

A modular virtual learning environment for interactive engineering education : design and implementation of a multi-system platform

M Marin (INEGI, Portugal) | RJC Carbas | EAS Marques | MM Kasaei | A Akhavan-Safar | LFM da Silva

Introduction

Engineering education struggles to convey complex, abstract concepts. In materials science, technical drawing and advanced joining processes (adhesive bonding, joining by forming and welding), traditional teaching relies heavily on static representations. This research presents the design and implementation of a modular virtual learning environment aimed at supporting mechanical engineering students through a more exploratory and practice-oriented approach.

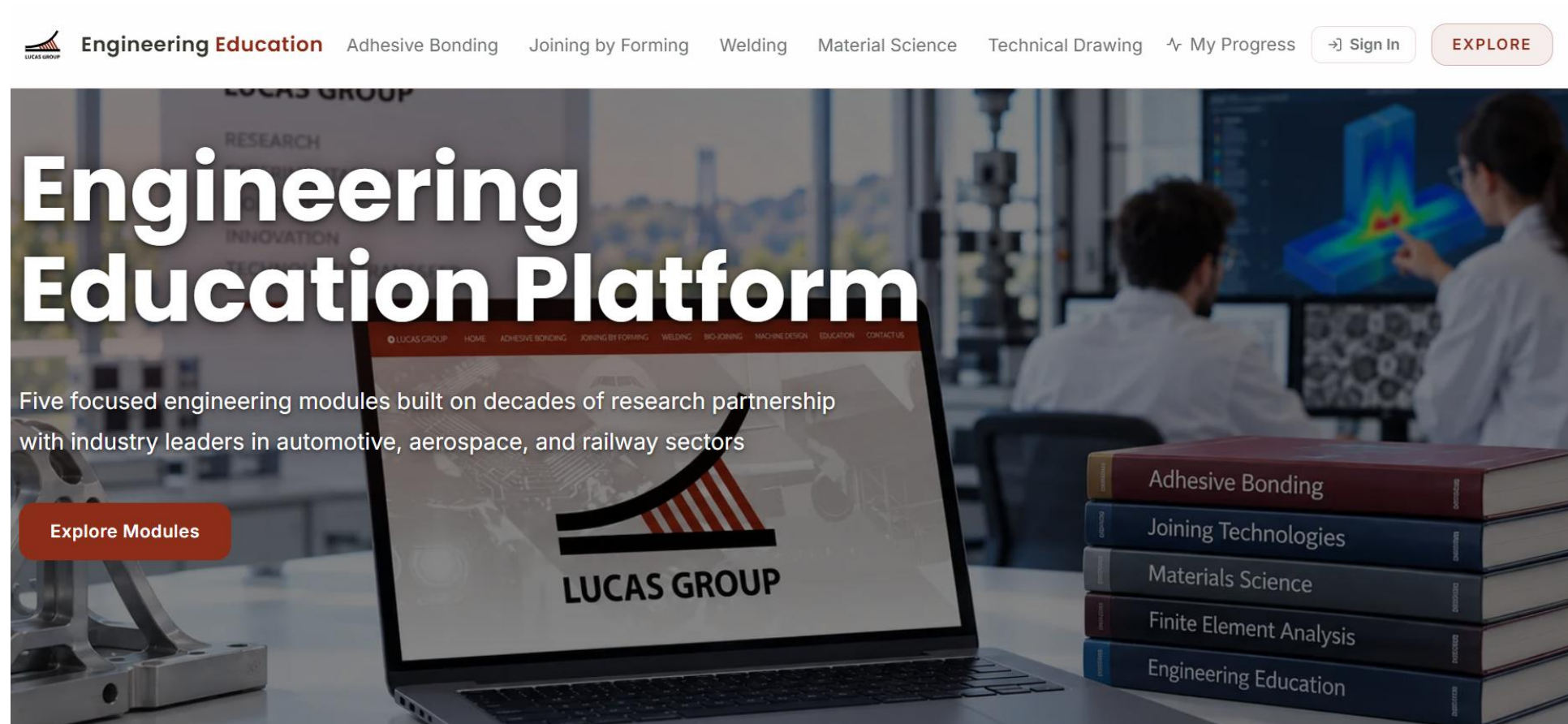


Figure 1 – Engineering Education Platform home page

Learning Modules

Material Science

This module is an interactive, web-based learning environment designed for engineering students and self-learners.

