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Technology and Aging: An Emerging Research and Development Sector in Maine

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Technology and Aging:

An Emerging Research and Development Sector in Maine

by Carol H. Kim, David Neivandt, Lenard W. Kaye, and Jennifer A. Crittenden

The authors discuss the importance of research for developing products and services that cater to the needs of a rapidly growing aging population and provide examples of projects underway at the University of Maine. Products designed to improve and protect older adult health and well-being represent a significant opportunity for economic growth in Maine.

It is often assumed that the aging of Maine will have a negative impact on economic and innovation prospects. However, Maine's older-adult demographic provides a critical opportunity for developing products and services that can cater to the needs of a rapidly growing aging population nationally and globally.

Older adults are already incorporating innovative products and devices in their daily lives, making them a prime audience for the next generation of new and emerging technologies. In 2013, 59 percent of adults 65 and older used the Internet and 77 percent used a cell phone to communicate with family, friends, and providers. Older adults are also the fastest-growing age group of users of social networking sites (Pew Research Center 2014).

As a state, Maine is no stranger to the use of technology to support older adults and deliver health care services. For example, telehealth is already used extensively throughout the state to serve patients of all ages and provide access to specialty care in rural areas. Other technology trends can be expected to take increasing hold in Maine as broadband (high-speed Internet access) reaches more communities, businesses, and individuals around the state. This includes the use of smart-home technology to provide remote monitoring of loved ones; the increasing use of wearable technology that will allow older adults and caregivers to monitor vital signs, sleep, and physical activity; the use of personal emergency-response systems allowing an individual to reach emergency assistance when needed; and medication-adherence technologies that remind an individual to take medication or that provide medication monitoring for a caregiver. Internet sites and apps are also creating opportunities for rural older adults to connect with others elsewhere in the country, whether they are grandparents who want to stay in touch with their grandchildren or individuals looking to interact with others for support across the country.[1] In this respect, Maine's rural nature provides ripe opportunities for using technology to reduce social isolation and deliver the best care and support possible at a reduced cost.

AARP has identified nine focal points of health innovation that represent areas poised to experience rapid expansion and tap into the $7.1 trillion longevity economy. Such technologies, encompassing products and services used for and by adults over the age of 50, represent a five-year revenue potential of approximately $30 billion nationally (AARP 2014). These technologies are segmented into the following categories of innovation:

- **Medication management**—Technologies for tracking and managing medication adherence
- **Aging with vitality**—Maintaining health and well-being through preventive interventions that preserve hearing, sight, and cognition.
- **Vital-sign monitoring**—Technologies often including features for tracking, recording, and sharing vital-sign information with designated caregivers and health care providers
- **Care navigation**—Products designed to put older adults and caregivers in the driver's seat of their care. These technologies include features such as tracking care expenses, appointments,

and connecting with health and social service providers.

- **Emergency detection and response**—Technologies that allow for remote monitoring of a loved one, fall detection, and personal emergency-response devices that allow individuals to quickly connect with emergency support when needed.
- **Physical fitness**—Applications, devices, technologies, and approaches for maintaining and boosting physical fitness.
- **Social engagement**—Technologies that allow users to stay engaged with others as they age including web-connected applications, devices, and websites that provide outlets for connecting and engaging.
- **Diet and nutrition**—Innovations include solutions that allow individuals to track food intake, monitor personal nutrition, learn more about nutrition, and prepare meals.
- **Behavioral and emotional health**—Solutions encompass products and services that boost behavioral and emotional health through support groups, self-help options, and education.

A key ingredient for developing technologies for healthy aging is the cross-fertilization of ideas to address the wants and needs of the 50+ market.

The AARP innovations model is an apt framework through which to view new and emerging technologies in aging, as these areas of innovation lend themselves particularly well to interdisciplinary and interprofessional research and discovery through a variety of methodologies. From psychology to computer science, nutrition, engineering, biomedical science, and even the arts and humanities, these nine areas of innovation invite researchers to develop technologies for aging in place that appeal to a wide range of target audiences using unique approaches. For example, an innovation within the behavioral and emotional health area could marry well-established approaches from the field of psychology with platforms readily available within computer science and new media to create interactive apps for boosting emotional health.

