

**A National Science
Foundation
Engineering
Research Center
since 2006**

Quality of Life Technology Center (QoLT ERC)

Carnegie Mellon University (lead institution) and University of Pittsburgh

Technology to enable self-determination for older adults and people with disabilities

The Quality of Life Technology Engineering Research Center (QoLT ERC) will transform lives in a large and growing segment of our population—people with reduced functional capabilities due to aging or disability. About 60 million Americans have a disability that affects one or more of their major life activities. Perceptive, cognitive, and musculoskeletal diseases that impair motor skills increase dramatically with age. In 2030, more than 20% of the U.S. population will be over 65 years of age, with one in two working adults serving as informal caregivers. Globally, the number of people older than 65 years is anticipated to double between 1997 and 2025. The economics are staggering; an estimated \$1B could be saved annually in the U.S. if all seniors' entry into long-term care facilities could be delayed by a single month. As individuals, families, and communities, we are facing new challenges to attain, prolong, and preserve the quality of life. The challenges are significant, and failure to address them will have negative consequences for our economy, our healthcare system, and society itself.

The vision of the Quality of Life Technology (QoLT) Center is to develop intelligent systems ranging from individual devices to comprehensive environments that enhance body and mind. They monitor and communicate with a person and understand his/her needs and task goals, and compensate for or replace diminished capabilities appropriately, safely, reliably, and graciously. Such future QoLT systems will not be just machines for convenience or saving labor, but will be intelligent assistants. They will restore and preserve independence, allowing people to freely perform valued and necessary activities of daily living so that they can fully participate in society. They will enhance and augment the capabilities of caregivers, and will also delay or prevent the manifestation of functional impairment.

The Center will expand the QoLT workforce by growing the pool of engineering students whose substantial clinical and socio-economic training and experiences will motivate them to create technologies to improve quality of life; and by growing the pool of clinically-oriented students whose engineering training and experiences will help them understand how best to integrate technology into their practices. The Center will also prepare students and current professionals to be effective collaborators in interdisciplinary teams—one of the most recognized and yet difficult-to-overcome challenges in the development and implementation of systems for people's use.

The Center will catalyze a large and technologically sophisticated industry sector that ultimately will help all of us to function more capably, perceptively, and intelligently. The QoLT industry consortium includes a wide spectrum of companies covering all aspects of daily life: medical devices, assistive technology, information technology, consumer electronics, healthcare, and insurance.

Research

QoLT systems will augment people in different settings with different functionalities. The setting might be at

home, where the systems provide personal support and help for daily living; it could be a neighborhood, where the systems help a person to engage in community activities; or it could be more societal, where QoLT helps people drive safely through their communities and participate in society. In each setting, QoLT systems provide different forms of functionality: enhancing dexterity and mobility, helping with some home chores, supporting memory, coaching through job functions, helping to drive cars, and so on. In other words, QoLT research will deal with almost all aspects of human living.

