Structured Interview Questions for Organizations Like Seven Hills**

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting an interview of organizations that work to improve the independence of developmentally disabled individuals through the use of assistive technology to develop a better understanding of how to best meet the needs of the participants at Seven Hills. We strongly believe this kind of research will ultimately improve the accessibility of assistive technology at Seven Hills Foundation. Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will appear on the questionnaires or in any of the project reports or publications.

This is a collaborative project between Seven Hills Foundation and WPI, and your participation is greatly appreciated. If you are interested, a copy of our results can be provided at the conclusion of the study.

### Cotting School Questions

- What is your role at the Cotting School?
- How is your role related to the participants at the Cotting School?
- Can you briefly describe what makes the Cotting School unique from similar organizations such as Seven Hills Foundation?
- What types of technologies are being used at the Cotting School for your participants or your staff?
- What types of programs are available at the Cotting School that incorporate technology?
- How does your organization integrate new technologies?
- Does the Cotting School use any tools for organizing your technologies or inventory?
- Is there a certain process the Cotting School follows for introducing new assistive technologies to participants or staff?
- Could you please tell me more about your Assistive Technology Assessment Center?
- Are there any resources or websites you regularly use that you feel we might be able to use?
- Do you work with or know of any other individuals or organizations that you think we should contact?

## Appendix D: Copy of the Entry Log

Project #	6	7	8	9	10
Date					
Name of Program					
Name of Contacts					
Name of Project					
Page # or Description					
Rate the ease of the building process (on a scale of 1 to 5 with 1 being very easy and 5 being very difficult)					
Rate the success of the project and how well it benefited the participant (on a scale of 1 to 5 with a 1 being not helpful and a 5 being very helpful)					
Write a short description of how the project has benefited a participant/participants.					

## Appendix E: Compiled Entry Log Data

Project	Project	Program	Contact	Description/ p. #	Ease of assembly	Success	Description
iPad Stand	n/a	ADH	Ben Marshall	Flag Stand, Loc-Line, Plastic	2	2, needs copper wire in loc-line	Sturdy iPad stand for those w/ limited mobility in extremities.
Foot Stool	n/a	ADH	Ben	Pink Board, Duct Tape	1	5	Helps keep head up during group and lunch
Walker Hook	2/11/2016	ADH	Ben	PVC Pipe, Zip Ties, Tape	1	3, had to be rebuilt for more strength	Can hold her purse while using walker
iPad Stand	10/13/2015	WDH Aspire	Taylor Johnson	(p.85)	1	5	Helps indiv. to use iPads more effectively
Brush Grips	11/3/2015	WDH Aspire	Taylor Johnson	(p.75) Model Magic	1	5	Increased the individual's abilities to control the brush
Color Pencil Grip	11/5/2015	WDH Aspire	Taylor Johnson	(p. 139) Industrial Twist Tie	1	5	Allow for quick adaptation for multiple indiv. in same class
Recessed iPad Holder	1/12/2016	WDH Aspire	Taylor Johnson	(p.179)	2	5	Allowed indiv. to use iPad without it sliding around on their trays
Cup Holder	3/15/2016	IQP	WPI Team	Clamp, Industrial Twist Tie, Loc-Line	2	5	Allowed them to drink their beverage without constant assistance from staff.
Book/ipad Stand	3/15/2016	WCPC	WPI Team	Clamp, Loc-Line, Acrylic, Corner Guard	3	3	User could view their iPad without having to hold it
Plate Guard	3/15/2016	WCPC	WPI Team	Plate, CD Holder, UGlu	2	5	Keeps food on the plate while the client eats.
Writing Grip	4/6/2016	WCPC	WPI Team	Industrial Twist Tie	1	5	Allows clients with poor grip strength to hold and use a writing utensil
Stylus Grip	4/6/2016	WCPC	WPI Team	Industrial Twist Tie	1	4	Enables the use of a stylus for iPads or iPhones

## **Appendix F: Technical Manual for the Database and Web Interface**

See Attached Document

## Appendix G: Semi-Structured Interview Questions for IT Specialists

We are a group of students from Worcester Polytechnic Institute in Massachusetts. We are conducting an interview of the IT Specialists at [insert location] to learn how to format our assistive technology database. We strongly believe this kind of research will ultimately improve the creation and success of our assistive technology database. Your participation in this interview is completely voluntary and you may withdraw at any time. Please remember that your answers will remain anonymous. No names or identifying information will appear on the questionnaires or in any of the project reports or publications.

