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# **6th Annual OpenModelica Workshop**

## **Feb 3, 2014**

### **Workshop Opening**

### **OpenModelica – Status and Directions**

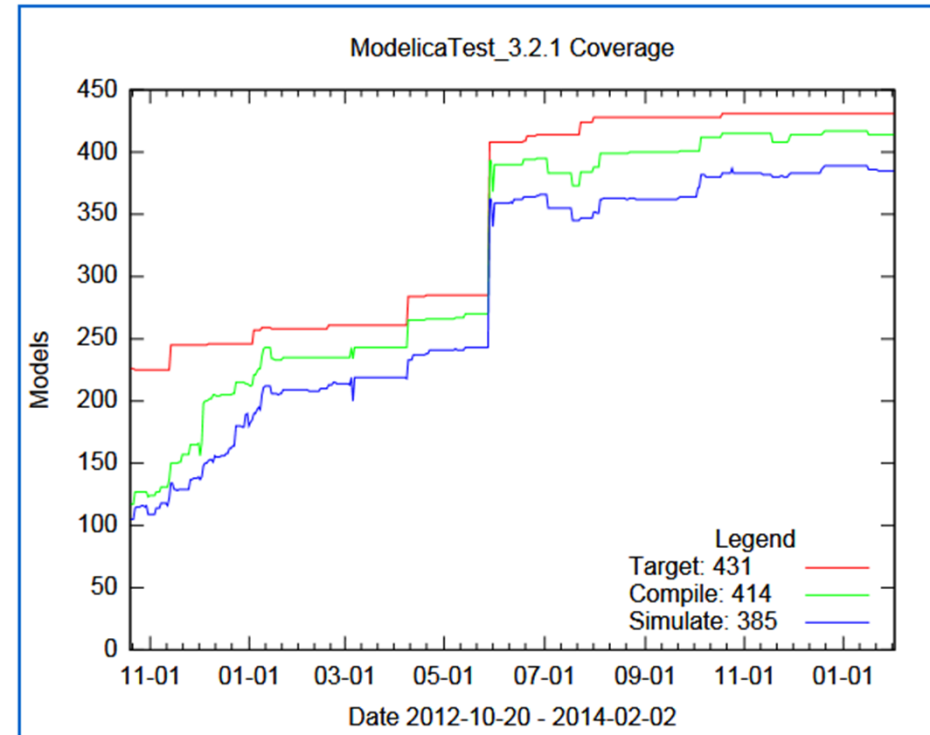
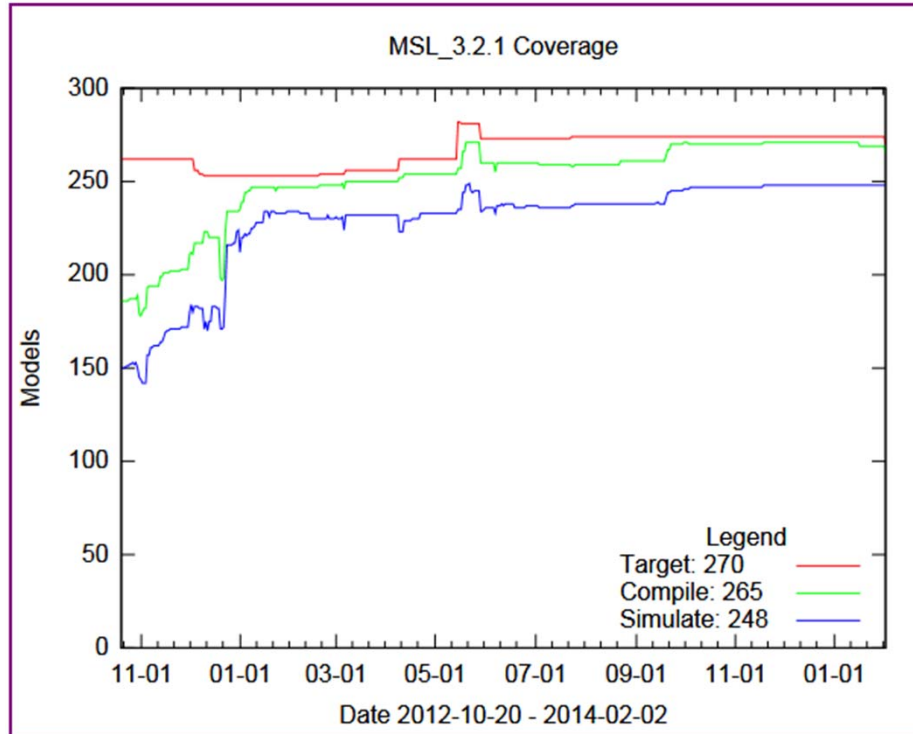
**Peter Fritzson**

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# To All Participants!

