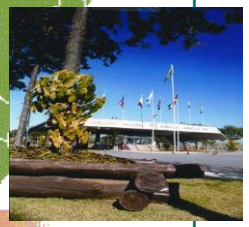
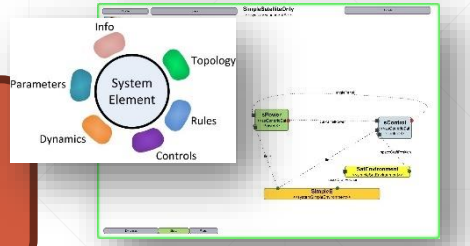
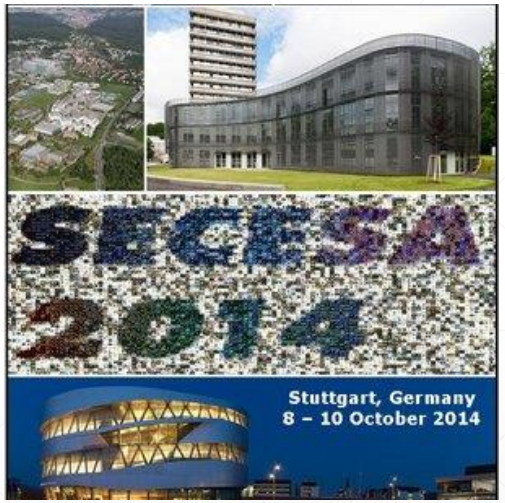
Ph.D. pathway...



Postgraduation Course: Space Engineering and Technology

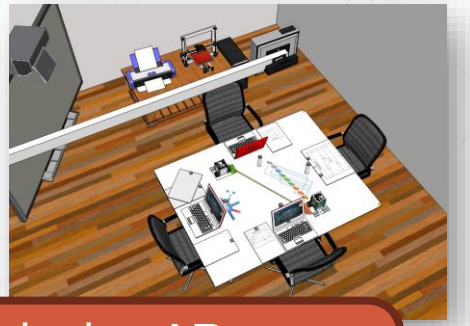
Developing a MBx diagram to use CE into a AR Collaborative Environemnt





Integrating Knowledge with System Models: A Knowledge Based Engineering Approach
Pathmeswaran Raju (1), Craig B. Chapman (2)

OPM



Developing AR Collaborative Environment to **MBCE using OPM**

AR – Augmented Reality
MB – Model Based
CE – Concurrent Engineering
OPM – Object Process Methodology

A Model Based Concurrent Engineering Framework using ISO-19450 Standard

Christopher Shneider Cerqueira

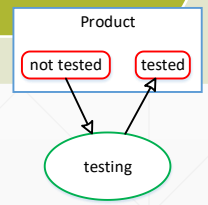
Ana Maria Ambrosio

Claudio Kirner

Agenda

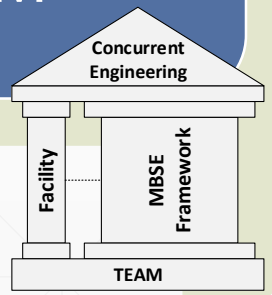
[meta-presentation] [presentation of the presentation]

ISO-19450 – Object Process Methodology (OPM)

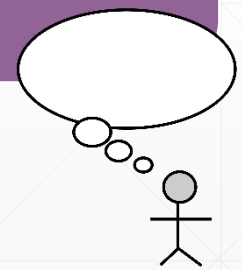


How OPM fits in CE??

MBCE proposal using OPM



Final Considerations



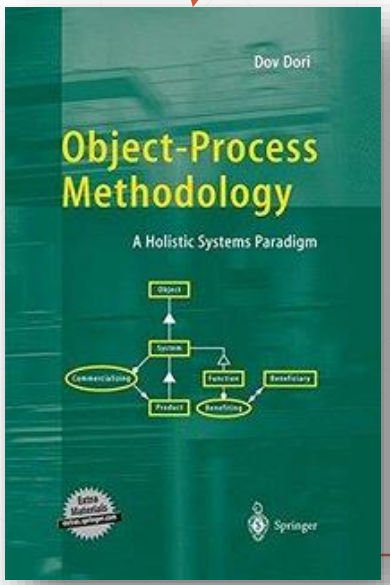
ISO-19450 - Object Process Methodology (OPM)

OPM

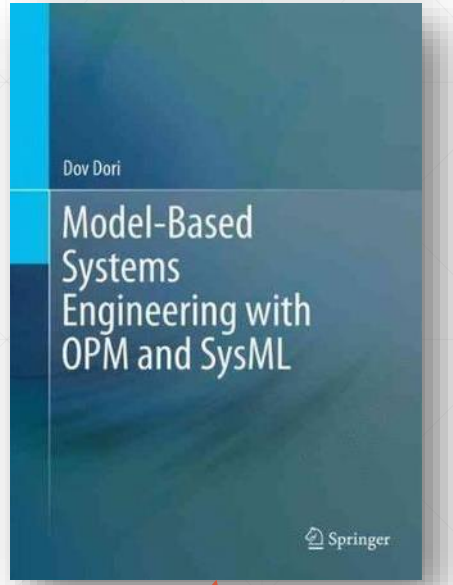
Prof. Dov Dori

Created in 2002

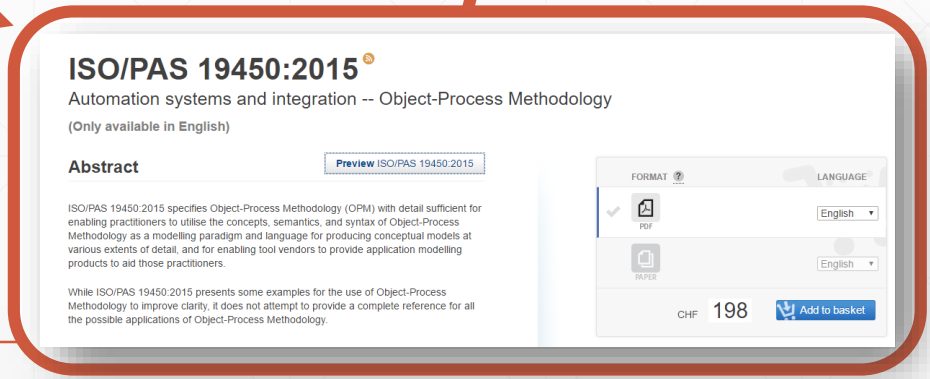
- A Single Diagram – Maps Behaviour and Structure
- 2 Building Blocks and 10 basic relations
- Designed to “Systemic View” and “Concept Design”
- Simulation Ready



improving and showing it applicability

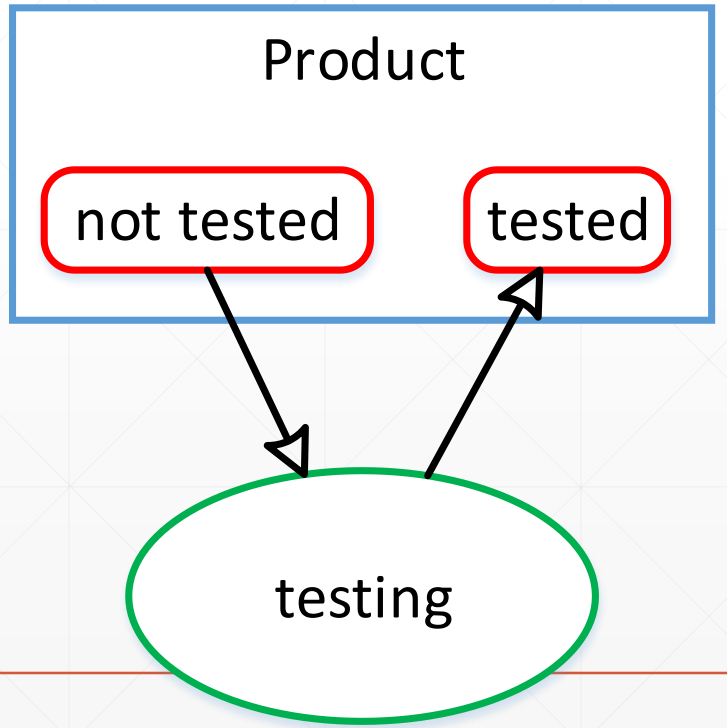


- ~130 Pages standard
- Published in late 2015
- Intended to “*Automation Systems and Integration*”
- Has the “**power**” of a ISO seal.



OPM has only two building blocks (things):

1. **Objects with states**
2. **Processes**



All the other OPM elements are relations (links) between things.

