MSDL

Modelling, Simulation and Design Lab

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McGill

School of Computer Science

OO Design; Modelling and Simulation; Modelling and Simulation Based Design

Learning all the time ...

- **Theoretical Physics (Ghent, Belgium)**
  quantum field theory (models of models, unify)

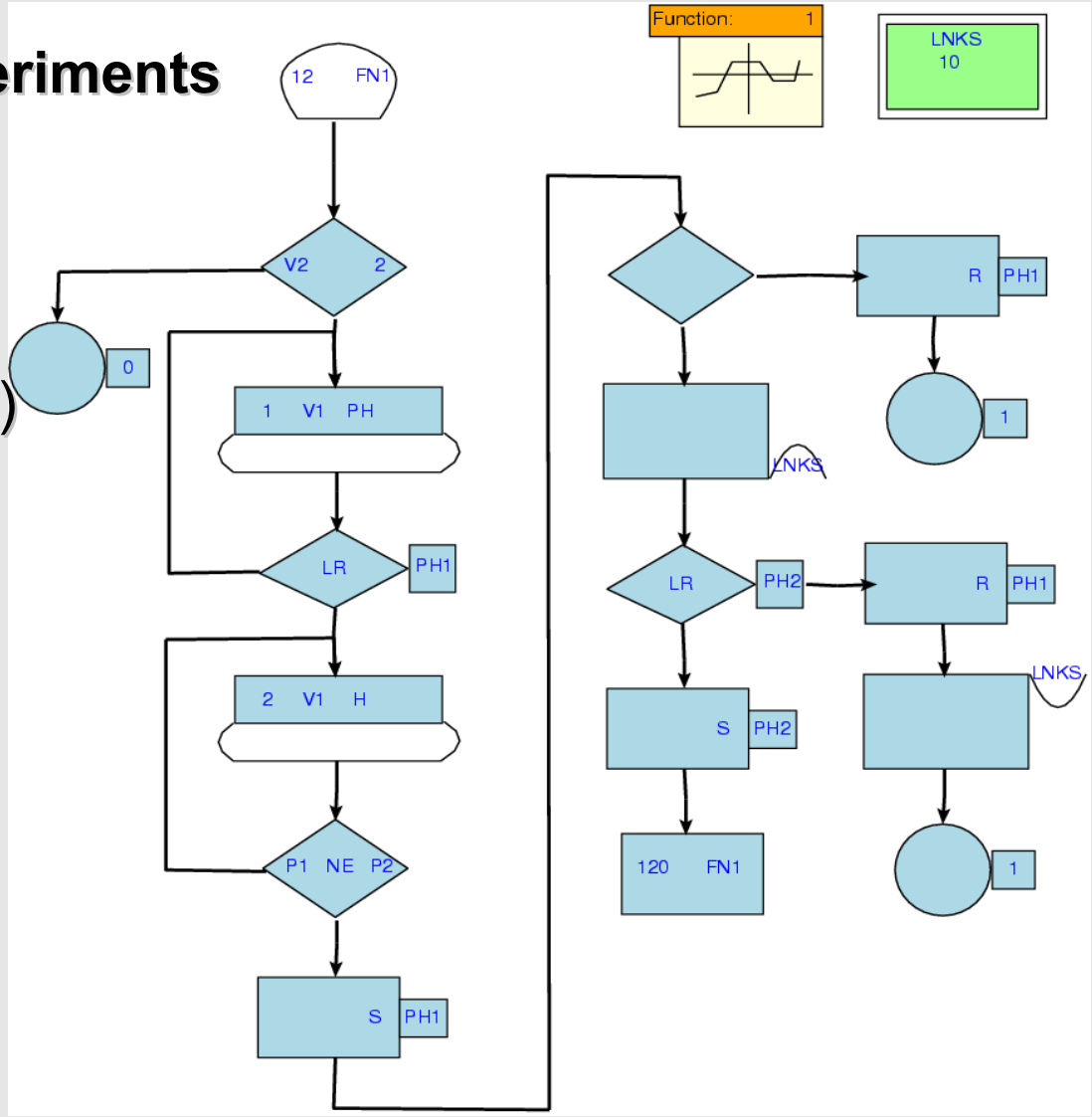
- **Pedagogy (Ghent, Belgium)**

- **Computer Science (Ghent, Belgium)**
  compilers (prolog interpreter)
  visiting Laurie Hendren
  at McGill (optimizing compilers – gcc 1.37)

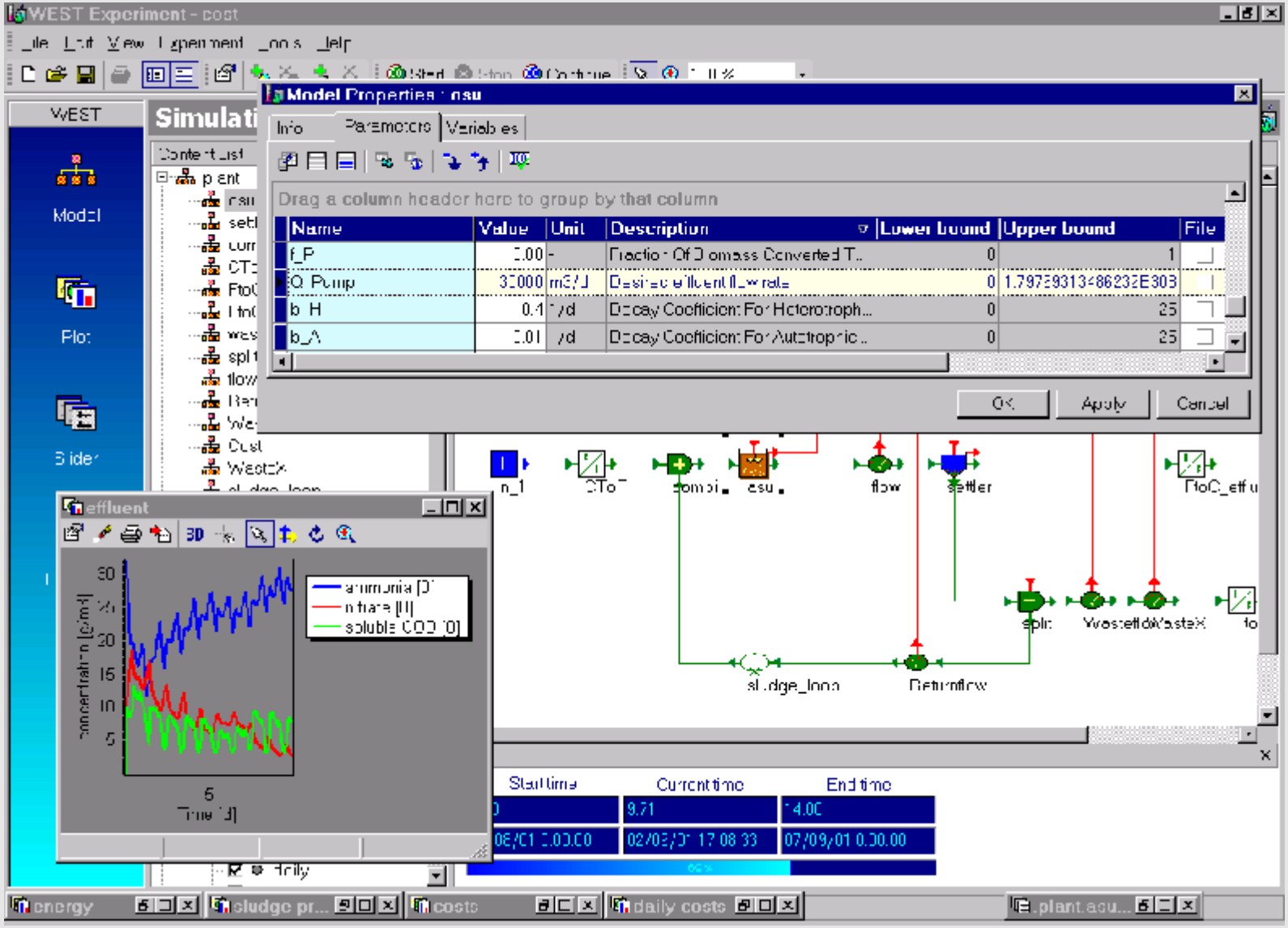
- **Doctor of Science (Ghent, Belgium)**
  math-CS-biology-chemistry-physics
  multi-formalism modelling, FTG, ...

