

Models, Modeling, Knowledge and Transformation

Leon McGinnis
ISyE, ME, MARC, TI

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ABSTRACT

If we want to influence transformation, we have to understand what are the mechanisms at our disposal to do so. Then we have to exploit those mechanisms to achieve our objectives. What is the role of modeling in this? What do we have to know? How can we best deploy models to support transformation? As usual, I will have more questions than answers, and a few opinions to share.

Background: SysML (omgsysml.org); LM Aero; GE Energy; Boeing; Rockwell Collins; longtime fascination with modeling process

Outline

- Typical problem
- Typical approach
- Why it's seldom successful
- Some new technology
 - UML, SysML and MOF
 - MDA
 - QVT
- A different approach
 - Discrete event logistics systems: toward a domain specific language
 - Modeling the modeling application
 - Model transformation
- Implications for teaching, research and practice

Wind Supply Network

GE GSCM, Greenville, SC
GE GSCM, Pensacola, FL
GE GSCM, Techapi, CA
MFG Blades, TX & SD
TPI Blades, Newton, IA
MFG Nacelles, AL & CA
VCI Nacelles, Quebec
Marmen, Towers, Canada
GETS, Gearbox

GE GSCM, Salzbergen, Germany
SGL Rotec Blades, Bremen, Germany
LM Blades, Denmark & Spain
Fassmer Nacelles, Germany & Poland
CMC Nacelles, Spain
Jupiter Nacelles, Denmark
Fassmer Spinners, Poland

LM Blades, Hosakote & Dobbspet, India

GSCM, Shenyang, China
TPI Blades, Taicang
LM Blades, Tianjin City

- ★ GE Manufacture
- ▲ Blade Supplier
- ▬ Nacelle Supplier
- Spinner Supplier
- ✱ Tower Supplier

What is the best way to supply blades to customer sites? Where should new blade sources be developed? How much should we invest in blade tooling?

Typical Approach

- Develop wind turbine demand by geographic region
- Develop transportation cost models
- Develop production cost models
- Develop investment cost models
- Formulate honkin' big mixed integer, multi-period location-production-inventory-transportation model
- Crank it through a high end solver
- Format solution for ppt
- Voilà

Issues

- That's not really the question
- The wind turbine OEM is concerned about
 - Volatility due to governmental “participation” in the market
 - Dynamic response of the network can be a huge factor
 - The market is changing
 - Etc
- In other words, understanding both the dynamic response of the network, and the fundamental risks and their mitigations is the concern.
- The typical approach gives a perfectly good answer, but to a fairly limited question
- So what ***should*** we do?

What do we do?

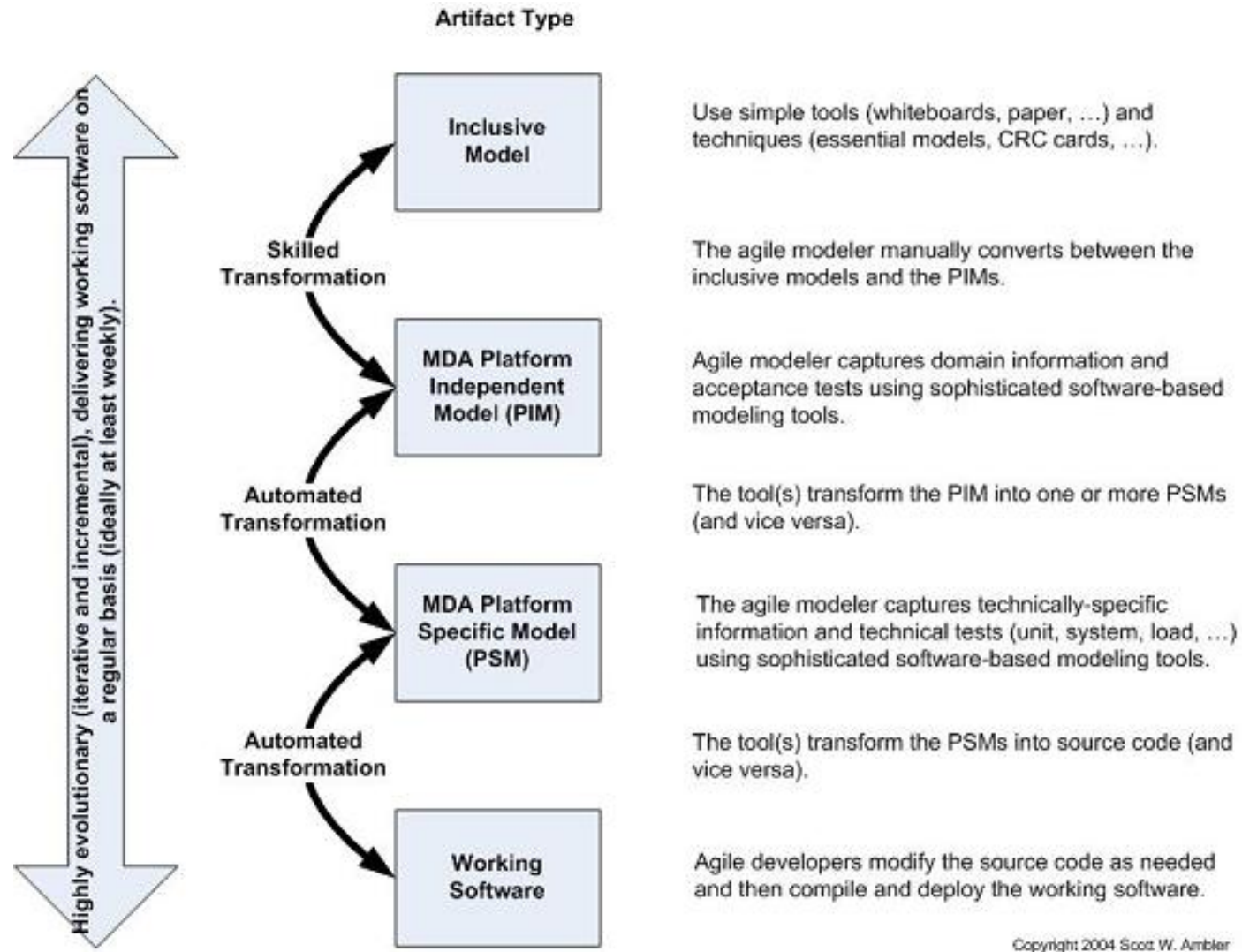
- We create **models**
- What is a “model”?
- An abstract representation of ... something
- **Formal** models use a **language** which has **syntax** to which we add **symantics**
- Example: $e = mc^2$ or $a = \pi r^2$
- Formal models are a way of encoding what we know so it is useable and re-usable
- Formal models are really useful, which is why we learn so many modeling languages:
 - Optimization
 - Probability
 - Statistics
 - Simulation
 - Finance
 - Java
 - Biology
 - Chemistry
 - ...