Structural

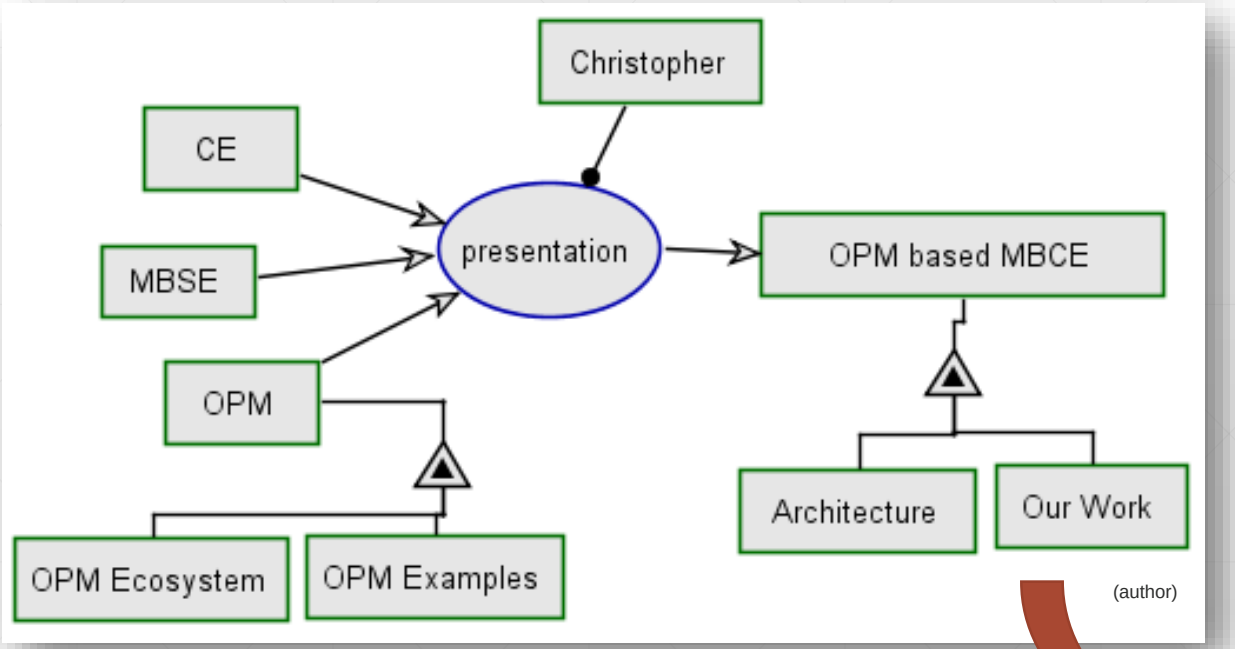
- Relational
- Aggregation
- Exhibition
- Specialization
- Instantiation

Procedural

- Transforming
  - Consume/Create/Effect
- Enabling
  - Agent/Instrument
- Control
  - Events/Conditions
  - Invocations/Exceptions
  - Multiplicity
  - Logical

OPM has two simultaneous cognitive channels: visual-OPD and textual-OPL

Diagram (OPD)

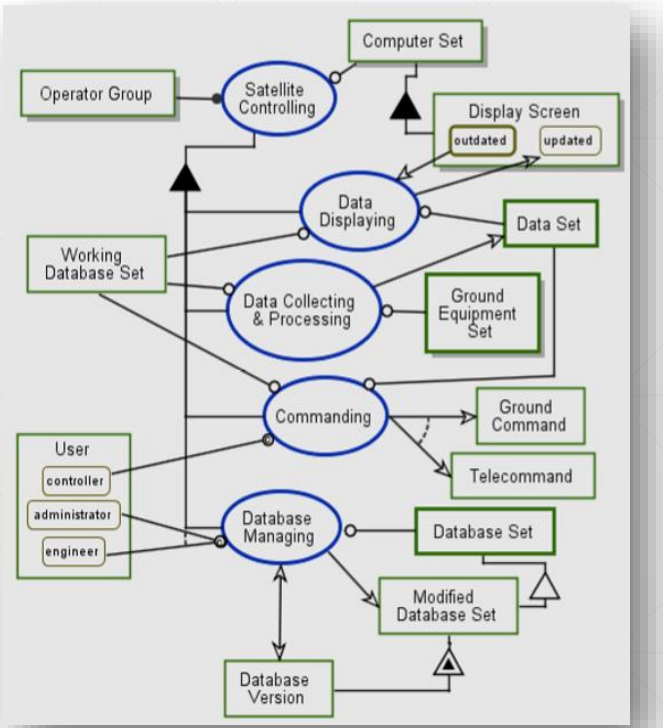


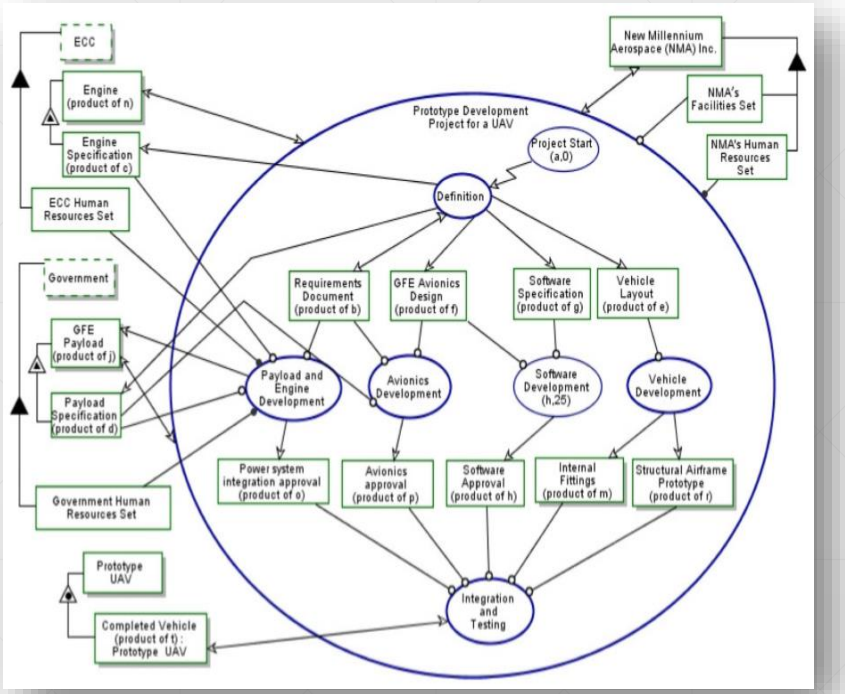
Textual (OPL) – auto generated

- Christopher handles presentation.
- OPM exhibits OPM Examples and OPM Ecosystem.
- OPM based MBCE exhibits Architecture and Our Work.
- presentation consumes OPM, CE, and MBSE.
- presentation yields OPM based MBCE.

3 Use Examples:

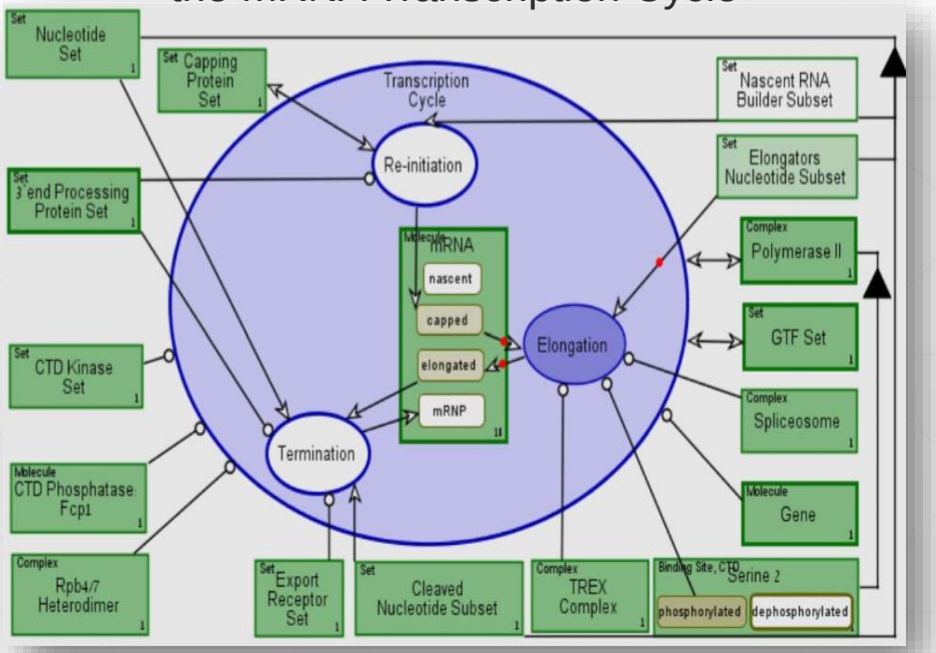
Model-Based Guidelines for User-Centric **Satellite Control Software** Development





Project Management vs. Systems Engineering **Management**: A Practitioners' View on Integrating the Project and Product Domains

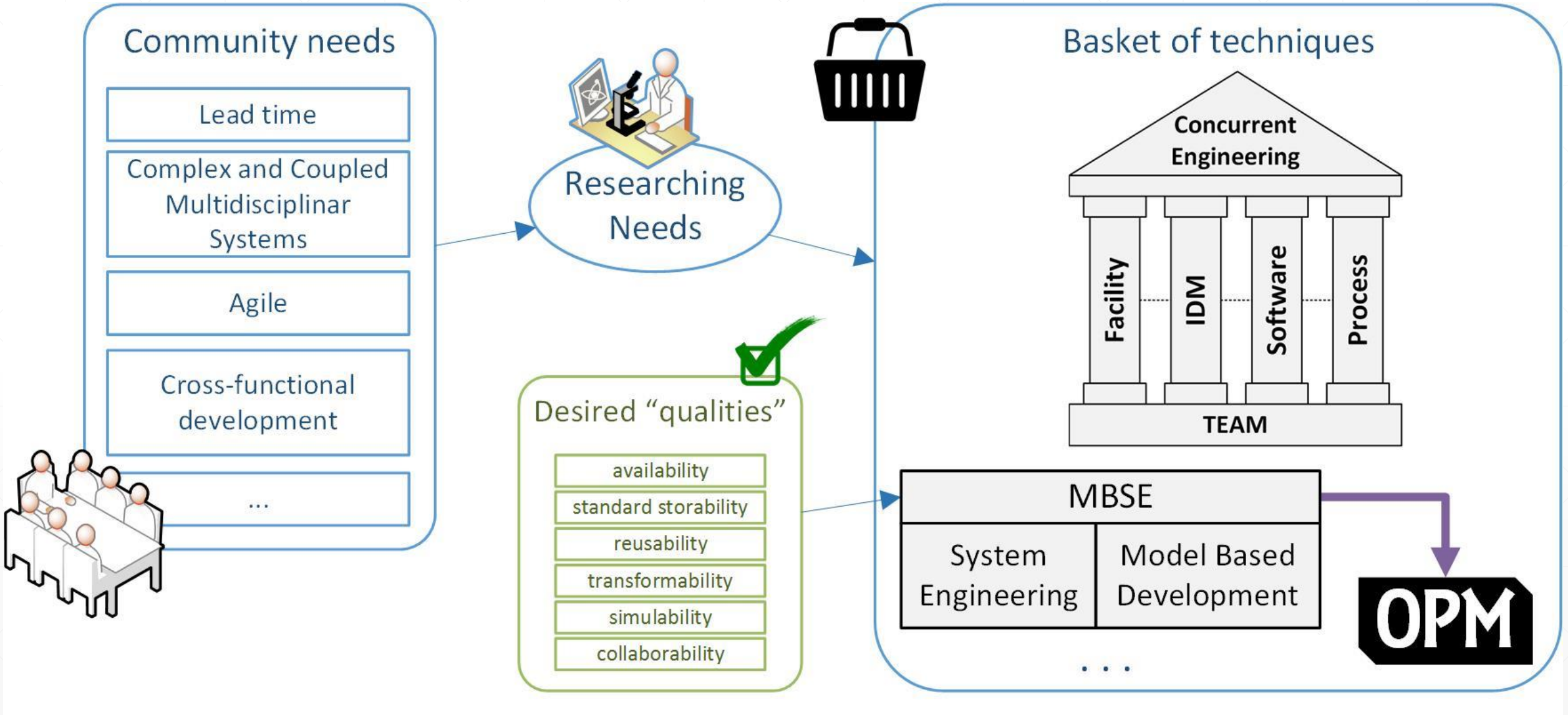
Conceptual Model-Based Systems **Biology**: Mapping Knowledge and Discovering Gaps in the mRNA Transcription Cycle



