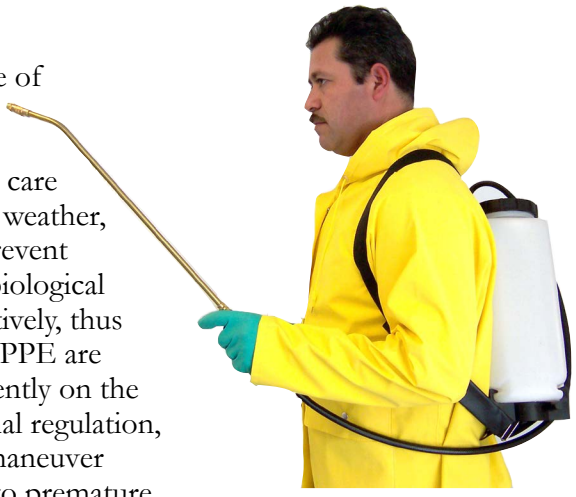
Personal Protective Technologies

This project has evaluated and improved textiles and personal protective garments for workers in hazardous occupations, leading to better safety and job performance.

Who cares and why?

Personal protective equipment (PPE) protects individuals from a wide range of occupational hazards. In agricultural settings, pesticide applicators need special protection from the chemicals they use. "First responders" on the scene of a terrorist attack or natural disaster and "first receivers" in medical care facilities often need special garments to protect against fire, debris, extreme weather, chemicals and pathogens, and other hazards. Well-designed PPE can also prevent injuries among soldiers who encounter IEDs, small arms, and chemical or biological warfare agents. These workers rely on PPE to do their jobs safely and effectively, thus saving lives and preventing widespread damage; however, improvements to PPE are much-needed. User feedback and performance tests indicate that PPE currently on the market has many outstanding issues related to fit, comfort, durability, thermal regulation, and moisture control. For example, poor fit makes it difficult to use tools, maneuver through small spaces, and move quickly, and poor thermal regulation leads to premature exhaustion. Moreover, many workers do not receive proper guidance on how to select, use, and maintain PPE. Good communication with PPE users and multidisciplinary collaboration among researchers is needed to make sure that practical, top-of-the-line PPE is available for a wide variety of hazardous occupations.



Agricultural workers require special protective garments when spraying chemical pesticides to avoid getting the chemicals on their skin or breathing in vapors. Photo courtesy of Pacific Northwest Safety and Health Center.

What has the project done so far?

NC-170 members have trained firefighters to use PPE (above). In addition, researchers in Iowa, Missouri, New York, and Hawaii have held 12 focus group meetings with over 100 firefighters from 11 fire departments, leading to better conceptual designs for garments. For example, researchers at Oklahoma State University have worked on smart clothing that can monitor temperature, heart rate, and blood oxygen content of firefighters. Photo by Lynn Boorady, Buffalo State.

Over the past five years, NC-170 scientists and designers have made major achievements in materials research, garment design, and user education. Researchers across the U.S. have identified and developed textiles with attractive properties, such as UV ray protection, moisture, heat, and bacteria control, and the ability to detoxify pathogens and pesticides. For example, researchers at Oklahoma State University have completed a project on smart textiles for chemical detection that was funded through the Approaches to Combat Terrorism program of the U.S. Intelligence Community. Other NC-170 researchers have used advanced tools (including 3D scans) and user feedback to evaluate existing PPE and have collaborated with laboratories, designers, and manufacturers worldwide to develop new PPE. Researchers at many institutions have focused on improved PPE for firefighters and military personnel (see photos). With regard to agricultural workers, scientists from New York, California, Minnesota, Missouri, and Iowa have used data from over 60 interviews and surveys and 250 photographs of body positions to address fit issues for protective coveralls. Design sessions and consultations with manufacturers have led to multiple prototypes of disposable protective coveralls with reduced catching and tearing and improved fit and comfort. Hospital patients and workers have also been target audiences. Researchers at Colorado State University have initiated a hospital patient apparel redesign project, and researchers at the University of Hawaii have used funding by the Christopher & Dana Reeve Foundation and University of Hawaii Women's Center to evaluate immobile patient gowns. Addressing NASA's needs, studies at the University of Minnesota have led to better fit and sizing of a full-body space suit, a hood, and hand-warming glove liner for astronauts.

Impact Statements

Increased user satisfaction by designing more practical PPE based on nuanced performance testing and user feedback.

Ensured a baseline level of protection for workers by setting standard performance specifications for PPE sold in the U.S.

Improved tools and methods for testing PPE performance.

Improved infection and odor control by developing antibacterial textiles that have been used in healthcare apparel, military clothing, and civilian products.

Improved protection from dangerous chemicals and pathogens by developing self-decontaminating materials for industrial workers, first responders, public health workers, and military personnel.

Designed body armor that has been adopted by the U.S. Marine Corps.

Made it possible for PPE users to work safely under adverse environmental conditions by improving moisture and heat control of textiles.

Helped PPE users perform their jobs quickly and comfortably even in highly active situations by refining PPE fit and sizing systems.

Kept first responders out of dangerous situations by integrating reliable wireless sensors into PPE to monitor vital signs, track location, and detect potential hazards.

Established an easy-access database that helps users, manufacturers, researchers, and purchasing agents select and use appropriate PPE.

Educated thousands of workers through training courses, outreach programs, interactive websites, and articles. Expanding audiences include young students interested in designing new materials, Amish farmers interested in low-tech ways to reduce pesticide exposure, and orchard and vineyard workers concerned about thermal comfort while performing winter tasks.

NC-170 researchers have made many improvements to PPE for combat or defense scenarios. For example, prototype design work at Oklahoma State University (supported by funding through the Naval Research Laboratory) has resulted in QuadGard® arm and leg armor that has been tested and approved for combat. More than 600 units have been used by the U.S. Marines to protect against shrapnel from IEDs and small arms. Researchers have also developed a quick-release ballistic vest with a cooling pad that has increased comfort and mobility and decreased the risk of injuries from the impact of the body armor. Other studies and design sessions have resulted in: a prototype for infrared camouflage; rechargeable odor-free underwear garments tested by the U.S. Air Force; and nanofiber membranes and coated fabrics that provide chemical and biological protection (supported by Defense Threat Reduction Agency and U.S. Army Natick Soldier Center). Photos by Semra Peksoz, Oklahoma State University.

What research is needed?

More work is needed to continue to improve PPE design and function. For example, firefighter footwear and gloves with improved fit, protection, and function need to be developed based on new data (such as measurements of active hands) and antimicrobial performance and user acceptance of redesigned hospital apparel need to be evaluated in real hospital environments. Researchers also need to focus on developing decontaminating materials to industrial scale, and further work is needed to develop PPE and address fit and sizing issues for women's figures.

Want to know more?

Administrative Advisor:
Marilyn DeLong (mdelong@umn.edu)

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Written and designed by Sara Delheimer