What is the appropriate role for modeling in enterprise transformation and how can we best exploit modeling technology?

New Technology

- MDA
- UML, SysML and MOF
- QVT

MDA: model driven architecture



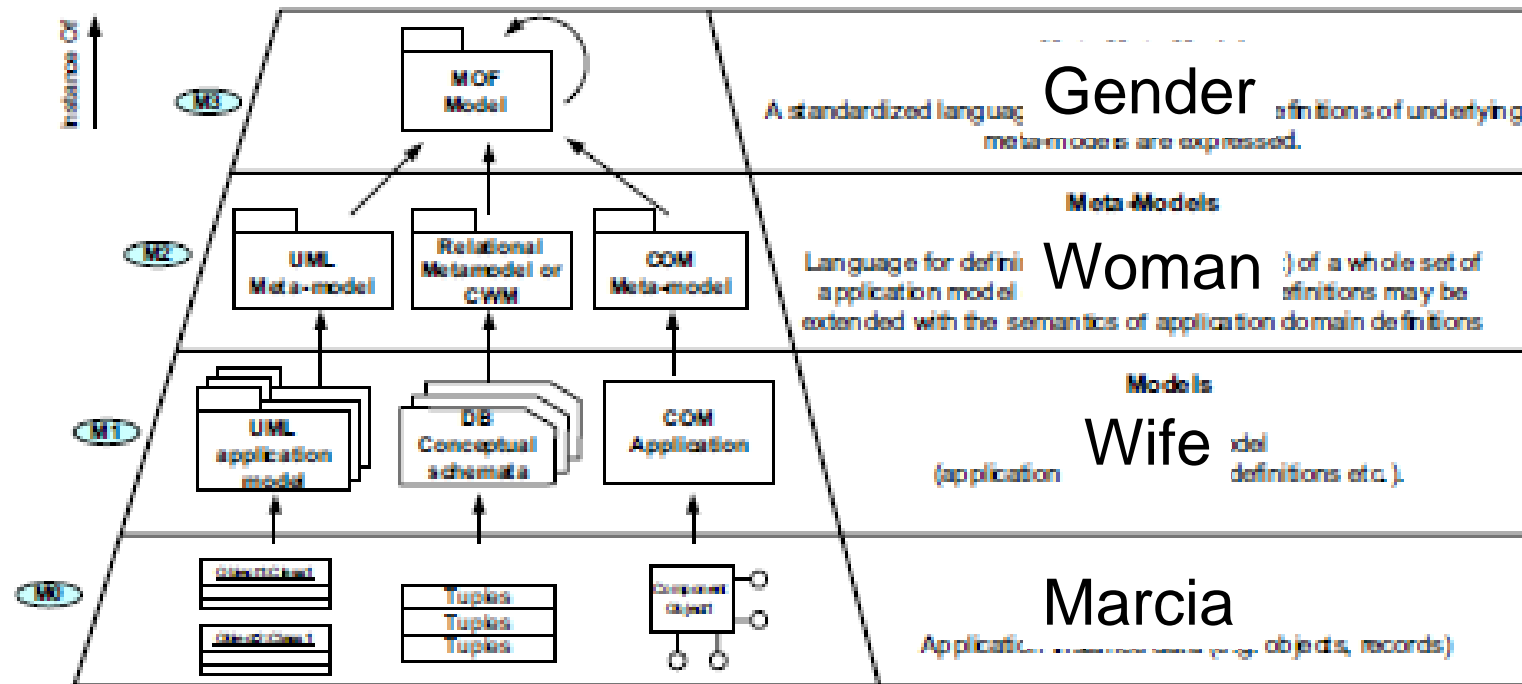
Copyright 2004 Scott W. Ambler

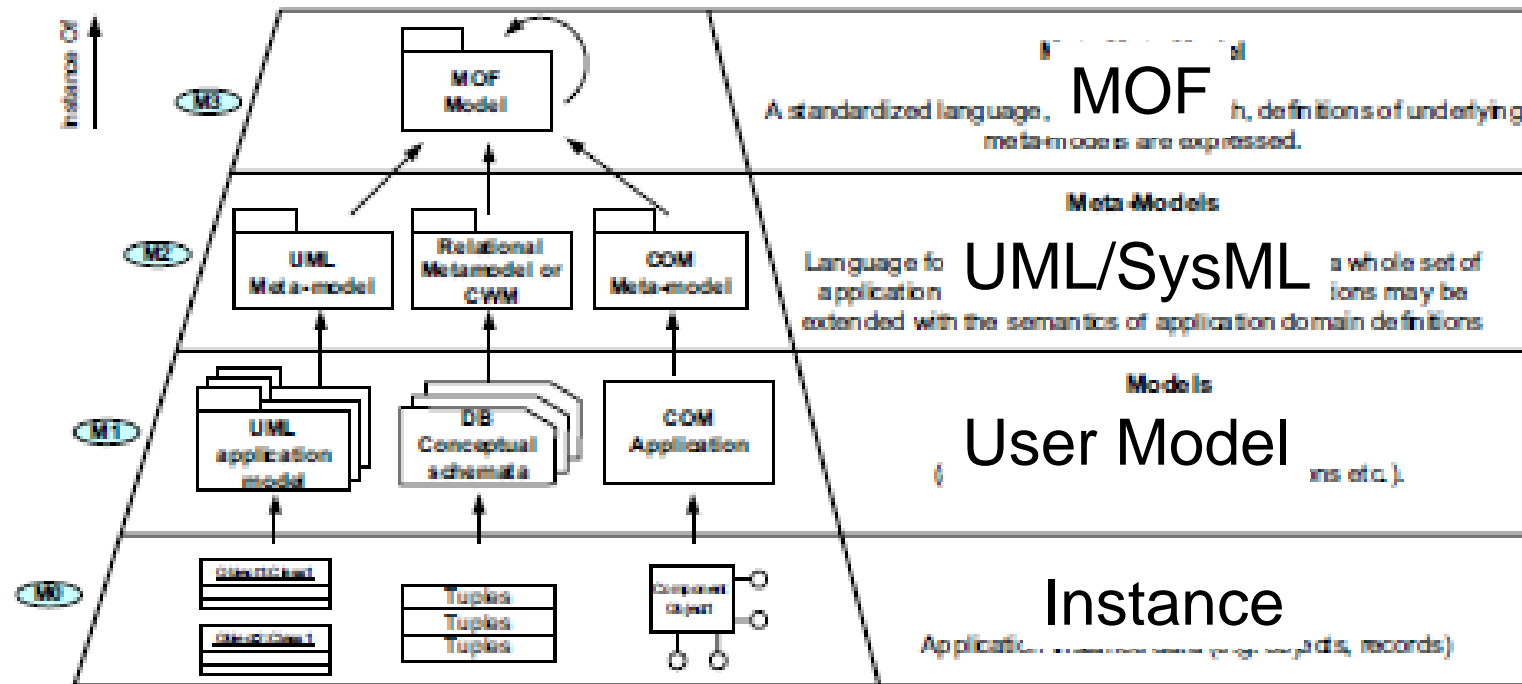
Why MDA?

- The “fun” part of software development is designing the application—what it does, how it works, how it interfaces with users and other systems
- The “drudge” part of software development is the actual code writing and debugging—implementing slight variations of what you already know how to do, just in a slightly different context or with slightly different requirements, for slightly different hardware platforms
- What if we could do the former in such a way that we could automate the latter?

