# Development of digital educational concepts for realistic plant simulation for the application of safety PLCs in vocational training and further education

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The cooperative SafetySim research project aims to develop and implement a simulation and training application for learning safety-relevant aspects of the use of programmable logic controllers for machines and systems in electrical engineering training professions. A 3D-based training system has been developed for this purpose. The SafetySim system supports the application of safety PLCs in the implementation of safety functions.
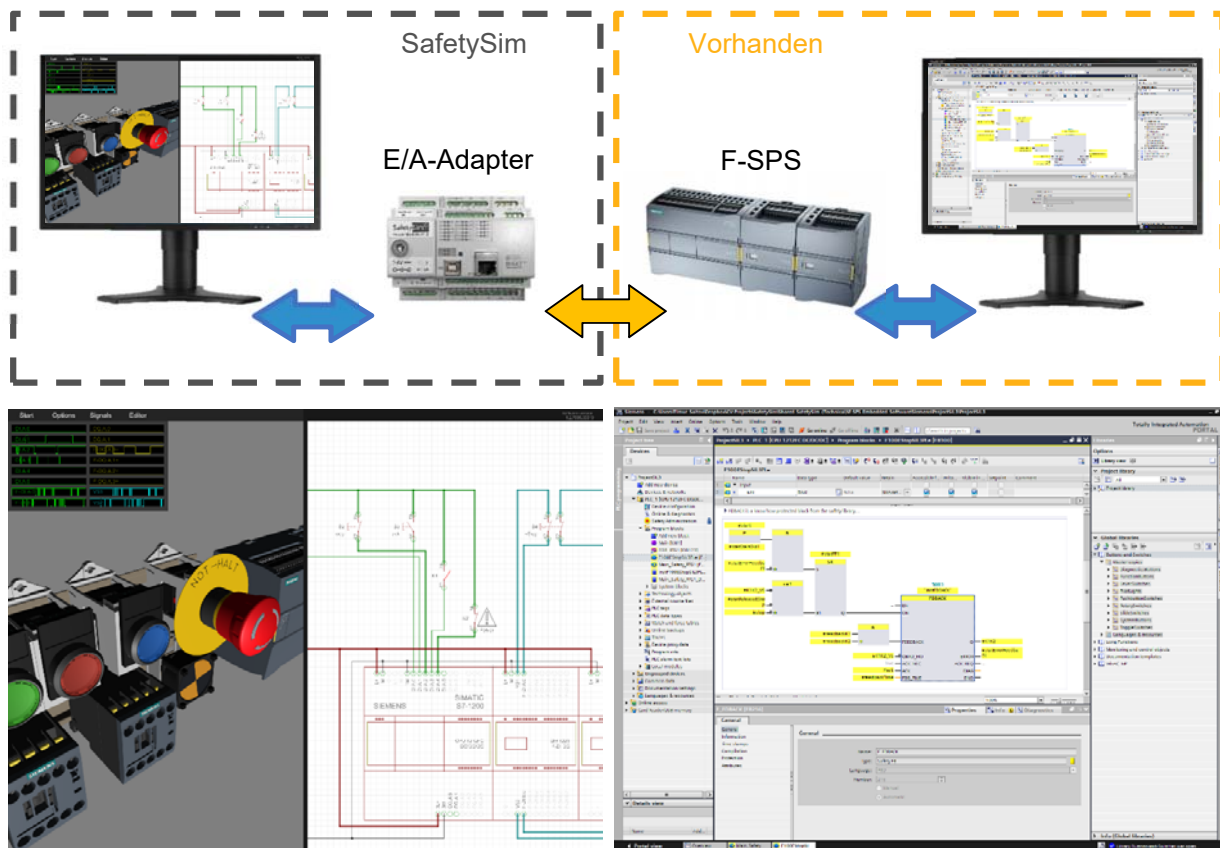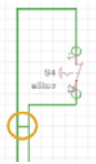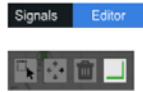

It is didactically prepared in such a way that the special functionalities and conditions can be easily conveyed. For this purpose, a 3D simulation software has been developed which simulates safety equipment (including associated sensors/actuators) of a machine in a physically and electromechanically correct way.

At the same time, a complete 2D circuit diagram is simulated in real time. An editor mode allows changes to be made to the animated circuit diagram at run-time.

The realized simulation implements the concept of a "digital twin". Such a twin shows exactly the same behavior and functionality as a real machine/plant, so that the physical controller can be moved from the simulation to a real machine/plant without further changes in software. The necessary signals are processed and conditioned by an I/O adapter with self-developed firmware so, that they can be received by commercially available safety PLCs or sent to the simulation software via the I/O adapter.

Additionally, the didactic approach allows the induction of classical errors into the simulated components and actuators e.g. contact discrepancies, wire breakage, permanent contactor welding, short circuits and cross-connections. The realization of this behavior is achieved in real-time on standard computer technology. The reactions of the safety PLC to the induced errors can be observed and analyzed in real-time by the trainees during the training.
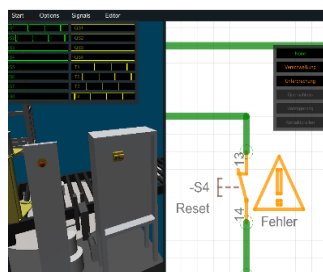
Circuit diagrams can be edited or created with the Autodesk Eagle external schematic editor. The integration of modern didactic learning concepts, the associated evaluation possibilities of the learning progress and the targeted focus on learning safety-related faults (e.g. wire breakage, defective contactors/ relays etc.) are also part of the overall project scope.

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