



Functional Design-Prototyping using OpenModelica

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Outline

1. Introduction
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3. Road Map for Functional Prototyping
4. Summary and Outlook



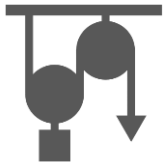
Product-Design in Engineering Education

- interdisciplinary student project to develop excavator control devices
- combine product design, machine simulation, media design and rapid prototyping facilities
- very inspiring and instructive for all parties involved

... even for OpenModelica

FUNCTIONAL DESIGN-PROTOTYPING

Designing an Interactive Product



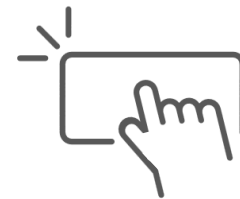
Functionality

- requirements
- variants
- validation



Appearance

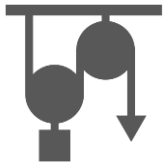
- shape
- visual and haptic



Experience

- comfort
- familiarization

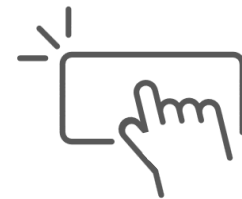
Comprehending Design

**Functionality**

- simulation
- physical prototypes

**Appearance**

- sketches, drawings
- models, mockups

**Experience**

- interactive simulator

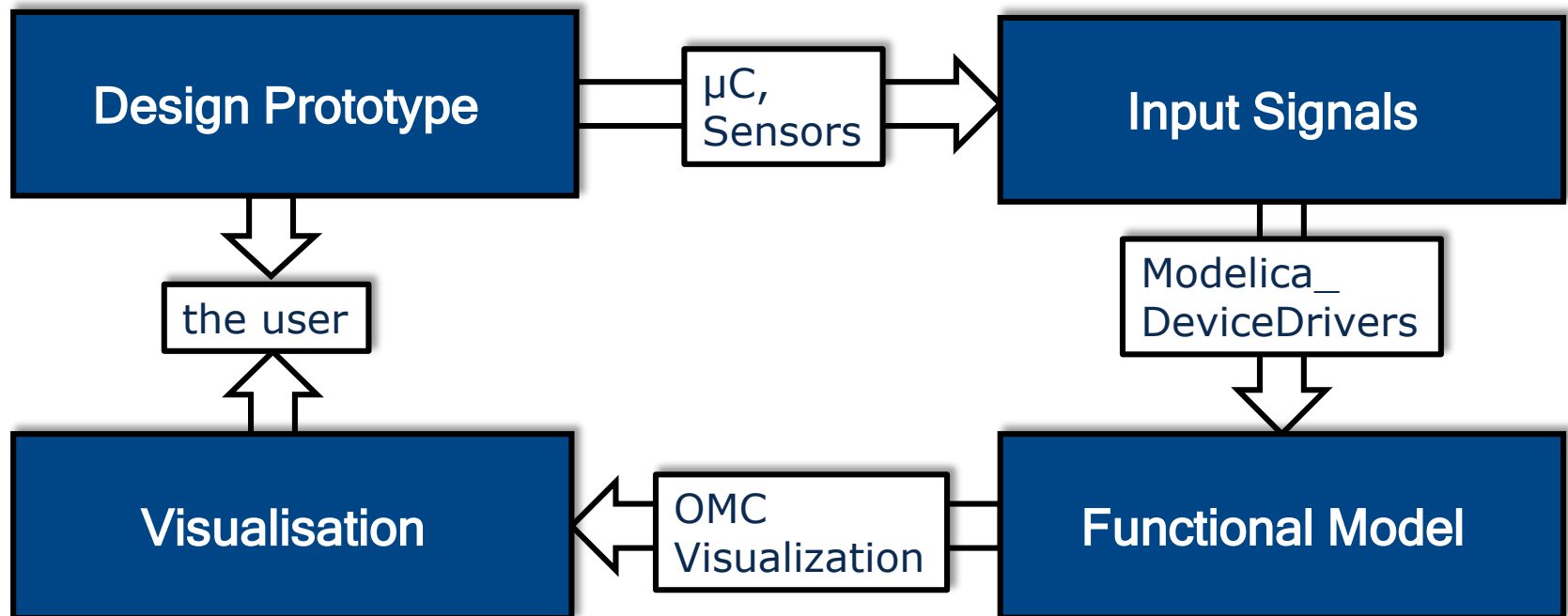
Design-Prototyping has to be **fast, easy, cheap** and **meaningful!**

... interactive simulators are complex, costly and extensive.

