Industrial Adoption of Model-Driven Engineering: Are the Tools Really the Problem?

Jon Whittle, John Hutchinson, Mark Rouncefield Håkan Burden and Rogardt Heldal What is the biggest challenge that companies face when adopting MDE?

## Most would say tools...

- Den Haan:
  - One of the main reasons MDE fails
- Kuhn:
  - Five problems of MDE; all tool related
- Staron:
  - Too immature for cost efficient adoption

We don't understand how tools are actually used in industry.

### Contribution

A taxonomy of issues professionals have with MDE tools

## We asked practitioners about their experiences about MDE tools

20 companies39 professionals100s of data points300,000 words of transcribed data

#### Method

Cluster

- 19 interviews
- 18 companies

Annotate

- Technical
- Internal org.
- External org.
- Social

- 20 interviews
- 2 companies

Validate

#### Purpose of the taxonomy

Checklist for developing new tools Framework for evaluating existing tools

Identifies Technical,

Organizational and

Social factors

of MDE tools that open new research possibilities

Table 1. Technical Categories.

Sub-Category	T	able 4. Social Cat	ogorios
A P. A. M. Barrier B. A. B.			
- Modeling Behavior - Action Languages - Support Domain-Specific Languages	Category		Sub-Catagony
<ul> <li>Support for Architecture</li> <li>Code Generation Templates</li> <li>UML Profiles</li> <li>Scoped Code Generation</li> </ul>	Control Impact of tools on u et in control of their p oj	Socia	
- Tool Scal	Trust Impact of trust on wol us	e and adoption	Vendor Trust Engineers' Trust
Tools	Ta le 3. External Organizational Categories.		
ex y	Category	Evton	
- Accidental Complexity Introduced by Tools	External Influer	cxten	nai
- Whether Took Match Human Abstractions - Usability	Factors which no direct conti		
- Theoretical Formal Seman cs ndations of Tools	Commercial Aspects Business consider tio	Orgar	nizational
- Impact on Que ity - Impact on Productivity - Impact on Mantainability	on tool use and ap lic		
	- Support Domain-Specific Languages - Support for Architecture - Code Generation Templates - UML Profiles - Scoped Code Generation - Tool Scal - Tool Scal - Tools - Tools - Tools - Tools - Ether - July aty of Generated Code - Formal Seman cs - Impact on Que - Impact on Profiles - Code Generation - State Code - State	Support Domain-Specific Languages Support for Architecture Code Generation Templates UML Profiles Scoped Code Generation Tool Scal Tool Scal Tools External Influence Category  Category  Trust Impact of tools on u et in control of their p of Trust Impact of trust on vol use  Category  Trust Impact of trust on vol use  Category  Category  Category  External Influence Factors which no direct contin  Commercial Aspects Business consider to on tool use and ap lic	Support Domain-Specific Languages Support for Architecture Code Generation Templates UML Profiles Scoped Code of heration Tool Scal Tool Templates  Lether Language Considering Accidental Complexity Introduced by Tools Whether Tool Match Human Abstractions Usability Theoretical Foundations of Tools Formal Seman cs Impact of tools on uncert in control of their proj  Category  Category  Trust Impact of trust on cool use and adoption  Talle 3. External Organiza  Category  External Influence Factors which no direct control  Commercial Aspects Business consider to on tool use and applic

ub-Category

Tailoring to Existing Processes Sustainability of Tools

Level

Internal Organizational

Category

Q

## Usability

If you want intuitive tools develop your own.

# Accidental complexity



## Tool versioning (or the Portability Paradox)



Table 1. Technical Categories.

Category	Sub-Category	Table 4. Social Ca	atamorias
Tool Features	- Modeling Behavior - Action Languages - Support Domain-Specific Languages	Category Category	Sub-Catagony
Specific functionalities offered in tools	- Support for Architecture - Code Generation Templates - UML Profiles - Scoped Code Congration	Control Impact of tools on u et in control of their p oj	
Prestical Applicability	- Tool Scal	Trust Impact of trust on pol use and adoption	Vendor Trust Engineers' Trust
Techni	60 101	Ta le 3. External Organiz	zational Categories.
Co	ex y	Category	
Challenges brought on by exces- sive complexity in tools	- Language Complexity - Accidental Complexity Introduced by Tools	External Influence External	nai
Human Factors Consideration of tool users	- Whether Tools Match Human Abstractions - Usability	Factors which no direct conti	
Theory Theory underpinning tools	- Theoretical Foundations of Tools - Formal Seman cs	Commercial Aspects Business consider to	nizational
Impact on Development Impact of tools on technical suc-	- Impact on Queity - Impact on Projectivity	on tool use and ap lic	

Sub-Category

Tailoring to Existing Processes
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## Tailoring tools to existing...

... processes

... culture



## Low hanging fruit

...but be careful not to overgeneralize

Table 1. Technical Categories.