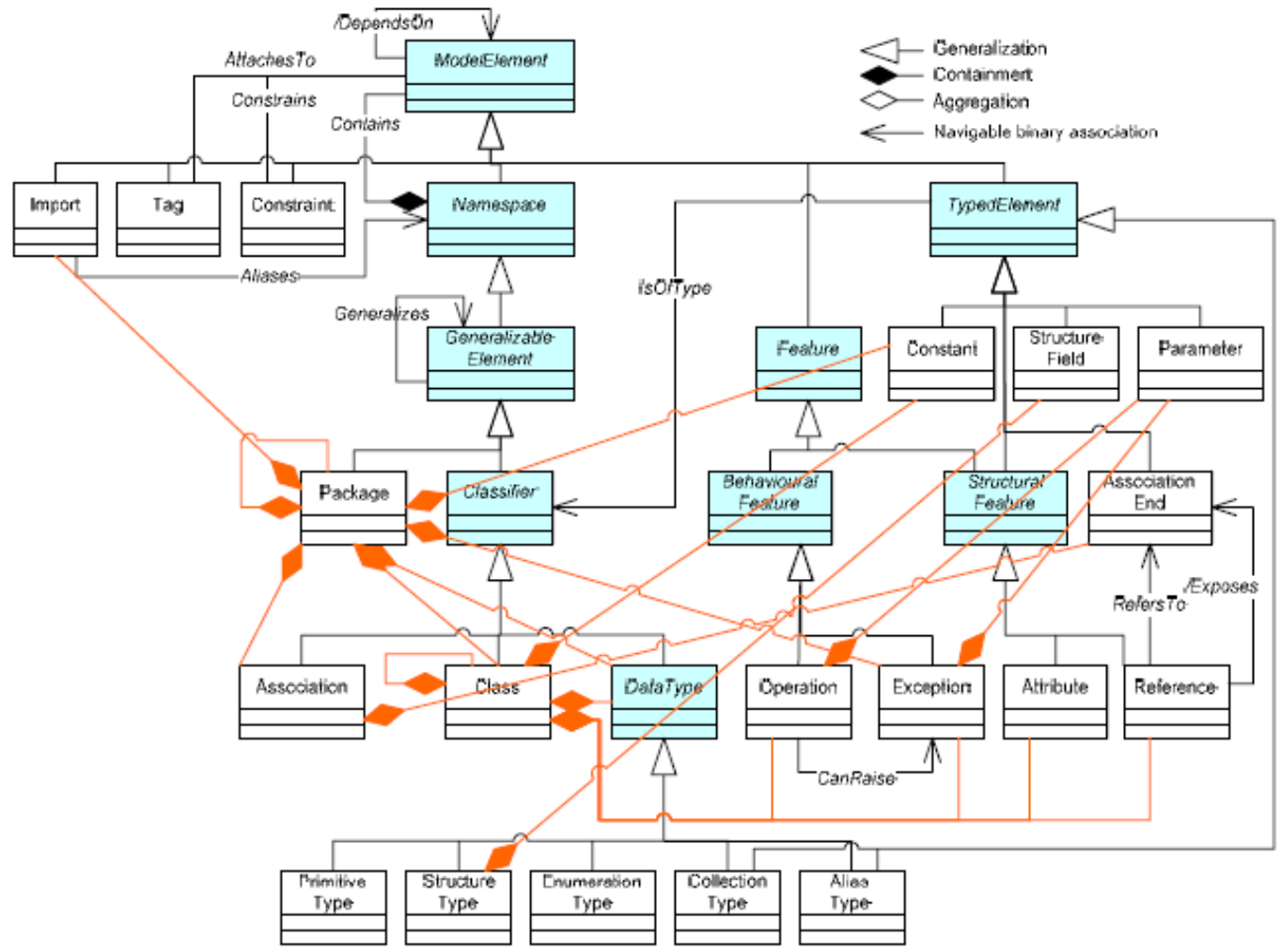
MDA depends on

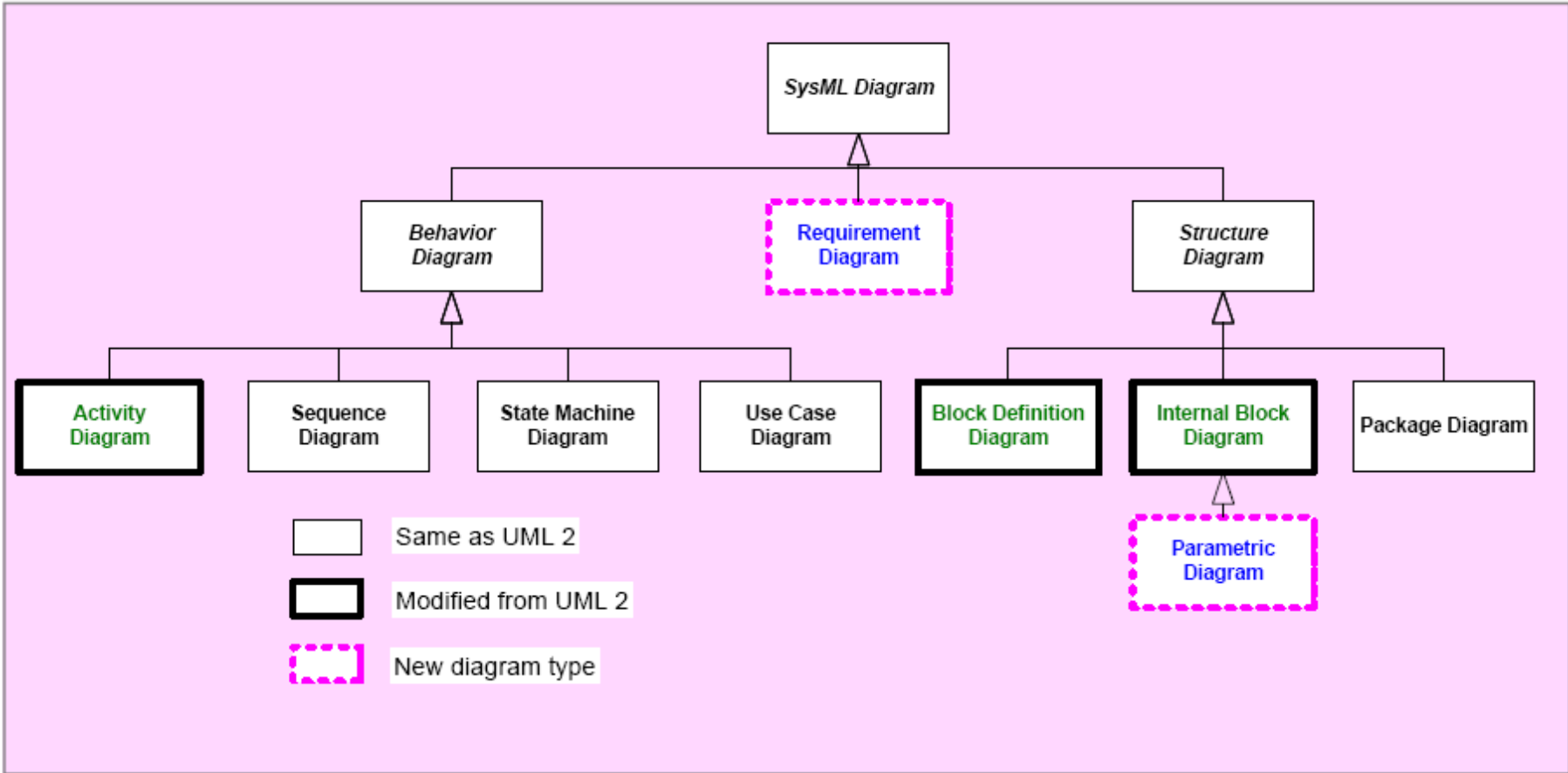
- Modeling language standards
 - MOF (Meta Object Facility)
 - UML (Unified Modeling Language)
 - SysML (Systems Modeling Language)
- Transformation standards
 - QVT (Query/View/Transformation)
- Model exchange standards
 - XML (eXtensible Markup Language)
 - XMI (XML Metadata Interchange)