Designing Modelling Languages/Simulators

- **CSSL simulators**
- **Real-time simulators, fixed point code**
  (AD10, ADI RTS)
- **Distributed simulators and experiments**
  (Time Warp)
- **Discrete-event simulators**
  DEVS
  Hierarchical GPSS
- **MSL-USER** (non-causal modelling)



Building WWTP DSM&E environment the hard way



DSM, model transformation, experiment management, optimization, model storage, distributed simulation&experimentation, ...

Simulation in Europe

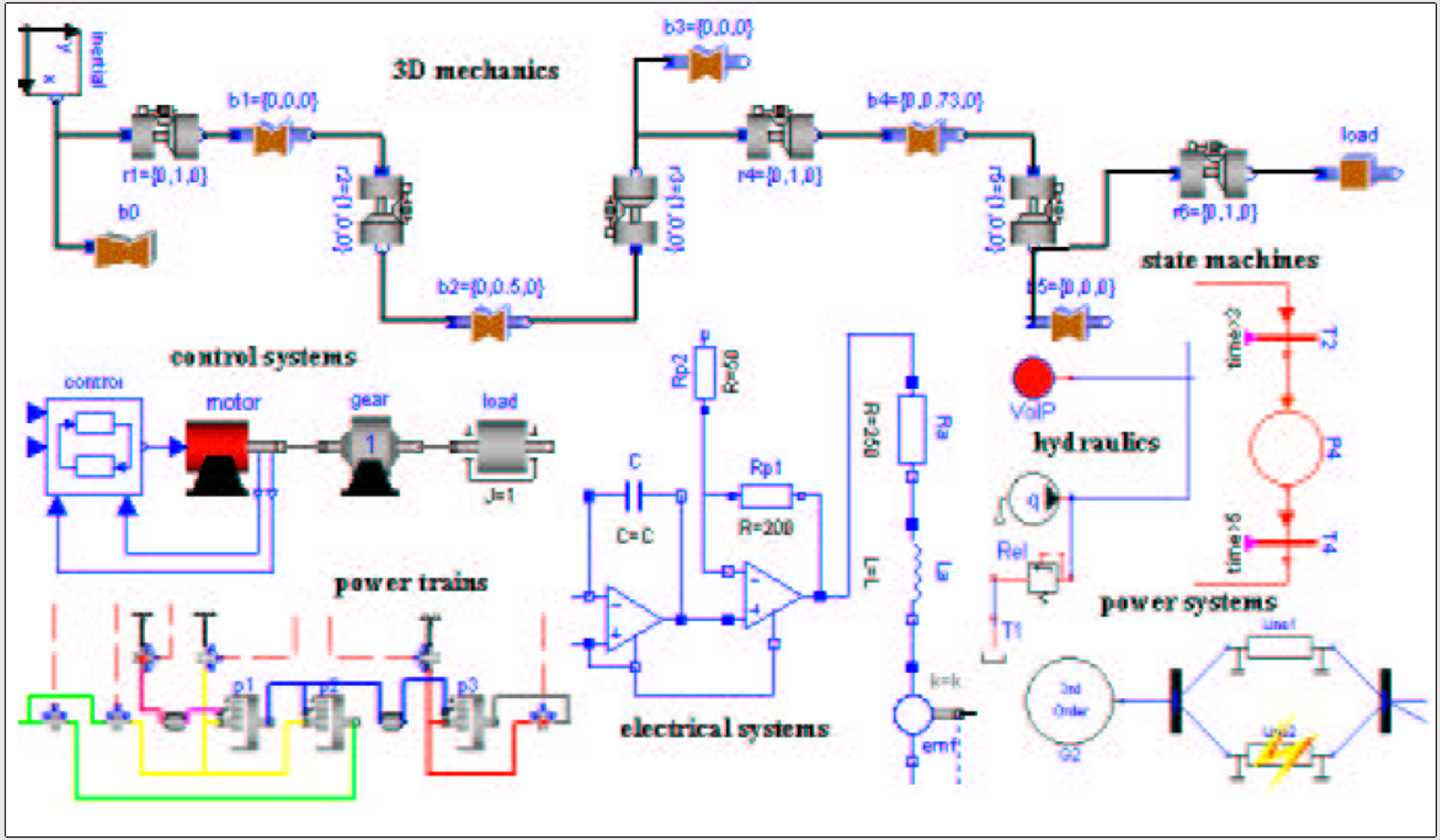
ESPRIT **Basic Research Working Group 8467 (co-founder)**
Industry – Academia: future of M&S, key problems

1) multi-paradigm modelling
2) non-causal modelling of physical systems
3) meta-modelling (STEP/EXPRESS)
4) usability by end-user (GUI, DSM, traceability, ...)

(SiE report)

SiE

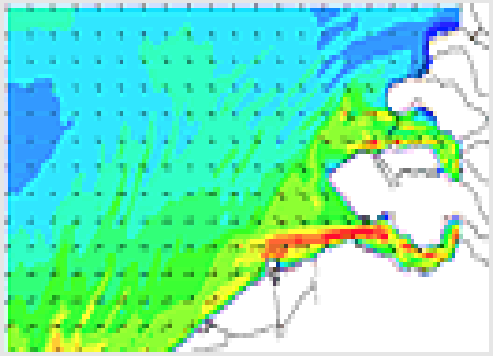
Modelica (www.modelica.org)



SiE spin-off, co-founder, muModelica compiler

Belgian Navy and MUMM

Management Unit of the North Sea Mathematical Models
MUMM | BMM | UGMM
Department VI of the Royal Belgian Institute of Natural Sciences



Concurrent Engineering Research Center (DARPA)

CERC
West Virginia University

(software) process modelling

At different **levels of abstraction**:

- “management” level (planning)
- “operational” level (orchestrating)

Using **most appropriate formalisms**:

- Forrester System Dynamics
- Process Interaction
- DEVS
- Statecharts

Continuity between
abstraction levels, formalisms !

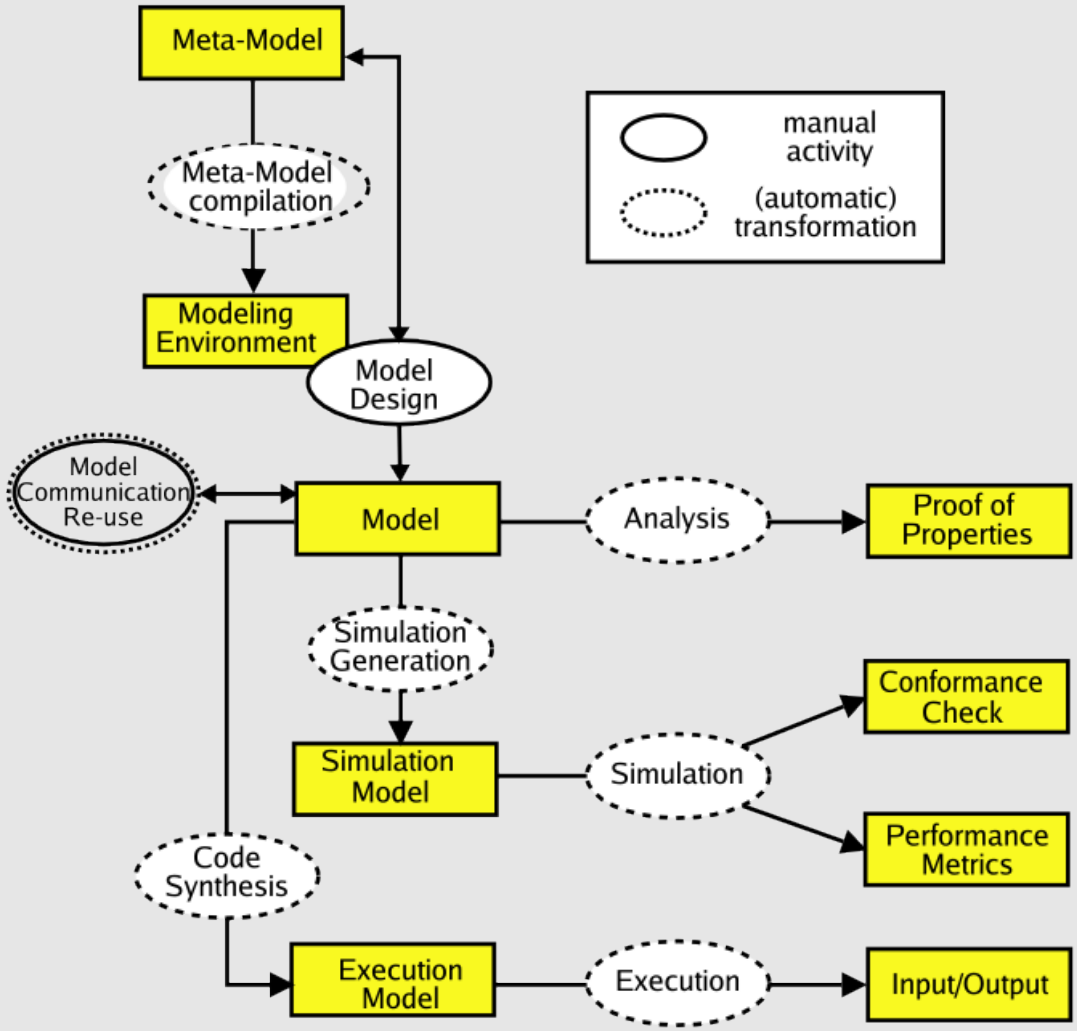
Modelling, Simulation and Design Lab

- started in 2001
- Modelling and Simulation
  applied to Software Engineering applied to ...
- fundamental research => prototypes => deployment