How can the development of interactive
(driving)-simulators for rapid prototyping be
accelerated,
cheapened,
and simplified?

ROAD MAP FOR FUNCTIONAL PROTOTYPING

Rapid Simulator Prototyping - Ingredients



Physical Device Prototyping

- Rapid Prototyping is cheap, fast and widely-used
 - 3d-printing, laser-cutting, CNC-milling
- Makerspaces offer public access to machinery
- Free CAD software
 - educational licenses at your institute
 - FreeCAD <http://www.freecadweb.org>
 - AUTODESK FUSION 360 <http://www.autodesk.de/products/fusion-360>

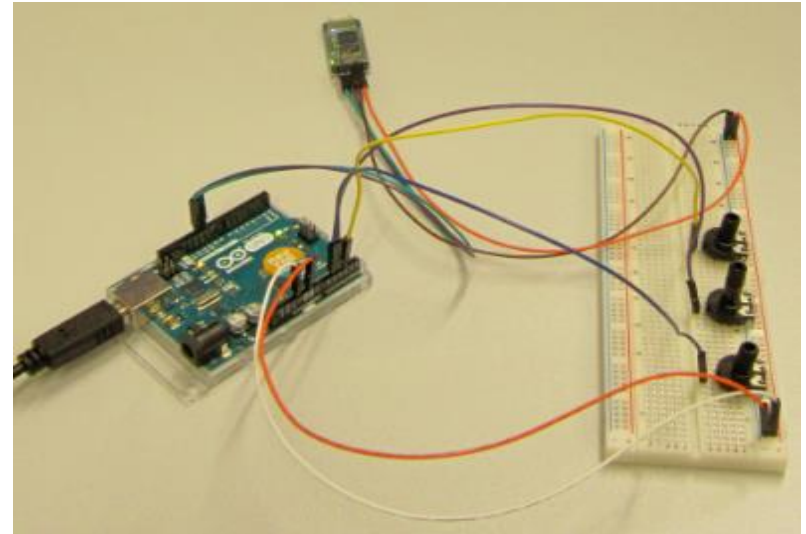


SLUB Dresden Makerspace

<http://www.slub-dresden.de/service/arbeitsplaetze-arbeitsraeume/makerspace/>