(royalty free image)

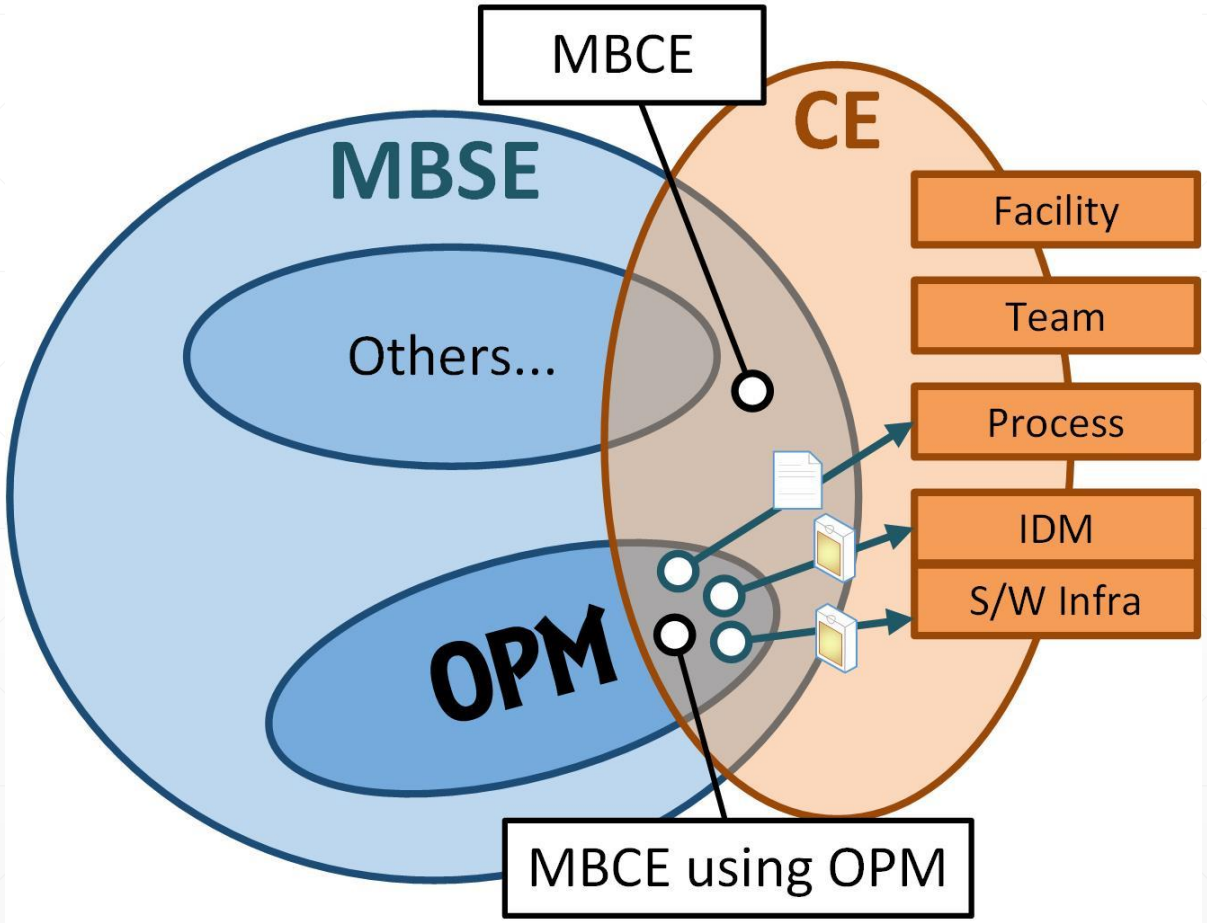
How OPM fits in CE??

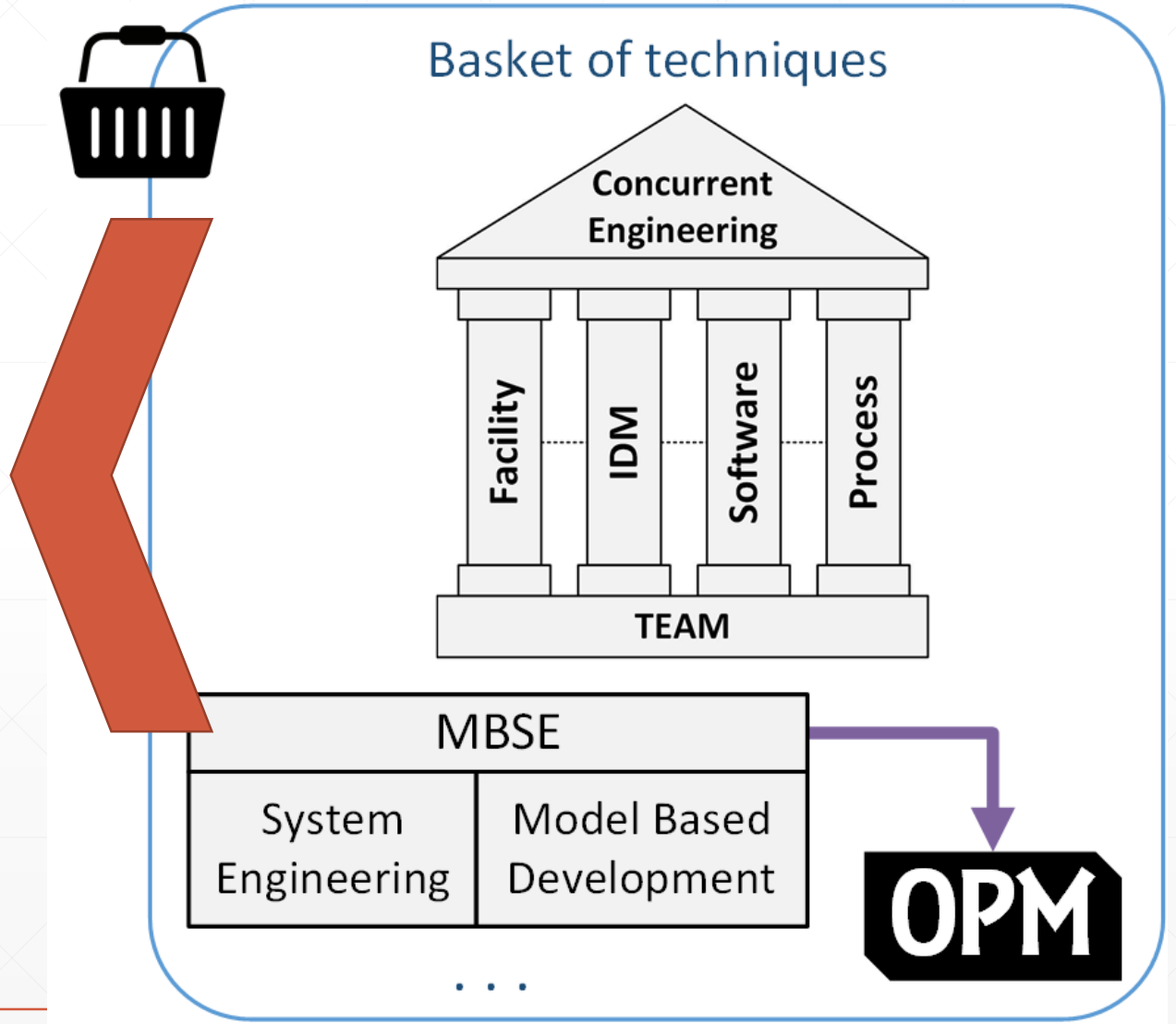
briefly ... Our proposal blends CE with MBSE using OPM

