

## Adapting Cyber Physical Production Systems to Small and Mid-Size Manufacturing Companies

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**Abstract :** The main thrust of our research is to determine Industry 4.0 readiness of small and mid-size manufacturing companies in our region and assist them to implement Cyber Physical Production System (CPPS) capabilities. Adopting CPPS capabilities will help organizations realize improved quality, order delivery, throughput, new value creation, and reduced idle time of machines and work centers of their manufacturing operations. The key metrics for the assessment include the level of intelligence, internal and external connections, responsiveness to internal and external environmental changes, capabilities for customization of products with reference to cost, level of additive manufacturing, automation, and robotics integration, and capabilities to manufacture hybrid products in the near term, where near term is defined as 0 to 18 months. In our initial evaluation of several manufacturing firms which are profitable and successful in what they do, we found low level of Physical-Digital-Physical (PDP) loop in their manufacturing operations, whereas 100% of the firms included in this research have specialized manufacturing core competencies that have differentiated them from their competitors. The level of automation and robotics integration is low to medium range, where low is defined as less than 30%, and medium is defined as 30 to 70% of manufacturing operation to include automation and robotics. However, there is a significant drive to include these capabilities at the present time. As it pertains to intelligence and connection of manufacturing systems, it is observed to be low with significant variance in tying manufacturing operations management to Enterprise Resource Planning (ERP). Furthermore, it is observed that the integration of additive manufacturing in general, 3D printing, in particular, to be low, but with significant upside of integrating it in their manufacturing operations in the near future. To hasten the readiness of the local and regional manufacturing companies to Industry 4.0 and transitions towards CPPS capabilities, our working group (ADMAR Working Group) in partnership with our university have been engaged with the local and regional manufacturing companies. The goal is to increase awareness, share know-how and capabilities, initiate joint projects, and investigate the possibility of establishing the Center for Cyber Physical Production Systems Innovation (C2P2SI). The center is intended to support the local and regional university-industry research of implementing intelligent factories, enhance new value creation through disruptive innovations, the development of hybrid and data enhanced products, and the creation of digital manufacturing enterprises. All these efforts will enhance local and regional economic development and educate students that have well developed knowledge and applications of cyber physical manufacturing systems and Industry 4.0.

**Keywords :** automation, cyber-physical production system, digital manufacturing enterprises, disruptive innovation, new value creation, physical-digital-physical loop

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