

Modular Course C: Design Engineering

UNIT C1: Digital Design and Engineering Tools

LC1.2 – Computer-Aided Engineering (CAE) in
L&F sector



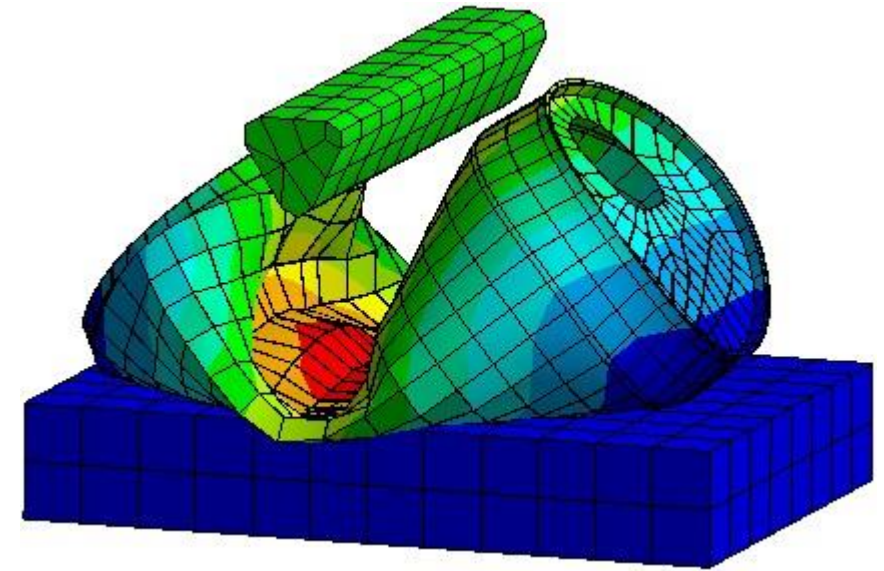
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DISHOLEA | Improving the digital
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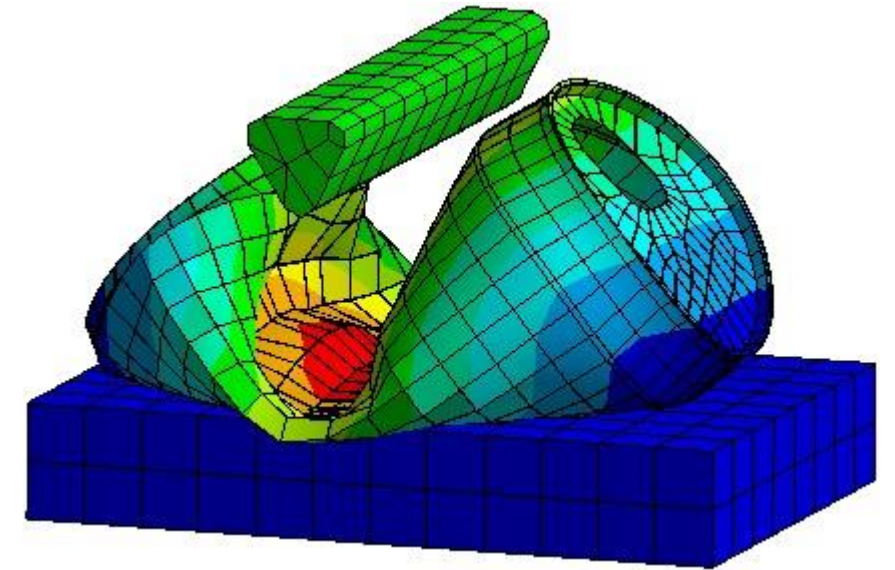
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Computer-Aided Engineering (CAE) is an engineering discipline that enables the analysis of the mechanical, physical, and functional properties of product design in a computer environment. CAE allows predicting the performance of the product before production by conducting virtual testing during the design verification process.



