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Assistive technology adaptations for farmers with physical disabilities

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Abstract

A disproportionate number of workplace deaths and injuries in Manitoba occur in our agricultural industry. In the case of injury, many farmers are left with a permanent disability, making it challenging to continue in their occupation. Assistive technologies (ATs) can help many farmers as they seek to increase, maintain, or improve their functional capabilities. These technologies could include new tools or modifications to machinery, and they may be designed by a rehabilitation professional or the farmer themselves. The objectives of this project are to document assistive technologies presently in use by farmers with disabilities, and evaluate their compliance to existing safety standards. Questionnaires and personal interviews will be used to collect information on ATs from the farmers who use them. Current industry standards will be studied; relevant clauses will be isolated and used to assess the safety and durability of ATs for agricultural applications. Finally, this information will be synthesized to produce a catalogue of new devices and guidelines designed to aid in the development of assistive technologies for agricultural applications.

Keywords: assistive technology, agriculture, disability, farmer.

INTRODUCTION

Agricultural workers are exposed to a wide variety of risks, and are not subjected to the same safety control measures as their industrial counterparts. This combination contributes to their susceptibility to occupational injuries and fatalities. Although the number of agricultural incidents has not been well documented in the past, the Canadian Agricultural Injury Surveillance Program (CAISP) has worked to quantify their magnitude. "With an average of more than 100 deaths and 1,500 hospitalizations resulting from agricultural injuries in Canada each year, agriculture is one of this country's most hazardous industries" (CAISP 2003). Following a serious injury, many farmers are left with a permanent impairment which may lead to a disability. A disability can be defined as an inability to "perform an activity in the manner or within the range considered normal for a human being" (WHO 1980). It has been estimated that 25 % of farmers and farm workers in America suffer disabilities (including amputations, impaired vision, stroke, head injury, etc.) that impede their ability to carry out essential farming tasks (Hancock 1998). Despite these new obstacles, many farmers wish to continue to work on the farm. A study of farmers with an upper-extremity loss (Reed and Claunch 1998) found that farmers feel that farming is "in the blood" and can't imagine leaving farm life even after loosing an arm to the occupation.

Following a disabling injury, the combination of rehabilitation and appropriate assistive technologies (ATs) can help a farmer adapt to their new disability by compensating for their sensory or physical losses. Furthermore ATs can help farmers with disabilities increase their productivity with day to day tasks, thus minimizing the lost farm income which often accompanies an owner operator's injury. An AT is commonly defined as "any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized that is used to increase, maintain, or improve functional capabilities of individuals with disabilities" (PL 100-407 1988). Successful ATs are those that enhance the user's capabilities, leading to greater functional outcomes (Cook and Hussy 2002). These devices range from simple, low tech aids, to complex mechanical or electrical systems.

The assistive technologies that will be focused on at this time are those that augment functional capabilities related to musculoskeletal limitations, for example, an amputation, or loss of function in one or more limbs. This study will not include standards pertaining to ATs used to compensate for limited visual, auditory, or cognitive function. Furthermore, recommendations for the use of tactile coding of displays and controls have been excluded from this study. User recognition of tactile codes requires a high level of tactile sensitivity, which would not be expected from people with some upper extremity limitations, those who wear work gloves, or those who do significant labour with their hands (calluses decrease sensitivity).

In urban centers, many people would consult with an occupational therapist and a rehabilitation engineer to select or design appropriate ATs. However, there is limited accessibility to ATs for many people living in rural areas (as most farmers do), and multiple trips to the city may not be feasible. "Rural residents with disabilities may not only rely on friends and family for some services that urban residents might receive from formal providers, but rural residents may also receive some services from professionals acting "outside" of their specialties" (Offner et al. 1992). This limitation, combined with the problem solving nature of farmers has led many to design and build their own ATs. A multitude of inventions are born on the farm as farmers develop an idea from their desire to perform a task or operation more effectively. In consultation with friends or neighbours, they may refine the idea, and find the means to

manufacture the chosen solution. These unique designs have the potential to benefit others with similar needs. Often, this potential is not realized, as many original designs have not been documented, and this valuable information is not shared.

Resources such as *The Toolbox* (Breaking New Ground Resource Centre 2000) and the *Changing Gear Machinery Modifications Catalogue* (Saskatchewan Abilities Council 2000) describe some equipment modifications, special tools and farming aids that are currently in use, and often designed by farmers with disabilities. The fact that the authors of both compilations request that new ideas be sent to them is a strong indication of the continuing need for a complete collection of ATs for agricultural applications.

The goal of this project is to increase the safety and accessibility of ATs to farmers with disabilities. To accomplish this goal the following objectives must be realized: 1) document assistive technologies presently in use by farmers with disabilities, and 2) evaluate their compliance to existing safety standards. A mailed questionnaire and interview protocol will be used to collect information on AT from farmers who use them. All devices will be evaluated for safety, durability and efficiency using relevant industry standards. The data collected and assessed through these objectives will be used to compile a catalogue of any new ATs that are presently in use by Manitoba farmers (including a safety assessment of each tool), and suggest guidelines for the design of new ATs for use in agricultural applications.