## Very Welcome to this Sixth Annual OpenModelica Workshop!

# During 2013: Both MSL 3.2.1 & ModelicaTest 3.2.1 Coverage 92.6% and 89.6%, including most of Fluid



**Another increase in coverage is expected within next 2 weeks when a bunch of new improvements are checked in.**

# Goals for the OpenModelica Effort

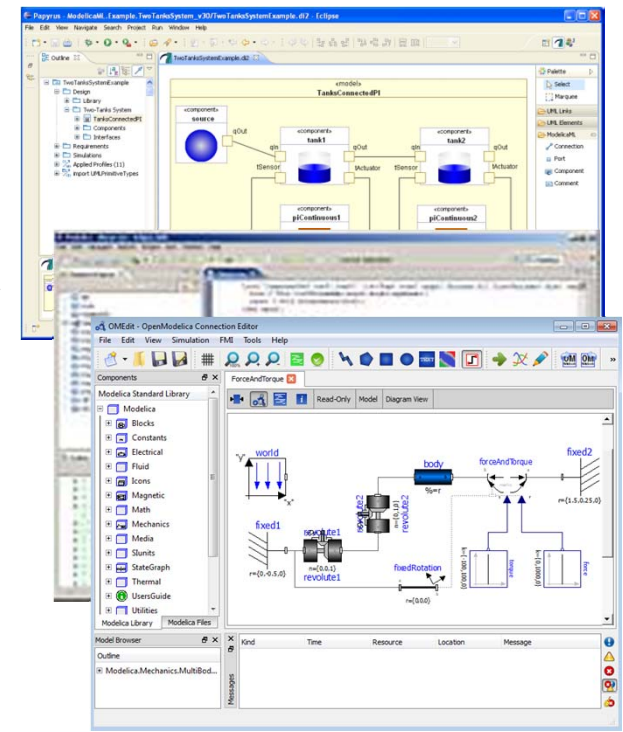
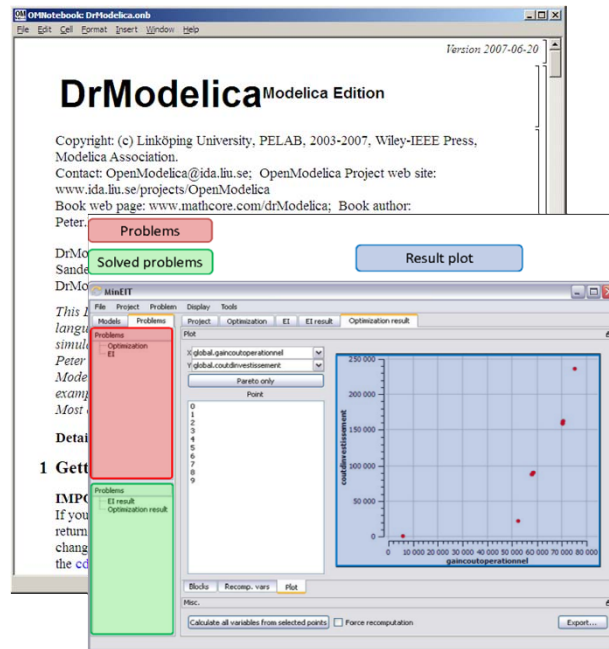
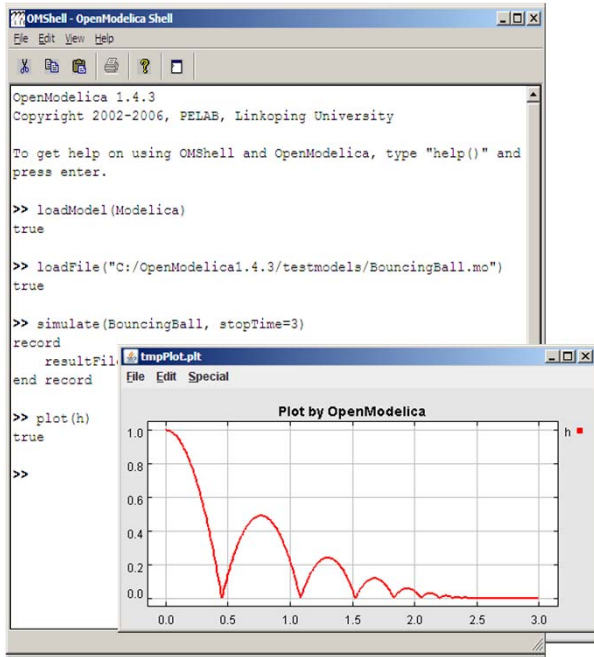
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- Comprehensive **modeling, simulation and systems engineering** environment for research, teaching, and industrial usage
- **Open-source** for both **industrial** and **academic** usage
- Invitation for **open-source cooperation** around OpenModelica, tools, and applications

# The OpenModelica Open Source Environment

[www.openmodelica.org](http://www.openmodelica.org)