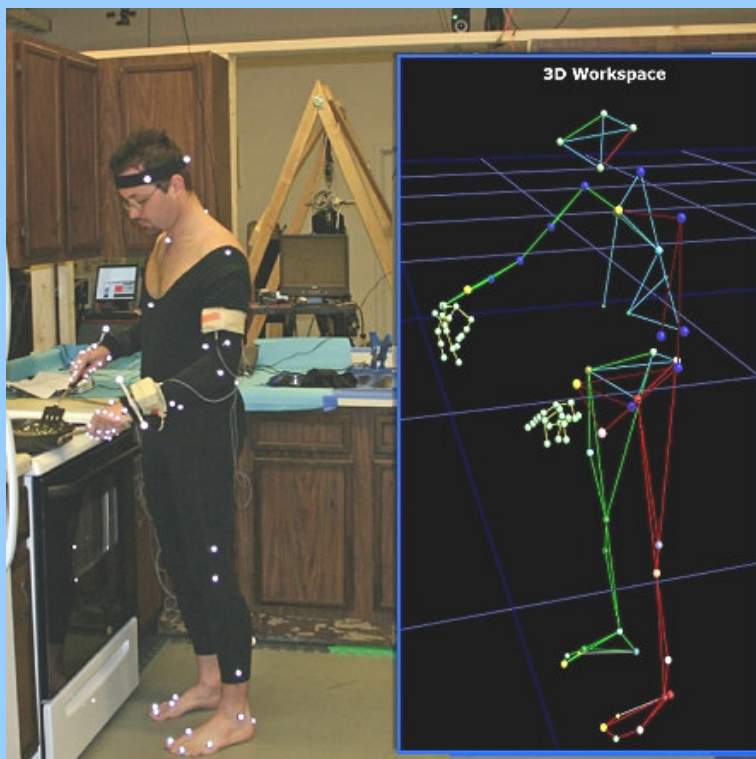
The Center's research vision is relating human physiological, physical, and cognitive function to the design of intelligent systems; creating technologies and systems that make a measurable positive impact on quality of life; working closely with user groups throughout design, development, testing, and deployment phases to account for adoption, evaluation, and privacy concerns; and developing a curriculum to motivate students and inspire under-represented groups to pursue careers in QoLT. To realize this vision, we must overcome a number of technological, sociological, and economic barriers or impediments to our progress and adoption of our advancements. These barriers present challenges that drive the creation and organization of our research plan from the top.

Working on real cases to solve actual problems is the focus of the Center's family of engineered systems. We have chosen four human activity domains and corresponding families of engineered systems:

- Cognition: Reasoning and Remembering – The Virtual Coach
- Independent Residential Living – The Active Home
- Movement Through and Physical Interaction with the Environment – The Personal Mobility and Manipulation Appliance
- Independent Transportation – Safe Driving

QoLT's engineered systems and research are prioritized in the underlying thrusts to make a genuine impact on important identified needs, and to maximize the likelihood that new technologies will cut across multiple systems so that more impact can be made. These four families of engineered systems dictate what kinds of science and technological advances the Center needs to target, and in turn, how and when those advancements will be integrated into engineered systems.

Our fundamental work is divided among four interrelated thrust areas grounded in more traditional disciplinary research domains: Person and Society, Perception and Awareness, Mobility and Manipulation, and Human-System Interaction. These domains reflect socioeconomic motivators and constraints, functional capabilities for both machine cognition and motion, and man-machine symbiosis.



QoLT Grand Challenge is to sense and measure human activities

As depicted in the QoLT Research Organization Diagram, we integrate and test QoLT systems in real-world testbeds, including a ten-acre site that will feature homes, stores, community centers, and civil infrastructure that supports older adults, people with disabilities and others who simply want technology to enhance their quality of life. This real setting for QoLT systems evaluation spans home, community, and society. Cross-cutting efforts among all thrusts and settings include QoLT Grand Challenge and QoLT Assessment and Evaluation Methods.

Education

QoLT systems require integration across a number of engineering, health, and social science disciplines. This in turn requires the Center to teach and demonstrate processes whereby multiple disciplines unite to jointly create socially positive products. The QoLT Center's goal is a growing community of engineers, scientists, practitioners, and consumers who are intellectually prepared and motivated to create, assess, and apply technology to benefit people with disabilities and older adults. Specific education and outreach objectives are:

- develop, enhance, and disseminate curricula that emphasize participatory design, teamwork, and cross-disciplinary training;
- inspire and motivate students of all ages to embrace QoLT; and
- empower people—especially individuals with disabilities—to be able to improve their own lives and the lives of people they know, through the application of engineering and design principles in concert with lateral and multidisciplinary problem-solving.

QoLT's education activities target virtually everyone: K-12, undergraduate, graduate, post-graduate, industry, end-users, and the general public.

