Contribution ID: **71** Type: **POSTER**

In-Depth Analysis of How Various Parameters of Immersive VR-Based Training Influence Performance

Virtual Reality (VR) has emerged as a powerful tool for training in high-risk and resource-intensive fields such as semiconductor manufacturing, where traditional hands-on learning is often limited by safety, cost, and facility access constraints. This study presents the development and in-depth evaluation of a Photolithography-focused Virtual Training Environment (PL-VTE) designed to support skill acquisition in one of the most precision-critical semiconductor fabrication processes. The research investigated how variations in some major VR design parameters influence trainee performance, procedural accuracy, knowledge retention, and perceived presence. Guided by literature-based VR design principles, an enhanced PL-VTE module has been developed in Unity 3D and deployed on Meta Quest headsets. A mixed experimental design compared outcomes between VR-based and traditional training groups using pre- and post-tests, performance tracking, interviews, concluding, and presence questionnaires. Findings provide evidence-based guidelines for optimizing immersive VR training in engineering education and address existing gaps in VR-based instructional design. The study contributes to the advancement of pedagogically sound, accessible, and effective immersive learning environments for technical skill development.

Academic or Professional Status

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Session Classification: Poster Session

Track Classification: Education & Workforce Development