- **Advanced Interactive Modelica compiler (OMC)**
  - Supports most of the Modelica Language
  - Modelica and Python **scripting**
- **Basic environment for creating models**
  - **OMShell** – an interactive command handler
  - **OMNotebook** – a literate programming notebook
  - **MDT** – an advanced textual environment in Eclipse
- **OMEdit** graphic Editor
- **OMOptim** optimization tool
- **ModelicaML** UML Profile
- **MetaModelica** extension
- **ParModelica** extension



# Main Events 2013 and January 2014

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- Modelica **Compliance Test Suite** delivered to Modelica Association, more than 1000 test cases (Sept 2013)
  - Large number of incompatibilities detected and can now be tested
  - Very important for tool and library compliance in Modelica community
  - Contributed to making the MSL 3.2.1 release more Modelica compliant
- OpenModelica **1.9.0 release** (October 2013)
  - OpenModelica compiler support for most of the Fluid library; thermo-fluid applications.
  - Good support for the **significantly updated Modelica Standard Library (MSL) 3.2.1**.
  - Much better support for the Modelica Test library
  - Significantly enhanced graphical user interface in OMEdit.
- OpenModelica **1.9.1 beta1 release** (January 31, 2014)
  - Further improved support for a number of libraries including MSL 3.2.1, ModelicaTest 3.2.1, PetriNet, Buildings, PowerSystems, OpenHydraulics, ThermoPower, and ThermoSysPro.
  - **Breakthrough:** The first run-time Modelica debugger for equation-based models
  - Further enhanced compiler front-end scalability, speed and memory, will be part of 1.9.1 final release.
  - Better coverage of Modelica libraries using Fluid and Media, will be part of 1.9.1 final release

# OpenModelica – Outlook for 2014

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- Whole 2014. Continued high priority on better coverage for Modelica libraries including MSL 3.2.1, ModelicaTest 3.2.1, PetriNet, Buildings, PowerSystems, OpenHydraulics, ThermoPower, ThermoSysPro, etc.
- Whole 2014. Development of more Industrial Use Cases
- February 2014. OpenModelica 1.9.1 final release; better perf. & coverage
- March 2014. Switching to Bootstrapped compiler including the Debugger within the OMEdit GUI. Better performance & coverage
- Spring 2014. GUI support for replaceable in libraries
- Spring 2014. All of Fluid library simulating
- Spring 2014. Improved FMI 2.0 support
- Fall 2014. Partial support for Modelica 3.3 clock-based synchronous and state machine features
- Whole 2014. Further improved simulation performance and coverage

# During 2013 Improved Testing and Nightly Builds for increased quality

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- OSMC bought two new powerful test and build multi-core servers during 2013
- Performs builds for three platforms (Windows, Linux, Mac) every night
- Significantly increased test suite size for better coverage
- Run a test suite after each check-in, using parallel builds, for quick feedback to developers to remove introduced errors



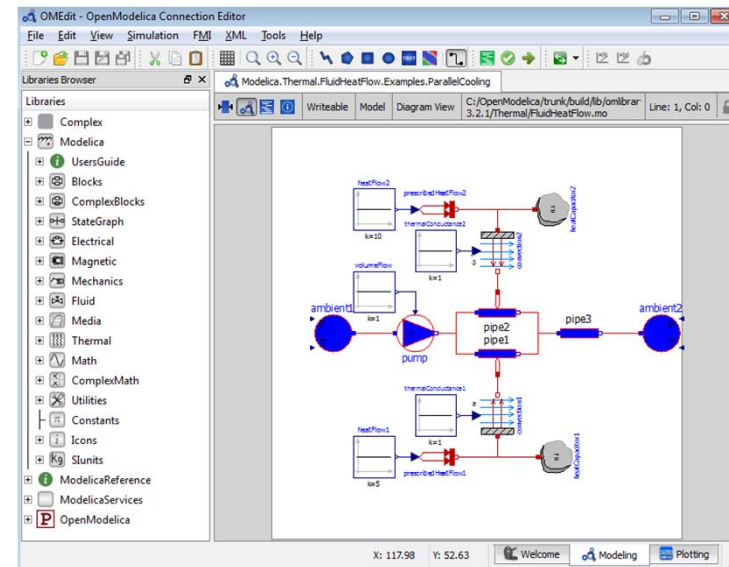
# Current Main Industrial OpenModelica Usage (not including research)