MATERIALS AND METHODS FOR PARTICIPANT RECRUITMENT AND DATA COLLECTION

Before commencing data collection a comprehensive literature review must be completed to identify all existing projects involving the use of ATs by farmers with disabilities. Also, a more general review will be required to collect background information on agricultural injuries, coping with disabilities, design and selection of ATs, and the use of ATs by people with disabilities. Furthermore, industry standards (ASAE, ANSI, BSI.) that may be relevant to the use of ATs in agricultural settings must be collected. Later on, these standards will be dissected and critically evaluated to determine which sections are applicable to different groups of ATs.

This non-experimental research will be conducted using a two phase, sequential mixed methods approach (Creswell 2003). A questionnaire will first be administered to participants to collect mainly quantitative data. To elaborate on the primary data, interviews will be conducted with a subset of the initial study population. This will allow the opportunity to perform a more detailed exploration on the use of ATs for farming application.

Participant Recruitment

The majority of the data collected for this project will come directly from farmers themselves. Due to the use of human subjects, the project must be approved by the University of Manitoba's Education and Nursing Research Ethics Board (ENREB) before it can proceed, and informed consent must be obtained in writing from every participant. Once approved, the project will be advertised within agricultural communities, and interested farmers with disabilities will be invited to participate in the study. Some eligible farmers will initially be contacted through a study package distributed through Manitoba Farmers with Disabilities which will describe the project, the expectations for participants, and the intended project timeline. Other participants will be recruited by advertising for the project at local farm trade shows, presenting at the

Canadian Agricultural Safety Association's annual conference, and printing articles in rural newsletters.

All participants will be asked to complete a questionnaire (described below). The ATs described in the farmers' responses will be compared to those already documented in the existing resources (*The Toolbox*, *Changing Gear*). Those farmers describing unique experiences or ATs will be invited to participate in an in-person interview, to further describe their responses. These interviews will be arranged for a time and location of the participants' convenience.

Questionnaire

A mailed-out questionnaire will be used to collect initial information from farmers with disabilities who use ATs. A modified Dillman mail survey technique will be used to administer the questionnaire (Dillman 2000). This tool was designed using closed items (check boxes) so that it is simple to complete, and open items (short answers questions) to add depth and flexibility to the collected data (Domholdt 2005). It will be distributed to all participants and will be used to collect fundamental information such as, the nature of their disability, the ATs that they currently use for farm related tasks, and any problems or safety concerns they may have with their current ATs. The objective will be to collect enough information about their devices to determine if they are using: a) a unique tool or an existing tool in an innovative way, or b) an existing tool as intended.

Interview Protocol

The interviews will follow an open ended set of questions and will be used to collect more detailed information as necessary. Participants will be asked to describe in detail 1) the effects of their disability on their day to day activities, 2) the ATs that they use, and the tasks they are used for in a typical day, 3) how they acquired their ATs (a modified product or unique design), 4) who co-operated to design and build the device (if applicable), 5) any safety concerns with their ATs, and 6) any additional features they desire. All interviews will be tape recorded, and photographs will be taken of ATs where allowed by participants. The interview process should provide a complete picture of how the AT, the tasks the technology is used for, the human user, and the surrounding environment fit together.

The combination of questionnaire and interview should yield adequate information to describe the types of ATs that are commonly used in agricultural applications. Table 1 is a summary table of the information that we expect to collect. The characteristic impairments listed are only a few examples of what we expect to see.

ANALYSIS OF COLLECTED DATA

Categorization of Assistive Devices

Once all data has been collected the ATs will be categorized for analysis. This grouping is aimed to facilitate the evaluation of the ATs, and the creation of proposed guidelines. It is unlikely that the same standards (or sections thereof) can be used to evaluate the safety and reliability of all ATs used by farmers. The technology categories have been chosen to separate ATs that have

very different methods of operation, and group those that use approximately the same level of technology (high/low) and potential hazards. In general, ATs that are powered by the user will require different safety considerations than those that are electrically powered.

The five categories of ATs that were used were: Low tech mobility aids, Low tech environmental controls, High tech mobility aids, High tech environmental controls, and Prosthetic attachments. The term "low tech" refers to a simple device that is relatively easy to manufacture, while a "high tech" device is more complex, often requiring specialized knowledge to design and manufacture, including electrical and computer equipment (Cook and Hussy 2002). As the name suggests, mobility aids are technologies that increase the mobility of a person with lower extremity impairment. Environmental controls are technologies that increase a person's control over their surroundings; these include modifications to existing controls, or the implementation of alternate control mechanisms. Examples of ATs related to agriculture that would fall into each of these categories are listed in Table 1.