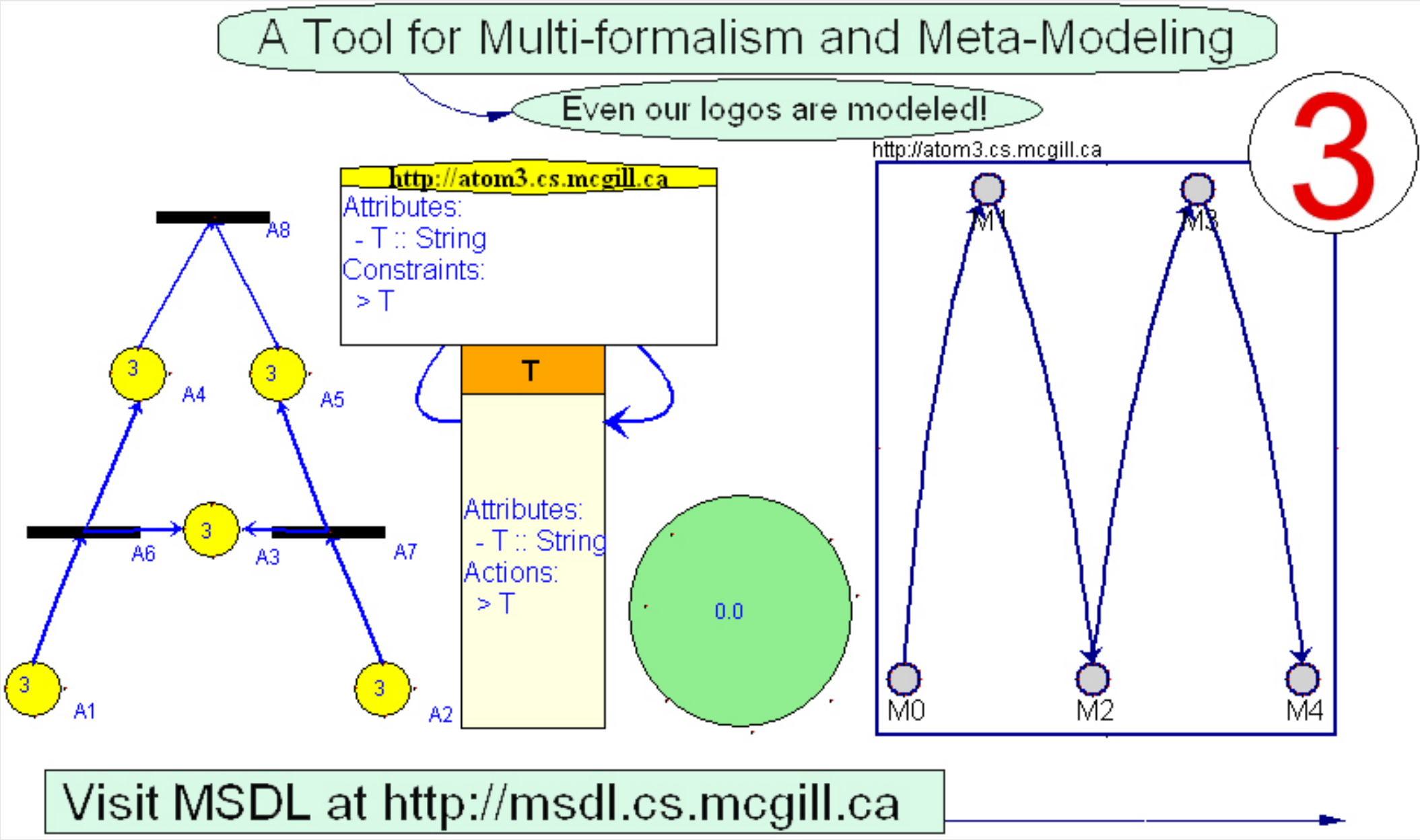
Modelling, Simulation and Design Lab

- **applications** of domain-specific modelling (and simulation)
  - software design
  - environment
  - traffic
- domain-specific **visual modelling**
  - specification of reactive behaviour
  - link concrete and abstract syntax
- **meta-modelling** and **model transformation ((T)GG)**
- **theory/foundations**:
  - new formalisms, multi-formalism modelling
  - formalism transformation

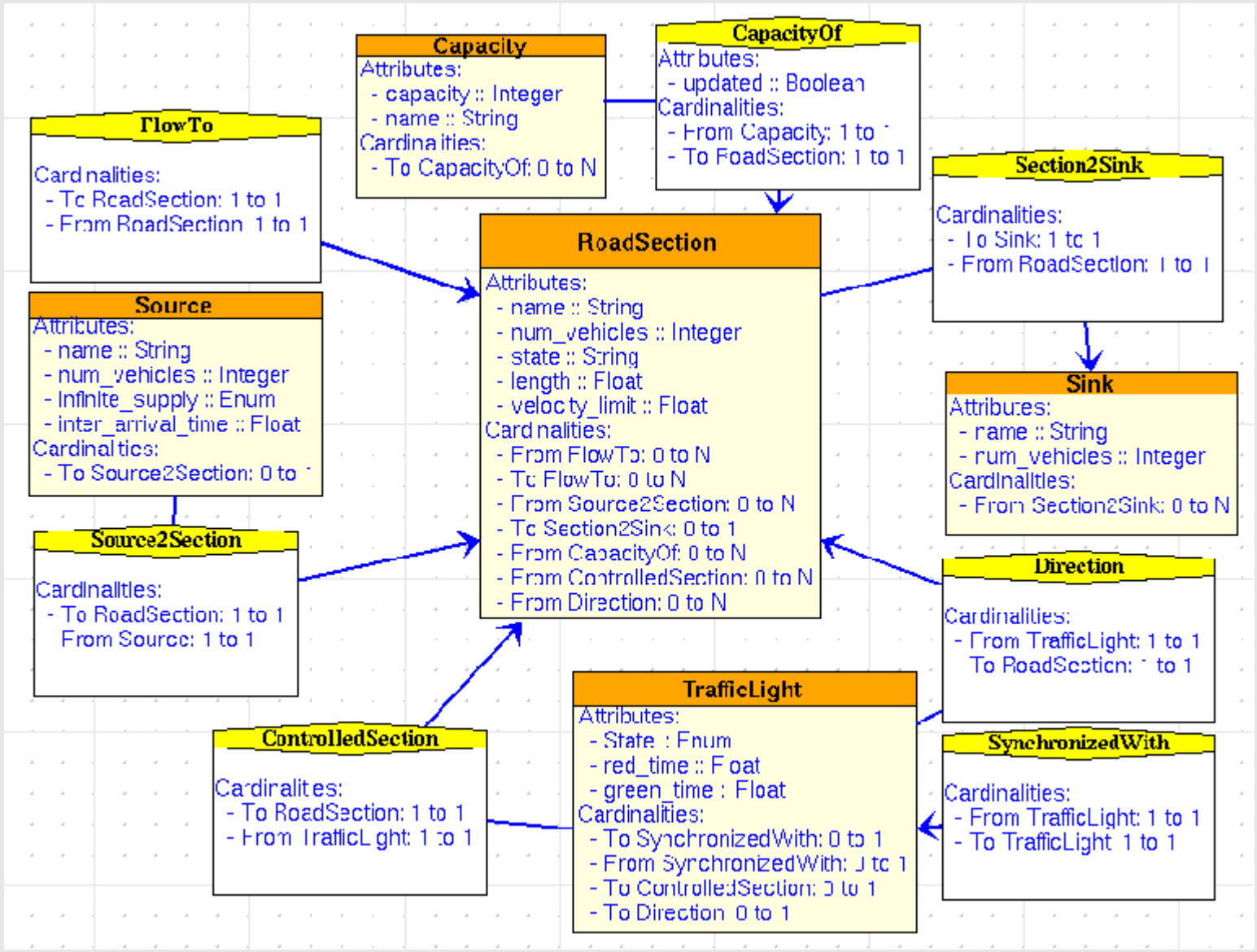
Modelling and Simulation Based Design



Our CAMPaM tool ...