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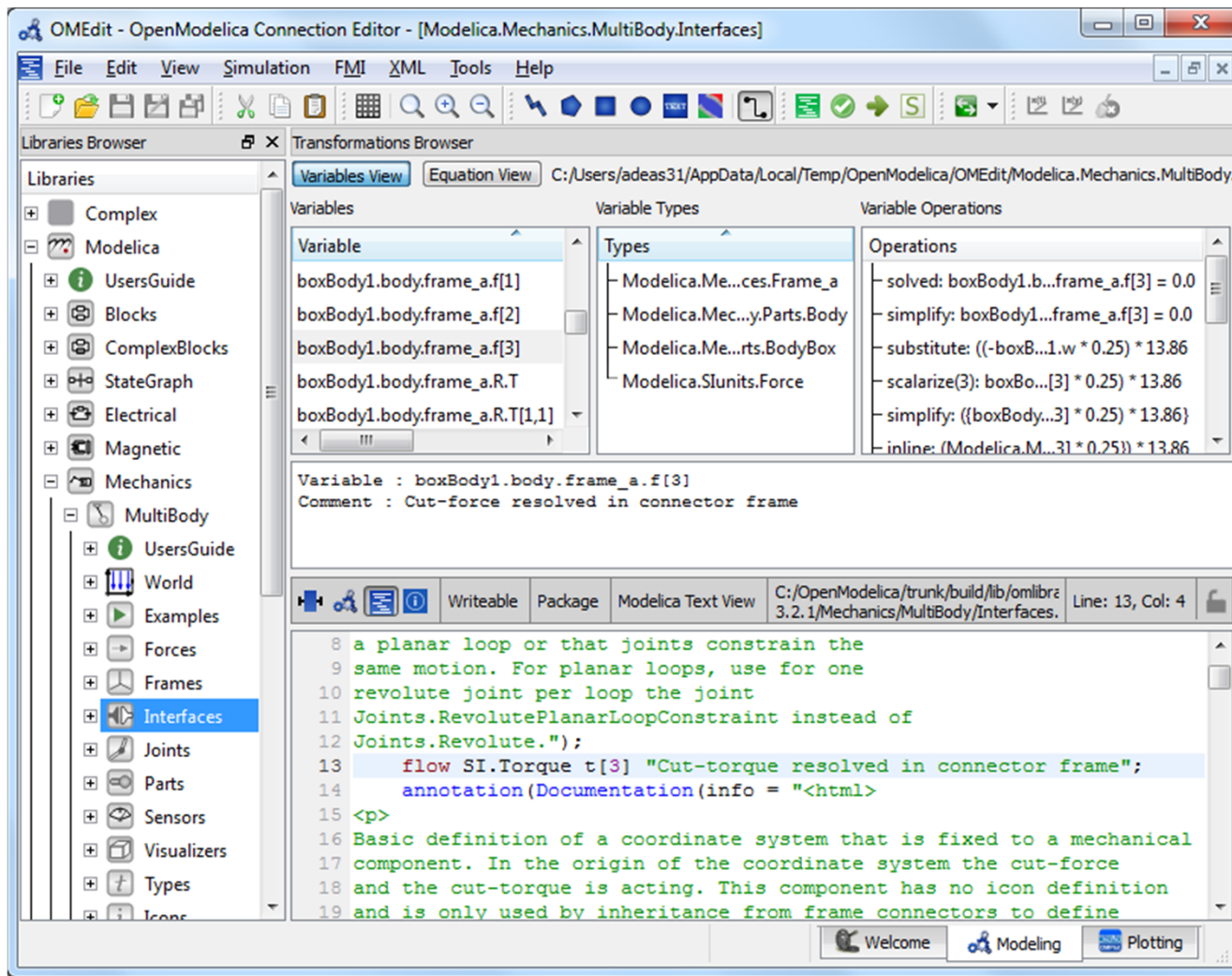
- Wolfram-MathCore, OEM usage of OM compiler frontend in Wolfram SystemModeler product
- DHI, OEM usage of OM compiler frontend in DHI product
- Bosch-Rexroth, inhouse product usage for Modelica model import and simulation
- STEAG, usage in power plant applications

# During 2013 – Significantly Improved OpenModelica Connection Editor OMEdit

- Supports final MSL 3.2.1
- Implemented in C++ Qt library
- Autosave and recovery features
- Improved libraries browser
- Variables browser search
- Preserving user customizations
- Convenient parameter editing in variables browser
- Fast re-simulation without re-compilation after parameter change



