INNOVATIVE APPROACHES TO ELUCIDATE OPTIMAL DEPLOYMENT OF CB SENSING ASSETS

Bioindustrial Manufacturing Assessment For Tactical Operations: A Paper Study

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Current investments in the U.S. bioindustrial manufacturing ecosystem will field much needed bioproducts into military systems in the coming decades and require significant workforce development. These non-medical investments come at an unprecedented scale and underscore our government's commitment to developing bioindustrial manufacturing and related biotechnologies as both critical and disruptive technologies. The potential for domestic and large-scale bioindustrial manufacturing to secure national security material supply chains is unchallenged. The potential for modular and automatic bioindustrial manufacturing to untether logistics for tactical operations in austere environments, including contested regions and space, must be established.

Applications of bioindustrial manufacturing for defense have demonstrated the ability to produce materials with enhanced properties, superior chemical consistency, and greater process reliability compared to traditional manufactured chemical precursors and finished products. Production of
sustainable aviation fuel (SAF) from agriculture feedstocks and drop-in replacements for foodstuff
commodities ranging from proteins to palm oil are both examples of successful business ventures that support the bioeconomy, help meet commitments to global climate obligations, and supply national security materials amid escalating events in the Ukraine and Middle East.

The Department of Defense (DOD) anticipates that the multi-domain battlefield of the future will challenge the U.S. and its allies in every domain (e.g., air, space, sea, and communications). In an
economic battle over Multi-Domain Operations (MDO), supply chain resiliency will be the primary geopolitical tool that is leveraged by multinational conglomerates. Bioindustrial manufacturing of critical
chemicals and materials at the site of tactical operations and in forward-deployed environments including space, is the next application of bioindustrial manufacturing as a critical technology. For successful scaling and bioprocess engineering, however, a common manufacturing foundation that is accessible by non-technical personnel is required.

Advances in modularization and automation are poised to achieve and integrate bioindustrial manufacturing toward operational agility and readiness to, ultimately, untether logistics. Modularity has
been widely adopted across diverse industrial processes because it lowers costs, increases production volumes, and allows for efficient process customization. Automation of advanced and modular units for bioindustrial manufacturing will decrease workforce training needs and, therefore, lessen the burden to
deploying systems. Automation is further enabled by the rapidly evolving field of artificial intelligence and machine learning. Collectively, timing to assess these state-of-the-art technologies to enable operational applications of bioindustrial manufacturing is ideal to leverage this critical technology for
operational success.

Therefore, our objective is to assess the potential for bioindustrial manufacturing modularity and automation to obviate logistical challenges in a wide variety of operational situations including austere environments and contested regions where untethering logistics may be critical to success. The study contains four main tasks: 1) Determine the state of the art in bioindustrial manufacturing modularization and automation; 2) Analyze chemical and material needs required for complex and tactical operational situations; 3) Determine testing and evaluation requirements for bioindustrial manufacturing platforms and components analysis; and 4) Outlook on modular and automatic bioindustrial manufacturing platforms and components analysis. In collaboration with experts and site visits, a Final Report will be delivered at the beginning of 2025.