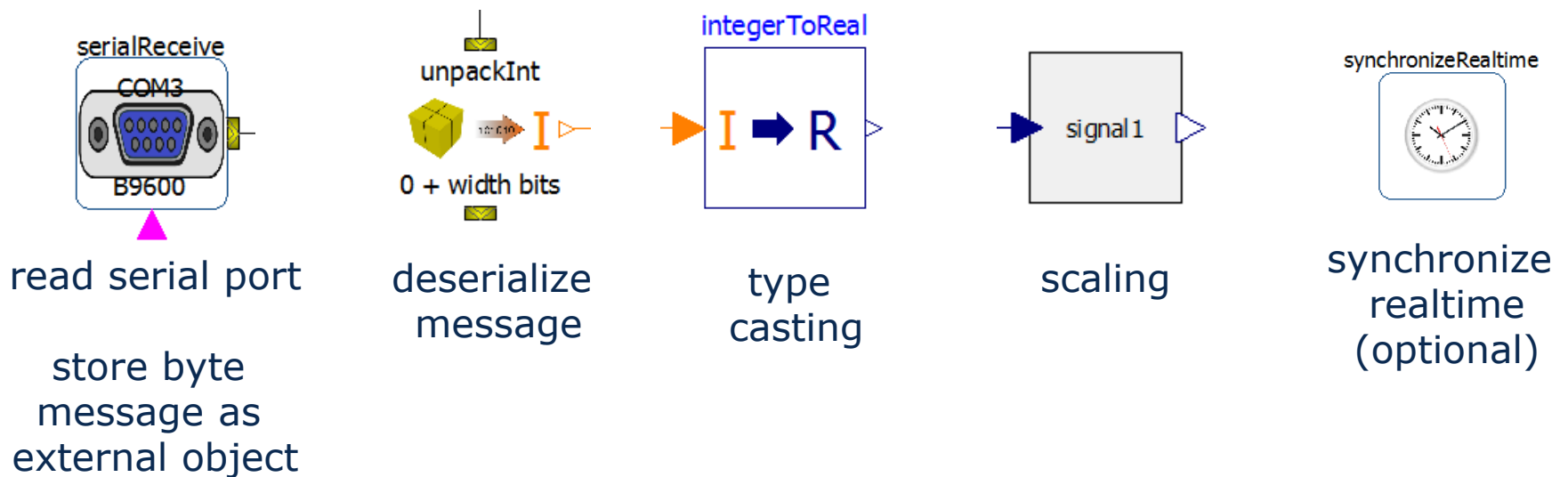
Sensor Concept

- electronics
 - basic sensors
 - control elements
- low-budget μ C-boards
 - Arduino, Raspberry Pi
- Communication
 - USB, Bluetooth



Sensor Signals as Model Inputs

https://github.com/modelica/Modelica_DeviceDrivers



Modelica_DeviceDrivers and OMC

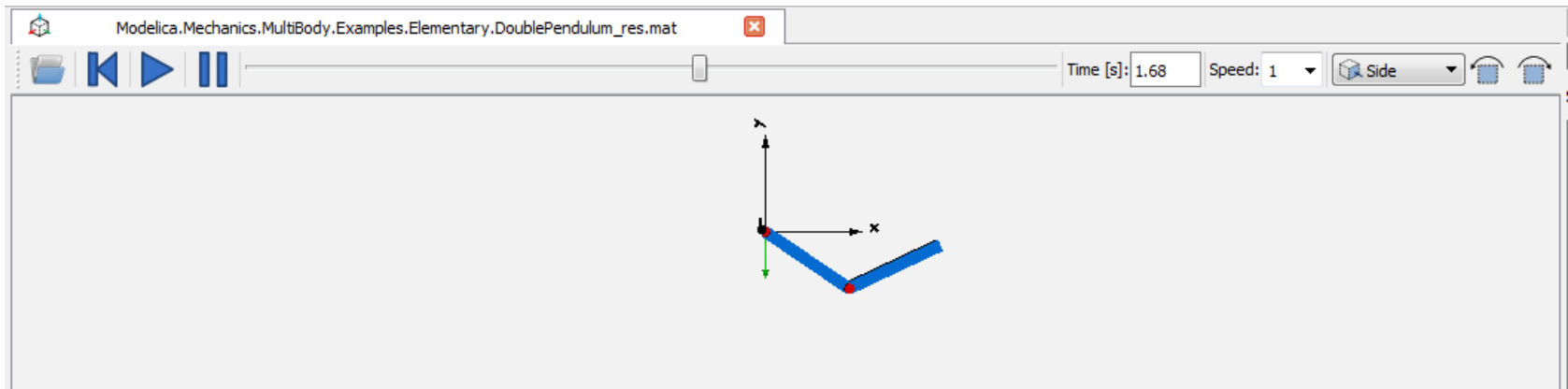
- Efforts to get serialPort and packager running:
 - ExternalObject alias-detection and substitution
 - Linking external libraries under windows
 - String parameters for external constructors for FMUs
 - Avoid multiple evaluation due to flattened equations
 - Fixes in M_DD

```
input ExtObj e1;  
output ExtObj e2;  
e1 = e2;
```