# Run-Time Debugger for Equation-Based Models Integrated with OMEdit – first in a Modelica tool



Mapping error  
Positions back  
to source model

Tracing symbolic  
transformations

Talk this afternoon

Hands-on tutorial  
tomorrow

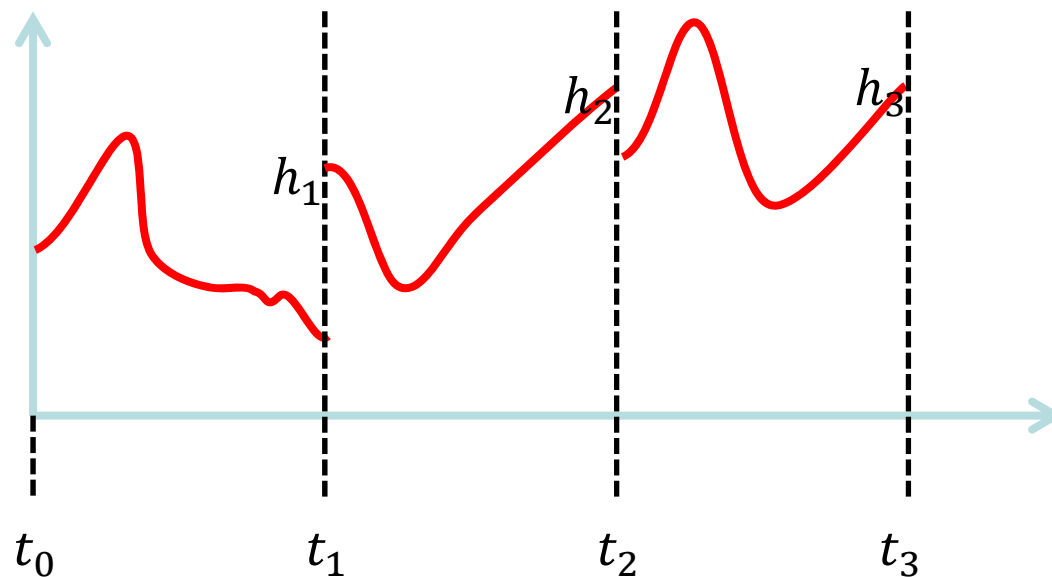
# Multiple-Shooting and Collocation Dynamic Trajectory Optimization in OpenModelica

- Minimize a goal function subject to model equation constraints, useful e.g. for NMPC
- Multiple Shooting/Collocation
  - Solve sub-problem in each sub-interval

In OpenModelica  
1.9.1 release

Talk later today.  
Hands-on tutorial tomorrow

$$x_i(t_{i+1}) = h_i + \int_{t_i}^{t_{i+1}} f(x_i(t), u(t), t) dt \approx F(t_i, t_{i+1}, h_i, u_i), \quad x_i(t_i) = h_i$$



# Prototypes of Parallel Execution with OpenModelica

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- ParModelica – Parallel Algorithmic Modelica Code Execution on GPU
  - Speedup factor 300 of matrix multiplication on NVIDIA Fermi GPU
- Parallelization of partitioned models
  - Speedup factor 4 of small model on 4-core machine
- Finegrained parallelization of equation models
  - Talk later today

# OpenModelica Compiler Bootstrapping

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- Bootstrapping = OMC Compiler Compiles itself
- Advantages
  - **Faster** compilation for the developers
  - Complete Modelica language for **easier programming**
  - Better error messages and maintainability
  - Makes a faster Modelica **debugger** possible
  - Makes **performance** analysis possible
  - some **Modelica 4** like features
- Status
  - Dec 2010, OMC first compiled itself
  - During 2011-now, used for development with the new debugger
  - Dec 2012. Automatic memory reclamation operational
  - **Jan 2014. Tuned. 4 months hard testing. Ready for deployment**

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# The Open Source Modelica Consortium

## Purpose of the Consortium

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- The Open Source Modelica Consortium, created the 4th of December 2007 in Linköping, Sweden, in the following called OSMC, is a non-profit, non-governmental organization with the aim of developing and promoting the development and usage of the **OpenModelica open source implementation of the Modelica computer language** (also named Modelica modeling language) and **OpenModelica associated open-source tools and libraries**, collectively named the OpenModelica Environment, in the following referred to as OpenModelica.
- OpenModelica is **available for commercial and non-commercial usage under the conditions of the OSMC Public License**. It is the aim of OSMC, within the limitations of its available resources, to provide **support and maintenance of OpenModelica**, to support its publication on the web, and to **coordinate** contributions to OpenModelica.

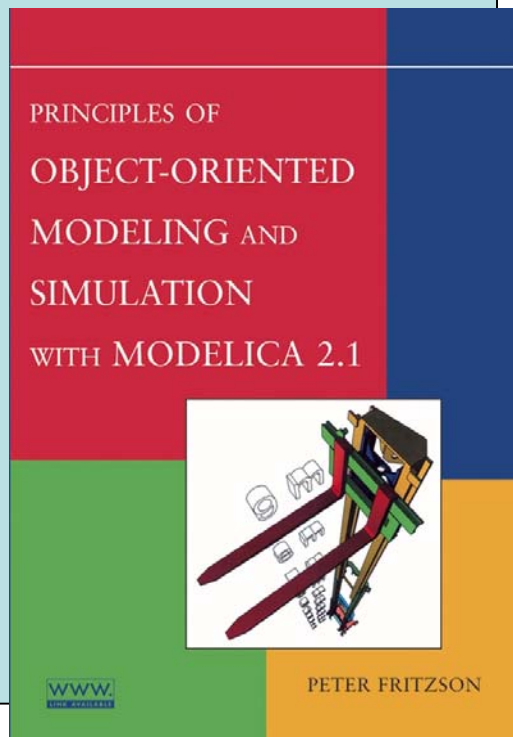


# Peter Fritzon's Personal Release, Nov 26, 2013

## New Big Modelica Book, in Print probably May 2014

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Principles of Object Oriented  
Modeling and Simulation  
with Modelica 3.3