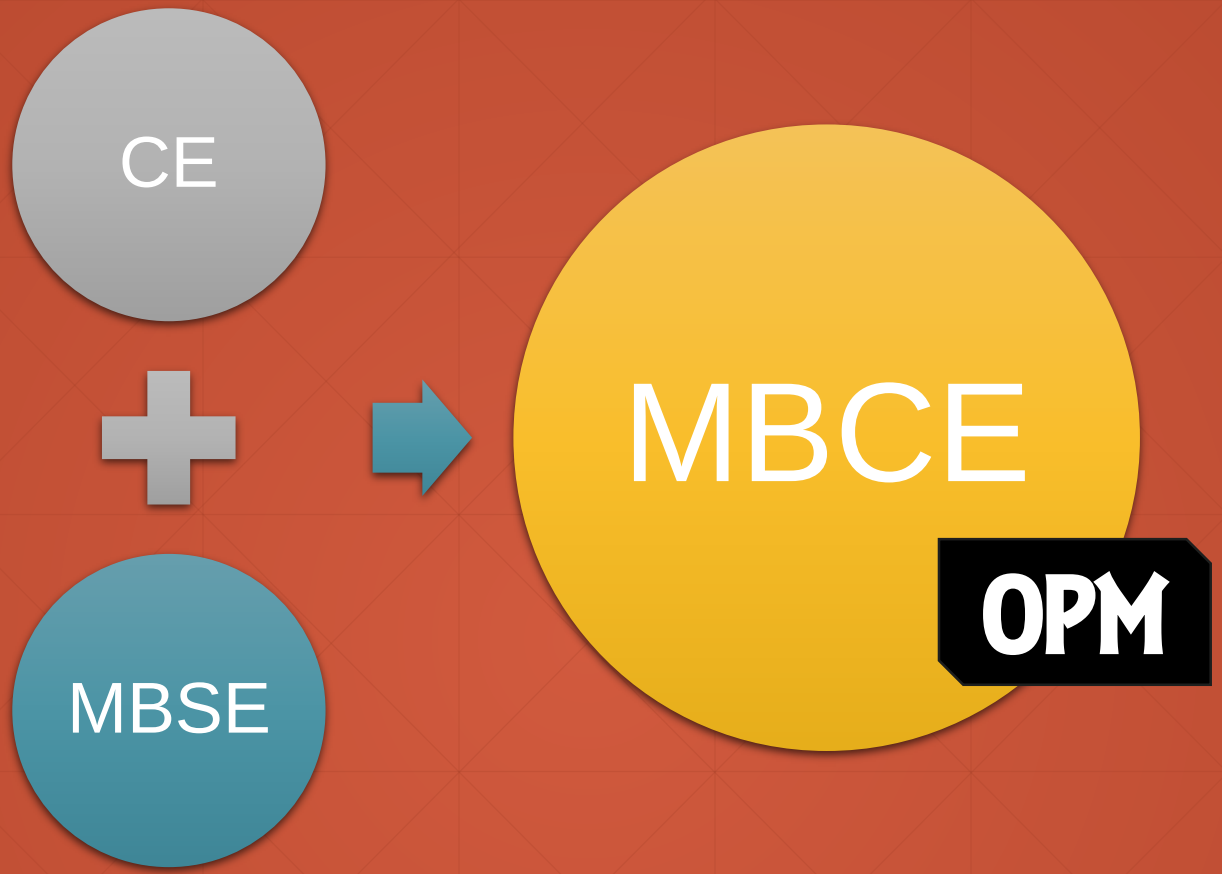


https://www.researchgate.net/publication/3076487_The_Historical_Roots_of_Concurrent_Engineering_Fundamentals
https://www.ucl.ac.uk/syseng/research/defining-systems-engineering

briefly ... Our proposal blends CE with MBSE using OPM

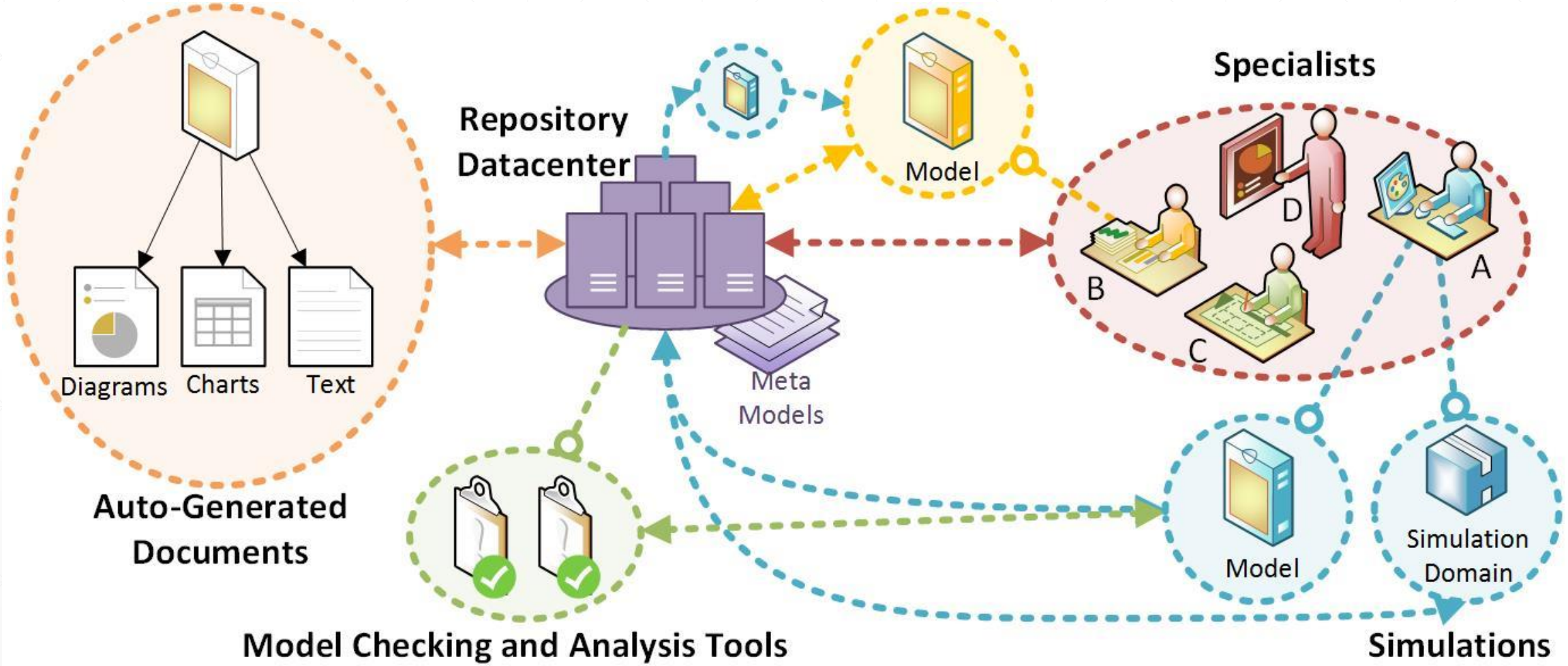






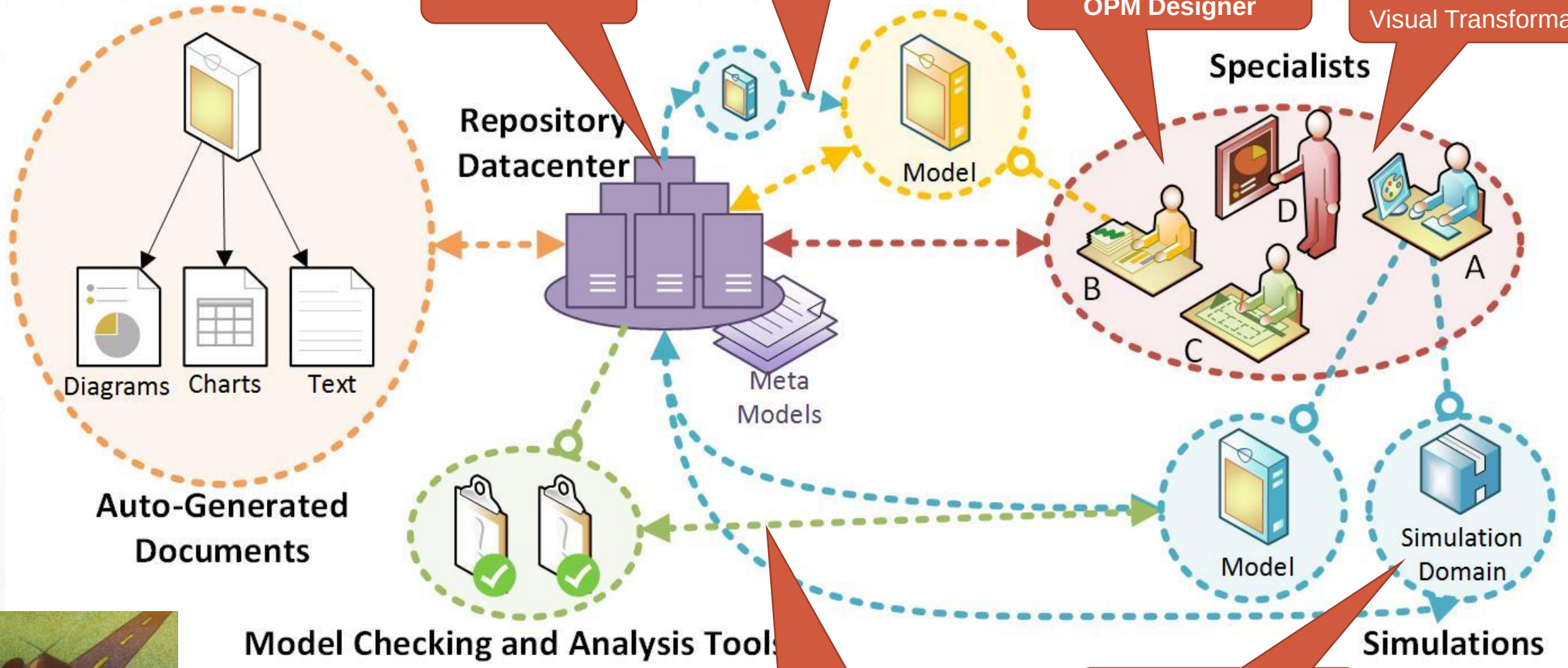
MBCE proposal using OPM

MBCE architecture



(author)

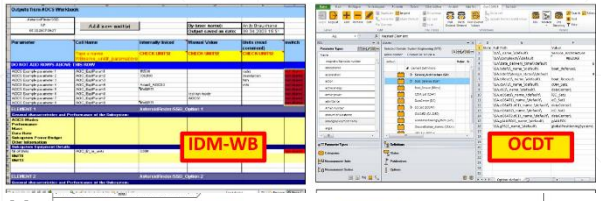
MBCE issues



(author)

