

## **Just-in-Time Learning for the Factory Floor**

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The manufacturing industry faces a shortage of skilled and semi-skilled labor. Additionally, many industries are changing product lines very quickly, especially high-tech products which have a quick product turn-over-cycle. While machines can be reconfigured quickly, humans in general are not quick about learning new techniques. It takes time to retrain the workforce to support the new production needs. While many individuals may perform the identical function within the manufacturing process, each person needs to be trained, and experience gained by one individual is not easily conveyed to another individual. Furthermore, if an individual can be quickly trained in the new manufacturing process, this new capability could be leveraged to facilitate cross-training. This would enable varied, less mundane work for each individual.

What we propose is a concept called Just-in-Time Learning, where augmented reality and machine learning are combined to observe, train, and assist in the manufacturing of complex assemblies. Augmented reality can guide the assembly/test operations and machine learning can, over time, improve the guidance given to the assembly line workers. For instance, suppose that a worker needs to assemble a mechanical electrical system such as a micro pump. A worker that assembles the physical mechanism would see superimposed in their field of vision an action, consisting of a synthetic hand holding a synthetic tool and part performing some operation on the actual product. The worker would then find that tool and part and imitate the action of the augmented reality scene. In the background, the AI would observe the actions of the worker, checking for completeness, and gauge how well the worker was able to process the instruction. By having the AI observe the actions of several people, it can accumulate knowledge on how best to represent the process with augmented reality and improve the assembly/test process. Thus, over time the AI would be able to learn across individuals, perfect the assembly/test process, and convey that knowledge to each individual involved in that aspect of the assembly/test process. This method facilitates the knowledge transfer from one individual to the next. Training is accomplished for each step of the manufacturing process. The steps are updated over time as the AI learns how to improve the assembly/test process and this information is conveyed using augmented reality.

Realization of this vision of the future assembly line requires a cross-disciplinary approach involving computer scientists to develop the AI and image recognition, electrical engineers to perform precise localization of objects to position augmented images, and human factors experts to improve usability. Individual key technology elements to realize this assembly line are in the R&D now, they simply need to be brought together to realize this new approach.

We believe Just-in-Time learning has the potential to improve human productivity, revolutionize the way that people are trained, and improve the quality of life for factory workers. It has the ability to facilitate knowledge sharing among factory workers by using their common experiences to recognize innovations in best practices.