ARMA received a new 4-year integrative award from the National Science Foundation as part of the National Robotics Initiative. This award titled “NRI: INT: MANUFACTURING USA: COLLAB: In-Situ Collaborative Robotics in Confined Spaces” in a collaborative award with the Biorobotics lab of Dr. Howie Choset at the Robotics Institute of Carnegie Mellon University. The following summary listed below is the same as in the public summary page. We will be updating a new project page with research outcomes as results mature in the coming years.

Many manufacturing operations require workers to perform operations in confined spaces, subjecting them to possible fatigue and injury from performing tedious tasks in non-ergonomic postures. Intelligent robotic assistants can facilitate safe and ergonomic reach into such spaces, while allowing human workers to remain physically present and in full control over delicate operations. The project will investigate the use of highly reconfigurable, in-situ, collaborative robots (ISCRs) with the enhanced perception and support-autonomy needed to allow a worker and a robot to safely share a common space and collaborate through physical interaction. Conventional robots cannot be used as ISCRs because they are bulky, special-purpose and difficult to program. This project's ISCRs are expected to reduce worker fatigue and musculoskeletal injuries, which are responsible for more than 34 percent of lost work days in the United States, and increase worker productivity. Their added intelligence is also expected to make the robots easier to use, by offering a human-friendly means of interaction. The research has potential applications in the aerospace industry, including the manufacture and service of the fuselage and wings, inspection and repair of hydraulic lines or fuel tanks and pipes, caulking, welding of structural joints and deburring.

This work to support effective human-robot collaboration in confined spaces makes three main technical contributions: 1) design and control strategies for ISCRs, 2) contact detection and location estimation and 3) simultaneous contact-force and navigation (SCAN) planning, so that a robot can use bracing to maneuver deep into a confined space. The ISCRs allow compliance and robustness to geometric uncertainty, reduced inertia, contact sensing and regulated force of interaction with the environment. This new design enables the exploration of real-time estimation for contact state detection, a screw-theoretic approach for constraint identification, and stiffness modeling. The research will also develop planners to achieve SCAN within a semi-structured environment with uncertainty and will use intentional contact to allow enable the robot to reach deep into confined spaces.