Still several gaps to fill

Storage: Database – using graph approach



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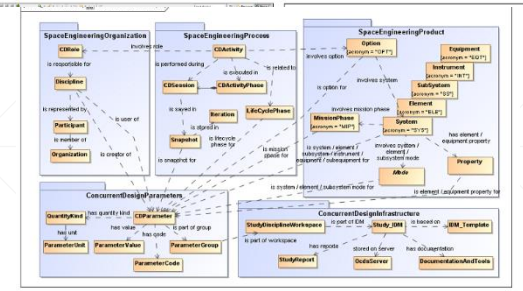
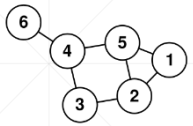


Figure 4-3 SEIM main information object types and relationships
[ECSS-E-TM-10-23]

Parameter
Relationship

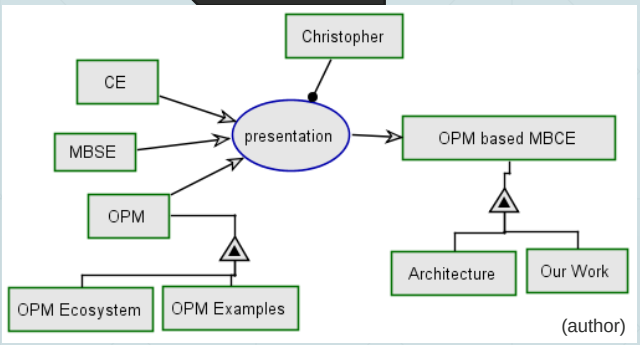


Mental Graphs

PostgreSQL

Relational DB
vs.
Graph DB

OPM



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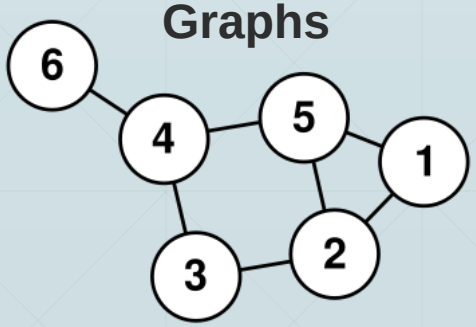
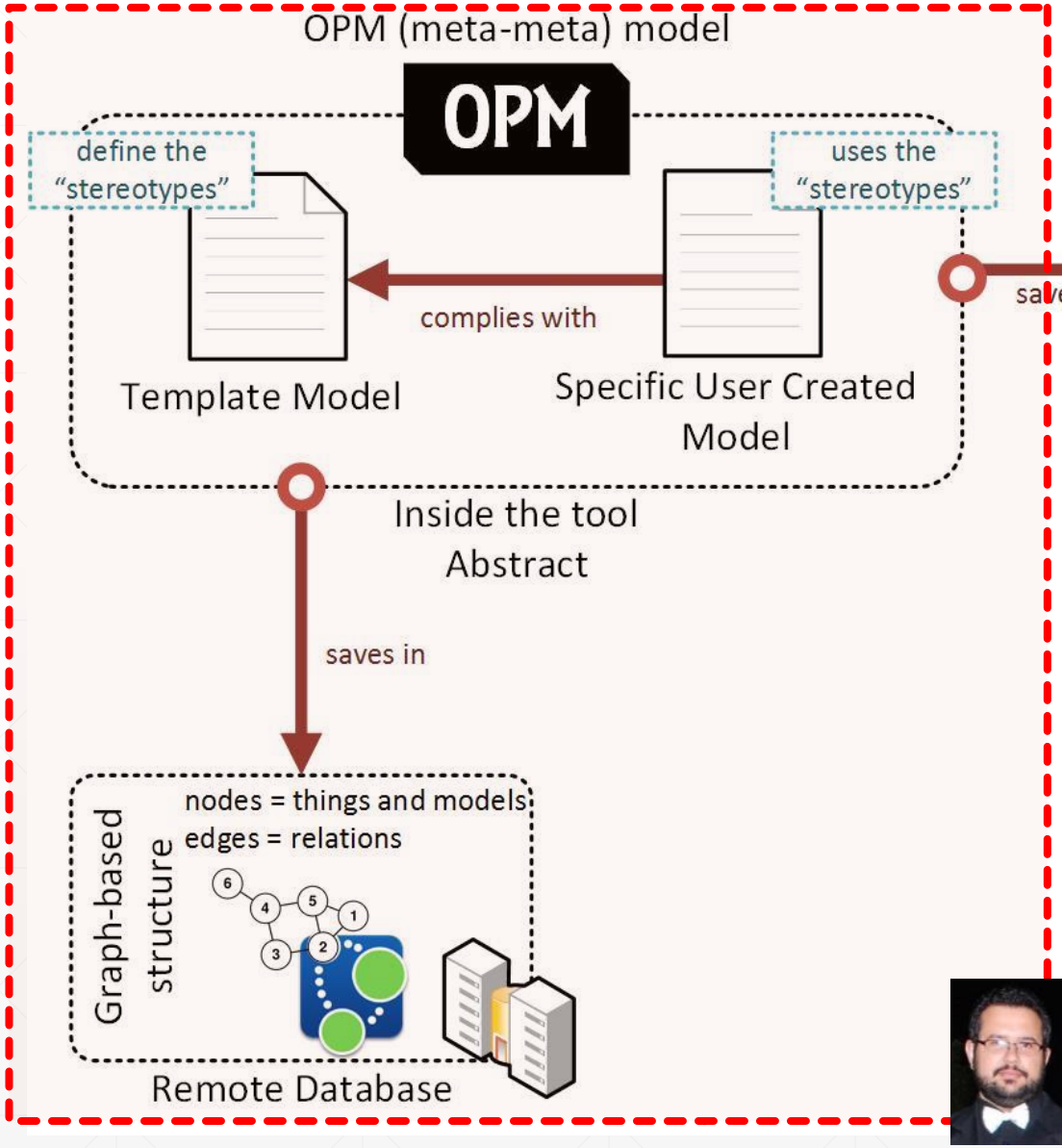
Graphs

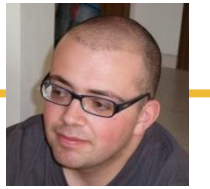


Neo4J

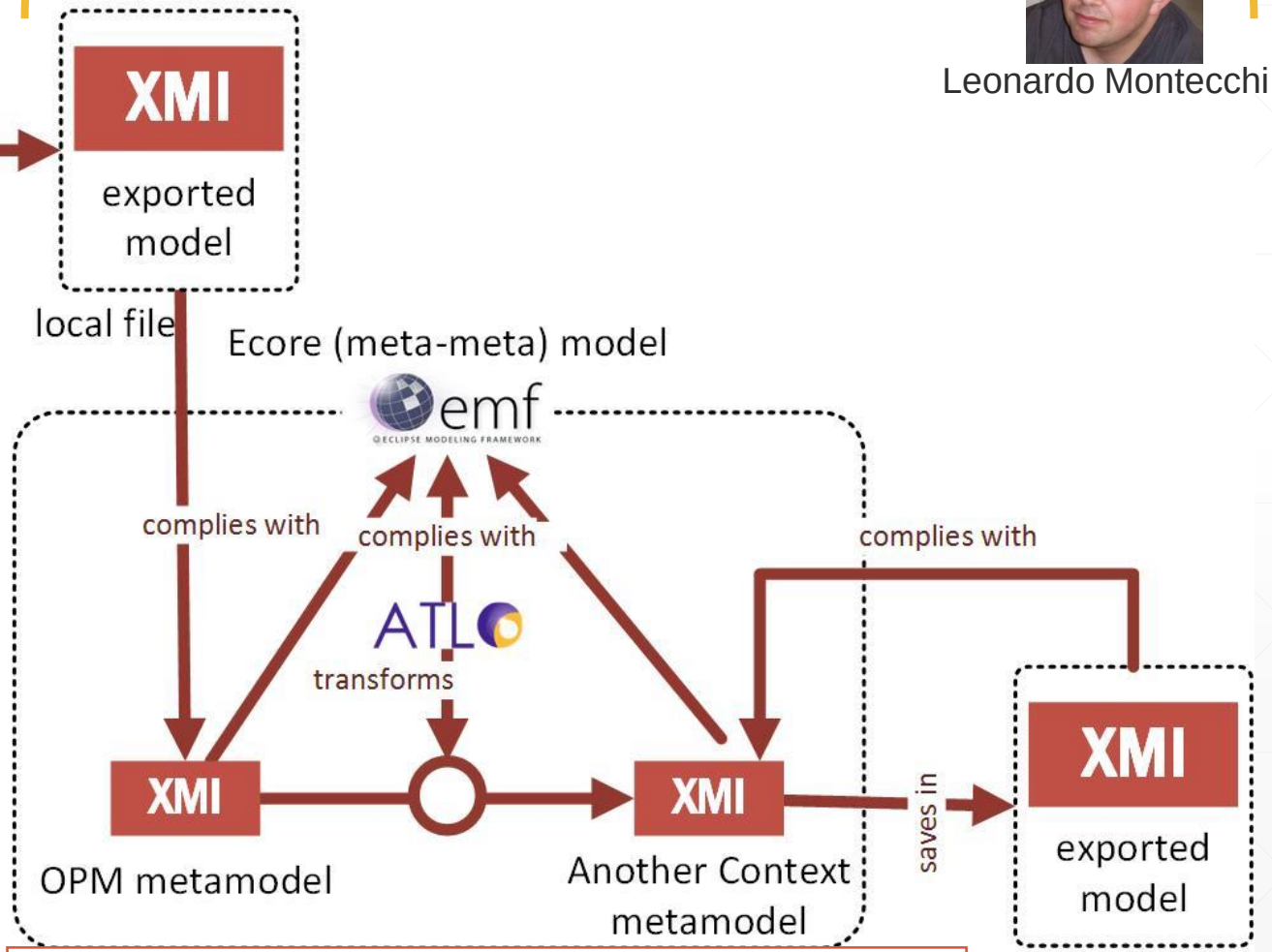
Model Transformation



further collaboration with the Università degli Studi di Firenze



Leonardo Montecchi



- to other tools
- perform analysis (fault-trees, model-checking, etc.)