DEVELOPMENT OF TECHNOLOGIES FOR AGING AT THE UNIVERSITY OF MAINE

The University of Maine (UMaine) recently identified aging as one of its "emerging areas of excellence." By seizing this opportunity, UMaine is positioning itself for creating cutting-edge research and learning opportunities that can reinvigorate the state's economy with new industries that feed an expanding 50+ market.

UMaine scientists are designing and testing products that maximize quality of life at home and in the community regardless of life stage and that maximize the ability of older adults to stay physically active, engage in satisfying activities, and preserve their safety and well-being. Not only are these products designed to improve and protect the health of older adults, but they also represent a significant opportunity for economic growth in Maine.

A key ingredient for developing technologies for healthy aging is the cross-fertilization of ideas to address the wants and needs of the 50+ market. The following sections provide examples of how UMaine is developing innovations that help older adults to age in place, while tapping into an expanding market to create economic opportunities in Maine.

Aging with Vitality

Within the aging-and-vitality focus area, UMaine is developing technologies to prevent falls by helping individuals compensate for age-related declines to preserve function and avoid injury.

Edge Detection

One of the most common challenges that occur with age is a loss of visual contrast sensitivity. This can be extremely dangerous for older adults as it turns commonplace low-contrast features, such as cement stairs, curbs, or benches into falling hazards. Indeed, accidental falls lead to more than 25,000 deaths per year and medical and health care costs of over $30 billion annually.[2]

Current solutions to the low-contrast falling problem involve using bright, high-contrast markings to

distinguish potential hazards, e.g. the edges of subway platforms. While these techniques are an excellent solution for drawing attention to the hazard and limiting falls for older adults and travelers, it is simply not practical or cost effective to paint high contrast lines on all potentially dangerous edges in the environment.

The goal of UMaine's work in this area is to improve safety and reduce falling via a cost-efficient solution that can be implemented without an expansion of existing infrastructure. To do this, UMaine researchers are exploring the use of computer vision to detect low-contrast edges in the environment and improve their visibility. This is done using an algorithm that analyzes the contrast of a live video feed, and once a relevant edge is detected, superimposes virtual highlighted edges onto the image of the physical environment, using a head-mounted display. As camera and display hardware become smaller, the hardware will be mounted on simple glasses and will provide a cost-effective solution to the problem of accidental falls by allowing older adults to easily identify and avoid obstacles that they may otherwise fail to observe. The system can also be used to convey and enhance other environmental cues that may be hard for older adults to access such as the text on signs.

Head Protection

In 2013, over 2.5 million people over the age of 65 were treated in hospital emergency departments for moderate to severe injuries from falling, including traumatic brain injury (TBI). In fact, adults 65 and older have the highest rate of TBI hospitalizations and death as compared to their younger counterparts. To further compound this issue, every year between 700,000 and one million patients suffer a fall during a hospital stay, with a resultant increase in hospital operational costs in excess of $13,000 per patient and an increase in patient length of stay of 6.3 days per incident.[3]

In light of the prevalence and severity of fall-related injuries, UMaine is working to develop nonstigmatizing protective gear to reduce the risk of injury for persons at risk of falling. UMaine is working in conjunction with James R. Ferguson of Alba-Technic, LLC, Winthrop Maine, who holds U.S. and European patents on a highly effective impact-resisting material system. Research has focused on the development of protective headgear. Researchers have recently initiated a project to expand the work to developing hip protection. The development of the headgear was supported by a National Institutes of Health/National Institute on Aging SBIR Phase I/II award, by the Maine Technology Institute (MTI), and is currently being supported by a National Science Foundation STTR Phase I award under the small batch manufacturing program.

