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**From Training to Control: Generative AI in Operator Training Simulators and as a New Paradigm for Process Control**

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ABSTRACT

Recent advances in generative AI (GenAI) particularly large language models like GPT—are reshaping the landscape of chemical engineering, with emerging applications in both education and industrial process control. This work presents an integrated vision for how GenAI can serve dual roles: as a scaffold for learning within operator training simulators (OTS) and as a foundational basis for process control.

In an educational context, we developed a GPT-engineer embedded within an industry-facing OTS (from TSC Simulation) used within an OTS for undergraduate chemical engineering subjects. The AI agent roleplays as a plant supervisor, providing interactive support before, during, and after simulated process safety incidents, to help guide student learning through root cause analysis and process safety training. Student feedback across three years of deployment highlights strong performance and student satisfaction, while suggesting improvements to effort expectancy and accessibility (the industry-facing software creates a significant initial technical jump for students to understand).

Iterative revisions in 2025 have introduced scaffolded learning activities to better align the simulation experience with students’ zone of proximal development (ZPD), aiming to enhance their ability to navigate digital control interfaces, and apply P&ID knowledge in realistic fault scenarios.

Beyond education, we propose that the same generative AI technologies used for simulation-based learning can form the basis of a novel paradigm for process control. GPT agents can integrate seamlessly with distributed control systems (DCS), drawing on diverse internal datasets (incident logs, SOPs) and external datasets (weather data, financial information) to provide real-time decision support. Multi-agent architectures and cross-checking mechanisms further mitigate AI error risks, making GPTs suitable for industrial deployment. Case examples highlight how such systems can optimize operations in complex settings. For example, an alarm is triggered, the GPT can search prior incident logs and other documentation to identify and rank likely causes for root cause analysis protocols. GPT-agents can also integrate into sales platforms, financial data (commodity prices, shipping), storage capacity and unit operation models to optimize production throughput.

This dual application—education and control—suggests a pathway to broader integration in which generative AI first augments human learning and is tested and proved in offline digital-twin simulations first, before prototyping and integration into control rooms of the future.

KEY WORDS

GenAI, GPT, Process control, Operator Training Simulator, digital twin

BIOGRAPHY

Christopher Honig is a senior lecturer in the department of Chemical Engineering at the University of Melbourne. He has an interest in the application of GenAI and GPTs in tertiary education

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