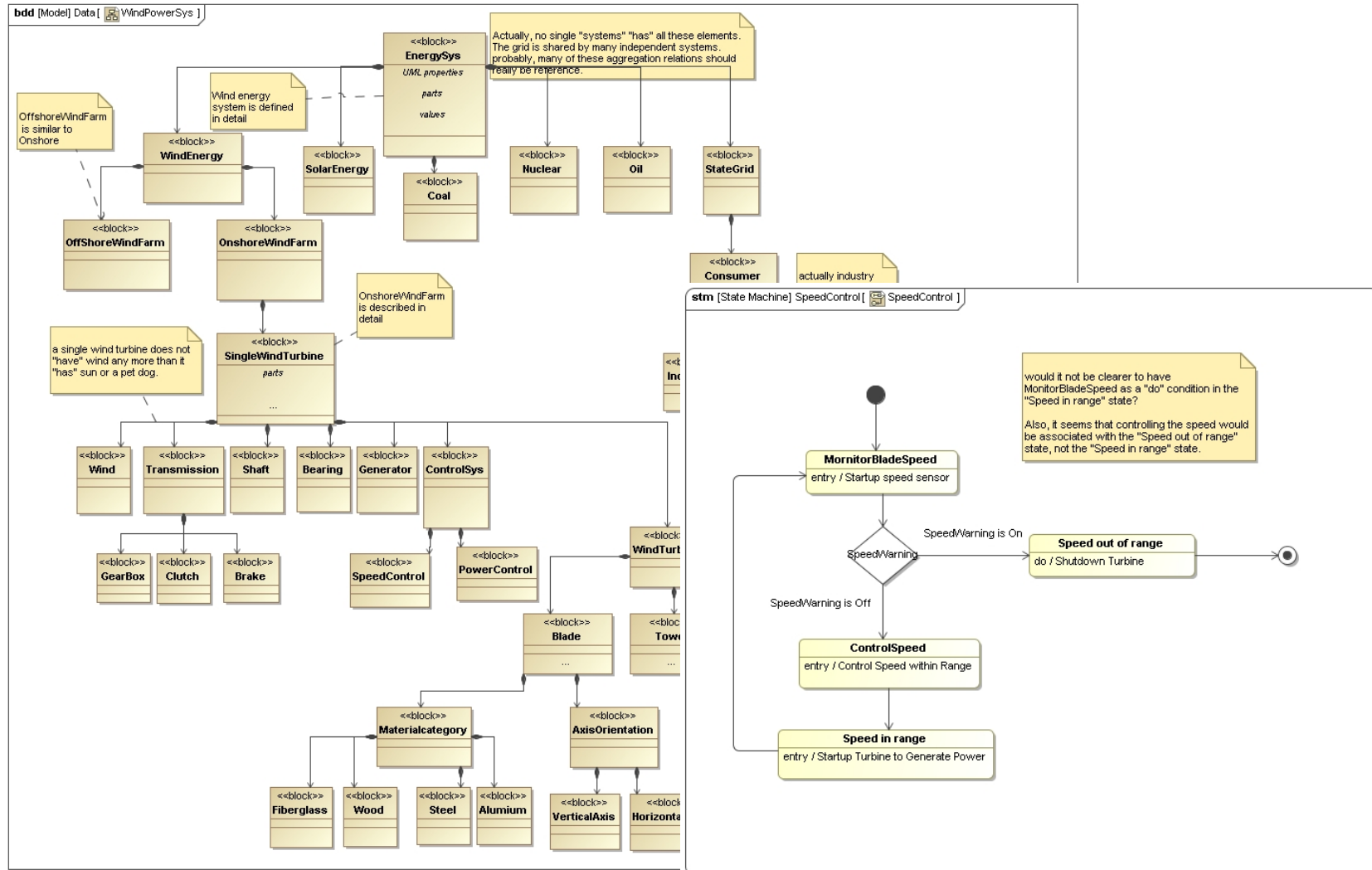


What MOF looks like

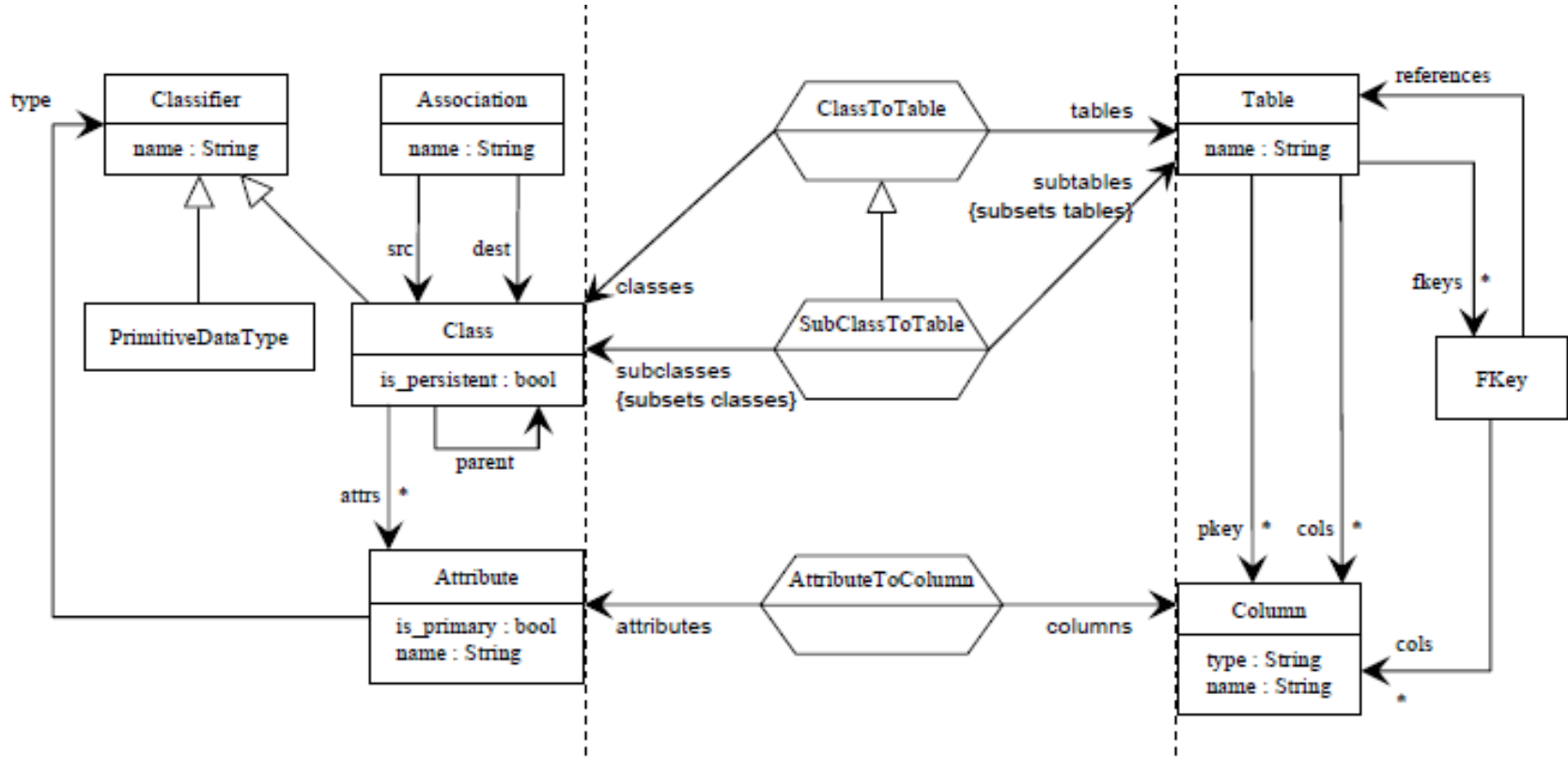




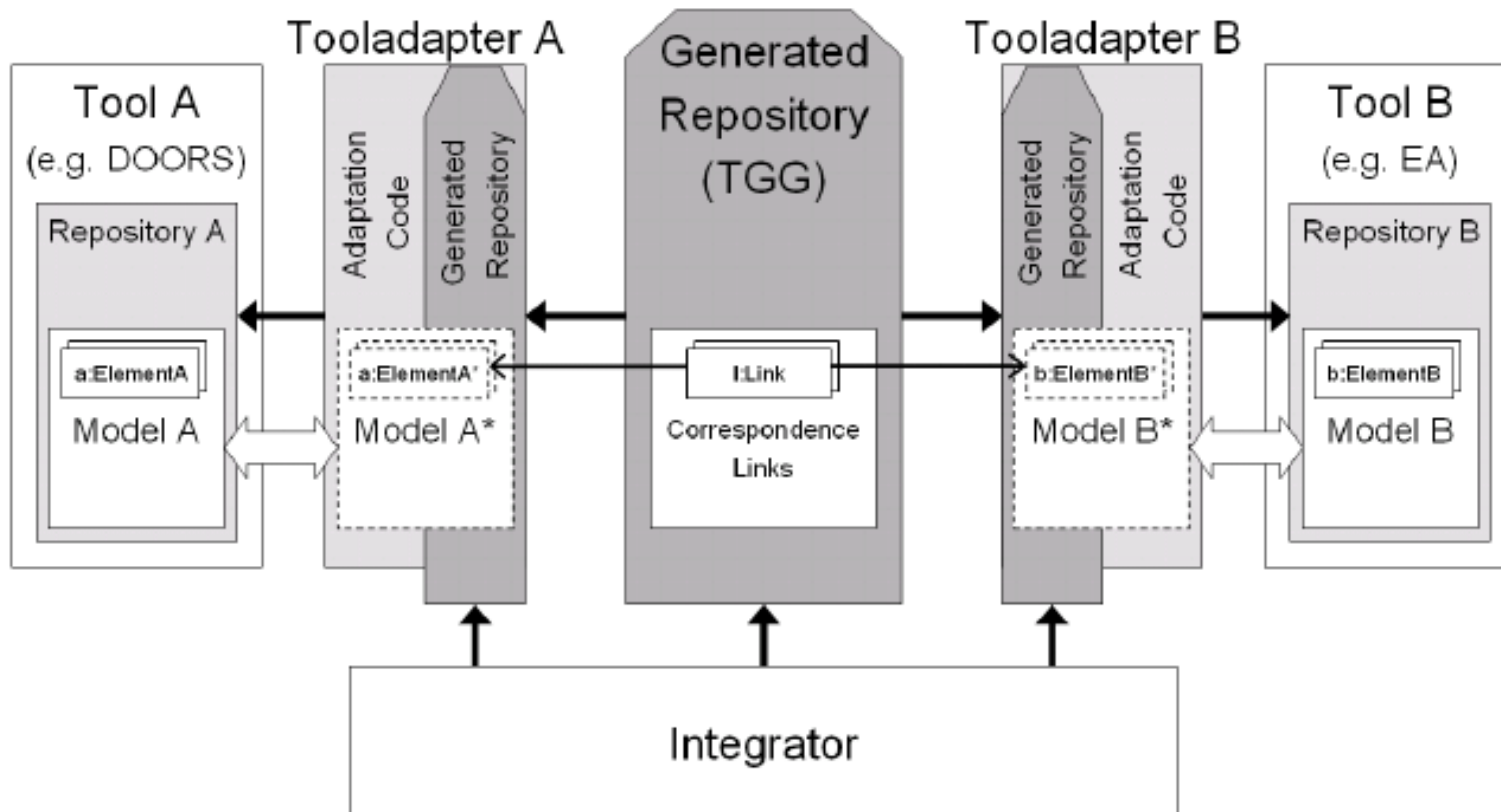
A SysML Diagram



Model transformation



Tool integration via transformation



Carsten Amelunxen, Felix Klar, Alexander Königs, Tobias Rötschke, Andy Schürr, **Metamodel-based Tool Integration with MOFLON**, ICSE'08, May 10–18, 2008, Leipzig, Germany

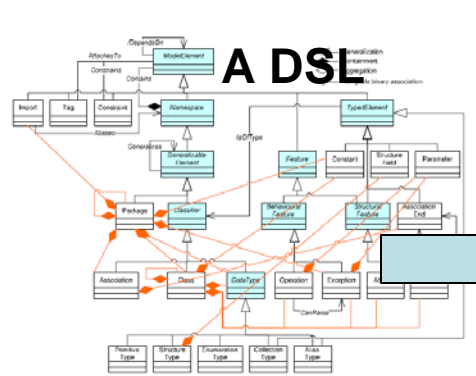
What is the real power of MDA?

- Knowledge encoding for re-use!