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Alba-Technic's SMARTY® concept offers a headgear option for older adults that is designed to be integrated into fashionable headwear, while providing protection against head injury. Advanced manufacturing techniques create a contoured impact-resistant structure for the headgear, and the shape of the internal impact-resisting system is designed for fit, aesthetic appeal, function, and comfort and then covered with a fabric material that can be selected by the user. It is important that the technology is lightweight and can be incorporated into caps, scarves, and hats, because other commercially available products are bulky and often stigmatizing for the wearer. Additionally, focus groups of health care experts and potential wearers of the product suggest that people would only wear this protection if it looked like everyday headwear such as a ski or baseball cap. In a recent social marketing and consumer preference trial conducted by the University of California-Los Angeles in a senior community in southern California, there was a significant increase in the acceptance of the prototype SMARTY® product as measured by a pre- and post-attitudes questionnaire based on the theory of planned behavior. Performance of the headgear is tested by an apparatus designed and fabricated at UMaine, which has demonstrated that various versions of SMARTY® significantly reduce the likelihood of head injury and have the potential to reduce a major injury to a comparatively minor one.

Hip Protection

Falls account for a significant number of hip fractures. Hip fracture in the elderly is disabling and may lead to death. With more than one-third of adults 65 and older falling each year, it is imperative that new solutions be developed to address this issue. UMaine's Hip Project aims to leverage the current research and development in head protection by creation of innovative, wearable hip protection for elders. Current hip protective gear is bulky and unsightly, so people do not use the gear. UMaine is developing, and aims to commercialize, an aesthetically pleasing hip protection system consisting of undergarments and a changeable and fashionable shell for women and men that elders at risk of falling will feel comfortable wearing.

Technologies for monitoring vital signs provide the opportunity for convenient remote monitoring of health indicators, while reducing medical costs and allowing individuals to remain in their homes longer.

Driving Simulator

Driving can be one of the most important aspects of an individual's independence. Unfortunately, it is also one of the most dangerous practices for older adults. According to the Insurance Institute for Highway Safety, the likelihood of experiencing a fatal car crash increases with driver age, and drivers over the age of 85 have higher rates of fatal crashes than any other age group. Older adults are now driving longer and logging more miles, which increases the potential for fatalities on the road.[4]

To address this growing problem, UMaine is exploring ways to keep drivers in the aging population safer by (1) better characterizing the situations where accidents and other dangerous driving events occur, and (2) developing new compensatory techniques to provide key information to reduce these events. To this end, UMaine has built a driving simulator specifically designed for aging adults. Using a combination of actual vehicle hardware and a head-mounted display, the simulator immerses the driver in a virtual car and driving environment. It has been demonstrated that driver behavior in these simulated, virtual environments closely resembles driver behavior in reality. The simulator provides an excellent means of assessing problems faced by aging drivers in a fast, safe, and affordable manner. In addition the simulator enables researchers to develop and test augmented-reality tools that address the problems that older adults have seeing or identifying road signs and markings. The technology superimposes highlighted and higher-contrast edges on road signs and magnifies them, making it easier for older adults to see them. Researchers are currently determining which specific method of augmentation is most effective. Future work will expand upon the augmented-reality research by helping elder drivers to locate and identify landmarks.

Vital Signs Monitoring

Technologies for monitoring vital signs provide the opportunity for convenient remote monitoring of health indicators, while reducing medical costs and allowing individuals to remain in their homes longer. Addressing one aspect of this technology area, researchers at UMaine are developing innovations that will allow the monitoring of sleep patterns of older individuals.

UMaine is exploring early sleep-related movement (SM) dysregulation as an important marker of emerging cognitive decline in the aging population. Accurate analysis of body movements, changes in heart rate and respiratory patterns, and identifying subtle periods of arousals during sleep reveal important information about brain activities and cognitive changes.