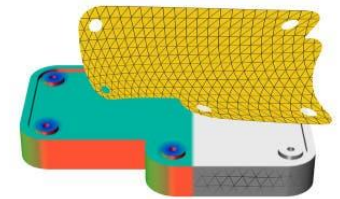
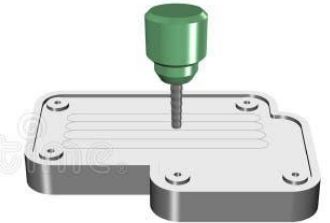
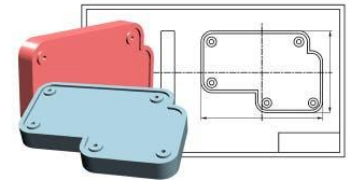
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Digital Product Development Chain

CAD: Computer Aided Design, making 2D and 3D designs on a computer screen using CAD software.

CAE: Analyses are performed to check how the model behaves in the real world

CAM: Computer Aided Manufacturing



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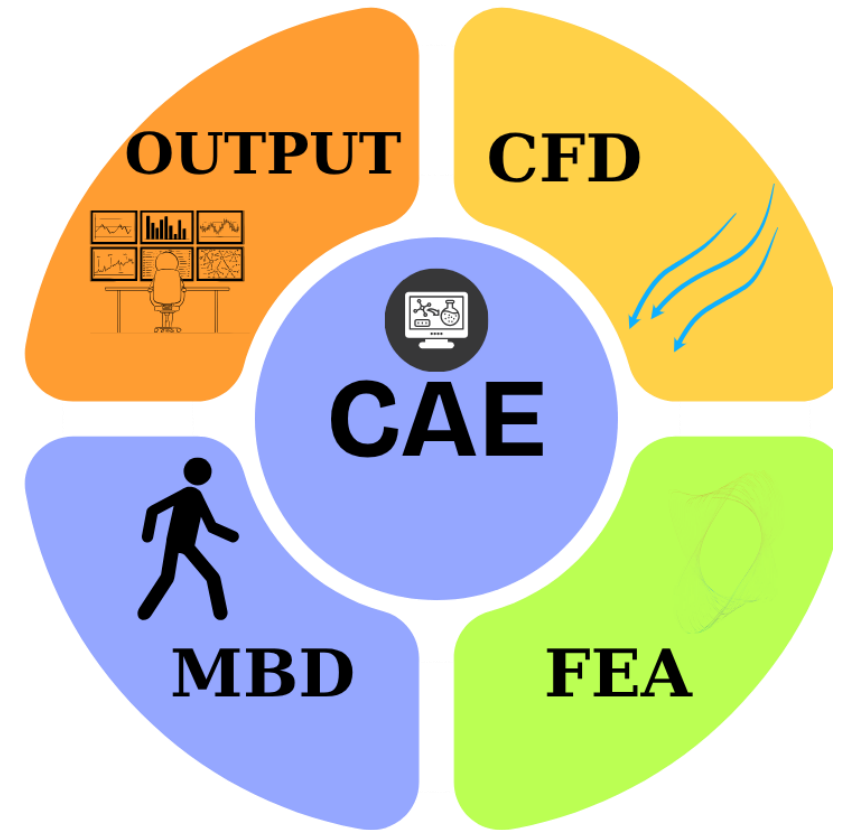
Types of CAE Analysis

CFD (Computational Fluid Dynamics):

Air/moisture flow simulations – used in shoe ventilation tests.

FEA (Finite Element Analysis): *It is used for stress, deformation and durability analysis of materials.*

MBD (Multibody Dynamics): *It is used to measure the dynamic behavior of moving parts (e.g., footwear in a gait cycle).*

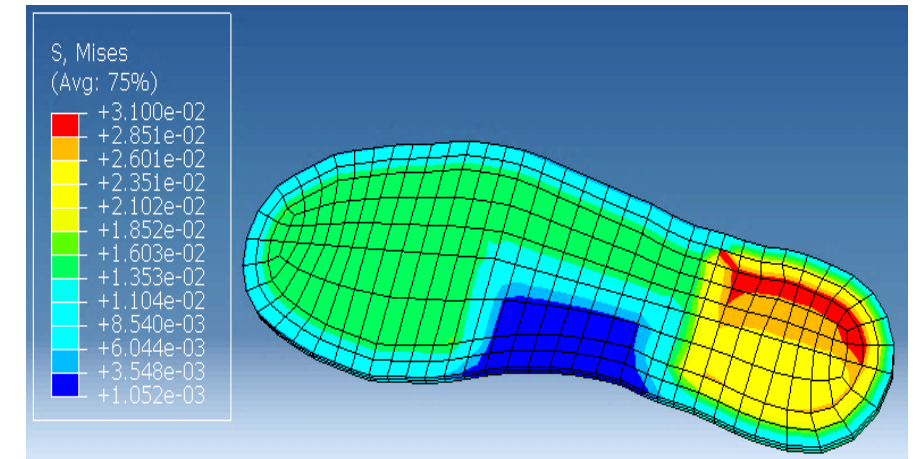


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Application Areas of CAE in the L&F Sector