## Peter Fritzon

### Principles of Object Oriented Modeling and Simulation with Modelica 3.3

**Wiley-IEEE Press, 2014, 1240 pages**



# Open Source Modelica Consortium

## Originally Created Dec 4, 2007

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### 7 Founding Organizational Members

- Bosch-Rexroth AG, Germany
- Equa Simulation AB, Sweden
- TLK Thermo, Germany
- VTT, Finland
- Linköping University, Sweden
- Hamburg University of Technology/TuTech, Institute of Thermo-Fluid Dynamics, Germany
- Technical University of Braunschweig, the Institut of Thermodynamik, Germany

# OSMC – Open Source Modelica Consortium

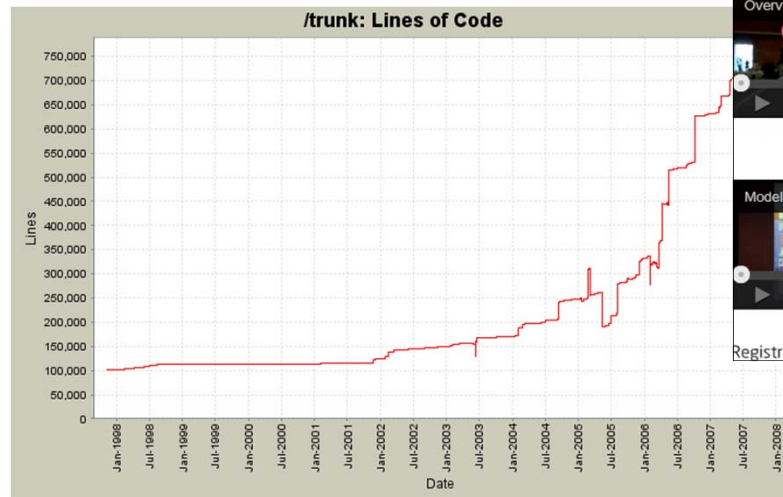
## 45 organizational members December 2013

Founded Dec 4, 2007

### Open-source community services

- **Website and Support Forum**
- **Version-controlled source base**
- **Bug database**
- **Development courses**
- **www.openmodelica.org**

### Code Statistics



**OpenModelica** Login Create an account

HOME DOWNLOAD TOOLS & APPS USERS DEVELOPERS FORUM EVENTS RESEARCH search...

**Top information**

**OMEdit**  
Enhanced OpenModelica Connection Editor.

**OMPYthon**  
The new OpenModelica Python Interface.

**Modelica/OpenModelica Videos**

Overview of Modelica, an...  
Modelica Cyber Physical M...

**Registration**

**Introduction**

OPENMODELICA is an open-source Modelica-based modeling and simulation environment intended for industrial and academic usage. Its long-term development is supported by a non-profit organization – the Open Source Modelica Consortium (OSMC).

The goal with the OpenModelica effort is to create a comprehensive Open Source Modelica modeling, compilation and simulation environment based on free software distributed in binary and source code form for research, teaching, and industrial usage. We invite researchers and students, or any interested developer to participate in the project and cooperate around OpenModelica, tools, and applications.

**Donate**

Please consider supporting our efforts.

Amount:  SEK

**Donate**

**Latest news**

February 2: OpenModelica 1.9.1 Beta1 released

CFP OpenModelica Workshop February 2014

October 09: OpenModelica 1.9.0 released

September 27: OpenModelica 1.9.0 RC1 released

February 1: OpenModelica 1.9.0 Beta4 released

October 19: OpenModelica 1.9.0 Beta2 released

Oct 16 : CFP OpenModelica/MODPROD Workshops February 2013

August 31: OpenModelica 1.9.0 Beta released

# OSMC 45 Organizational Members, Dec 2013

(initially 7 members, 2007)

## Companies and Institutes (22 members)

- Bosch Rexroth AG, Germany
- Siemens PLM, California, USA
- Siemens Turbo Machinery AB, Sweden
- CDAC Centre for Advanced Compu, Kerala, India
- Creative Connections, Prague, Czech Republic
- DHI, Aarhus, Denmark
- EDF, Paris, France
- Equa Simulation AB, Sweden
- Fraunhofer FIRST, Berlin, Germany
- Fraunhofer IWES, Bremerhaven, Germany
- Frontway AB, Sweden
- Gamma Technology Inc, USA
- IFP, Paris, France
- ISID Dentsu, Tokyo, Japan
- ITI, Dresden, Germany
- Maplesoft, Canada
- TLK Thermo, Germany
- Sozhou Tongyuan Software and Control, China
- STEAG, Dehli, India
- VTI, Linköping, Sweden
- VTT, Finland
- Wolfram MathCore, Sweden