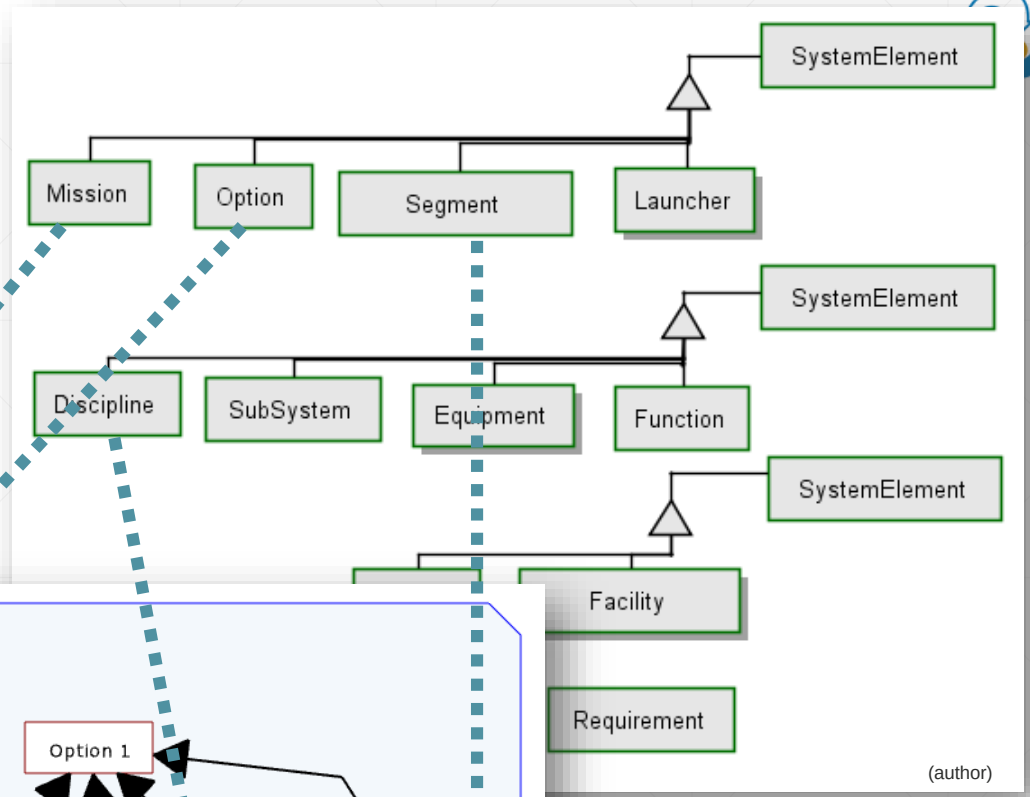
(author)

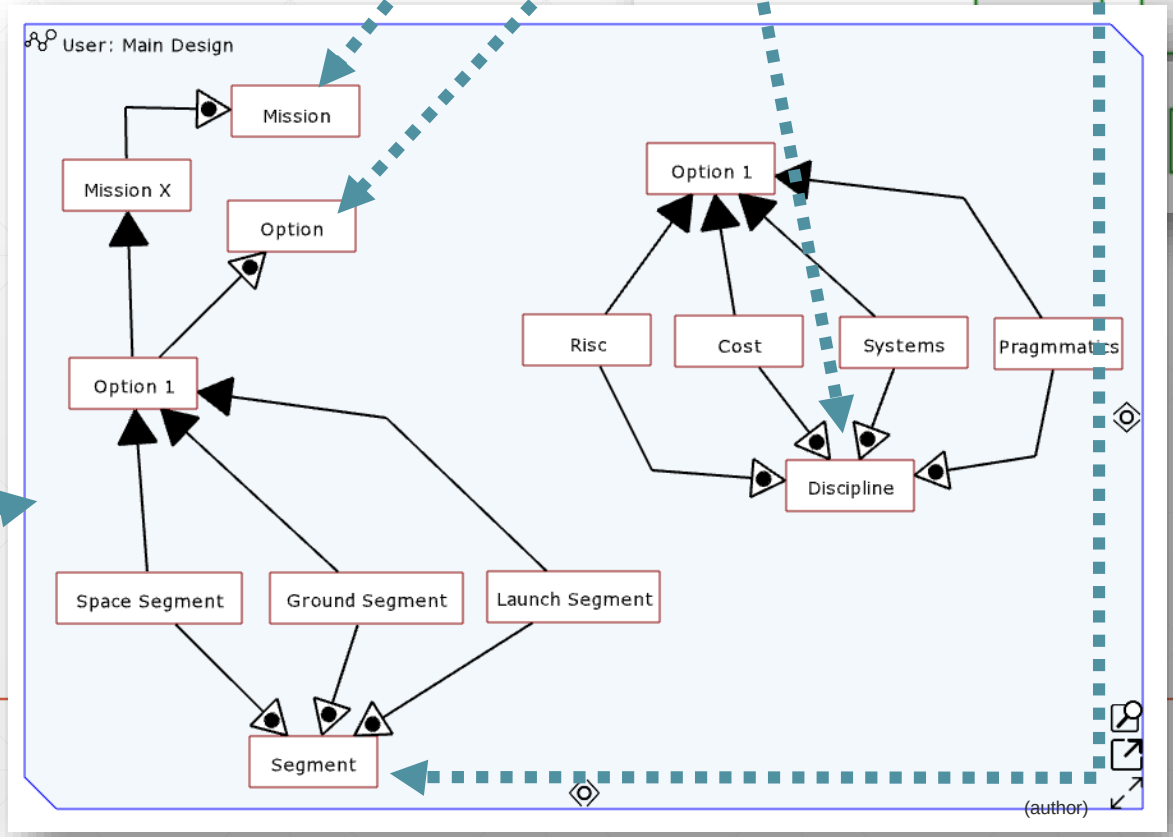
Model Transformation - OPM
<<*Template*>> vs. Model

Template or meta-model

Project X

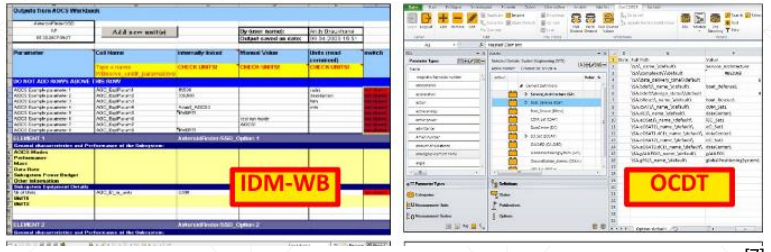
Model





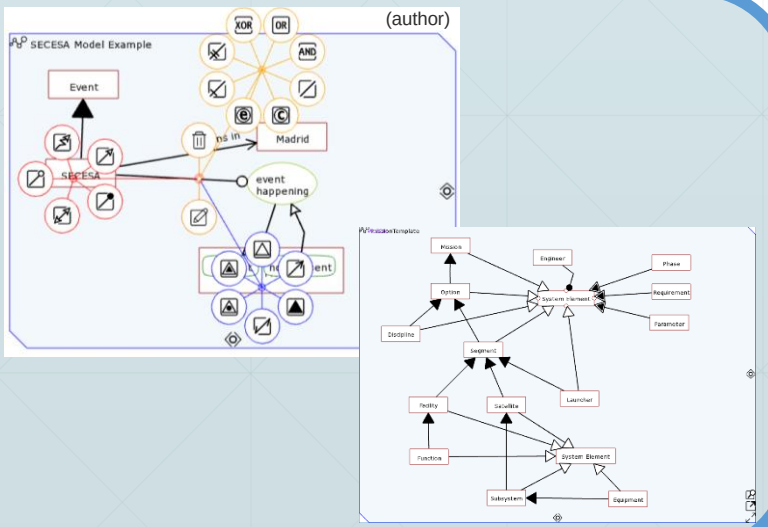
User Interface: OPM Designer

- *Document-centric model-based* user-interface tool
  “works directly into the final document”
- Textual/Parametric
- Web/**Local** based



[7]

- *Model-centric model-based* user-interface tool
  “works into models”
- Diagramatic
- Runs transformations using plain Java *(further collaboration)*
- **OPM Editor - Web**/Local based in JavaScript



- **OPCat** is a Prof. Dori (nowadays only) available **free option**.