Base Performance Analysis:

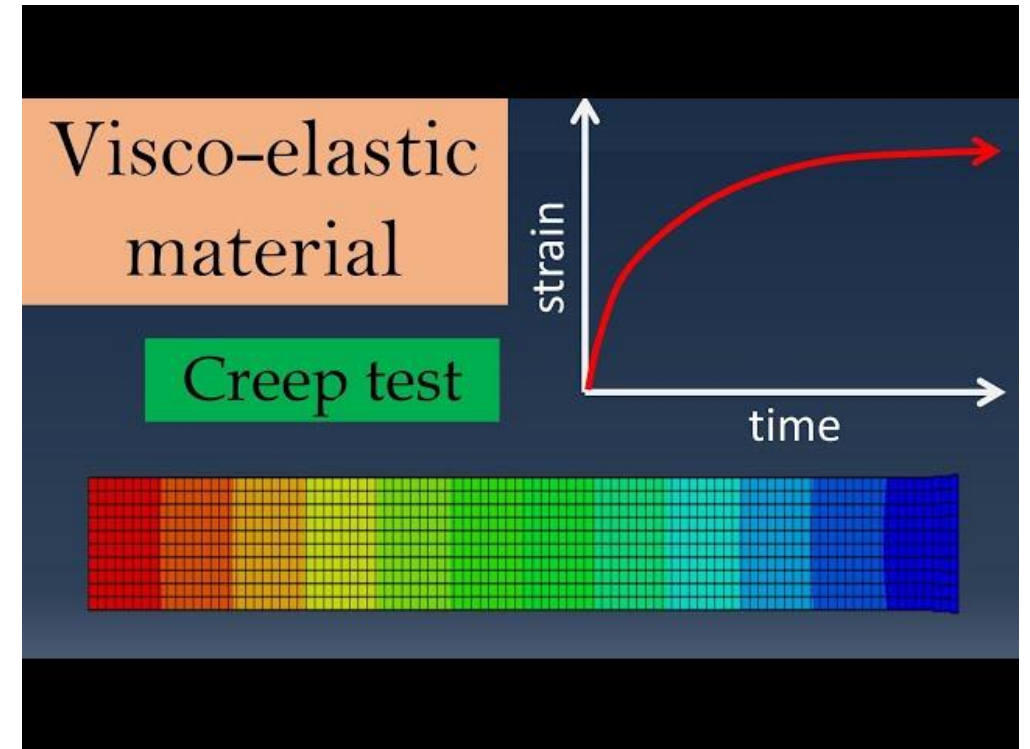
Numerical simulation of deformation, energy absorption and anti-slip behavior of shoe soles under walking, running or occupational safety conditions



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Application Areas of CAE in the L&F Sector