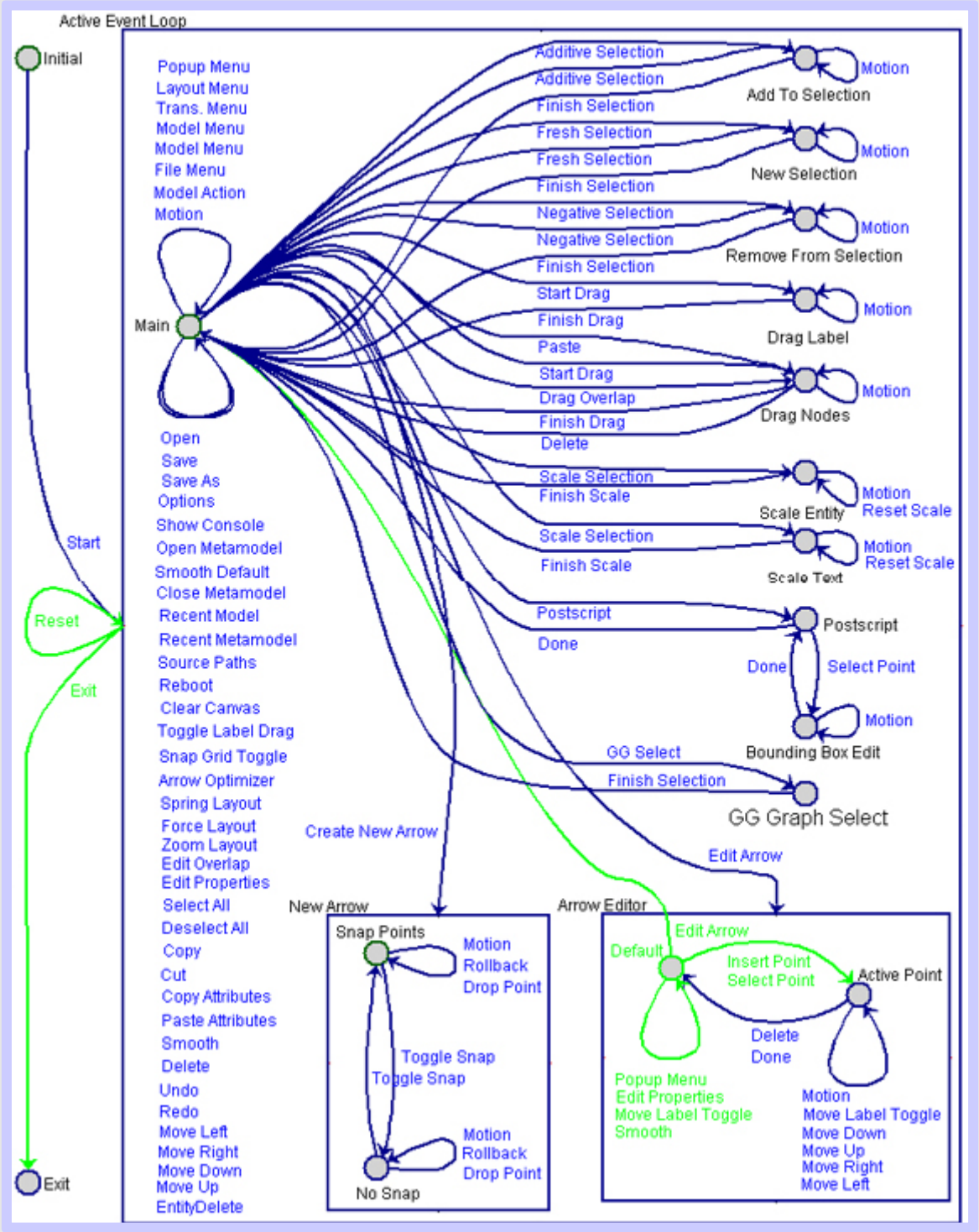


Meta-modelling Traffic

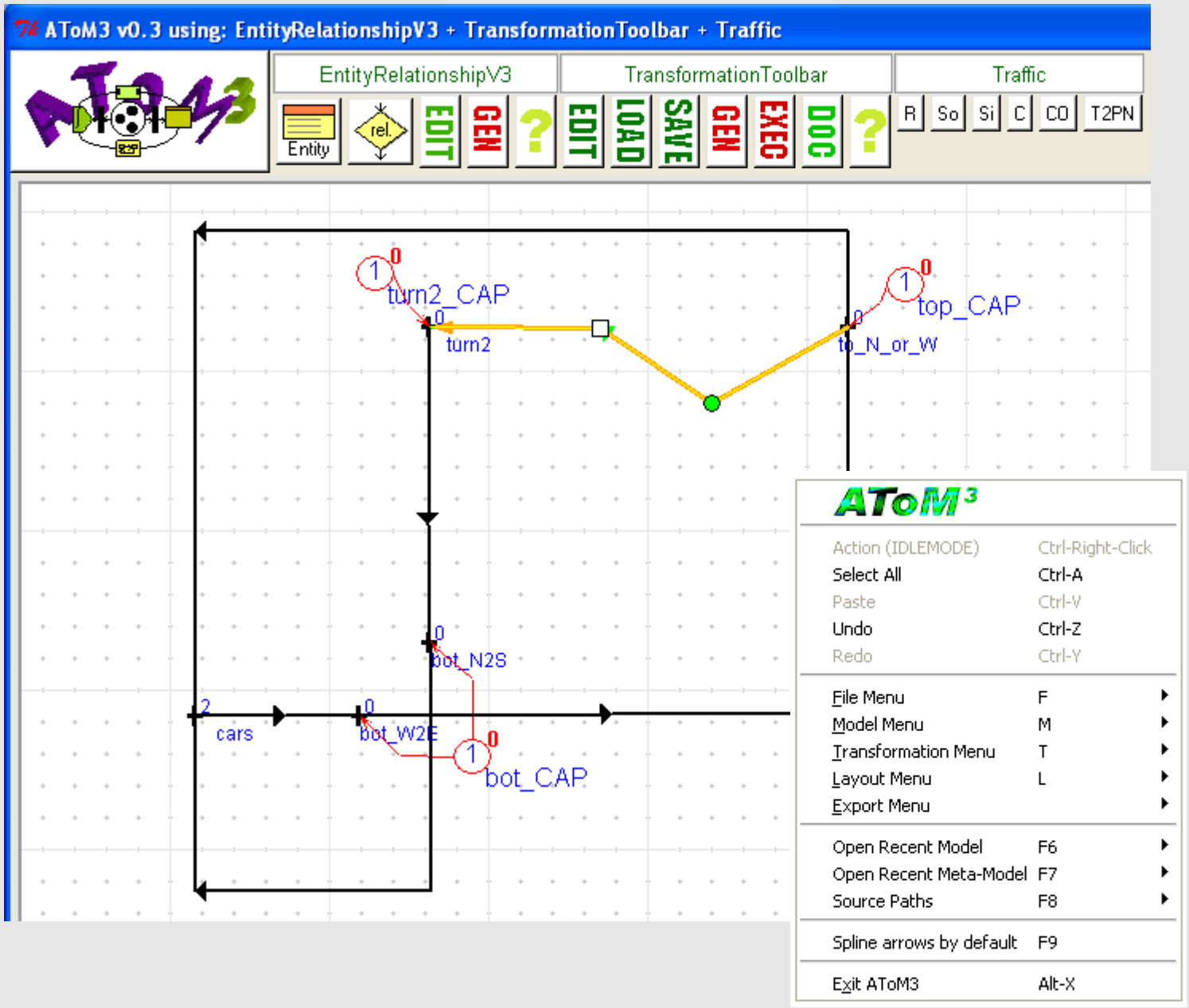


Dchart modelling of reactive behaviour of a visual modelling environment

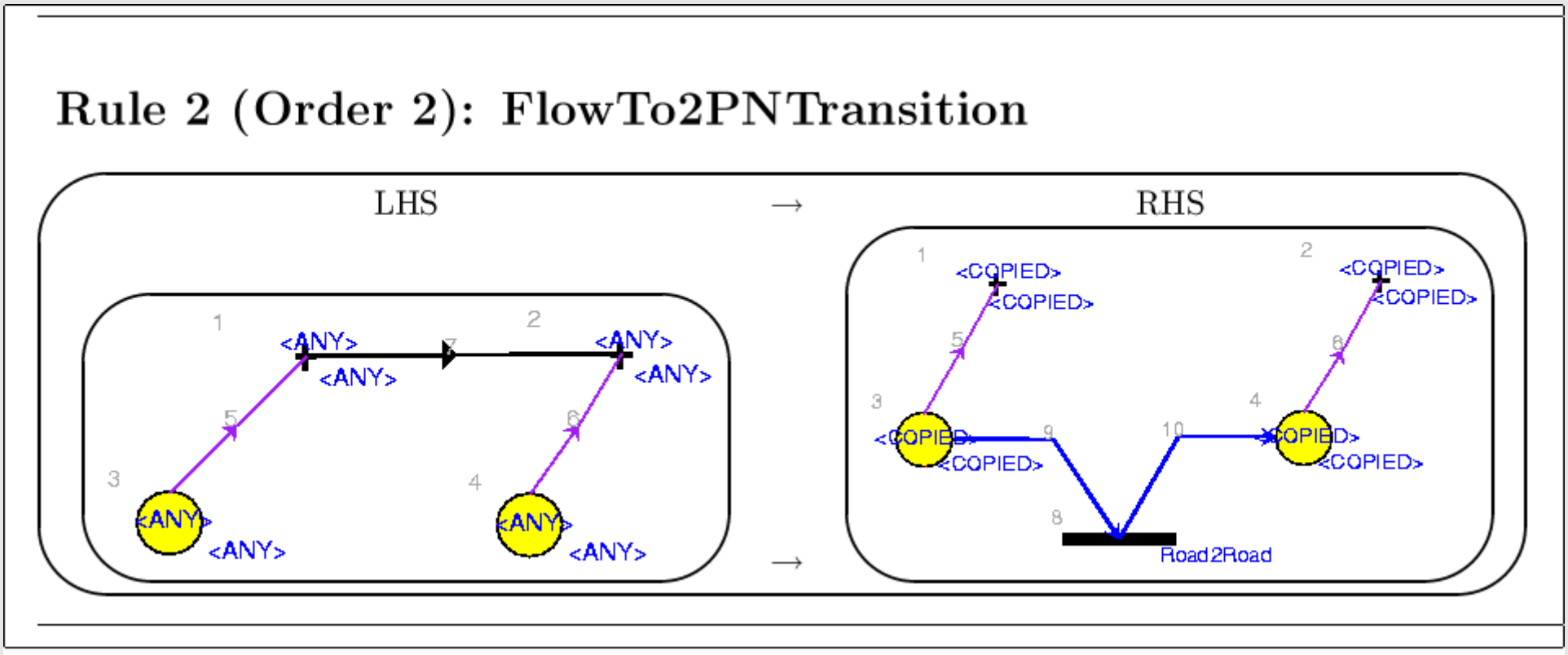
... has spawned a whole new thread of research on the modelling, analysis and synthesis of advanced user interfaces ...



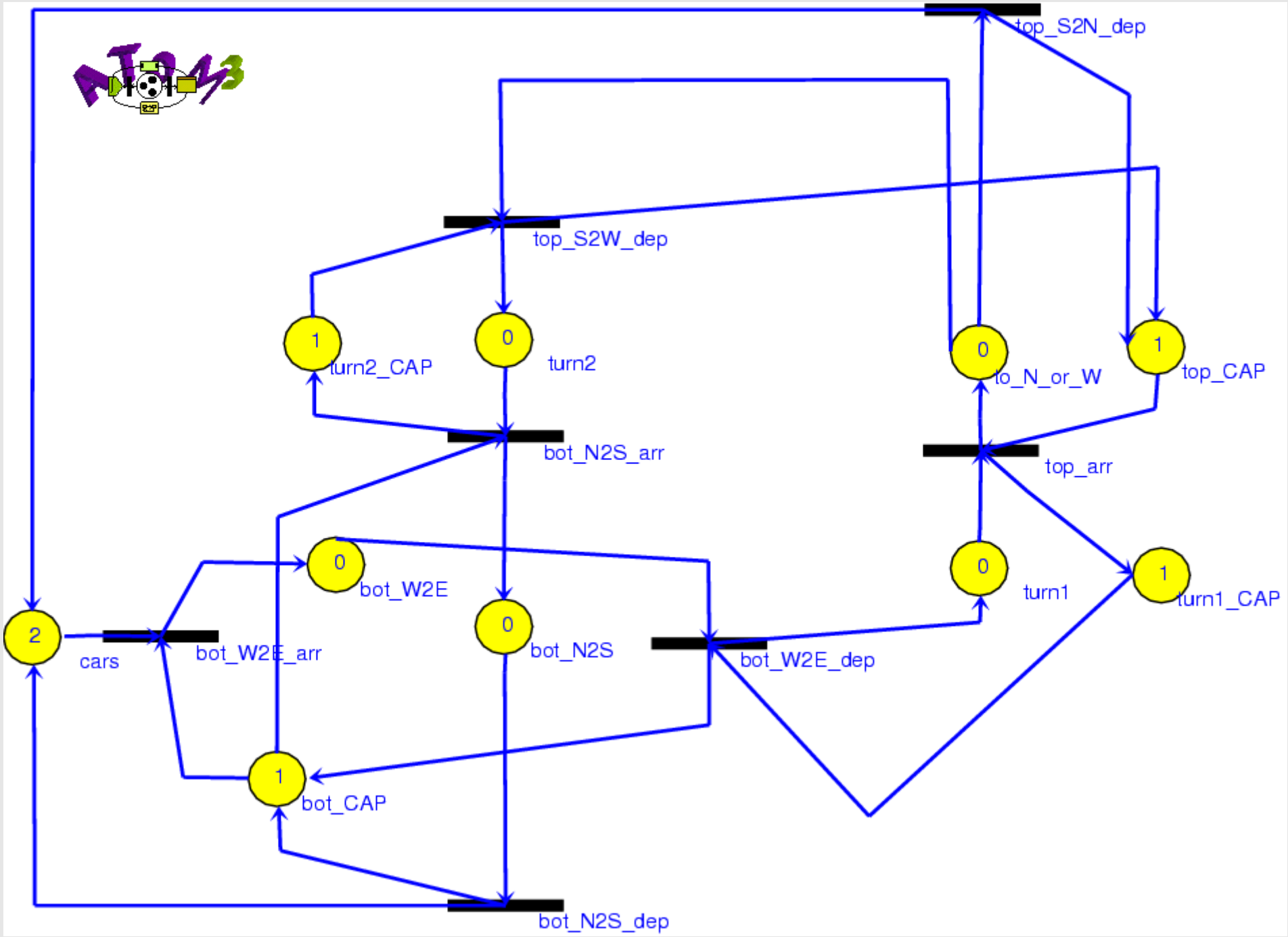
synthesized Traffic-specific modelling environment