One of our aims is to significantly increase children's interest in our activities and sustain that interest throughout their academic careers. Engineers-to-be need to be inspired and feel connected to remain engaged, and the QoLT Center is committed to broadening education opportunities for all young students. QoLT has an active K-12 outreach program that includes the QoLT Summer Institute (QSI), where students will participate in engineering projects and in QoLT education and outreach activities during the academic school year for K-12 students and older adults. The Fall Tech-Link Robotics Camp conducts robotic camp sessions for middle school students who are mentored by 4-5 graduate/undergraduate engineering students or professionals. They are trained as QoLT ambassadors and given opportunities at their schools to share their experiences with their classmates during the academic year. We expect to replicate similar programs in our partner institutions.

The Center's Research Experiences for Undergraduates (REU) program brings students together from around the country to work closely with the Center's faculty and graduate-student mentors to engage them in cross-disciplinary research and development projects. Our Research Experiences for Teachers (RET) program brings together high-school teachers who participate in QoLT research projects on both campuses, and participate in disability and aging sensitivity workshops. Teachers will develop new QoLT lesson plans for the upcoming academic school year, with progress follow-ups and continuing contact with the Center.

We are producing workshops, symposia, and conferences on QoLT-related themes available to a wide audience, particularly prospective end users, support providers, other stakeholders, and the general public. These activities serve to increase awareness of the developing QoLT discipline.

The Center curriculum at both universities focuses on QoLT-enhanced and new QoLT-related courses, eventually leading to a certificate program. Curriculum is disseminated to partner institutions through live or on-demand distance learning, curriculum and resource sharing for adaptation into partner courses and programs, and sharing of educational toolkits and instructions to help enhance existing courses.

Industrial Collaboration/Technology Transfer

The QoLT ERC industry program is based on a consortium of companies that are currently engaged in diverse markets of assistive technology, medical goods and devices, information technology, robotics, consumer electronics and appliances, healthcare provision, and health insurance. The Center will be a platform for corporate interaction within and across those markets, and will catalyze a new quality-of-life technologies industry sector. Member recruitment deliberately targets industry sectors and companies within those sectors that have a high probability of manufacturing, re-selling, or buying our families of engineered systems and/or components of those systems. A tenet of the Center is to collaborate with industry in the development, maturation, and field-testing of QoLT prototypes. Our model is based on the facts that: (1) extensive engineering and field testing is needed to create pre-commercial prototypes; and (2) having company representatives participate in the project is the most effective and efficient way to actually transfer technology.



Graduate student Emily Zipfel is exploring functionality of combined Personal Mobility and Manipulation Appliances.

The Center fosters working relationships and research project collaborations with member companies. Research collaborations range from student internships and staff exchanges to direct support of Center projects. We involve member companies in market assessments and development of business cases for new quality-of-life technologies. In particular, we engage them in student business plan competitions where, together, we define and execute market studies and analyses. We invite affiliates to attend "infusion" meetings, in which Center personnel meet with other specialists (clinicians, sociologists, etc.), stakeholders, and prospective end-users to discuss barriers, needs, opportunities, and approaches. The ERC provides special opportunities and licensing arrangements for companies that join at various membership levels.

We anticipate numerous spin-off companies. QoLT faculty entrepreneurs will be assisted and guided by technology transfer professionals at both universities. Spin-off companies can also take advantage of unique programs offered by regional technology-based economic development organizations which provide combinations of capital, business plan development, management team recruitment, incubation, and services to start-up companies. We have close, long-standing working relationships with all of them.