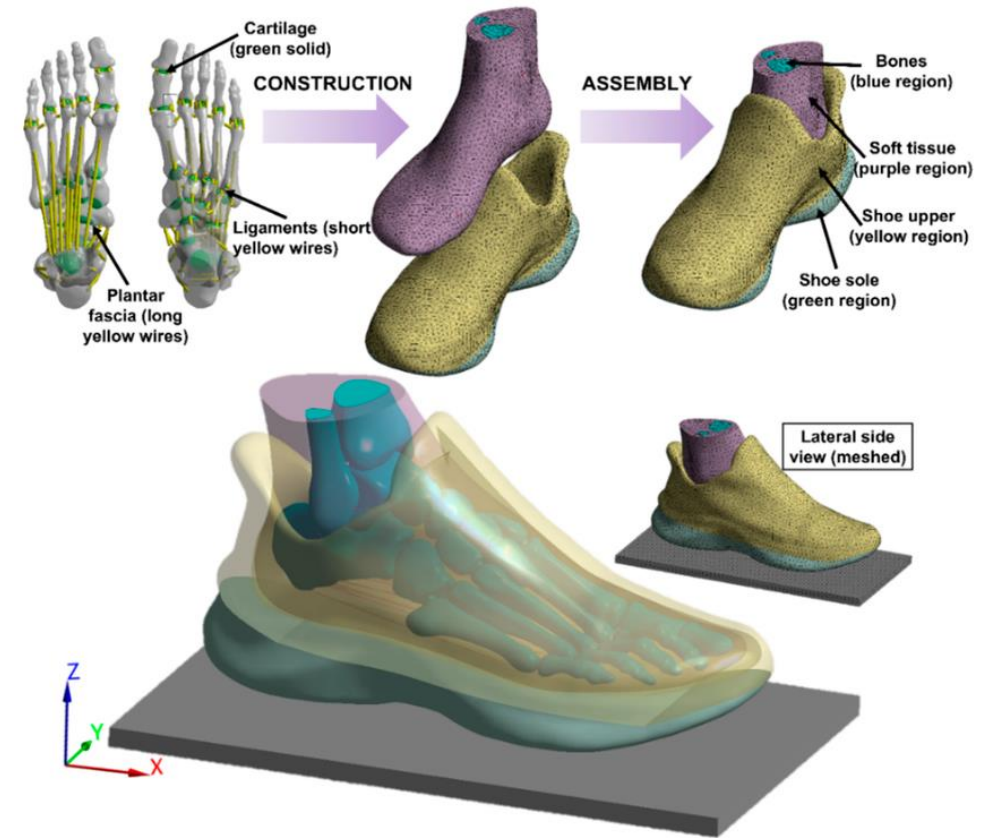
Material Modeling: The elastic moduli, shear coefficients, and energy absorption values of materials such as leather, rubber, TPU, and EVA are measured and defined in the CAE environment.



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Application Areas of CAE in the L&F Sector

Foot-Shoe Interaction: Models created with three-dimensional foot scan data are paired with virtual shoes to analyze pressure maps and movement restrictions.

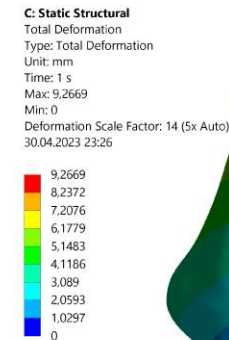


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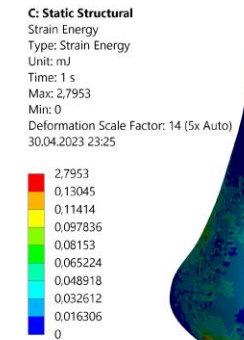
Application Areas of CAE in the L&F Sector

Comfort and Thermal Analysis:

Thanks to models that simulate heat and moisture permeability, sweating and temperature increases that may occur in long-term use can be evaluated.



(a)