Interactive Visualization Tools : Embedded virtual tools allow users to explore unit cells, crystal lattice systems, phase fields, and Miller index notations in real time.

Core Topics Covered : Focuses on phase diagrams (total, partial, and insolubility), crystal structures, and material characterization, all integrated within a clean, consistent web interface.

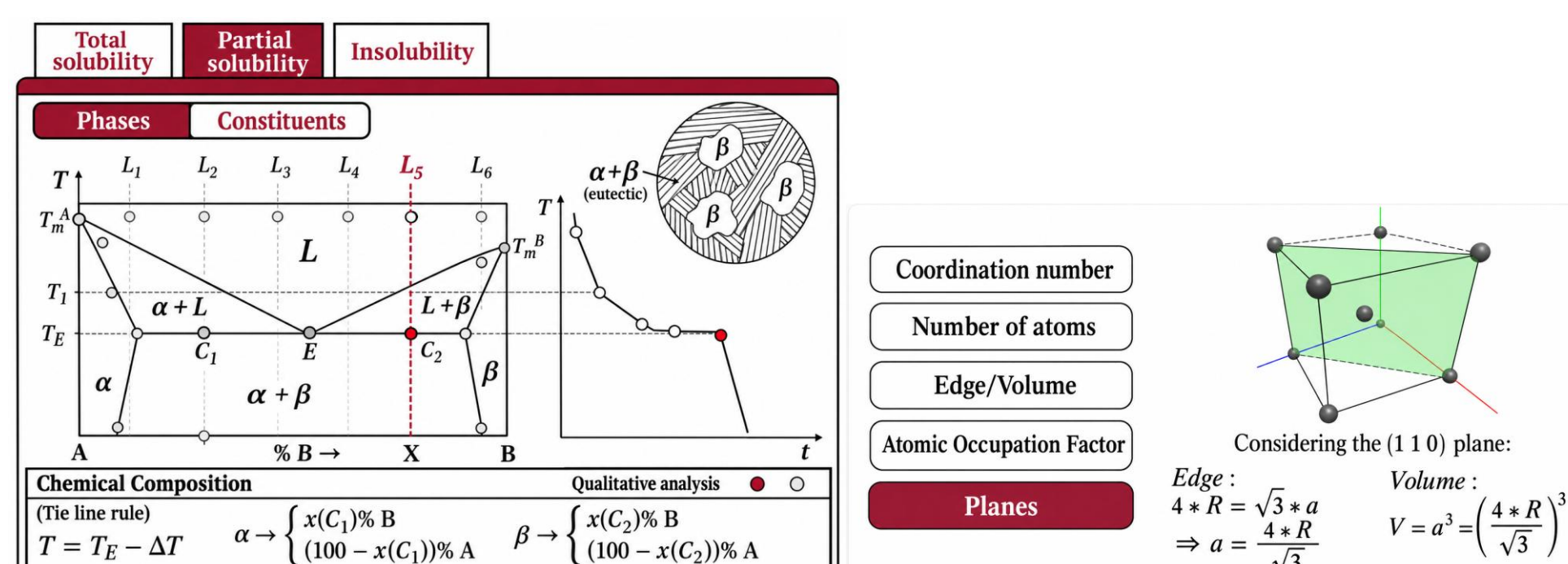


Figure 2 – Material Science (left) Phase Diagram (right) Crystallography

Technical Drawing

The Technical Drawing module on the Engineering Education platform is an interactive, academic learning tool developed to help engineering students master fundamental engineering drafting, standards, and visual communication principles.

Interactive Drafting Tools & Viewers : Provides digital tools for practicing orthographic projections, section views, geometric dimensioning, and reading technical drawings.

Core Topics Covered : Focuses on standard projection methods (1st and 3rd angle projections), line types, dimensioning practices, sectioning, and surface finish callouts aligned with industrial engineering practices.