This is a collaborative project between Seven Hills Foundation and WPI, and your participation is greatly appreciated. If you are interested, a copy of our results can be provided at the conclusion of the study.

### WPI IT

- Can you tell us about your role at WPI?
- Can you tell us more about how WPI utilizes databases?
- Which OS/Distribution (Redhat? CentOS?) do you use?
- Which database version? Type?
- What are the main differences between different database sizes? (Enterprises/Personal use)
- Do you have any advice for us regarding implementing a network-wide database?
- What are some good practices or pitfalls to avoid?
- Are there any resources you can point us to (books, websites, ...) that you think would help us?
- Are there other individuals whom you suggest we speak with? E.g. individuals with database experience, search engine experience, inventory, etc.
- Is it alright if we come to you for advice throughout the process of creating this database?
- Is there anyone else you think we might be able to contact that could help us develop this database?

### Seven Hills IT

- Can you tell us about your experience at the Seven Hills Foundation?
- Can you tell us about the infrastructure of the Seven Hills Network?
- PC with IIS at Goddard - running a database of past WPI group?
- Are/how are the multiple Seven Hills locations connected on the network?
  - What kind of servers are operating on the network?
    - Operating System?
    - Hardware specifications?
    - What capacity are they running at right now?
- In your opinion could the servers support a database right now?
  - Are there any databases operating on the network?
    - What kind of database and what is it used for?
- How could we set up a database on the Seven Hills network?



- Is the Seven Hills website hosted on site, or do you use an external hosting provider?  
If not:
  - Is it possible to set up a web-server on the existing network?
- Would it be possible to create an interface to the database we are developing that is only accessible while connected to the Seven Hills Network?
  - How could we set up this application on the network?
- Is it alright if we follow up with you if we have additional questions throughout the process of creating this database? If so, do you prefer we contact you via email or phone?
- Is there anyone else that you recommend we speak with to learn more database design and functionality at Seven Hills?

## Microsoft Engineer

- What is your role as a data architect at Microsoft?
  - Could you tell us about your experience working with and designing databases?
- Do you ever run into any obstacles or challenges when managing large amounts of data?
  - Could you describe them for us?
  - What sort of safety nets do you include to prepare data overload or other challenges?
- How would you organize data when designing a database?
- What database frameworks do you recommend?
  - Pros/cons?
- What advantages/disadvantages does Azure have?
  - If Seven Hills has an on-site webserver, does this make sense?
- How would you recommend we prepare for the worst case scenario when designing a database?
- What considerations should we consider as we design a database that will be accessed by many users at many locations?
- Do you have any other advice based on our project?
- Would it be alright if we followed up with you if we have additional questions? If so, do you prefer we contact you via email or phone?
- Is there anyone else that you recommend we speak with to learn about database design or function?

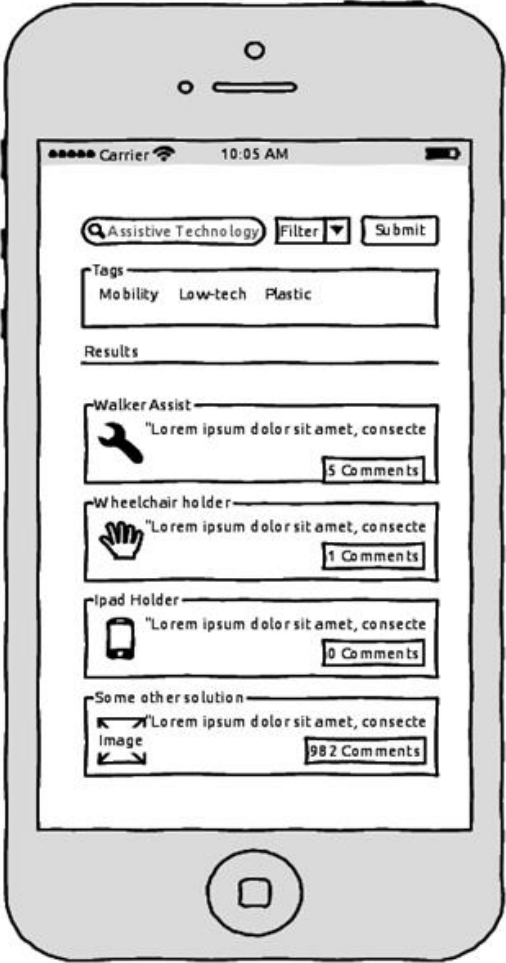
## Appendix H: Entity Relationship Diagram