Table 1: Categorization of AT and Standards to Review

Limitation	AT Category	Example of AT	Example of a Standard to Review
Limited mobility	Low tech mobility aid	User powered lift to machinery cab	ANSI/ASAE S318.15 Safety for Agricultural Field Equipment
	High tech mobility aid	Electrical lift to machinery cab	ANSI/ASAE S493 Guarding for Agricultural Equipment
Upper or lower extremity impairment	Low tech environmental control	Addition of large easy grip handles to tool or machine controls	ASAE EP443.1 Color Coding Hand Controls
	High tech environmental control	Fingertip braking control	ASAE S335.4 Operator Controls on Agricultural Equipment
	Prosthetic attachment	Wrench attachment for prosthetic arm	BS EN 894-1: Safety of Machinery – Ergonomic Requirements

Evaluation According to Existing Standards

Before information on ATs can be disseminated it is important to assess them systematically; the devices must be proven to be reasonably safe and reliable and controls must be designed to follow recommended methods of operations where possible. As no standards currently exist that are dedicated to ATs, assessment tools must be developed for each category. This will be done by gathering all industry standards relating to operation of agricultural tools and machinery, and isolating the clauses that apply to each category of ATs. Standards exist in many industries for the design and maintenance of processes and systems. They can be thought of as best practices and should be understood and adhered to by all to whom they apply. Although standards describe recommended procedures, they clearly state that simply by adhering to a particular standard, an individual/group is not immune to other legal obligations. The same will be true for

the assessment tools developed for ATs, and any publications will carry a disclaimer clearing the project and all co-operators of any harm arising from the use of ATs in agricultural applications. Table 1 lists examples of some standards that will be reviewed. There will be some overlap between the categories, and some standards will be relevant in multiple categories. This exhaustive standards review will include, but not be limited to, standards from the American Society of Agricultural Engineers (ASAE), American National Standards Institute (ANSI), and British Standards Institution (BSI).

The data collected on ATs and their compliance to current industry standards will be analyzed to identify trends in the current use of ATs in agricultural applications. Important concepts to study will be: 1) who is designing the ATs that farmers are using, 2) farmers' satisfaction with their ATs, and 3) how farmers perceive the safety of their devices. Once this information is teased out, it can be used to help other farmers learn from their cohort's successes and failures. This learning will be achieved through the circulation of two end products: the new AT catalogue, and suggested guidelines for the design of each category of technologies. The catalogue will expose farmers to ideas for ATs that already exist and their adherence to the suggested safety guideline, while the suggested guidelines will help them to make safe decisions in the design of a new AT.

EXPECTED RESULTS

Through this interaction with Manitoba farmers, we expect to find that they are contributing to the design and manufacture of unique ATs, with assistance from their local community or government programs. While programs have existed to share ideas for agricultural ATs, we expect that many designs have not yet been documented. There is an opportunity for these existing designs to benefit other farmers in similar situations; this cannot be realized until the design is documented and the information is shared.

Furthermore, many unique designs may not adhere to current industry standards. This is reasonable to expect, as standards compliance was likely not the primary objective of the designer. However, standardizing some aspects of existing designs may improve the safety of the device, as well as future user efficiency and convenience. Suggestions for safety and standardization will be included with catalogue entries where designs do not meet the determined design criteria.

The outcome of the standards review will be a list of suggested guidelines that promote the design of ATs that are safe, reliable and user friendly. This will be useful to farmers who are designing ATs themselves, or to Rehabilitation Engineers who are designing ATs but are unfamiliar with the safety and durability demands of tools used in agricultural applications.

We will be able to compare our catalogue of new devices to existing catalogues (*The Toolbox*, *Changing Gear*) to assess its uniqueness, usability and completeness. There are currently no standards for ATs used in agricultural applications to which we could compare our suggested guidelines. As these documents will be the first of their kind, their usefulness will need to be evaluated by farmers designing ATs, and by rehabilitation professionals who are familiar with the design of ATs for various applications.

CONCLUSION

The project will be successful when the following two objectives are complete: 1) new ATs in use on Manitoba farms are documented and 2) the compliance of current designs to relevant clauses of industry standards has been assessed. This valuable information can only be put to use, to increase the safety and accessibility of ATs to farmers with disabilities, when it is organized into a deliverable format. The information will be used to create a catalogue of new devices including safety assessments and guidelines for the design of new ATs. If the results of this project are communicated to all interested parties, this information will help farmers with disabilities to continue farming safely and effectively with the aid of ATs.

The most foreseeable limitation of this research is the difficulty in initiating and maintaining contact with farmers with disabilities. While bulk of the participants will be approached through Manitoba Farmers with Disabilities, it has been difficult to make contact with other potential participants through attendance at trade show and other gatherings. Once a contact is initiated, participants' busy schedules may make it difficult to complete the questionnaire and arrange for an interview. Furthermore, it will not be practical to interview every participant, possibly resulting in some cases where more detailed information is desired, but not attainable.

Completion of this project will certainly open doors for further work in the area of ATs for agricultural applications. Firstly, it would be beneficial to work with Manitoba Farmers with Disabilities to develop a method to update the proposed AT catalogue as new devices are brought forward. Also, work in the area of ease of use and ergonomics of ATs for agricultural applications would be useful in ensuring that farmers are using their technologies to their maximum efficiency. Finally, once this project is established, it would be interesting to consider expanding it to a national level. This would increase the complexity of the project, but also provide substantially more input, covering a wider range of limitations and experiences.

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