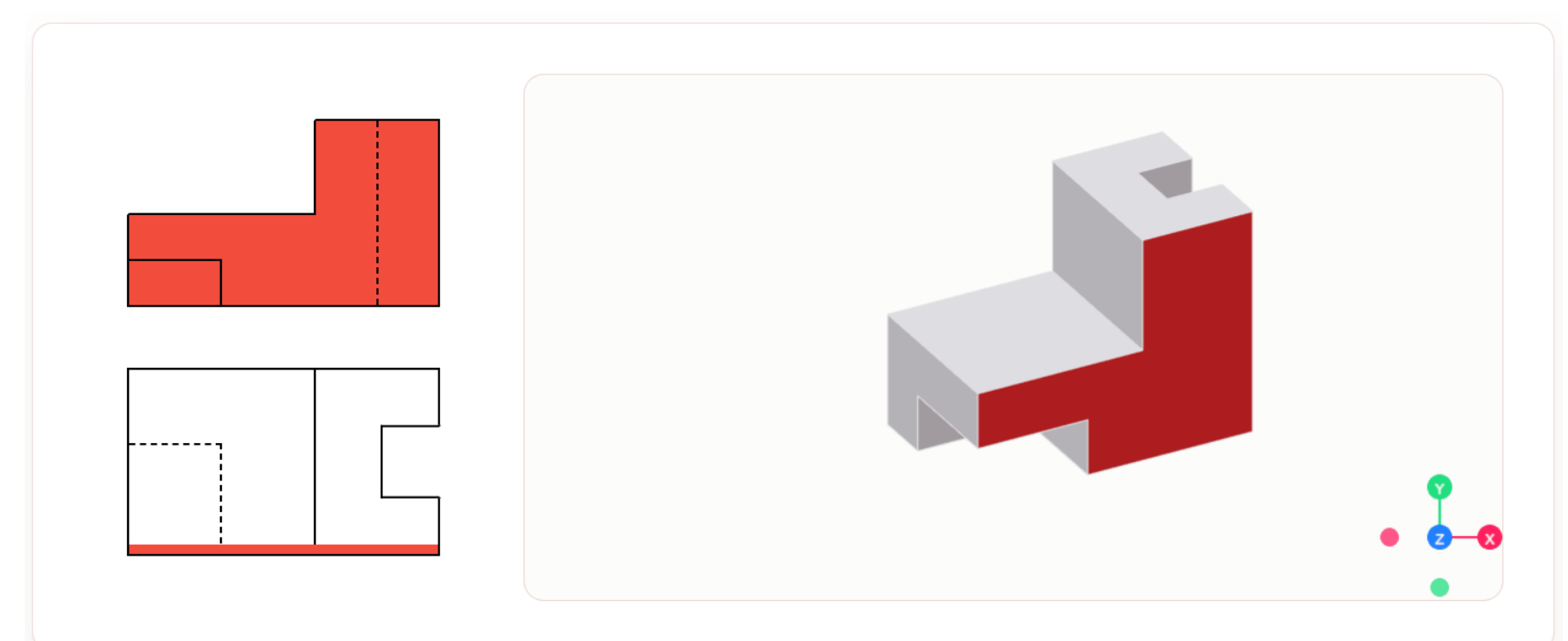


Figure 3 – Technical Drawing

Advanced Joining Processes

This module provides a modern, interactive overview of essential material assembly technologies, focusing on joining by forming, welding, and adhesive bonding.

Interactive Process Demonstrations : Features dynamic visualizations and interactive models that demonstrate joint creation, stress distribution, and thermal/mechanical behaviors across different techniques.

