INTEGRATION OF ADDITIVE MANUFACTURING IN TRADITIONAL MACHINE BUILDING PROCESSES

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The integration of additive manufacturing (AM) involves incorporating AM technologies into various industries to enhance production processes and product design [1]. AM offers advantages such as rapid, economical, and complex manufacturing processes, impacting traditional manufacturing methods and the entire industry chain. However, challenges exist in fully integrating AM with I4.0 technologies [2], with barriers and organizational factors negatively moderating the benefits of this integration. To address these obstacles, there is a need for systematic support for early function integration in AM, along with the development of scenario-based teaching systems to bridge the talent gap in AM-related specialties. Traditional machine building processes encompass a variety of manufacturing techniques used in the industry. These processes involve casting, forging, welding, extrusion, spinning, and power metallurgy to create rough shapes of parts, which are then refined to net shape through machining. In Russia, research on business process management in machine building enterprises is evolving, focusing on organizational design and production automation. The development of technologies for machining is a key aspect of traditional methods in this field. Additionally, cutting equipment plays a crucial role in ensuring quality and efficiency in the production process, with innovations aimed at improving cutting precision and workpiece quality. Electrical machine production integrates mechanical, chemical, and electrical processes, combining automation with manual assembly for tasks like coil winding and sheet cutting. The integration of additive manufacturing (AM) in traditional machine building processes presents a promising avenue for enhancing production capabilities. AM technologies offer the production of complex parts that are challenging to manufacture using traditional methods. However, challenges such as surface quality and process repeatability exist in AM, which can be addressed through innovative approaches like a hybrid Additive and Subtractive Computerized Numerical Control machine tool [3]. This integration of AM in traditional machine building processes holds significant potential for advancing manufacturing capabilities.

Figure 1 depicts layer thickness refers to the thickness of each deposited layer during the additive manufacturing (AM) process. It is a critical process parameter that affects the resolution, surface quality, and mechanical properties of AM-produced parts. Smaller layer thicknesses generally result in finer surface finishes and higher dimensional accuracy but may increase build time and cost. Build temperature represents the temperature at which the material is processed during the AM build process. It influences material flow, bonding between layers, and thermal stresses within the part. Optimal build temperature settings are essential to ensure proper fusion between layers, minimize defects such as porosity or warping and achieve desired material properties.

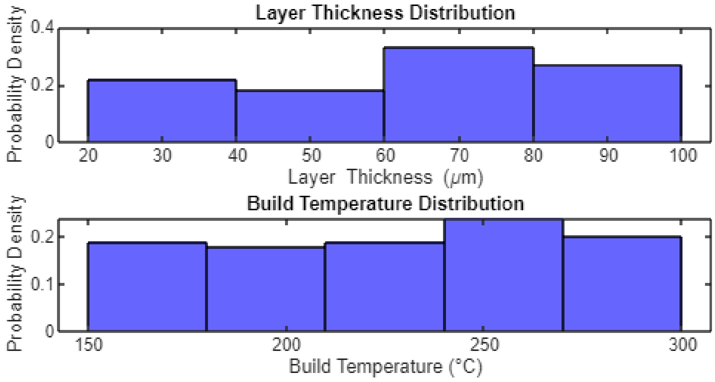

Figure 1. Layer Thickness, Build Temperature.

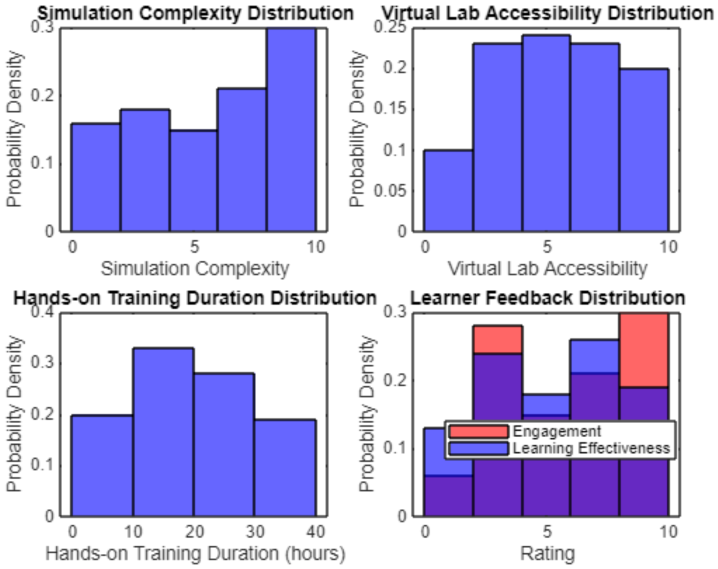

Figure 2. Simulation Complexity.

Figure 2 depicts simulation complexity refers to the level of intricacy and detail incorporated into interactive simulations within the teaching system. It encompasses factors such as the number of variables, the fidelity of models, and the depth of interactions. Higher simulation complexity allows learners to engage with realistic scenarios and explore a broader range of concepts and challenges related to additive manufacturing (AM) technology [4]. Virtual lab accessibility quantifies the ease of access and usability of virtual laboratory environments provided by the teaching system. It considers factors such as user interface design, navigation features, and compatibility with different devices. Enhanced virtual lab accessibility ensures that learners can readily access and engage with hands-on AM simulations and experiments, irrespective of their technological proficiency or device capabilities. Hands-on training duration denotes the amount of time allocated for practical, experiential learning activities within the teaching system. It encompasses activities such as operating AM equipment, designing parts, and troubleshooting process issues.

References

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