User Interface: Visual Transformation

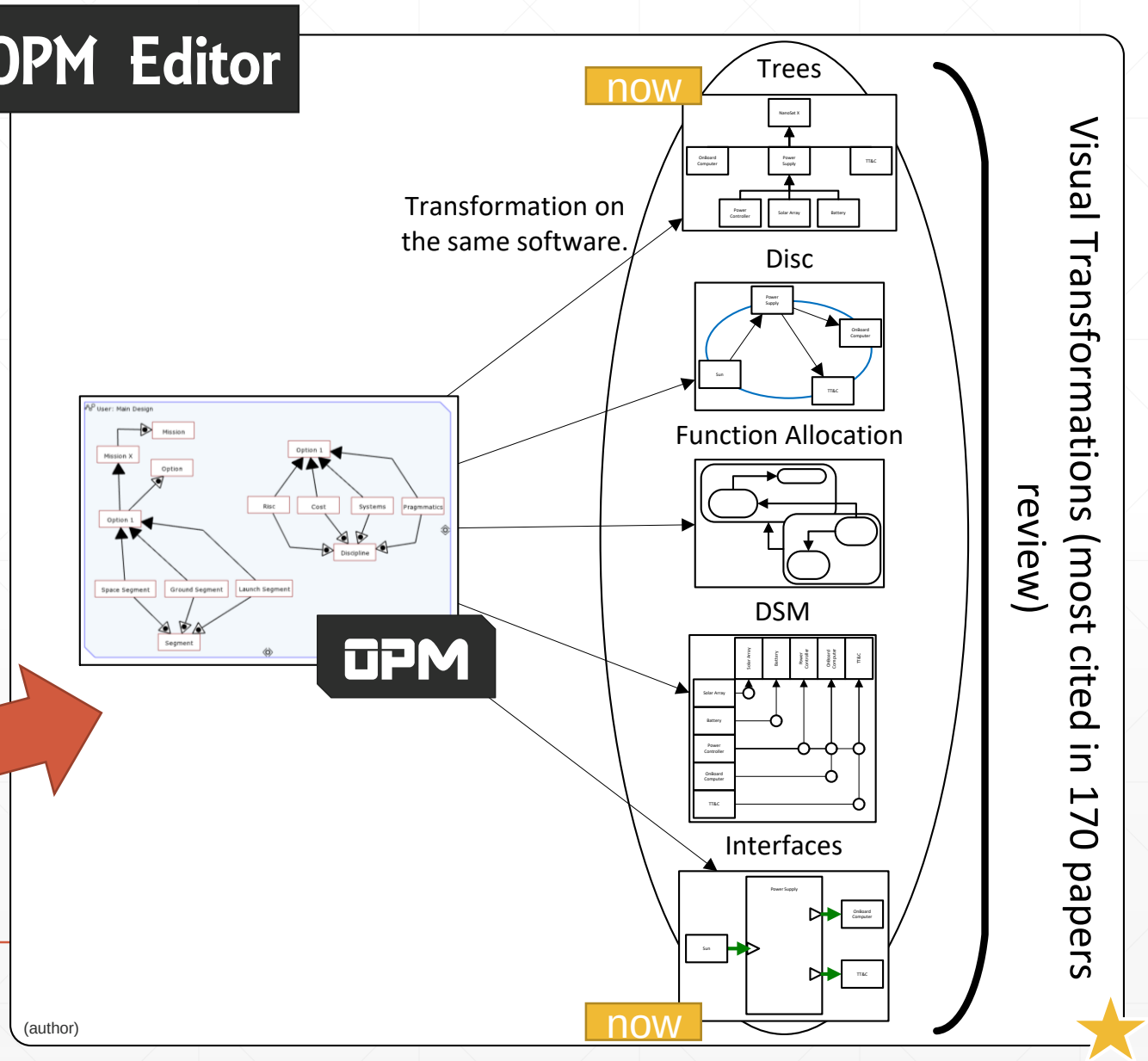
SECESA

Year	# works	# cite UI	# exclusive about UI
2010	48	28	3
2012	56	24	4
2014	66	29	5
Total	170	81	**12**

the most cited visual representations:

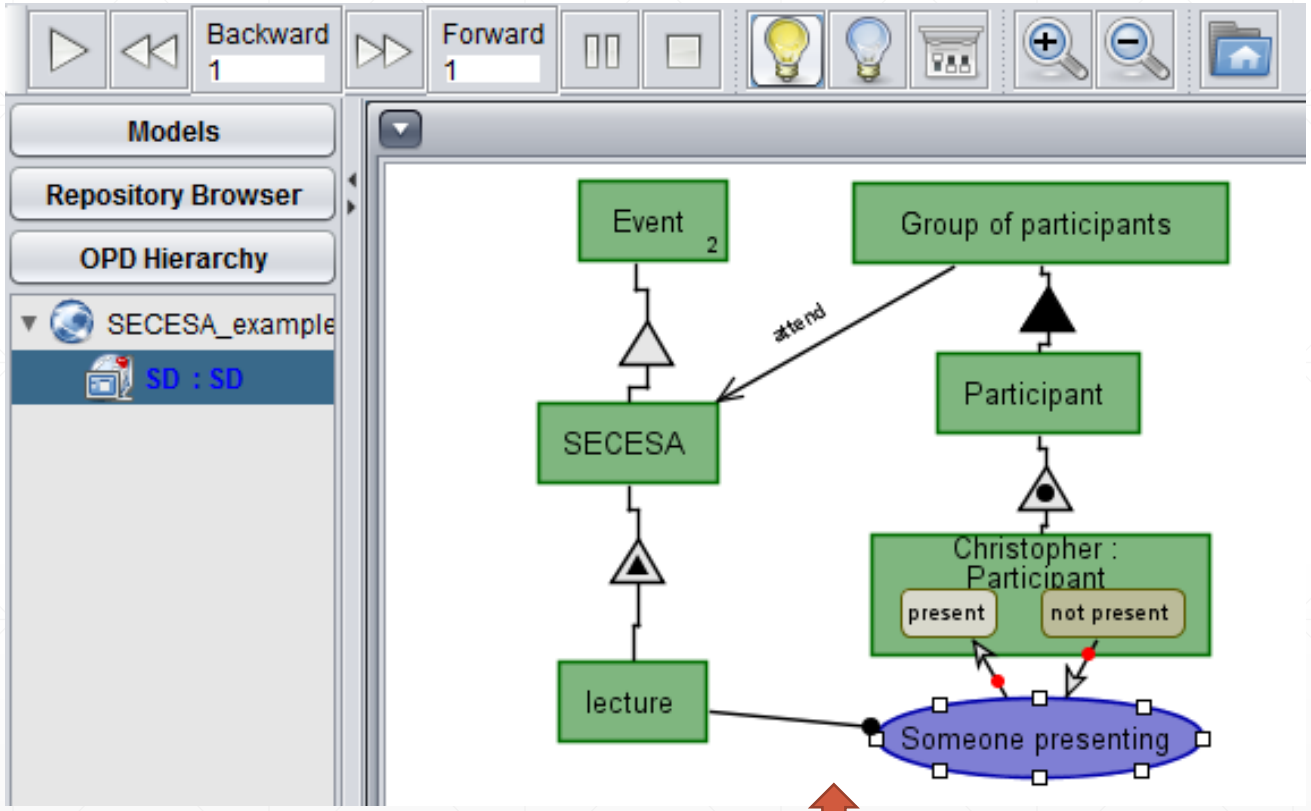
- **Trees,**
- **Tables,**
- **Discs,**
- **Block,**
- **FSM,**
- **DSM,**
- **Interfaces,**
- **3D,**
- **Etc..**

implementing



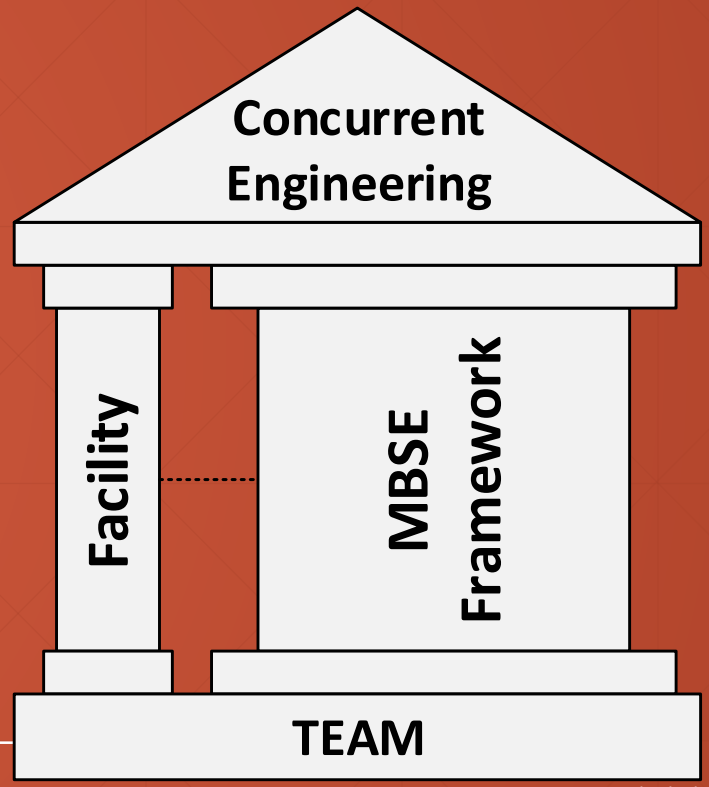
Simulation

- OPM is simulation ready
- Event-based simulation
- Main simulation activities are:
  - (i) enable processes,
  - (ii) transform objects, and
  - (iii) change object states.



- Figure with the **OPCat** Simulation Controls

Final Considerations



(author)

"Model Based Concurrent Engineering"

Final Considerations

OPM just turned to be a ISO standard. (15-Dec-2015)

Being looked by airspace companies (**EMBRAER/BOEING**)

Being researched to Concurrent Engineering (**Cambridge/INPE**)

- Knowledge Based Systems

Simpler to implement than any UML/SysML specification.

- Has direct compatibility with SysML models (**back/forth**)
- Being considered as a *de facto* substitute for SysML (**if it does not get reformulated**)

- Dual Channel → textual + visual
- Extra third Channel → simulation (**Active Processing**)

- More understandable than any UML-like visual representation to non-computer specialists.

It will be applied into the CubeSat Mission Definition of the INPE's MSc/PhD program

Questions to think:

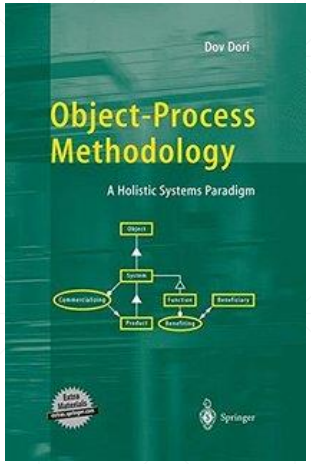
- How **easy** (or how **hard**) is to shift from doc-centric to (**OPM**) model-centric?
- Can **OPM** be ***the most relevant*** visual concept representation in CE?
- As it turned ISO, will **OPM** be an usual (space) engineering "*practice*"?
- Is **OPM** ready to **fulfill all CE needs**?

Thank you!
Questions?