## Appendix I: Relational Model

Solution	<u>SolutionID</u> , SolutionName, Description, Time, Difficulty, Instruction
Material	<u>MaterialID</u> , MaterialName, Vendor
Requirement	<u>SolutionID</u> , <u>MaterialID</u> , Amount
Tag	<u>TagName</u>
SolutionTag	<u>SolutionID</u> , <u>TagName</u>
Comment	<u>SolutionID</u> , <u>CommentText</u> , Name

# Appendix J: Graphical User Interface Mockup



# Appendix K: Post-Training Survey Questions

## Survey Format:

### Post-Training Survey

Assessment of database and database training session.

**1. How would you best describe this training session?**

*Mark only one oval.*

- Helpful
- Informative
- Confusing
- Irrelevant
- Other: .....

**2. After this presentation how comfortable would you feel using this database?**

*Mark only one oval.*

- Comfortable
- Not comfortable
- I would like more training

**3. Are there any other feature you would like to see in the database? (i.e. Comment section)**

.....

**4. Additional comments/concerns. \*Your comments are greatly appreciated!**

.....  
.....  
.....  
.....  
.....

## Post Training Survey Responses:

Timestamp	How would you best des	After this presentation h	Are there any other feat	Additional comments/concerns.	*Your comments are greatly appreciated!
4/15/2016 9:33:41	Helpful	Comfortable		Great Job!	
4/15/2016 9:33:51	Helpful	Comfortable			
4/15/2016 9:34:10	Helpful	Comfortable		Awesome Job!	
4/15/2016 9:35:44	Helpful	Comfortable	Related/similar suggestions: "People who searched this also searched ___"		
4/15/2016 9:35:59	Helpful	Comfortable			
4/15/2016 9:36:56	Informative	Comfortable		Looks like it's off to a great start, will be very helpful.	
4/15/2016 9:38:09	Helpful	I would like more training			
4/15/2016 9:38:33	Informative	Comfortable		Having written instructions would be helpful.	
4/15/2016 9:39:06	Helpful	I would like more training			
4/15/2016 9:39:23	Informative	Comfortable			
4/15/2016 9:39:33	Informative	Comfortable			
4/21/2016 12:06:03	Informative	Not comfortable			
4/21/2016 12:06:57	Helpful	Comfortable		I feel this will definitely help everyone find information easier.	
4/21/2016 12:07:32	Helpful	Comfortable		Sounds great, look forward to using it!	
4/21/2016 12:07:46	Informative	Comfortable			
4/21/2016 12:09:53	Helpful	Comfortable	Not yet	Thank you!	
4/21/2016 12:09:55	Helpful	Comfortable	Not yet	Thank you!	
4/21/2016 12:12:56	Informative	Comfortable		Looking forward to these tools.	
4/21/2016 12:13:11	Informative	Comfortable		Looking forward to these tools.	
4/21/2016 12:13:36	Informative	I would like more trainin	No, seems very useful so far		
4/21/2016 12:14:38	Informative	I would like more trainin	Not Yet	A great start. I would ask Ben	
4/21/2016 12:15:42	Helpful	Comfortable			
4/21/2016 12:17:19	Informative	Comfortable		Looking forward to using it.	
4/21/2016 12:17:37	Informative	Comfortable	Nothing yet.		
4/21/2016 12:17:50	Helpful	Comfortable			
4/21/2016 12:18:04	Informative	I would like more training			
4/21/2016 12:18:26	Helpful	Comfortable	Instructional videos		
4/21/2016 12:19:02	Helpful	I would like more training			

## **Appendix L: Database Instruction Manual**

See Attached Document

## Appendix M: Comparative Table of Online AT Databases

Database	Visual Representation	Sorting Features	Categories	Instructions/ Links
at4all.com	✓	✓	✓	✓
atsolution.org	✓	✓	✓	✓
abledata.com	✓	✓	✓	✓
instructables.com	✓	X	X	Just instructions