 - Modeling language: how we express design requirements, design intent, and design itself
 - Transformation technology: how we express the process of translating from one language (application design) to another language (software implementation)

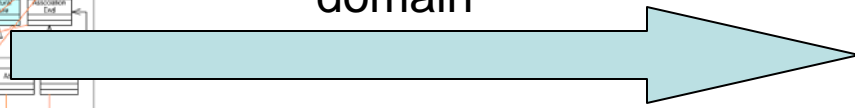
How is this relevant to us?

- [The TI “process”](#)
- We “design” decision support “applications” which we then need to “code” to create “solutions”
- What we do has strong analogies to software development
 - Requirements
 - Intent
 - Design
- Can we extend and exploit concepts from MDA to dramatically enhance the impact that we have in enterprise transformation?

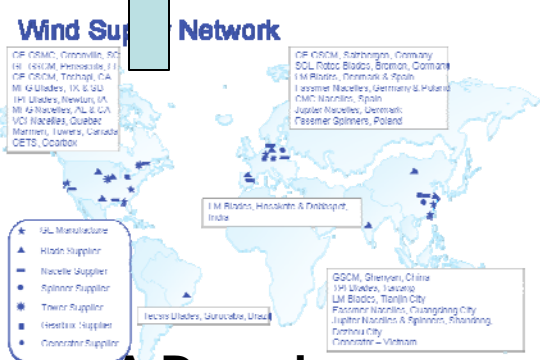
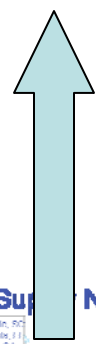
The essential concepts



Use DSL to create "federated" model of a problem of interest in the domain

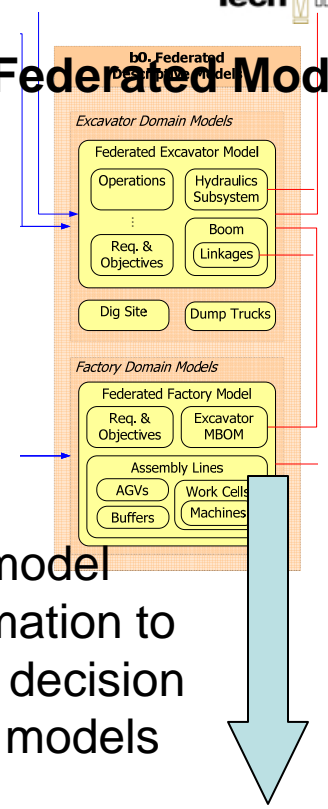


Use SysML to create a domain specific language (meta model)

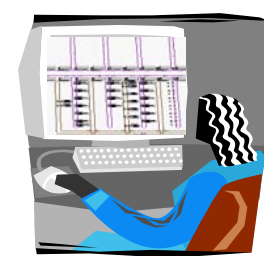
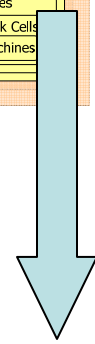