## Universities (23 members)

- TU Berlin, Inst. UEBB, Germany
- FH Bielefeld, Bielefeld, Germany
- TU Braunschweig, Germany
- University of Calabria, Italy
- Danish Technical Univ, Denmark
- TU Dortmund, Germany
- TU Dresden, Germany
- Georgia Institute of Technology, USA
- Ghent University, Belgium
- Halmstad University, Sweden
- Heidelberg University, Germany
- TU Hamburg/Harburg Germany
- KTH, Stockholm, Sweden
- Université Laval, Canada
- Linköping University, Sweden
- Univ of Maryland, Syst Eng USA
- Univ of Maryland, CEEE, USA
- Politecnico di Milano, Italy
- Ecoles des Mines, CEP, France
- Mälardalen University, Sweden
- Univ Pisa, Italy
- Telemark Univ College, Norway
- University of Ålesund, Norway

# Open Source Modelica Consortium

## Individual Members

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### (64 individual members, 3 February 2014)

- Peter Fritzson, Adrian Pop, Martin Sjölund, Per Östlund, Peter Aronsson, Adeel Asghar, Mikael Axin, Bernhard Bachmann, Vasile Baluta, Adam Bergmark, Robert Braun, Willi Braun, David Broman, Stefan Brus, Francesco Casella, Filippo Donida, Jens Frenkel, Mahder Gebremedhin, Pavel Grozman, Daniel Hedberg, Michael Hanke, Zoheb Hossain, Alf Isaksson, Kim Jansson, Daniel Kanth, Tommi Karhela, Juha Kortelainen, Abhin Kothari, Petter Krus, Alexey Lebedev, Oliver Lenord, Ariel Liebman, Rickard Lindberg, Håkan Lundvall, Abhi Raj Metkar, Eric Meyers, Tuomas Miettinen, Afshin Moghadam, Maroun Nemer, Hannu Niemistö, Peter Nordin, Kristoffer Norling, Lennart Ochel, Arunkumar Palanisamy, Karl Pettersson, Pavol Privitzer, Reino Ruusu, Per Sahlin, Wladimir Schamai, Gerhard Schmitz, Alachew Shitahun, Magnus Sjöstrand, Anton Sodja, Ingo Staack, Kristian Stavåker, Sonia Tariq, Mohsen Torabzadeh-Tari, Parham Vasaiely, Niklas Worschech, Robert Wotzlaw, Björn Zackrisson, Azam Zia

# Open Source Modelica Consortium – OSMC

## Board of Directors 2013

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- **Oliver Lenord**, OSMC Chairman; Manager, Siemens PLM, USA
- **Per Sahlin**, OSMC Vice Chairman; CEO, Equa Simulation AB
- **Peter Fritzson**, OSMC Director; Prof, Linköping Univ, Sweden
- **Juha Kortelainen**, Manager, VTT, Finland
- **Gerhard Schmitz**, Prof, Univ. Hamburg, Germany
- **Francesco Casella**, Prof, Politecnico di Milano, Italy
- **Jan Brugård**, CEO, Wolfram MathCore AB, Sweden
- **Kilian Link**, Manager, Siemens, Germany (and Sweden)
- **Lars Mikelsons**, Manager, Bosch-Rexroth, Germany.
- **Daniel Bouskela**, Manager, EDF, France
- **Bernhard Bachmann**, Prof, FH Bielefeld, Germany

# OSMC Board – 6 Meetings Jan 1 2013 – Dec 31 2013

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## Meeting dates

- 130110
- 130514
- 130619
- 131002
- 131105
- 131217

## Board Work

- Planning and prioritizing the OSMC work
- Admitting new members
- Planning the workshop
- Budget
- etc.

