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Open manufacturing architecture with modular and reconfigurable robotic hardware for on-demand manufacturing automation

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Manufacturing science has evolved over the decades during the modern era to include numerous new innovations that play a significant role in making it faster, better/safer and cheaper. While almost all throughout its progress, manufacturing has remained essentially a product-specific development approach, advent of newer technologies such as additive manufacturing has opened up the door to think beyond the conventional ways and into product independent, on-demand manufacturing. With the right set of design, optimization and execution tools manufacturing in the future can employ a radically different approach that is smart, reconfigurable and knowledge-driven. This work combines a wide range of cross-disciplinary innovations to enhance manufacturing at multiple scales. Highlighted areas include directed and parallel heterogeneous manufacturing at submillimeter scales, hybrid manufacturing combining additive and subtractive processes and complex system integration via holistic process optimization and robotics automation. With the objective to reduce manufacturing cost, operation and lead times and inventories, while improving the labor productivity and machine efficiency, this project takes the approach of optimized selection of granularity for manufacturing components; such as part design, tools, number of manipulation systems, category of sub tasks, etc. followed by hybridization of fabrication and machining processes and trust-based smart automation utilizing multi-robot cooperative control in product assembly and packaging. These three innovations, i.e., holistic optimization, process hybridization and reconfigurable automation have been validated through a real world application of on-demand manufacturing of consumer grade small motors.

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