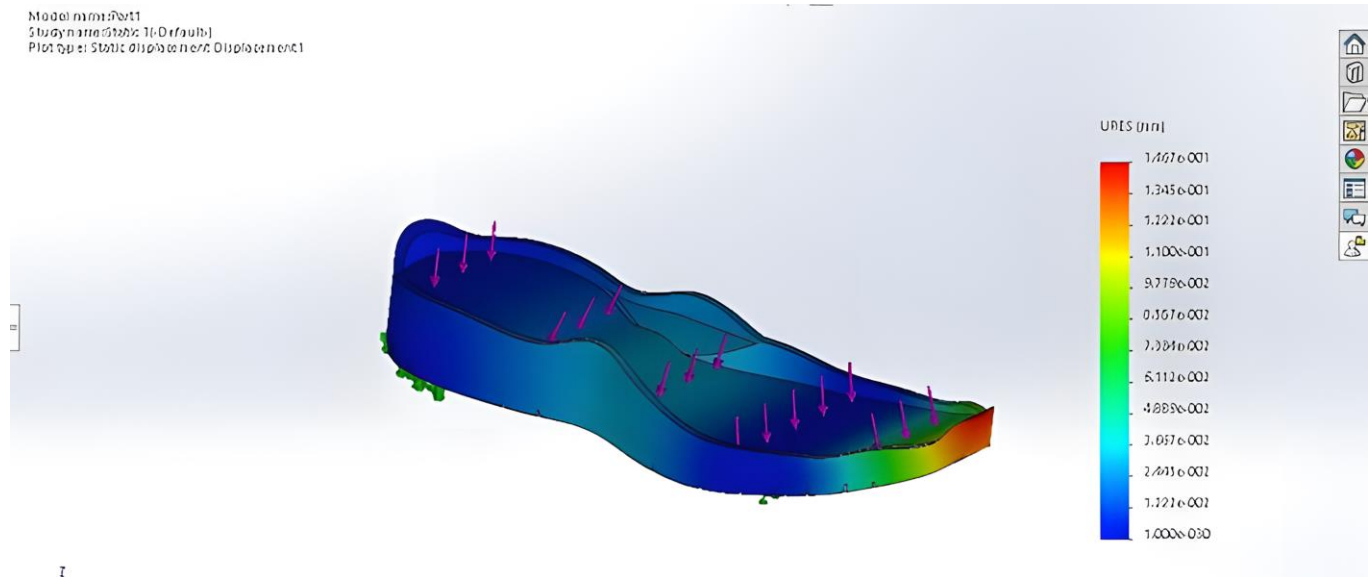


(b)

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CAE Software Used

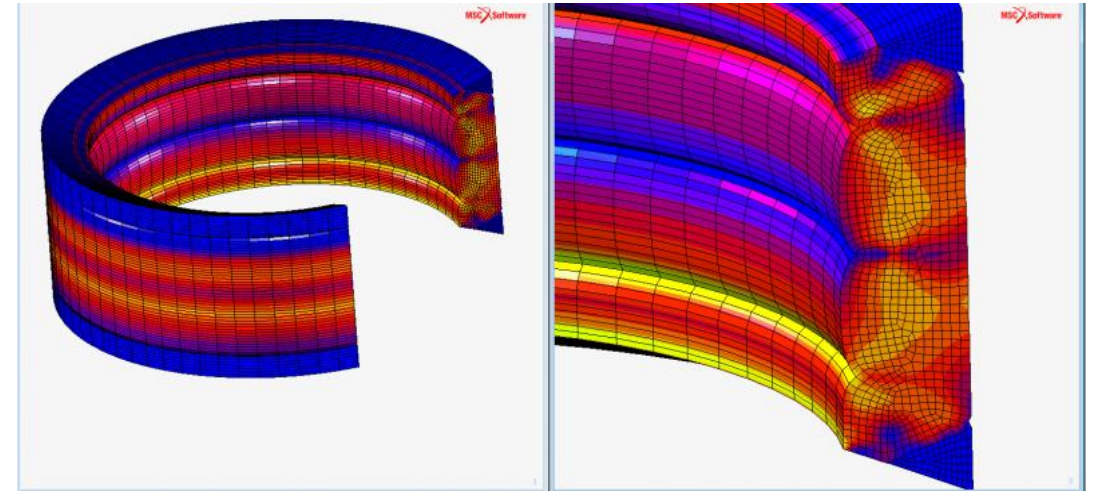
ANSYS and ABAQUS: It is used for stress and deformation analysis in shoe soles.



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CAE Software Used

MSC Marc and Nastran: Preferred in modeling the behavior of non-linear elastic materials



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CAE Software Used

Altair HyperWorks: It enables energy absorption and crash tests to be carried out in virtual environments.