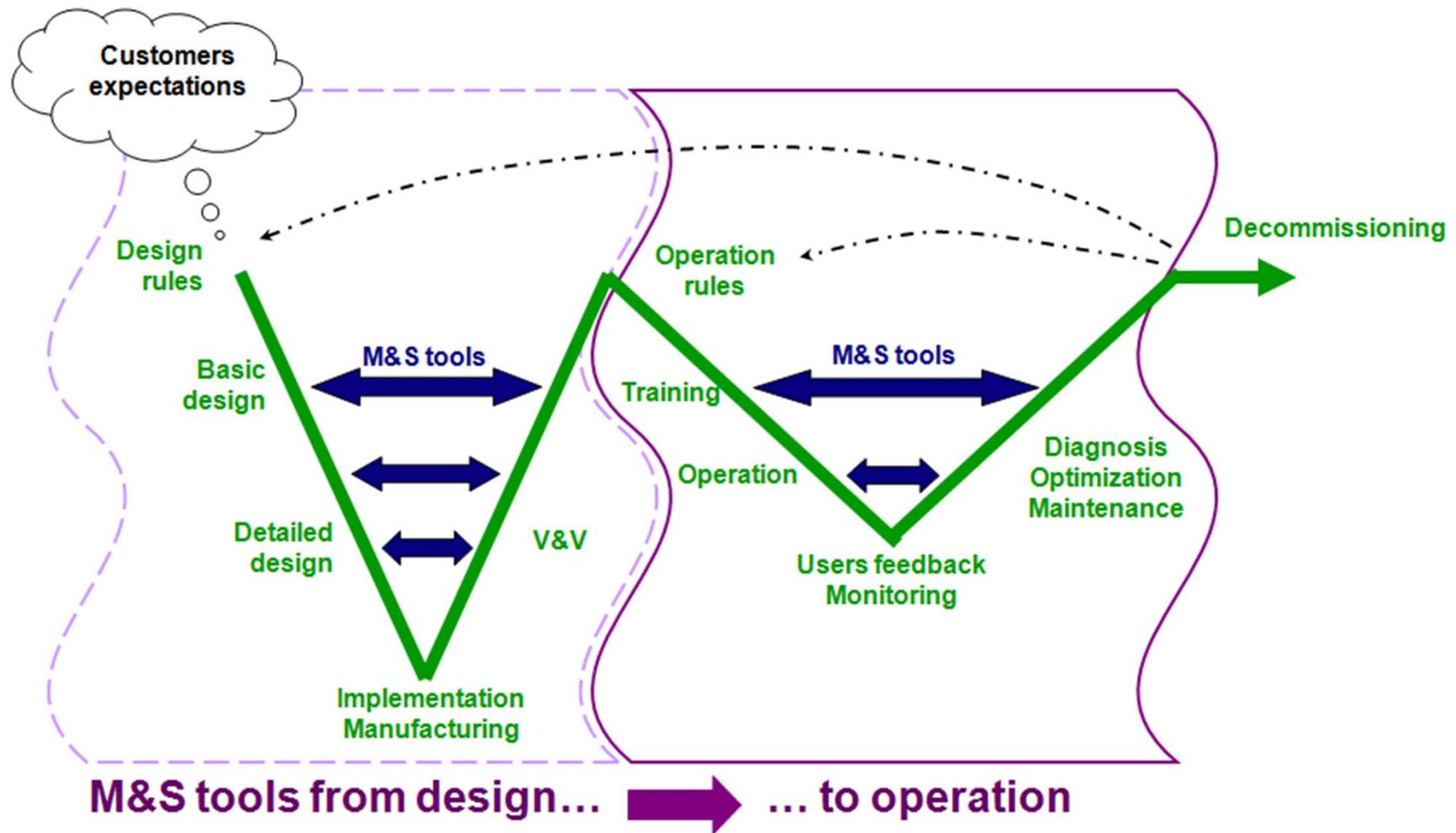


# Some Supporting Research Projects

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- ITEA2 MODRIO Project
- SKF- SICS East extension to MODRIO project for TLM co-simulation and Windpower application
- Simovate, national Swedish project
- STREAM, national Swedish project
- EU project PyModSimA – collaboration with DLR
- AVM project, collaboration with Vanderbilt, Xerox Parc

# MODRIO-Model Driven Physical Systems Operation



# Special Thanks

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- The developers who worked very hard during 2013. Adrian Pop, Martin Sjölund, Per Östlund, Adeel Asghar, Willi Braun, Lennart Ochel, Vitalij Ruge, Mahder Gebremedhin, Jens Frenkel, Modelers Francesco Casella, Bruno Scaglioni, and several other people.
- The 45 OpenModelica consortium organizational members for support including Bosch-Rexroth, Wolfram-MathCore, Siemens Turbo Machinery, Siemens PLM, EDF, etc...
- Master students and PhD students who made important contributions.

# Conclusions and Summary 2013/Jan 2014

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- January 2013. Breakthrough - simulating more than half of Fluid Library Models
- Sept 1, 2013. Compliance Test Suite to support Modelica Language compliance for MSL and between tools
- October 2013. OpenModelica 1.9.0 final release with improved library support and enhanced GUI (OMEdit)
- January 2014. Breakthrough – Run-time debugger for equation-based models; OM 1.9.1 Beta1 release
- 2014. Good prospects for the future – towards a standard high quality compliant open source Modelica implementation in Modelica, increased tool support for integrated systems engineering.

**Questions?**

**[www.openmodelica.org](http://www.openmodelica.org)**