Visualisation

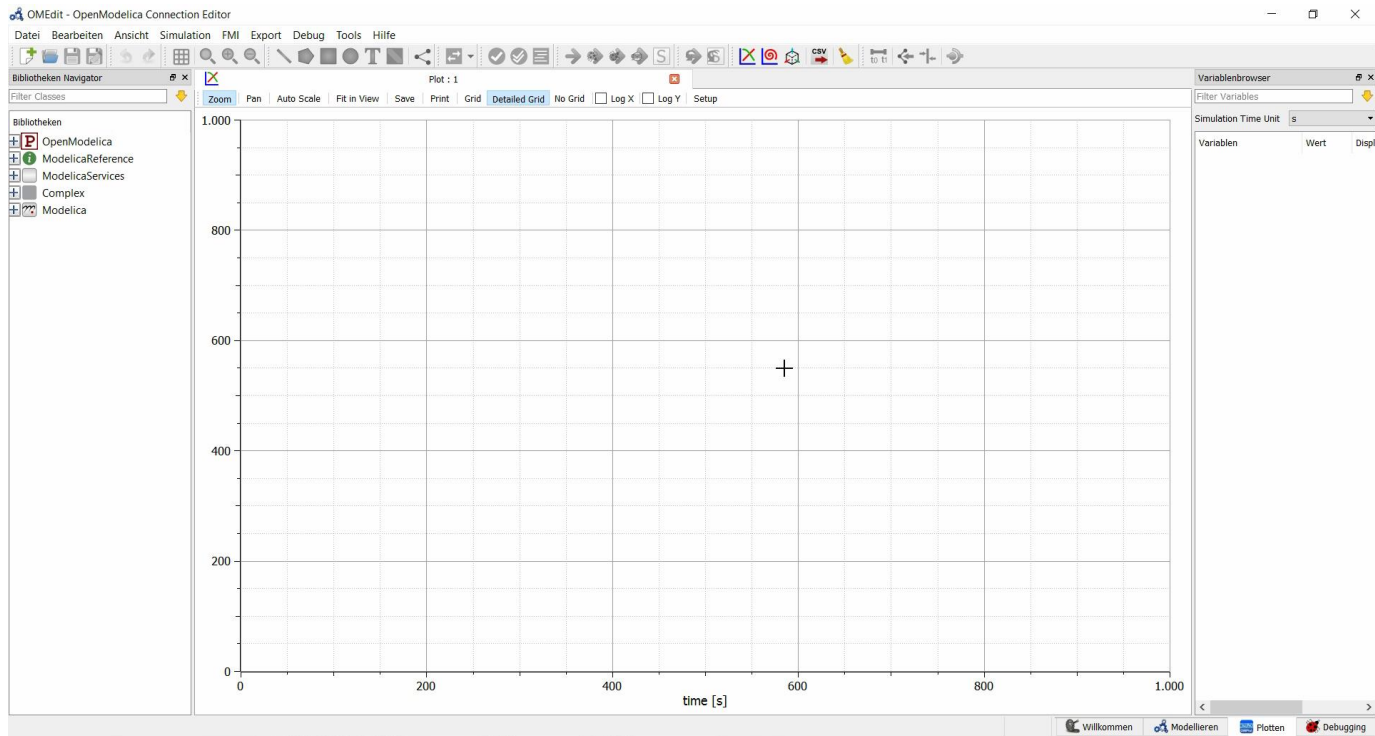
- OMEdit visualization feature based on scene description file *_visual.xml
- Visualization of MSL – multibody shapes (basic shapes, dxf, stl)

```
<visualization>
  <shape>
    <ident>world.x_label.cylinders[1]</ident>
    <type>cylinder</type>
    <r>
      <cref>world.x_label.r_abs[1]</cref>
      <cref>world.x_label.r_abs[2]</cref>
      <cref>world.x_label.r_abs[3]</cref>
      ...
    </r>
    <length>
      <exp>0.05303300858899107</exp>
    </length>
  </shape>
  ...
</visualization>
```



- Result Files (mat, csv) and realtime synchronized FMUs(me 1.0/2.0)

Visualisation



Proper Visualisation

... needs a tool that is designed for graphic application.



