Simantics Mechanics:
3D modelling and simulation tool for multibody system simulation

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VTT Technical Research Centre of Finland

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THE SIMANTICS PLATFORM
What is the Simantics platform?

1. An internal development project of VTT Technical Research Centre of Finland
   - Simantics is a project in Complex Systems Design and eEngineering theme programs
   - Project duration September 2006 – December 2012
   - Project budget ~2.4 M€ (total for core development)

2. Software platform for modelling and simulation
   - Application development platform
   - Integration solution for modelling and simulation
   - Efficient semantic ontology-based data modelling and database implementation

3. Software development community and philosophy
   - Simantics is an open source project, the platform is open for everyone to adopt for use
   - Flexible EPL licensing allows both open source and proprietary utilisation of the platform
   - Cumulates and rationalises modelling and simulation software development and use

For more information, visit: www.simantics.org
Plug-in architecture for modelling and simulation

For more information, visit: www.simantics.org
The Simantics platform in action
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SIMANTICS MECHANICS
SOFTWARE DEMONSTRATOR
Multibody system (MBS) simulation

- Multibody system (MBS) simulation is:
  - Special form of system modelling and simulation
  - A multibody system consists of (multiple) bodies that interact with each other through joints, forces acting on and between the bodies, and additional data constraining components (e.g. algebraic equations)

- The following is typical for MBS modelling:
  - Mass properties (mass, centre of mass, mass inertia tensor) of the bodies are primary data, but difficult to define for complex geometries → geometry is important
  - Space orientations (3D) are difficult to perceive → interactive 3D is important
  - In the overall simulation process, the time spent in the modelling phase is dominant

- Solid modelling is a convenient way of defining complex geometries
  - Two commonly used methods: constructive solid geometry (CSG) and boundary representation

Images:
Background on Simantics Mechanics

- The Simantics Mechanics MBS tool contains
  - A 3D CSG geometry modeller (a generic modelling component)
  - A 3D MBS model editor (a specific modelling component)
  - A MBS simulation visualiser (animation of the simulation results)
  - A results data plotting tool (a generic data visualisation component)

- OpenModelica\(^1\) with Modelica MultiBody\(^2\) library is used as the simulation backend
- Simantics platform\(^3\) is used as the application framework
- OpenCASCADE\(^4\) is used for solid geometry modelling
- Visualization Toolkit\(^5\) (VTK) is used for 3D visualisation

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1) [https://www.openmodelica.org/](https://www.openmodelica.org/)
2) [https://www.modelica.org/](https://www.modelica.org/)
3) [https://www.simantics.org/simantics](https://www.simantics.org/simantics)
4) [http://www.opencascade.org/](http://www.opencascade.org/)
5) [http://www.vtk.org/](http://www.vtk.org/)
Data model in the Simantics platform

- Different modelling and simulation approaches are modelled as ontologies and mapped together to form a consistent graph of model configurations.
- Both 3D geometry and MBS model are defined as specific ontologies.
- The user interface, modelling database, scene graph, and the rendering backend are kept in sync.
- The model in selected format (at the moment only Modelica) is created from the semantic graph when the case is simulated.

- The objective is to develop a backend independent MBS model editor and data management system, i.e. detach MBS modelling from numerical solving.
Demo video

Video will be available at https://www.simantics.org/simantics
Summary

- 3D modelling and visualisation tools increase remarkably the overall efficiency of the MBS modelling and simulation process
- Utilisation of platforms, such as the OpenModelica environment and the Simantics platform, and high-level software libraries, such as OpenCASCADE and the Visualization Toolkit, rationalises the software development for modelling and simulation
- Semantic data representation enables efficient data mapping and enables the development of a general data management system
- Future work with the Simantics Mechanics environment (a wish list):
  - Full support for all the main MBS modelling components
  - Redesign of the MBS ontology (software internal data model)
  - Support for 2D graph-based modelling and mapping between 3D and 2D model representations
  - Interactive modelling features, such as geometry feature picking
  - Usability improvements, e.g. new component location and orientation tool
  - Support for other common MBS simulation backends, such as MSC Adams and SIMPACK, and data mapping between different backend data models
  - Import of MBS models in third party file formats

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VTT creates business from technology