UMaine has developed a highly sensitive prototype device to wirelessly record high-frequency, ultra-low-amplitude time-series of these indicators for mild TBI diagnostics. The device is embedded within a mattress cover, so measurements can be made in the home rather than through costly and invasive sleep lab studies. The original work was funded by the U.S. Army with the intent of diagnosing and monitoring veterans and is currently being expanded for use by athletes and older adults. A study currently underway is assessing older adults (60–80 years) with a recent (< 6 months) history of a fall. Data will be collected and analyzed to identify changes in brain activity and cognitive degradation even in the early stages of decline.

Physical Fitness

Maintaining physical fitness during the aging process is an important component of preventing illness and increasing longevity. Adaptive solutions can be used to encourage physical fitness and provide opportunities for maintaining social contact and avoiding isolation by providing nonstigmatizing exercise options for older adults. Although durable medical equipment (DME)—such as walkers, crutches, and canes—is available, DME is minimally functional for outdoor exercise and is perceived as stigmatizing and inconvenient. Therefore, many people who would be unsafe without such equipment abandon it, withdrawing from exercise and movement. Created to fill a need for people who, without adequate mobility support, would be less likely, or unable or unwilling, to participate in ambulatory exercise, UMaine has developed an assistive jogger, which is currently in the early phase of commercialization. The assistive jogger is an aesthetically designed, convenient, foldable, actively steered, three-wheeled standing support device that assists with balance and weight-bearing during walking, jogging, and/or running. It is fitted with biofeedback and innovative load-sensing technology, which could be used to help individuals or caregivers to monitor vital signs during physical activity.

Emergency Detection and Response

When an older adult experiences a fall, a rapid medical response is vital to preserving health and function. UMaine is developing new technologies that integrate wireless detection and vital-sign sensors to accelerate response time and access by first responders after a fall has occurred.

Indoor Navigation and Monitoring

Problems related to the loss of sensory, cognitive, and motor function with aging can lead to many safety risks for older adults living independently. These risks are magnified for people who are geographically separated from their support network, as it is difficult for friends or family members to check in on older adults living on their own. This is especially true in Maine, which is sparsely populated and has a widely dispersed population. Current responses to this concern involve installation of expensive and obtrusive video-monitoring technology or an alarm trigger such as LifeAlert that requires the user to be conscious and physically able to activate the device.

UMaine is developing a low-cost, nonintrusive system that allows older adults to retain their dignity and a sense of personal privacy, while still giving their support networks a mechanism to check in and monitor their behaviors and important daily activities. To test and refine the system, UMaine researchers have created a typical apartment setting on campus. The monitoring system employs minute and low-cost technologies including radio frequency identification (RFID) tags and Arduino controllers. RFID tags emit no signal and require no power, and they can be readily and unobtrusively embedded into the physical structure of an apartment, for example, under carpets, or behind the paint on walls and ceilings. Typical RFID reading devices used in commercial applications are comparatively large (approximately the size of a hair dryer). UMaine has miniaturized the RFID reader to the point that it can be worn comfortably by an individual. The system tracks the user's location as she moves about her home and sends an alert if an issue is detected. For example, if the user has been stationary for several hours during the daytime, a text notification could be sent to the caregiver. With the addition of an accelerometer, the system can detect if the user falls and whether or not he gets back up. Critically, this functionality allows alerts to be sent to caregivers even if the user is unconscious or otherwise unable to communicate.

Importantly, since the system does not rely on cameras or visual tracking, the user's privacy and dignity are maintained. Databases may be employed to monitor regular activity and identify potentially dangerous deviations. The next iteration of development is to integrate a hazard-detection and -avoidance component into the system. RFID tags can be affixed to specific objects within the house (e.g., pets, shoes, cords, furniture) and the older user's spatial position relative to the tagged item tracked; if necessary the user can be alerted to a specific danger. The system holds the potential to reduce in-home falls and improve safety, efficiency, and independence.