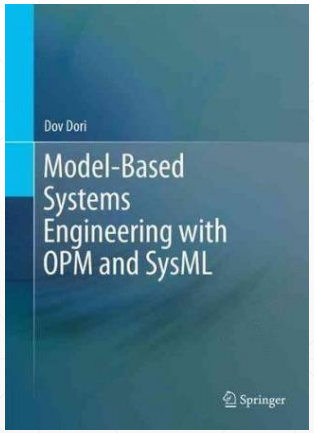
christophercerqueira@gmail.com
http://cscerqueira.com.br

- Prof. Ph.D. Ana Ambrosio - ana.ambrosio@inpe.br
- Prof. Ph.D. Claudio Kirner - ckirner@gmail.com

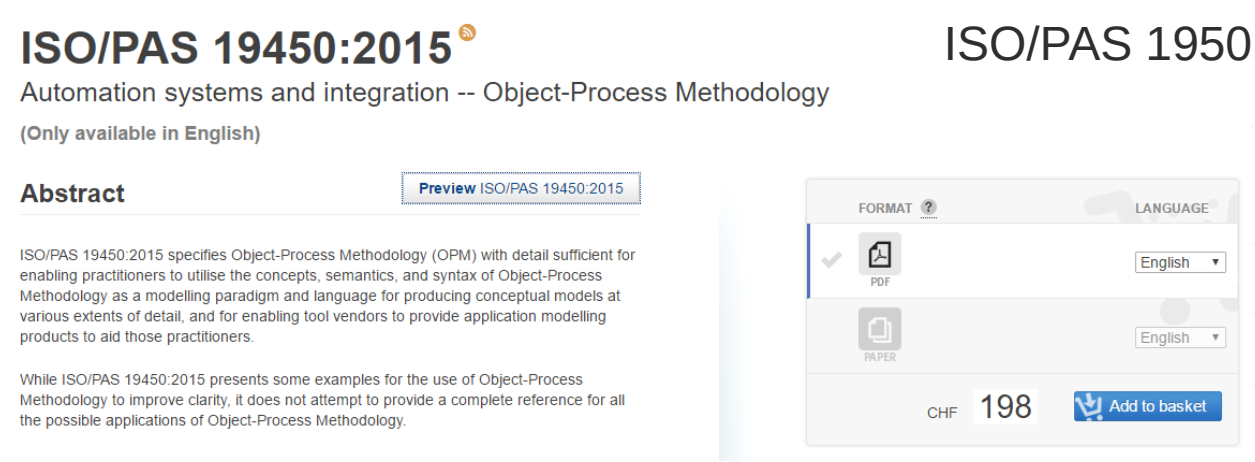
For further reading



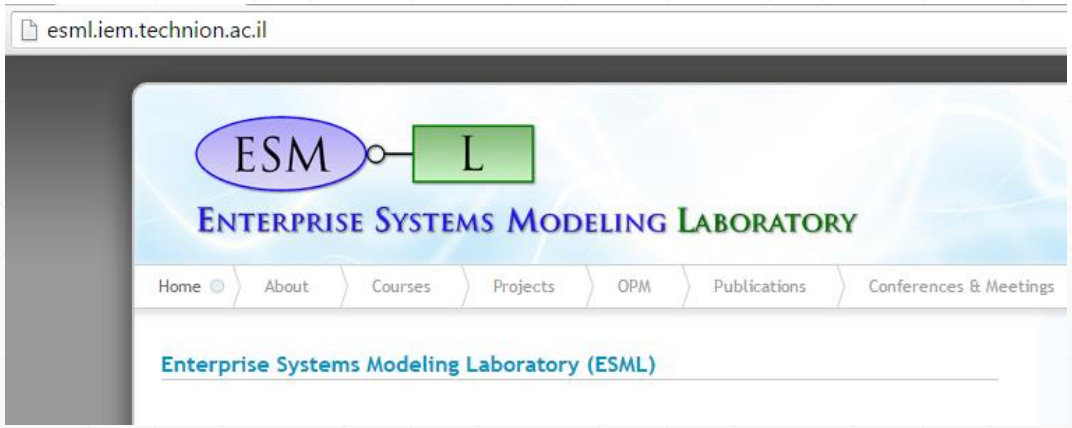
- Object-Process Methodology – A Holistic System Pardigm, Dov Dori



- Model-Based Systems Engineering with OPM and SysML

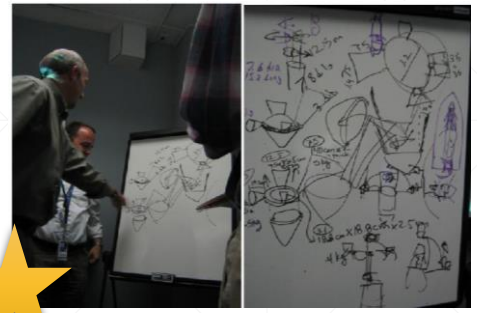


ISO/PAS 1950



All the free content at: http://esml.iem.technion.ac.il/

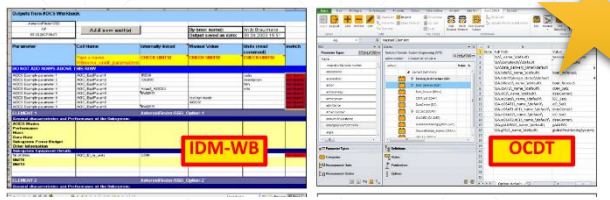
CE and Models – (model classification)



[TeamX]

(i) **free -** free descriptions of the systems with no formalism in it,

(ii) **loose** - free descriptions of the systems with a fair formalism in software interfaces,



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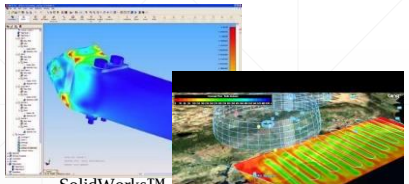


SolidWorks™

STK™

(iii) **domain specific** - described using a certain domain specific language, using the symbols and grammar available by the domains software used by the specialist; and

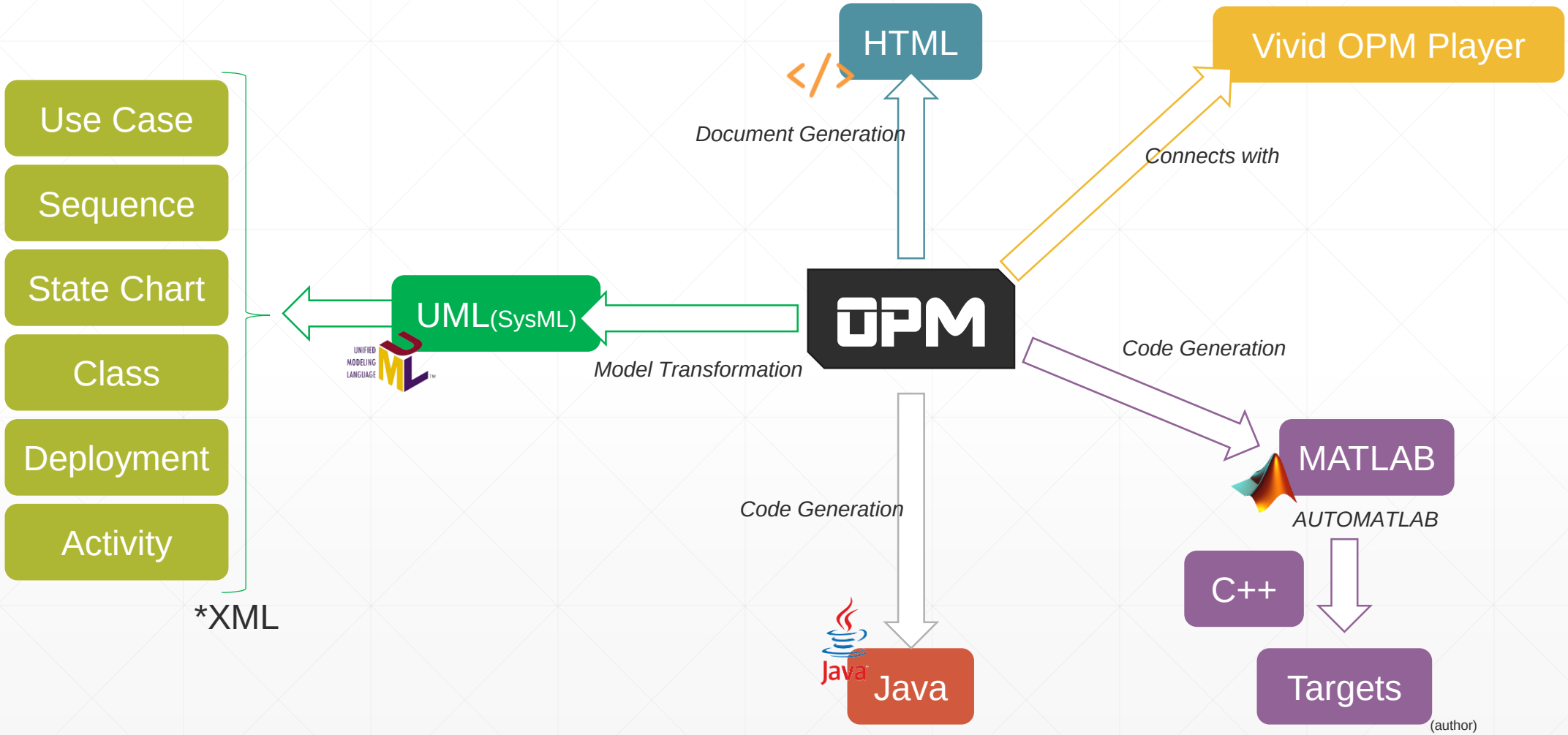
(iv**) tool independent** - described using a certain domain specific language that is a specialization of a higher-level meta language, and it is easily accessible by other tools.

emf ECLIPSE MODELING FRAMEWORK

UNIFIED MODELING LANGUAGE™

OPM

OPM Ecosystem (that I found)



In practice