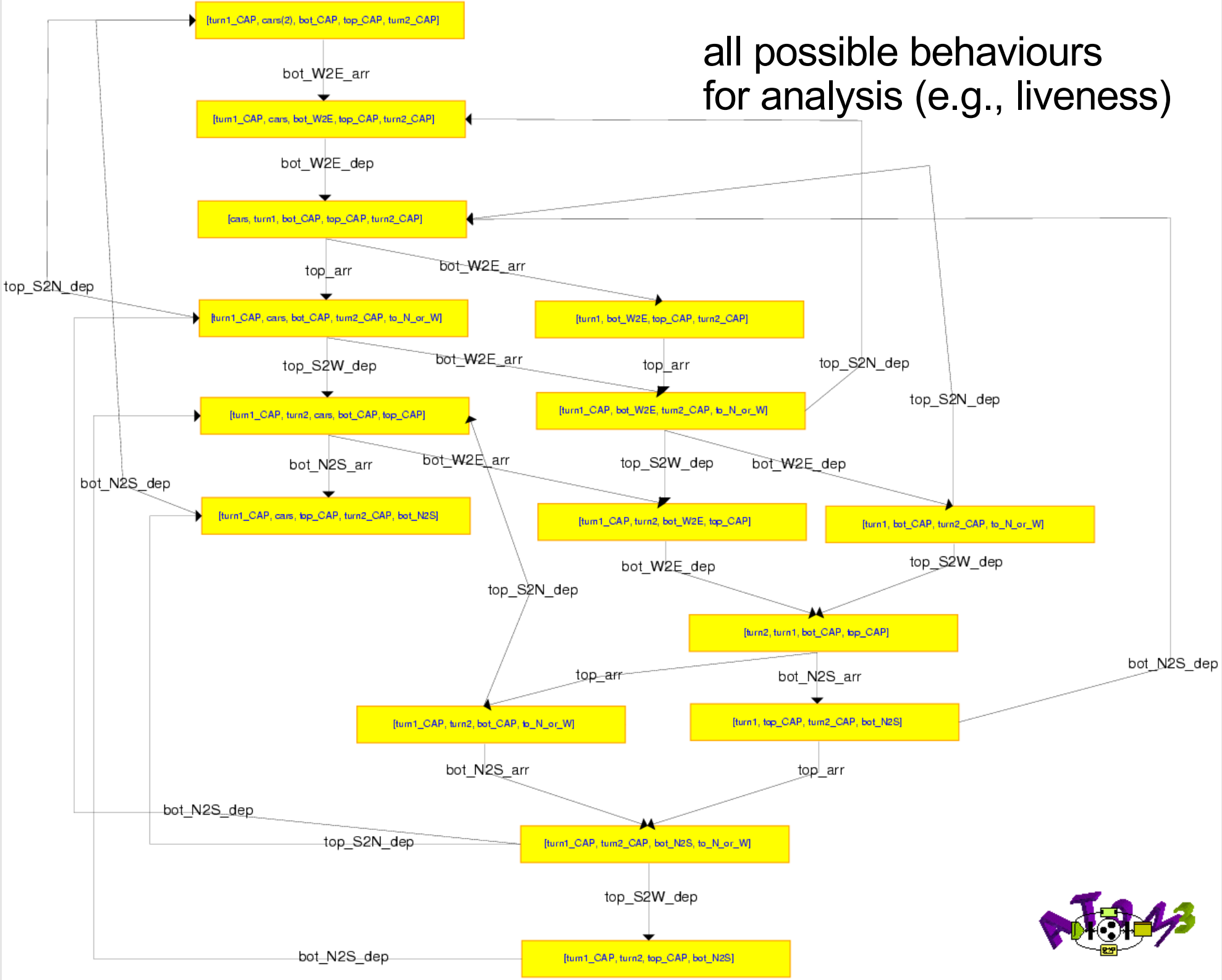
Explicitly model model transformation (using GG)



Result of transformation: Traffic dynamics in terms of Petri Nets



all possible behaviours for analysis (e.g., liveness)



```
==========================================
=                                        =
=  Conservation Analysis Results:  =
=                                        =
==========================================
```

$$1.0\ x[\text{turn1\_CAP}] + 1.0\ x[\text{turn1}] = 1.0$$

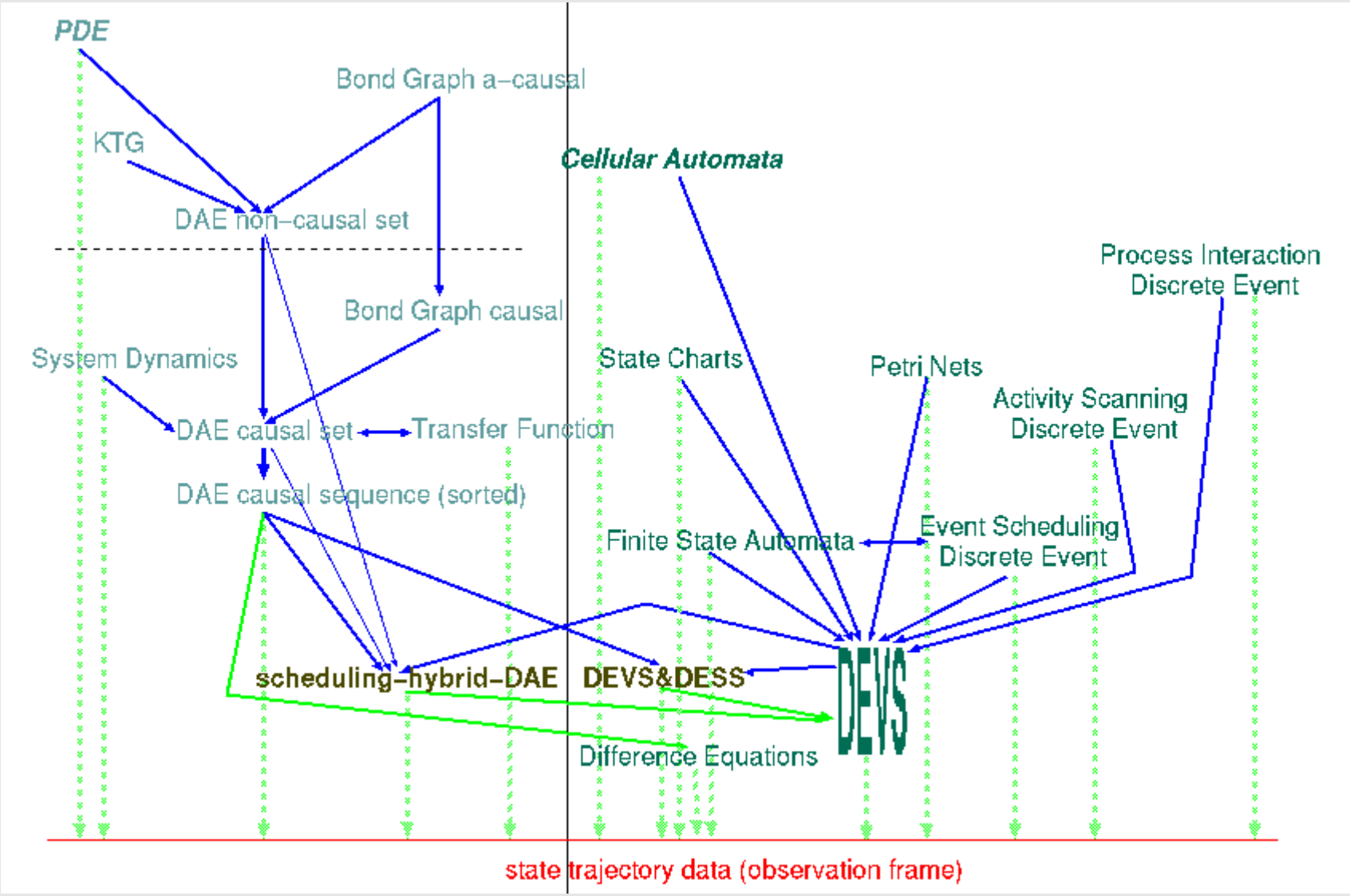
$$1.0\ x[\text{cars}] + 1.0\ x[\text{bot\_W2E}] + 1.0\ x[\text{turn1}] + 1.0\ x[\text{to\_N\_or\_W}] + 1.0\ x[\text{turn2}] + 1.0\ x[\text{bot\_N2S}] = 2.0$$

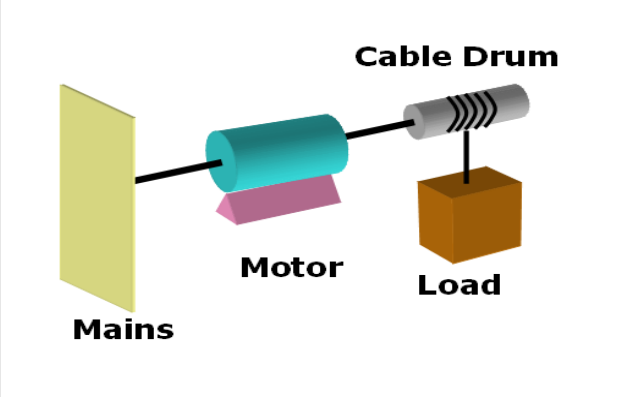
$$1.0\ x[\text{top\_CAP}] + 1.0\ x[\text{to\_N\_or\_W}] = 1.0$$

$$1.0\ x[\text{turn2\_CAP}] + 1.0\ x[\text{turn2}] = 1.0$$

$$1.0\ x[\text{bot\_CAP}] + 1.0\ x[\text{bot\_W2E}] + 1.0\ x[\text{bot\_N2S}] = 1.0$$