Sensor Systems for Home Appliances

Successful aging in place relies heavily on effective use of a range of appliances within a home, from cooking stoves to washing machines. Improper use of such appliances due to age-related loss of cognition or physical ailments may lead to ineffective or incomplete performance of the associated task or even physical injury. Indeed, cooking accidents are the leading cause of

fire-related injuries for older Americans. Cooking is the leading cause of home fires and fire injuries and most kitchen fires occur because food is left unattended on the stove or in the oven (U.S. Fire Administration 2015).

In spring 2014, senior bioengineering students at UMaine completed a capstone project in collaboration with residents of Dirigo Pines Retirement Community in Orono, Maine. The residents volunteered issues that they face in their daily lives that are potentially amenable to solution by engineering principles. One student group designed a safety stove, which incorporated motion sensors and an automated shut-off of the stove in the absence of movement for a certain period of time. In addition, the stove incorporated mass load sensors enabling the detection of rapid weight loss associated with combustion of food, which would lead to an automated shut-off. A second group developed an automated means of removing heavy, wet, and compressed clothing from a washing machine by using a mesh containment bag and a roller system that retrieved the bag.

CONCLUSION AND FUTURE DIRECTIONS

As illustrated by the examples in this article, UMaine is serving as fertile ground for innovation with significant economic potential. The recent designation of aging as an emerging area of excellence for UMaine will provide additional pathways for researchers from a variety of disciplines and from across system campuses to collaborate and innovate together. In fact, this is already well underway. The technologies presented in this article just scratch the surface. Not mentioned are a myriad of products, devices, and approaches for healthy aging arising from fields such as communication sciences and disorders, nutrition, communications, psychology, disability studies, and the arts and humanities.

What does the future of this field hold? Future technology trends will provide attractive, affordable, and effective solutions for helping individuals to age in place and maximize their independence. To be most effective, these technologies need to be easily integrated into daily life through wearable options and linked with existing appliances and devices in the home. Overall, technology options for older adults will be increasingly shaped by customization to meet individual needs and support the provision of health care as it moves toward home and community rather than institutional settings.

Furthermore, efforts to develop and improve technologies and products to assist aging individuals need to be responsive to the personal preferences of the aging population. The participation of older adults in consumer focus groups and field testing will ensure that the technologies are sensitive to the evolving needs and wants of this population and the settings in which the products will be used. Consultations with medical specialists in geriatrics will ensure that technology development is informed by the physical/mental health dimensions of the aging experience and clinical geriatrics best practices. New companies will continue to be formed in the state, commercializing products conceived through research and development. Such companies will retain Maine's best and brightest, contribute to Maine's economy, and assist Maine's aging population to live and thrive in place. Tapping into the 50+ market is imperative, not only for the health and well-being of Maine's older adults and their families, but also for the state's economy, turning the aging of the population into a ripe opportunity for learning, research, innovation, and business development.

ENDNOTES

1. More about this topic is available in this article by Jennifer A. Crittenden on the *Bangor Daily News* website: http://bangordailynews.com/2015/06/26/next/a-tech-friendly-future-for-seniors-from-smart-homes-to-an-app-that-lets-you-read-to-grandchildren-remotely
2. The statistics in this paragraph came from the following websites: http://www.nsc.org/learn/safety-knowledge/Pages/safety-at-home-falls.aspx and http://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html
3. Sources for this paragraph include two pages on the Centers for Disease Control's website http://www.cdc.gov/homeandrecreationalsafety/falls/adultfalls.html and http://www.cdc.gov/TraumaticBrainInjury/severe.html the Agency for Healthcare Research and Quality http://www.ahrq.gov/professionals/systems/hospital/fallpxtoolkit/fallpxtkover.html and Wong et al. (2011).
4. Information on older drivers may be found here: http://www.iihs.org/iihs/topics/t/older-drivers/fatalityfacts/older-people

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The Afari™ was co-invented by University of Maine professors Stephen Gilson, Liz DePoy, and Vince Caccese. The stylized mobility aid enables persons who need or want balance, stability, and/or weight-bearing assistance to participate in outdoor jogging, running, and distance walking in diverse terrain.