

**Grant:** AFC820-68

**Title:** Roof Bolting Module Automation for Enhancing Miner Safety

**Organization:** University of Kentucky

**Principal Investigators:** Steven Schafrik

**Topic:** Health and Safety Interventions

**Priority Area:** Machine Design and Ergonomics

## **SYNOPSIS**

**Problem Statement:** Underground coal mining involves repetitive processes in confined and hostile environments. Equipment operators, and especially roof bolter operators, are prone to exposure to hazardous conditions due to their proximity to the unsupported roof as well as dust and noise exposure. After hand tools, the roof bolter machine is responsible for the second highest number of nonfatal lost time injuries where the average injury incurred several months away from work. Physically demanding work over long periods of time in unfavorable environments also increases the probability of unsafe actions leading to accidents or near misses. This research aims at the development of automated processes within the roof bolting process with the ultimate goal of removing humans from hazardous environments.

**Research Approach:** The authors propose the development of a robotic assembly capable of carrying out the entire sequence of roof bolting operations autonomously. A detailed study of human motion will first be carried out using sensors and computer software. Computer simulations will be set up to design the trajectory to be followed by the robot. These trajectories would be optimized using various techniques to customize the robot for mining environment conditions. A replica of the bolter module and the software controlled robotic arm will be built and tested. The trajectory will be adopted by the robot and will include vital parameters like position, orientation, and robot speed. A human-machine interface will be integrated to enable a manual approval of the tasks and to override the system in the event of unpredicted or unsafe actions. The robotic arm will be deployed and thoroughly tested in a laboratory environment. The above processes will be iterated for refinement before the final deployment of the robot in a mining environment.

**Impact of the Research:** The roof bolter automation research will have a pronounced impact on the safety of underground mining operations. Mining rates in room and pillar panels or longwall development entries are often dictated by the extent and safety provided by the supported roof. Roof bolters typically operate under freshly exposed roof in order to provide roof and rib support. Their operators, however, are often exposed to distraction, falling debris, dust, and noise. Removing humans from these conditions may help eliminate injuries from roof falls as well as other hazards. Deployment of robotic equipment in sensor-driven roof bolting operations is a high-impact health and safety intervention for equipment operators. This is a novel approach to automation for underground mining equipment and has application for other machines where human motion and agility is intrinsic to the machine design.