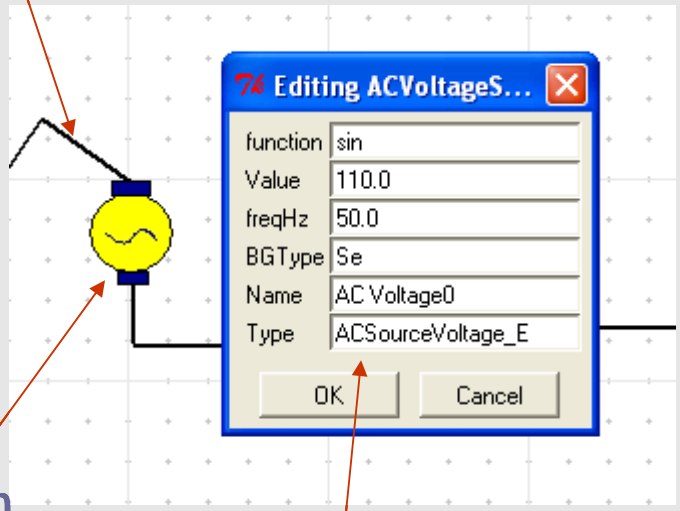
Formalism Transformation Graph





- modelling of **physical systems**
- domain-specific **design-space exploration** based on genetic algorithms