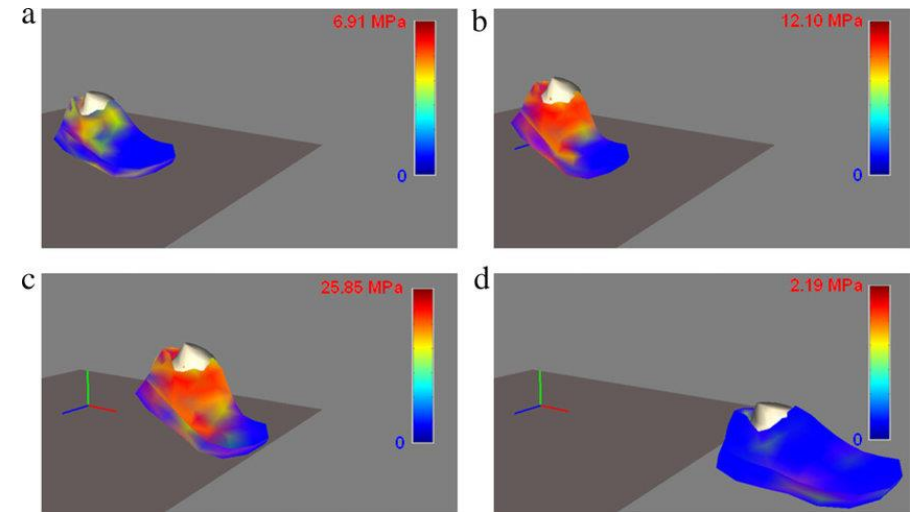


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CAE Software Used

Abaqus Foot Simulation Plug-in:

Matches sole pressure maps and sole geometry.



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Benefits of CAE Systems

- Design accuracy increases, error rate decreases.
- The number of physical prototypes decreases, the cost decreases.
- Material usage is optimized.
- Carbon footprint is reduced.



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CAE and Digital Transformation

- CAE is one of the digital transformation tools of Industry 4.0.
- It combines smart manufacturing, data analytics, and virtual testing processes.
- Digital twin" technology reduces the need for physical samples.
- It offers sustainable and environmentally friendly solutions in shoe production.



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Challenges in Implementing CAE Systems

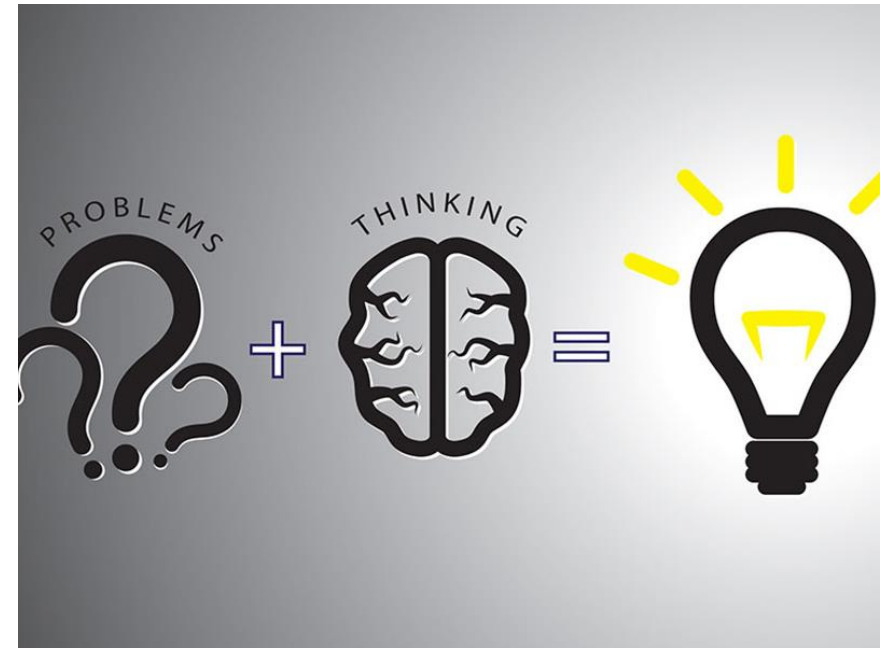
- High investment cost
- Software-hardware incompatibilities
- Need for personnel training



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Solutions:

- Cloud-based CAE systems
- University-industry collaborations
- Distance learning and VR-supported learning modules



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The Future of CAE Systems

- AI-powered design optimization
- Real-time simulations
- VR/AR supported comfort tests
- Personalized digital foot models
- Sustainability and energy efficiency analyses



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Conclusion and Evaluation

- CAE combines aesthetics and engineering in the design process.
- Digital testing accelerates product development.
- As a "digital craftsman", the designer of the future uses both creativity and analytical skills.

