

Personal Protective Technologies for Current and Emerging Occupational and Environmental Hazards

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The Need

Agricultural workers who come into contact with pesticides, insecticides or other harmful chemicals require personal protective coveralls (PPC) to prevent exposure. According to the National Institute for Occupational Safety and Health, more than 13 million workers in the United States are exposed to dangerous chemicals at work, and skin diseases are the second most common occupational illness. If workers do not have properly fitting PPC, their safety is at risk, as badly designed and sized coveralls may expose them to contamination through tears, or even become caught in machinery. The need for better-designed PPC has only increased since the COVID-19 pandemic, when many more workers (especially in medical settings) have begun wearing them.

The Approach

This project tested PPC design and sizing on agricultural workers in active postures. Researchers used 3D body scans and participant feedback to analyze fit of disposable coveralls: Body scans of 35 total male and female participants were analyzed in three different poses (standing, reaching overhead and stepping up) while wearing minimal clothing, wearing two commercially available coveralls and wearing a novel coverall design developed at Cornell. The project team also compared their 3D body scan data against virtual body and garment prototypes, in hopes of improving virtual fit simulations for the benefit of clothing designers and manufacturers; human fit testing is far more expensive than simulated testing. Though these comparisons were done with protective coveralls, the improvements in fit simulations could be applicable to many types of garments.

The Impacts

The two commercial designs were significantly bulky on participants, which increases risk of coveralls being caught on tractors or machine components. However, the commercial designs were too tight at critical areas, such as under the arm and around the hips and knees – areas that are frequent sources of discomfort and tears under the stress of necessary movements. Women experienced more fit issues than men, as unisex coveralls seem to have been designed for male bodies; women particularly struggled with tightness at the hips and with overly long torso components, which made the crotch of the coveralls fall low – creating hazards for tearing and tripping. The Cornell-designed coveralls were more tightly fitting overall, but they contained pleated sections under the arms, around the hips and at the knees to compensate for movement stress. This research uncovered significant shortcomings in commercially available coveralls and suggested some solutions that could better protect agricultural, medical and other workers who require personal protective coveralls.