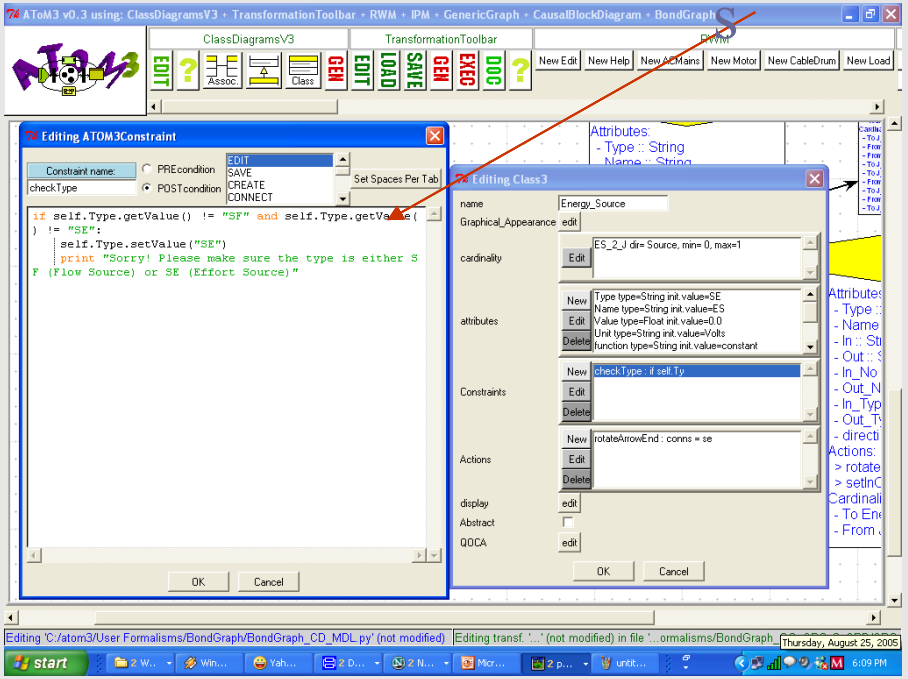
Edge



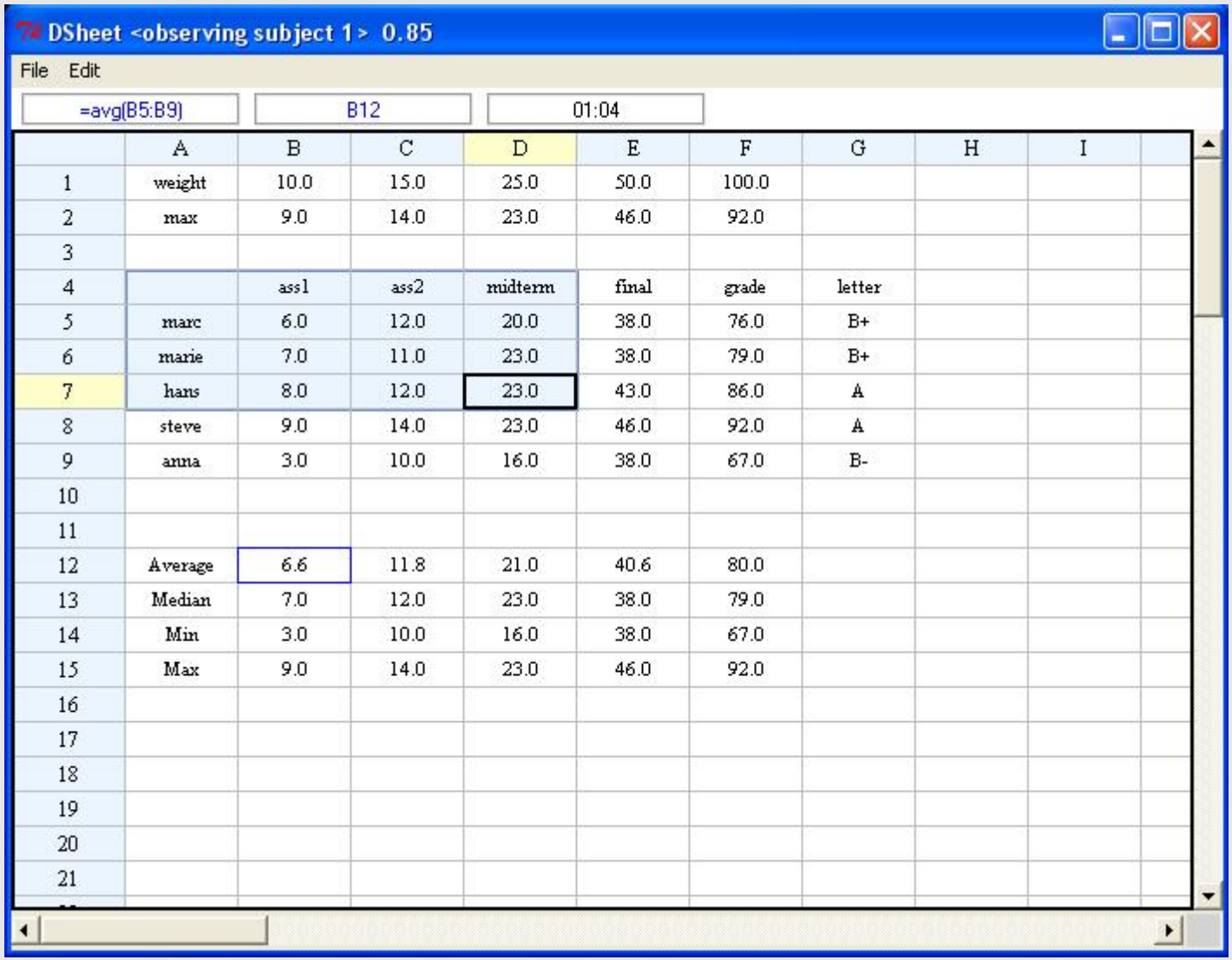
Icon

Attributes

Constraint

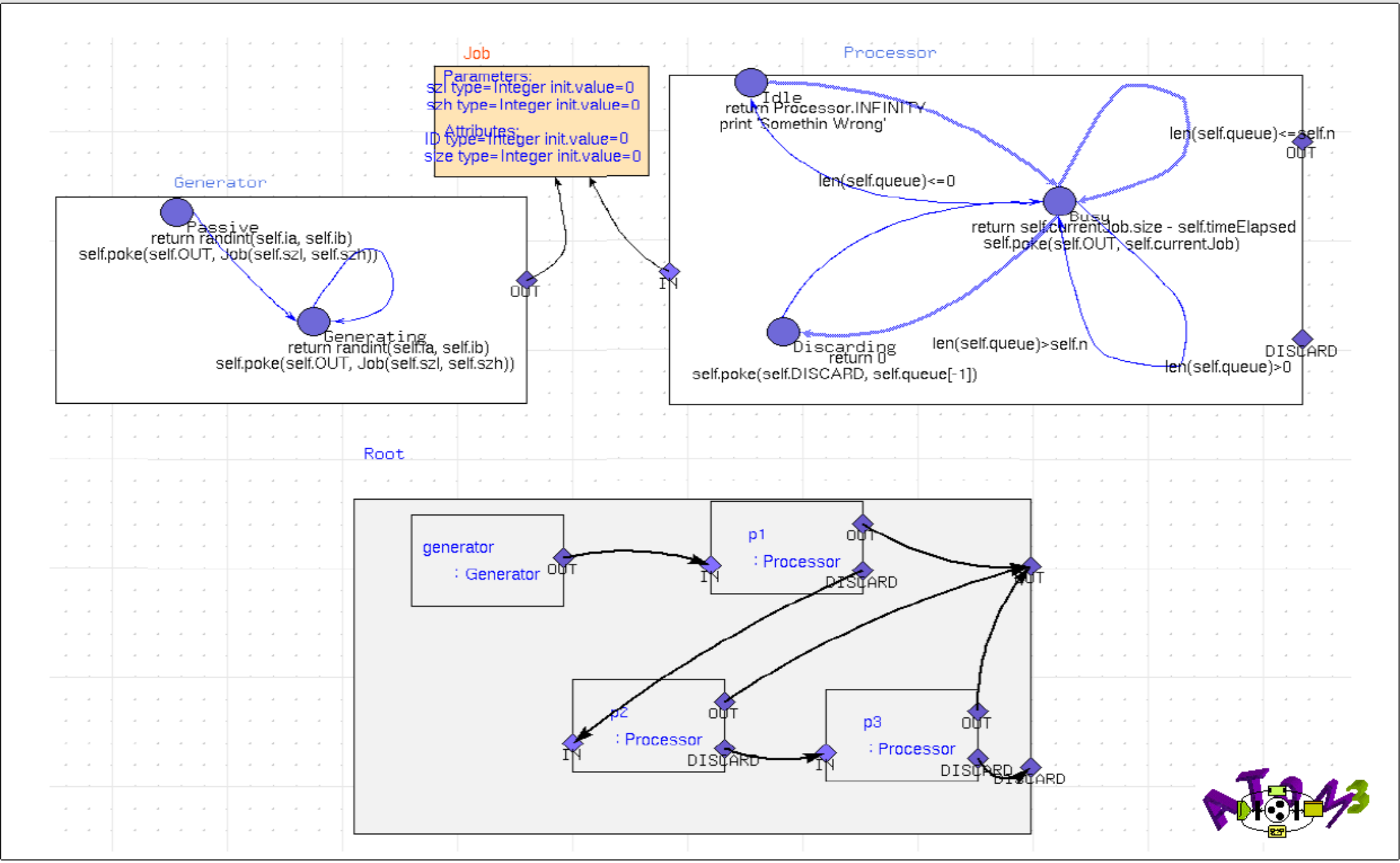


Software Engineering
e.g., Dsheet: the Designed Spreadsheet

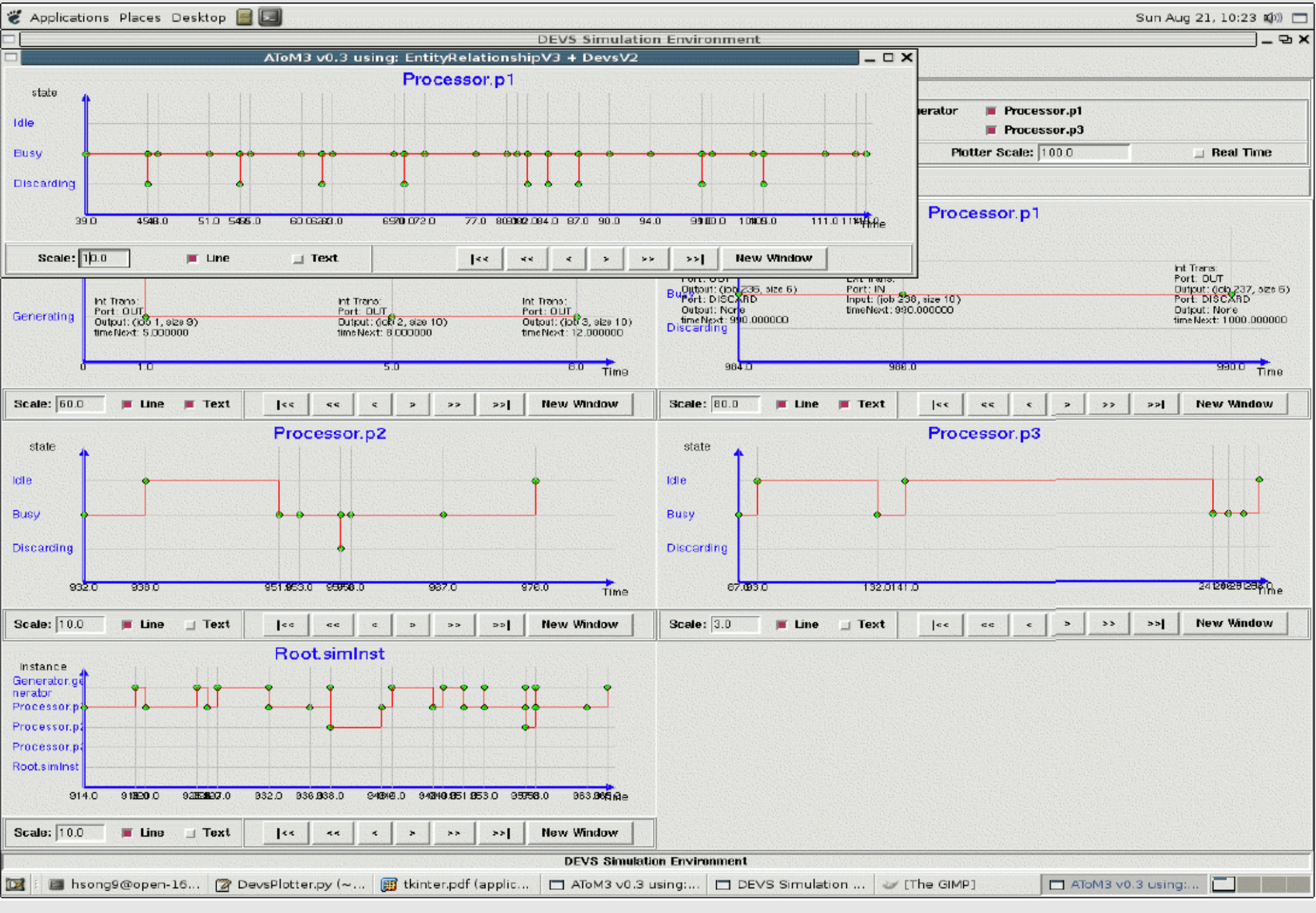


	A	B	C	D	E	F	G	H	I
1	weight	10.0	15.0	25.0	50.0	100.0			
2	max	9.0	14.0	23.0	46.0	92.0			
3									
4		ass1	ass2	midterm	final	grade	letter		
5	marc	6.0	12.0	20.0	38.0	76.0	B+		
6	marie	7.0	11.0	23.0	38.0	79.0	B+		
7	hans	8.0	12.0	23.0	43.0	86.0	A		
8	steve	9.0	14.0	23.0	46.0	92.0	A		
9	anna	3.0	10.0	16.0	38.0	67.0	B-		
10									
11									
12	Average	6.6	11.8	21.0	40.6	80.0			
13	Median	7.0	12.0	23.0	38.0	79.0			
14	Min	3.0	10.0	16.0	38.0	67.0			
15	Max	9.0	14.0	23.0	46.0	92.0			
16									
17									
18									
19									
20									
21									

DEVS: visual modelling, standardize



DEV(S): simulation, standardize



Interests

- **Collect/Structure Requirements for CAMPaM**

- Continue to work on **framework to "model everything"**
  At the most appropriate **level of abstraction**
  In the most appropriate **formalism**

- **Transformations as first-class models**
  -> higher order transformations

- **Model evolution, consistency (using TGGs) of multi-view models**
  syntax **and** semantics

- **Scale up -> need modularity (in all its forms)**

Workshop Success Metrics

- Maximize **\Sigma_p^participants successMetric(p)**
- Learn
- Convergence of ideas
- Publish CAMPaM report
- Plan publication of results