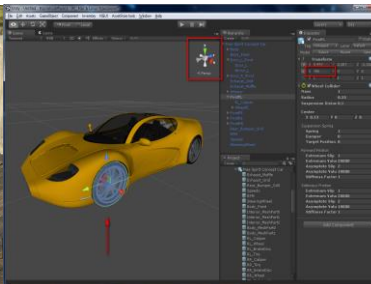
huge
asset store



nice
rendering



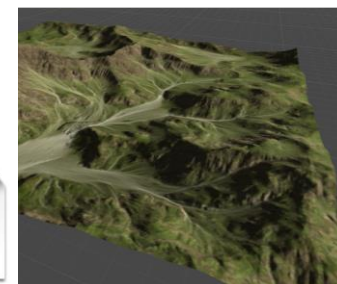
wysiwyg
editor



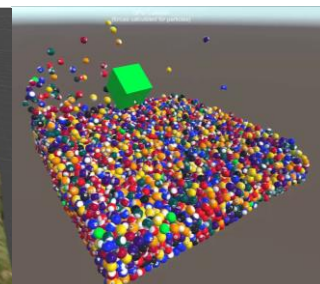
scripting



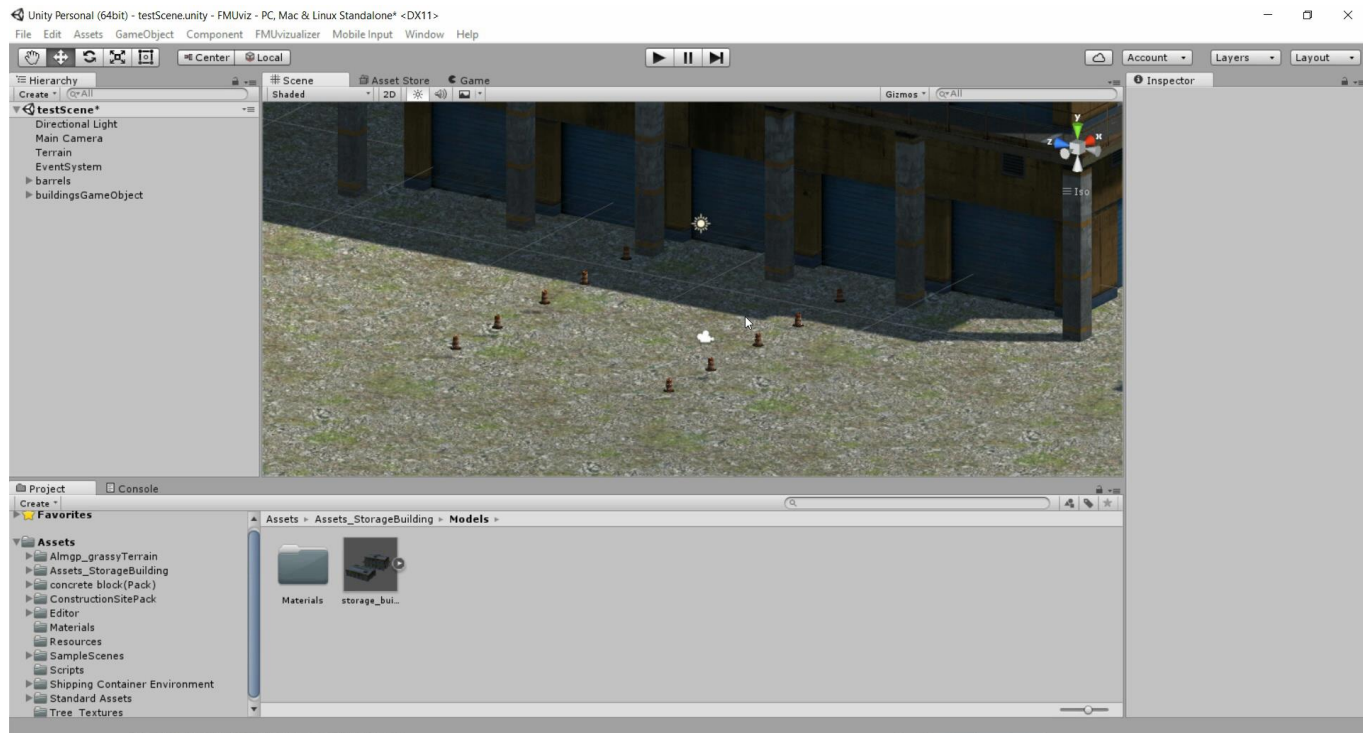
terrain
modeling