A Domain

Federated Model



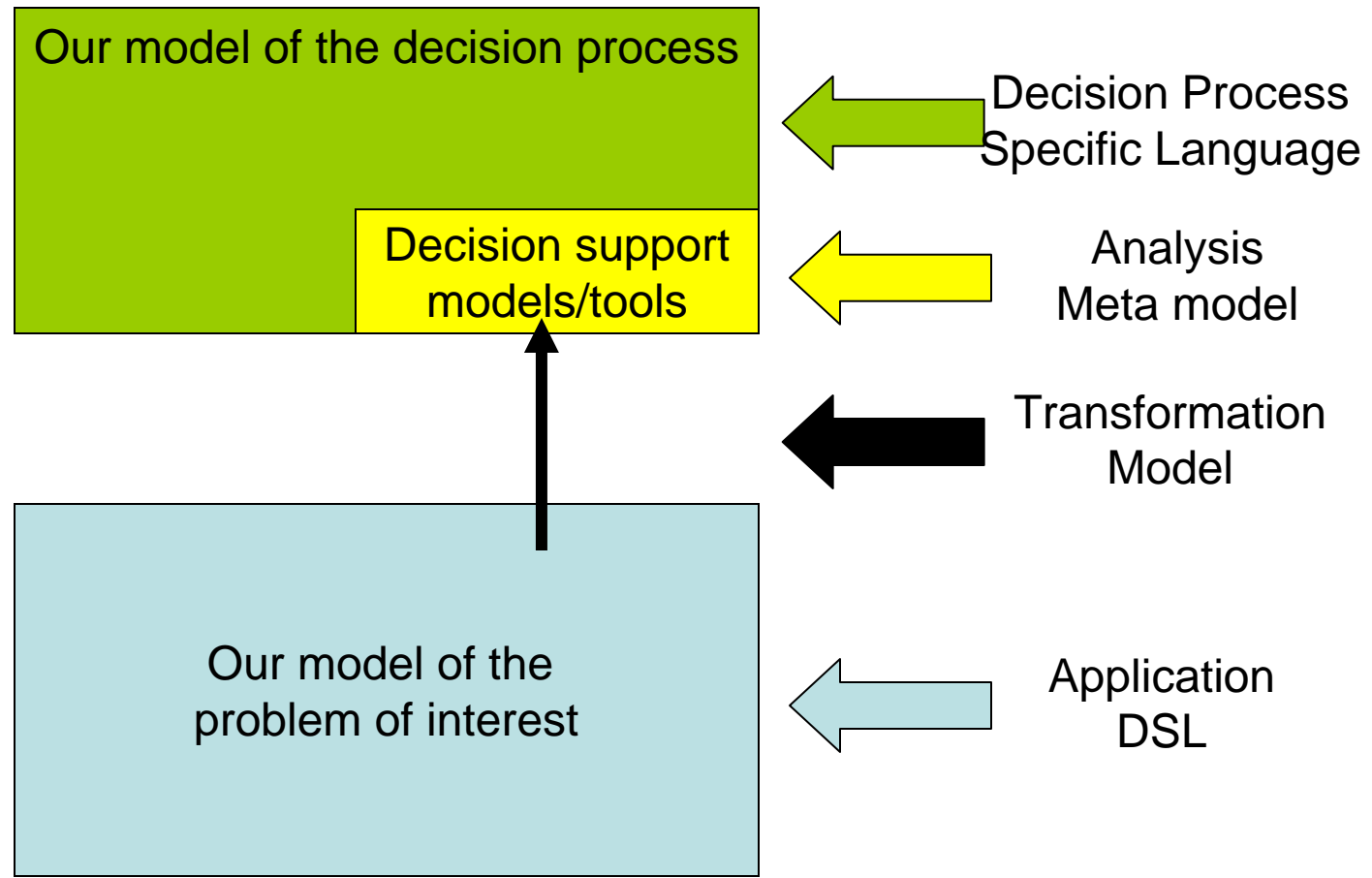
Use model transformation to generate decision support models



Two challenges

- Creating the technology and methodology to do this
 - Domain specific languages
 - Meta models for our standard analyses
 - Transformation mappings or rules
 - Demonstrations
- Developing the practices appropriate for the deployment of this new capability

What we have to invent



Why is this not total raving lunacy?

- Formal languages
- Incremental development—start small and build out
- Widely available supporting technology
- Enthusiasm from potential user community

Why this is total raving lunacy

- Requires a broader scope of competency
 - Domain
 - SysML
 - QVT
 - Analysis tools
- Not a natural way of thinking in the IE/OR community (today)
- Challenges the curriculum in fundamental ways

Current Funding

- LM Aero: \$3.2 million over 3 years; these concepts played a key role in the proposal
- GE Energy: \$250k over 4 months, potential follow-on; core aspect of proposal
- Rockwell Collins: \$50k gift: focus on model transformation for factory simulation
- Additional proposals in preparation

Thank you.



The Tennenbaum Institute Research Approach for Enterprise Systems

1 Domain in Transformation

Enterprise Systems Characterized by Scale, Scope, Complexity, and Technical & Human Capabilities

- Health Care Delivery System
- Manufacturing Enterprise System

Information and Communication Technologies

2 Frame the Challenges

Intents:

As Is

To-Be

Solution Intent:
Value Creation
Through Network Centric
Capabilities

Scope:

Activity

Function

Organization

Enterprise

Means:

Skills

Processes

Technology

Strategy

3 Identify & Create Required Knowledge

Change

Architecture

Network
Centricity

Complexity

Collaboration

Innovation &
Integration

Systems
Modeling

Org. Simulation/Games
& Visualization

Economic & Financial
Modeling

Statistical Modeling
& Data Mining

Organizational
Culture Change

4

Deploy Knowledge

Archival

Knowledge
(Research)

Collaboration
Venues

Skills
(Education
& Training)

Graduates

Applications

Partners

An example model

