1. **Research Title:** Cooperative Human and Machine Learning for Manufacturing

2. **Individual Sponsor:**

Dr. Andrew Gillman,
AFRL/RXMS AFRL/RXM,
2977 Hobson Way Wright-
Patterson AFB, OH 45433
andrew.gillman.2@us.af.mil

3. **Academic Area/Field and Education Level:**

Related Degree in Engineering, Computer Science, or Applied Math and StatisticsRobotics, Machine Learning, Artificial Intelligence
(MS or PhD level)

4. **Objectives:** Develop and integrate human-in-the-loop machine learning strategies, e.g. reinforcement and imitation learning, for automated manufacturing processes involving stochastic processes, complex robotic path planning, and/or critical anomaly detection.

5. **Description:** The manufacturing industry is augmenting existing processes with automation, where robotic systems are enabling higher throughput, safer working conditions, and improved process consistency. Additionally, many experienced technicians are nearing the age of retirement, and implementation of robotic systems have the potential to alleviate this knowledge loss while promoting a new age of collaborative human-robot manufacturing. A key challenge in transitioning to automation is the ability to handle processes with complex motion, stochastic behavior and/or unidentified physical phenomena. Meanwhile, humans can perceive and adaptto unexpected changes in order to achieve the desired results while traditional robotic programming is too fragile to adapt to these changes, and 11human in the loop" machine learning strategies bring the advantages of both worlds. Additionally, handling complex data streams from manufacturing processes with automatic correction has been limited in state of the art machine learning approaches compared to the numerous success stories of automated learning strategies in computer games and robotic manipulators. To address these needs, this project call seeks proposals with innovative approaches for employing human-in-the-loop machine learning techniques and/or demonstration of established techniques for novel manufacturing-related application areas. Applications areas of particular interest include robotically controlled spray processes and additive manufacturing (3D printing). Targeted objectives include development of imitation learning concepts for transferring expert level knowledge to robotic

systems, application of reinforcement learning for automated learning of optimal print path in extrusion-based additive manufacturing, and generation of automated anomaly detection and correction control strategies.

6. **Research Classification/Restrictions:** Unclassified and Unrestricted. Eligible for Public Release. Open to U.S. Citizen Students Only.

7. **Eligible Research Institutions:** All DAGSI Institutions