Core Topics Covered : Joining by Forming, Welding, Adhesive Bonding

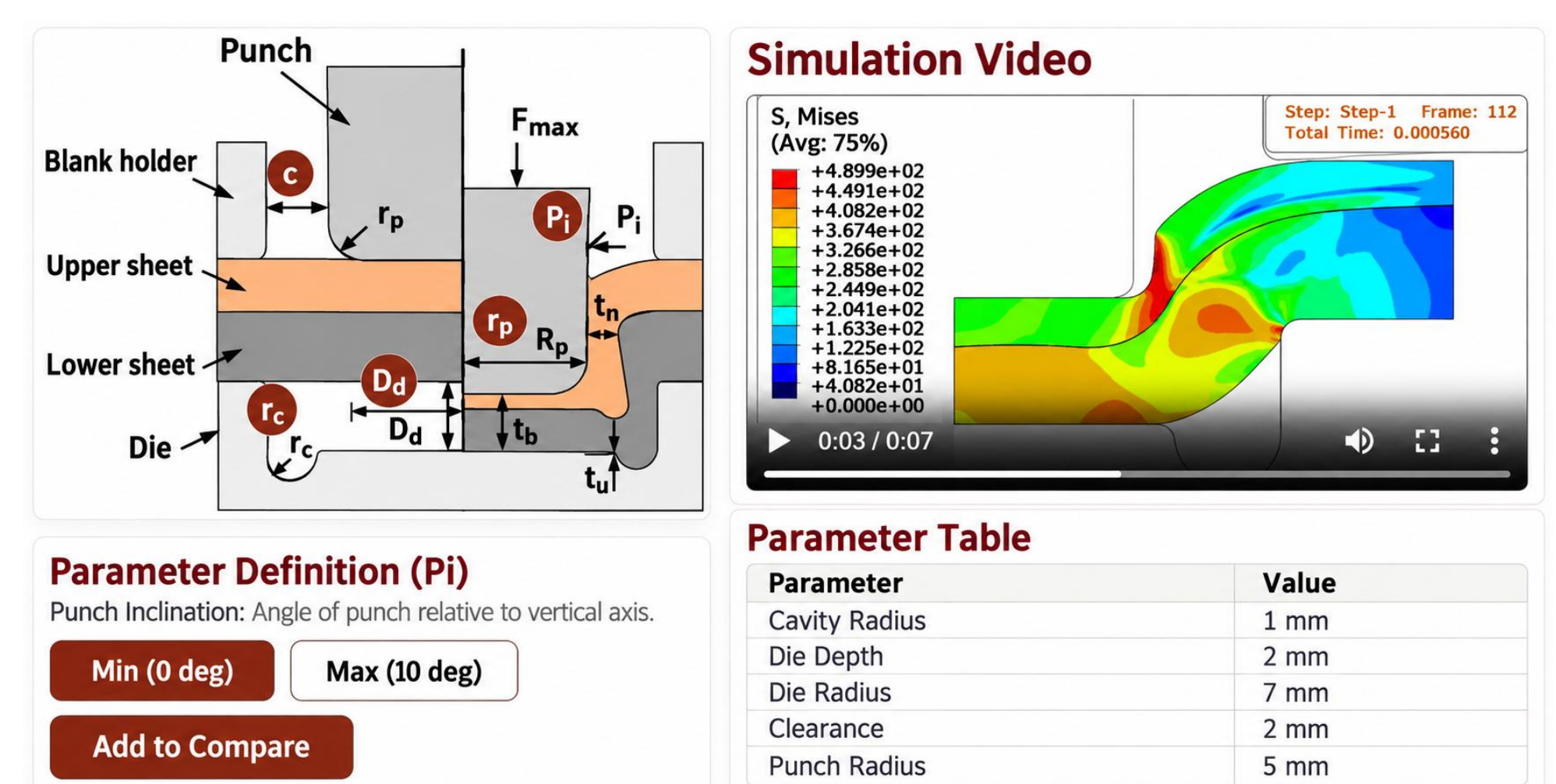


Figure 4 – Clinching Simulator

Conclusion

Together, these interactive modules on the Engineering Education platform, Material Science, Technical Drawing, and Advanced Joining Processes, provide a cohesive, digital-first learning ecosystem for modern engineering students. By combining structured theoretical foundations with real-time interactive tools, visual dynamic models, and targeted quizzes, the platform bridges the gap between fundamental academic concepts and real-world industrial practices, empowering learners to master complex engineering topics efficiently.

Try the platform

Scan the QR code