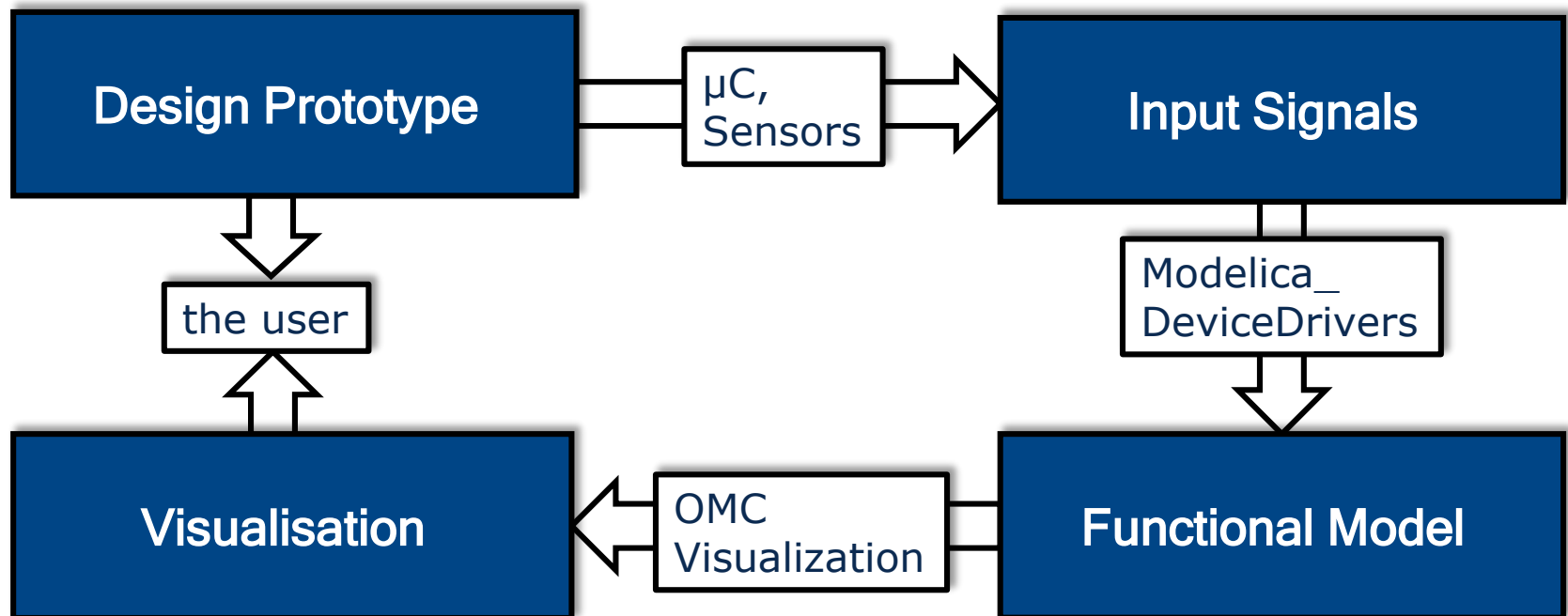
physics
engine



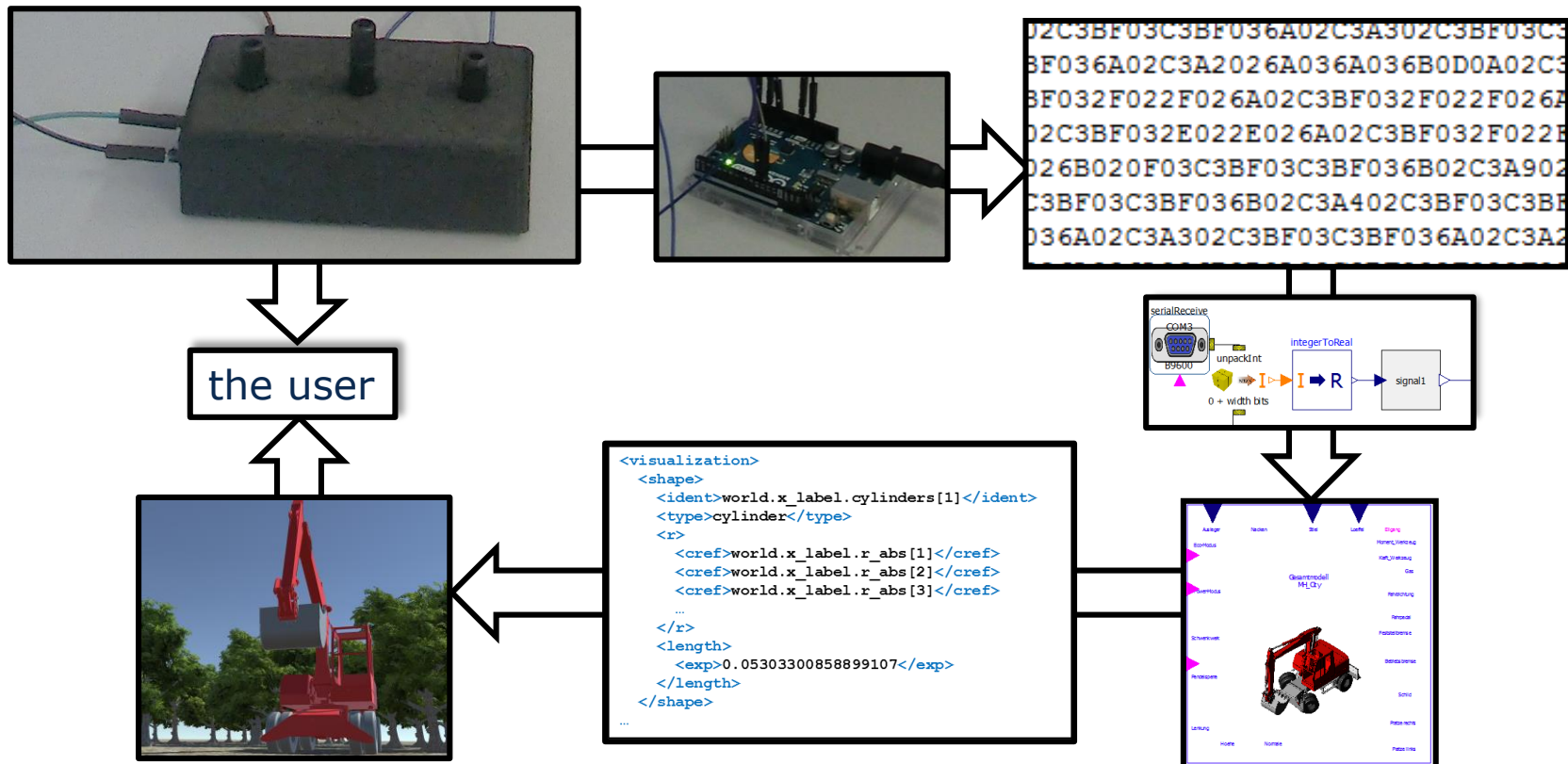
Proper Visualisation



Recap the Ingredients



Recap the Ingredients



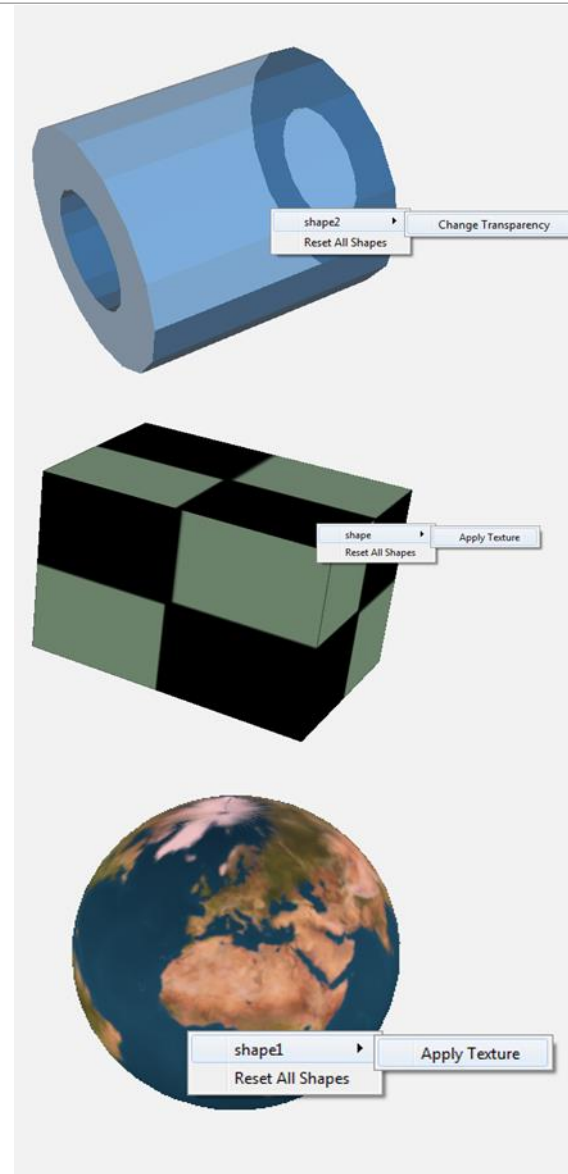
SUMMARY AND OUTLOOK

Summary

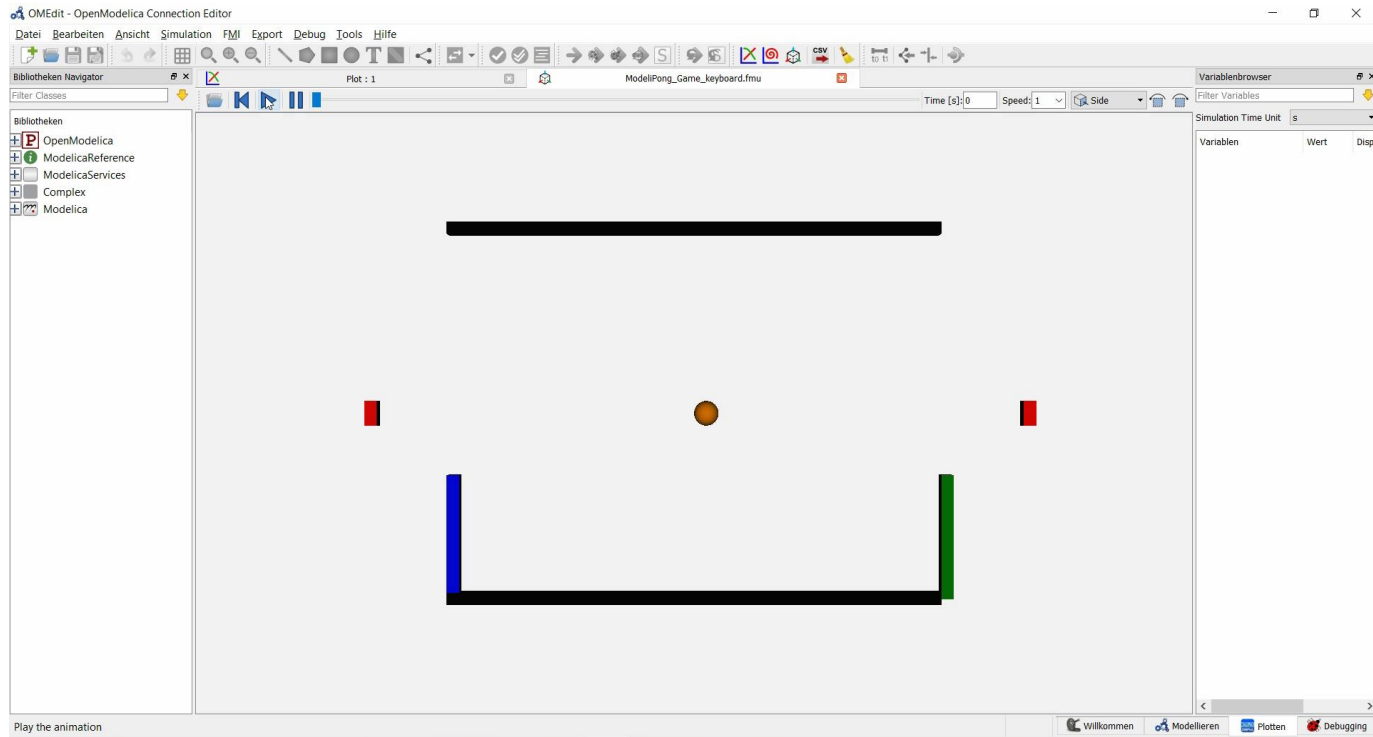
- successful, interdisciplinary student project at TU Dresden
- enhancements for visualization and partial M_DD support in OpenModelica
- FMU-based toolchain for rapid simulator setup

Outlook

- support M_DD in OMC
- work on realtime features
- enhance FMU-based visualization
- interactive simulations for teaching
- nice visualization



... or old-fashioned arcade games:



<https://github.com/vwaurich/ModeliPong>

Thank you for your attention.

Thank you OM-developers for your support.

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