**Project Summary**
The project, led by Bert van Beek from the Department of Mechanical Engineering, focuses on the development and application of ICT tools to support Time and Place Independent Learning (TPIL). These tools have been developed, tested, and applied in the course *4TC00 Model-based Systems Engineering*, which teaches model-based design of high-tech systems.

The project addresses two critical areas:

1. **Version control support**, including tools for retrieving student data from the learning management system (LMS), generating group repositories, analyzing and grading individual contributions, and detecting plagiarism.
2. **Digital twinning**, enabling students to work with realistic digital models of physical systems.

**Project Aim**
The project aims to implement advanced ICT tools that enhance the learning experience and effectiveness of student groups. By improving tool support for TPIL through repositories and digital twins, students can collaborate more efficiently, receive faster feedback, and engage in industry-relevant practices.

**Repository Tool Support**
Tool support for repositories is structured in four categories:

1. **Student data retrieval**: Exporting data from the LMS into spreadsheet and YML files for input into repository generation tools.
2. **Repository generation**: Introducing version control to improve collaboration, efficiency, and alignment with professional standards, supported by a graphical user interface (GUI).
3. **Contribution analysis and grading**: Automating the evaluation of individual student work through user-friendly tools that provide consistent feedback via a GUI, while reducing instructor workload.
4. **Plagiarism detection**: Integrating and extending tools for plagiarism detection in modeling languages, with planned GUI development to improve usability.

For all four categories, the development of **professional-grade, signed, auto-updating, multi-platform applications** is a key objective.

**Digital Twins**
The project also develops 3D digital twins that replicate real-world Festo manufacturing units. These twins enable practical and flexible testing of controllers, adding realism and applicability to student projects.

By achieving these objectives, the project seeks to improve student satisfaction, support independent and collaborative learning, uphold academic integrity, and prepare students for professional environments where such technologies are standard.

**Results and Learnings**
Progress to date includes:

* **Version control tools**: Three user-friendly applications with both GUI and command-line interfaces, designed for use even by instructors without a computer science background.
	+ *Canvasinfo*: Retrieves student data from Canvas and generates Excel and YML files for use in the Repobee GUI.
	+ *Repobee GUI*: Provides a graphical interface for configuring settings and generating student group repositories with Repobee.
	+ *Gitinspector GUI*: Analyzes student contributions within repositories, producing HTML and Excel reports consisting of multiple tables and graphs. These reports provide detailed insights into overall contributions as well as line-level authorship. Consistent author coloring is used across all output tables, making the results easier to interpret. The tool has proven highly valuable for grading individual contributions to group work.
* **Plagiarism detection**: Evaluation of JPlag for plagiarism detection has been completed, with GUI development planned as a next step.
* **Digital twins**: Four fully functional digital twins of Festo manufacturing units have been created. They are well-received by students, easy to use, and supported by extensive public documentation for both users and developers.
* **Future work**: For all four version control support categories, the development of professional-grade, signed, multi-platform applications is still pending.