Sub-Category	Table 4 Social (	Catagorias
- Modeling Behavior - Action Languages - Support Domain-Specific Languages	Category Category	Sub-Catagory
<ul> <li>Support for Architecture</li> <li>Code Generation Templates</li> <li>UML Profiles</li> <li>Scoped Code Generation</li> </ul>	Control Impact of tools on uset in control of their poj	al
- Tool Scal	Trust Impact of trust on vol use and adoption	Vendor Trust Engineers' Trust
60 101	Ta le 3. External Organ	izational Categories.
ex y	Category	
- Language Conplexity - Accidental Complexity Introduced by Tools		rnai
- Whether Tools Match Human Abstractions - Usability	no direct cont	
- Theoretical Foundations of Tools - Formal Seman cs	Commercial Aspects Business consider to	nizational
- Impact on Que ity - Impact on Projectivity - Impact on Mantainability	on tool use and ap lic	
	- Modeling Behavior - Action Languages - Support Domain-Specific Languages - Support for Architecture - Code Generation Templates - UML Profiles - Scoped Code Generation - Tool Scale Generation - Tool Scale Generated Code - Fools Tools - Tools - Expectage Conclusity - Accidental Complexity Introduced by Tools - Whether Tools Match Human Abstractions - Usability - Theoretical Foundations of Tools - Formal Semances - Impact on Quinty - Impact on Promuctivity	- Modeling Behavior - Action Languages - Support Domain-Specific Languages - Support for Architecture - Code Generation Templates - UML Profiles - Scoped Code Generation - Tool Scal - Language Con olexity - Accidental Co plexity Introduced by Tools - Whether Tool Match Human Abstractions - Usability - Theoretical Foundations of Tools - Formal Seman cs - Impact on Queity - Impact on Queity - Impact on Projectivity - Tool Scal - Trust - Impact of trust on wol use and adoption - Category - External Influence - Factors which - no direct continuous of trust on wol use and adoption - Category - External Influence - Factors which - no direct continuous of trust on wol use and applic - Commercial Aspects - Business consideratio - on tool use and applic

Sub-Category

Tailoring to Existing Processes
 Sustainability of Tools

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Category

Level



## Marketing issues

High

Low

Table 1. Technical Categories.

Category	Sub-Category	Table 4. Social C	ategories
Tool Features	- Modeling Behavior - Action Languages - Support Domain-Specific Languages	Category	Sub-Catagory
Specific functionalities offered in tools	- Support for Architecture - Code Generation Templates - UML Profiles - Scoped Code Concration	Control Impact of tools on uset in control of their proj	
Practical Applicability	- Tool Scal	Trust Impact of trust on vol use and adoption	Vendor Trust Engineers' Trust
Techni	60 101	Ta le 3. External Organiz	zational Categories.
Co	ex y	Category	
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Human Factors Consideration of tool users	- Whether Tools Match Human Abstractions - Usability	Factors which no direct conti	
Theory Theory underpinning tools	- Theoretical Foundations of Tools - Formal Seman cs	Commercial Aspects Business consideratio	nizational
Impact on Development Impact of tools on technical suc-	- Impact on Queity - Impact on Productivity	on tool use and ap lic	

Sub-Category

Tailoring to Existing Processes
 Sustainability of Tools

Level

## Internal Organizational

Category

## Trust...

... the tool?

... the vendor?

... the change?



## Open communities



Table 1. Technical Categories.

Category	Sub-Category	Table 4. Social Categories.		tegories	
- Modeling Behavior - Action Languages - Support Domain-Specific Languages - Support for Architecture - Code Generation Templates - UML Profiles - Scoped Code Generation	- Action Languages	Table 4. Bottai Categories.			
		Category		Sub-Category	
	Control Impact of tools on whether stakeholder in control of their project	rs feel	Interaction with Tool Vendors Subverting Tools		
Practical Applicability  Challenges of applying tools in practice  - Tool Scaleability - Tool Versioning - Chaining Tools Together - Industrial Quality of Generated Code - Flexibility of Tools - Maturity of Tools	Trust Impact of trust on tool use and adoption		Vendor Trust Engineers' Trust		
	Table 3. External Organizational Categories.				
Complexity - Tool Complexity	Category	Sub-Category			
Challenges brought on by exces- sive complexity in tools	- Language Complexity - Accidental Complexity Introduced by Tools	External Influences	- Marketing Issues		
Human Factors Consideration of tool users	- Whether Tools Match Human Abstractions - Usability	Factors which an organization has no direct control over		- Government and Industry Standards	
Theory Theory underpinning tools	- Theoretical Foundations of Tools - Formal Semantics	Commercial Aspects Business considerations impacting on tool use and application		<ul><li>Business Models</li><li>Cost of Tools</li><li>Selection of Tools</li></ul>	
Impact on Development Impact of tools on technical suc- cess criteria	- Impact on Quality - Impact on Productivity - Impact on Maintainability				

Table 2. Internal Organizational Categories.

Category	Sub-Category		
Processes Adapting tools to processes or viceversa	- Tailoring to Existing Processes - Sustainability of Tools - Appropriation - Integration Issues - Migration Issues - Offsetting Gains - Maintenance at Code versus Model Level		
Organizational Culture Impact of cultural attitudes on tools and their application	- Tailoring to Existing Culture - Inertia - Over Ambition - Low Hanging Fruit		
Skills Skills needed for tools to succeed	- Training - Availability of Skills		

## Conclusion & Future research directions

- 1) Match tools to people
- 2) Support for creativity
- 3) Right tool right problem
- 4) More focus on processes, less on tools
- 5) Open MDE communities

## Are the Tools Really the Problem?

Yes No

Tools are unintuitive People and and complicated

Tools need to adapt to an imperfect world

not the other way around

Organizations are just as important