Facilities

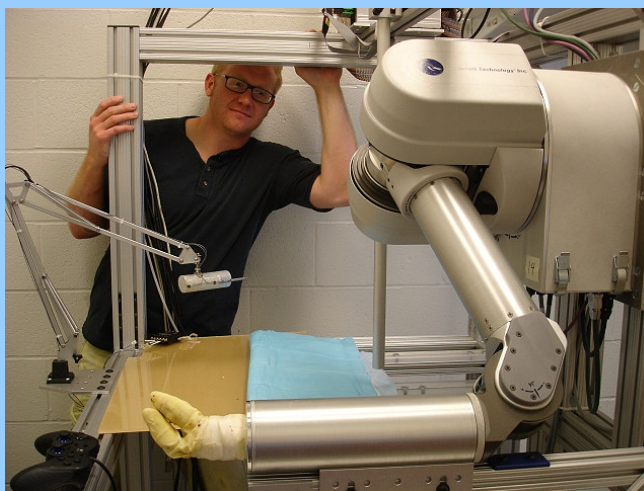
The Center is headquartered in two stories of an office building midway between the CMU and Pitt campuses. Its research and education facilities are co-located on CMU and Pitt campuses, within one mile of each other. The Center accesses CMU's Robotics Institute (RI) facilities, which includes laboratory space, high bays, dedicated shop spaces, office space, and general-purpose spaces including conference rooms, classrooms, and auditoria. RI currently has over 30 distinct laboratories, many configured for interdisciplinary research, while others are dedicated to investigation in a particular technology. RI has a complete range of equipment and tooling for virtually all forms of mechanical and electronic fabrication, prototyping, and assembly. RI's parent School of Computer Science maintains one of academia's best computational infrastructures.

The Center also accesses facilities of the Pitt Rehabilitation Science and Technology Department (RST) and the UPMC Center of Assistive Technology (CAT) on Pitt's main campus, as well as the nearby Pitt/VA Human Engineering Research Laboratories (HERL). RST and CAT have a wide range of assistive technologies including augmentative communication equipment, devices to accommodate people with hearing impairments, and a plethora of wheelchairs and seating systems. HERL also has a complete machine shop for the fabrication and testing of assistive devices.

In addition, the Center has shared Pitt-CMU graduate teaching laboratories for wearable and community-based sensing technologies through an NSF IGERT, and now is assembling a mobile/manipulative assistive robot laboratory. Student laboratories will be expanded across CMU and Pitt to support rapidly prototyping and evaluating futuristic QoLT applications.



QoLT's Tech-Link program is vectoring young people of all abilities towards technical careers



Active Home will include robots that most likely have manipulators

Center Configuration, Leadership, Team Structure

The CMU PI serves as the Center's Director, with the Co-PI at Pitt serving as Co-Director. There are two Research Directors; one for socio-economic aspects and one for technology aspects. Each Family of Engineered Systems and each of the four thrusts is led by a single, seasoned researcher who defines, executes, and manages the research at both CMU and Pitt in an integral manner.

The success of the QoLT ERC demands integration across a number of engineering, health, and social science disciplines, enabling us to teach and demonstrate the process whereby multiple disciplines unite to jointly enable socially positive products. Therefore, the Center has a diverse range of expertise including social psychology, computer science, robotics, rehabilitation sciences, human-computer interaction, clinical psychology, public policy, nursing, public health, mechanical and electrical engineering, and biomedical engineering.

Center Headquarters

Quality of Life Technology Center
Carnegie Mellon University
5000 Forbes Avenue, 417 SCRG 303
Pittsburgh, PA 15213
Tel (412) 268-6553 • Fax (412) 268-5807
Homepage: <http://www.qolt.org>

Center Director: Takeo Kanade
(412) /268-3016 • tk@cs.cmu.edu

Center Co-Director: Rory Cooper
(412) 365-5612 • rcooper@pitt.edu

Research Co-Director: Howard Wactlar
(412) 268-2571 • wactlar@cmu.edu

Research Co-Director: Kate Seelman
(412) 383-6727 • kds31@pitt.edu

Education Co-Director: Illah Nourbakhsh
(412) 268-2007 • illah@ri.cmu.edu

Education Co-Director: Dan Ding
(412) 365-4885 • dad5@pitt.edu

Outreach Director: Sondra Balouris
(412) 383-6797 • sab92@pitt.edu

Exec. Director, Industry Liaison Officer: Jim "Oz" Osborn
(412) 268-6553 • oz@cs.cmu.edu

Administrative Director: Colleen Everett
(412) 268-7674 • everett@cs.cmu.edu