Agentic AI-embedded Digital Twins for Semiconductor Manufacturing Education

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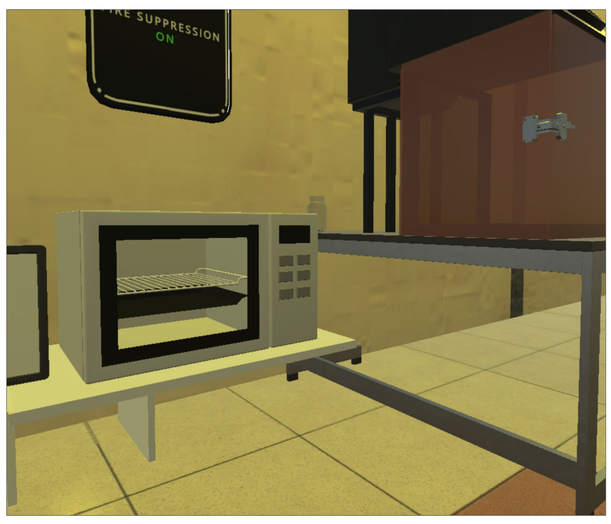
Abstract

There is currently a critical shortage of semiconductor personnel which is predicted to exceed 100,000 technician jobs by 2030, threatening the progress of semiconductor manufacturing. Traditional methods of education, such as in-person fab training lack scalability and immersivity. Simulation based learning makes use of interactive simulations to deliver training. Through the use of digital twins, learners can access these environments from any location, enabling scalable and immersive training. In addition, this project was done jointly alongside a team at Princeton and Mercer aiming to expand our work to device packaging as well.

Background

The work conducted in this study is an extension of work we conducted last year, which was published in the Journal of Advanced Technological Education. There, we developed virtual simulations for semiconductor training and ran a pilot with 29 participants. In this study, we aim to expand our *virtual simulation* to a *digital twin* with live feedback from the real fab, and high fidelity assets to enable more accurate learning. A digital twin is a simulation that emulated a real facility, together with live data and updates from that real space, in this project, our goal is to develop such a simulation to be used by semiconductor trainees and in career exploration.

Virtual Space



Real Facility (INRF@UCI)

Development

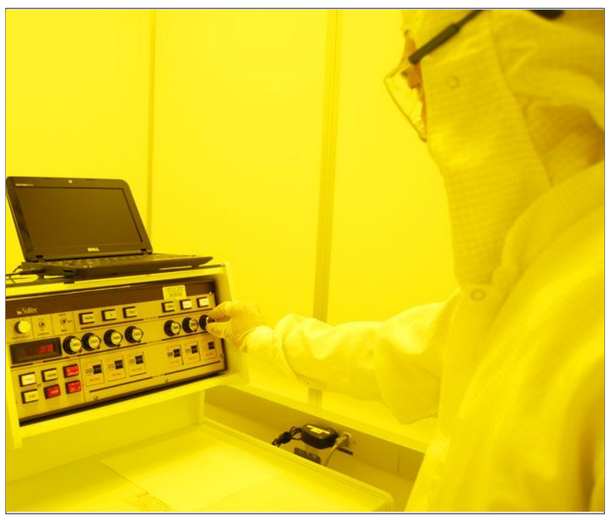
The facility we chose to model was the UCI Integrated Nanosystems Research Facility (INRF). We began by taking tours of the facility, taking detailed note of the machinery and process and obtaining standard operating procedures for each tool. The simulation was developed using the HyperSkill platform. Having been developed without code, the progression of events (steps) was defined using a graphical scenario flow with 60 total steps representing the typical actions taken in photolithography as obtained from procedures. Virtual assets were developed and animated by the team. This year's simulation is an extension and improvement of the previous simulation. As such, many assets were refined to be closer to those found in the real facility.

Features

The digital twin is interactive, and designed to guide the user through ~60 steps modelling the photolithographic process. These steps were designed in accordance with procedures and videos obtained from UCI INRF. In addition, to ensure our simulation is a digital twin, we plan to include live sensor data from the UCI Fab to increase the fidelity and accuracy of our simulation and scaffold the learning process. The digital twin also includes an embedded large-language model (LLM)-powered agent that can guide the user with personalized instruction, as well as help on a certain step or information about a machine.

Photos

Touring the UCI Fab.



Observing the process.

Acknowledgement

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