CS 846: Model-Based Software Engineering Winter 2012

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Empirical Assessment of MDE in Industry

John Hutchinson, Jon Whittle, Mark Rouncefield, Steiner Kristoffersen,
in Proc. of ICSE'11

http://se.uwaterloo.ca/~jmatlee/teaching/846

Who is Practising MBSE?

Sampling of Embedded Software Developed Using MDD

Automated doors, Base Station, Billing (In Telephone Switches), Broadband Access, Gateway, Camera, Car Audio, Convertible roof controller, Control Systems, DSL, Elevators, Embedded Control, GPS, Engine Monitoring, Entertainment, Fault Management, Military Data/Voice Communications, Missile Systems, Executable Architecture (Simulation), DNA Sequencing, Industrial Laser Control, Karaoke, Media Gateway, Modeling Of Software Architectures, Medical Devices, Military And Aerospace, Mobile Phone (GSM/3G), Modem, Automated Concrete Mixing Factory, Private Branch Exchange (PBX), Operations And Maintenance, Optical Switching, Industrial Robot, Phone, Radio Network Controller, Routing, Operational Logic, Security and fire monitoring systems, Surgical Robot, Surveillance Systems, Testing And Instrumentation Equipment, Train Control, Train to Signal box Communications, Voice Over IP, Wafer Processing, Wireless Phone

Anecdotal Evidence of *Benefits* of MBSE

- increased productivity, shortened development time

- improved quality

- use of standards, abstraction, formalisms

- improved maintainability, evolution

- improved communication and information sharing

- support for traceability among software artifacts

- early assessment of design

- improved reuse of software artifacts

- improved portability of solutions to new platforms

Mohagheghi & Dehlen,"Where is the Proof? - A Review of Experiences from Applying MDE in Industry", in ECMDA'08

Anecdotal Evidence of *Drawbacks* of MBSE

- thinking abstractly is hard

- developing and testing code generators takes time

- integrating generated code with legacy code takes time

- keeping the models and code in sync takes time

- MBSE tools are immature, brittle, not interoperable

- MBSE tools are rarely scalable to large models

- inexperience of developers

Hutchinson, Whittle, Rouncefield, Kristoffersen, "Empirical Assessment of MDE in Industry", in ICSE'11
Mohagheghi & Dehlen,"Where is the Proof? - A Review of Experiences from Applying MDE in Industry", in ECMDA'08
Selic, "Personal reflection on automation, programming culture, and model-based software engineering", in ASE 2008

Empirical Assessment of MDE in Industry

Objectives of Project

"collect and assimilate information on the way MDE is used in practice, which we will use to determine which approaches work best and provide the most valuable insights into MDE use"

http://www.comp.lancs.ac.uk/~eamde

Research Methodology

- online questionnaire
  http://www.comp.lancs.ac.uk/~eamde/docs/EAMDE%20Survey%20Questions.pdf

- structured / semi-structured interviews
  22 experts, from 17 companies working in 12 domains
  collectively have >360 years of software development experience
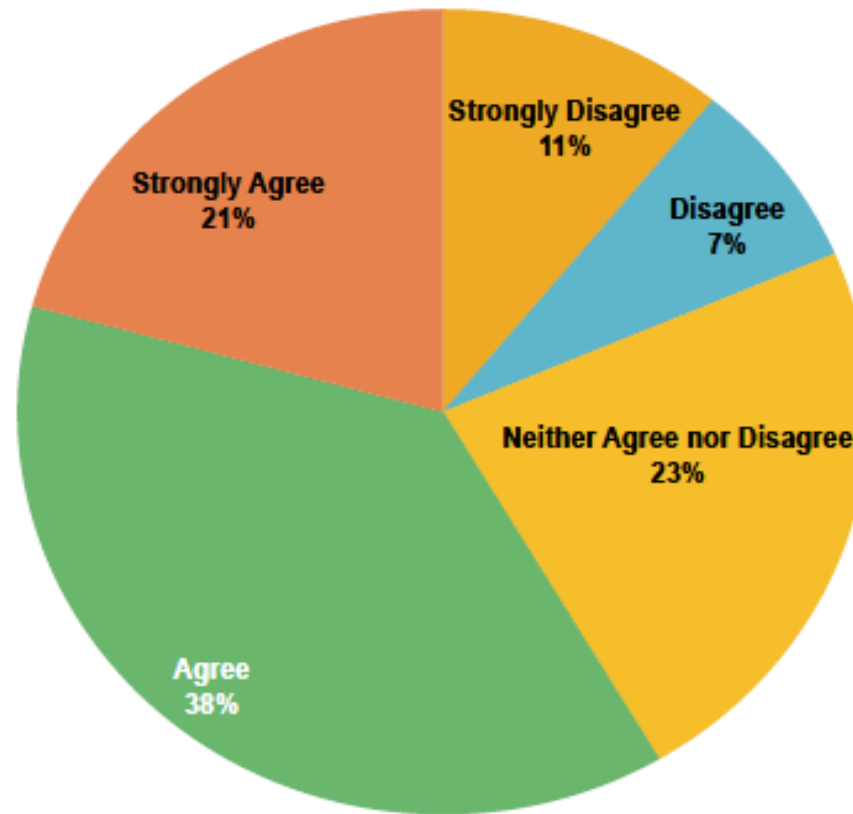
EA-MDE: General Opinion of MDE

Do you consider MDE to be a good thing? (401 respondents)

No
4%

Neutral
8%

Don't
know
4%

Yes
84%
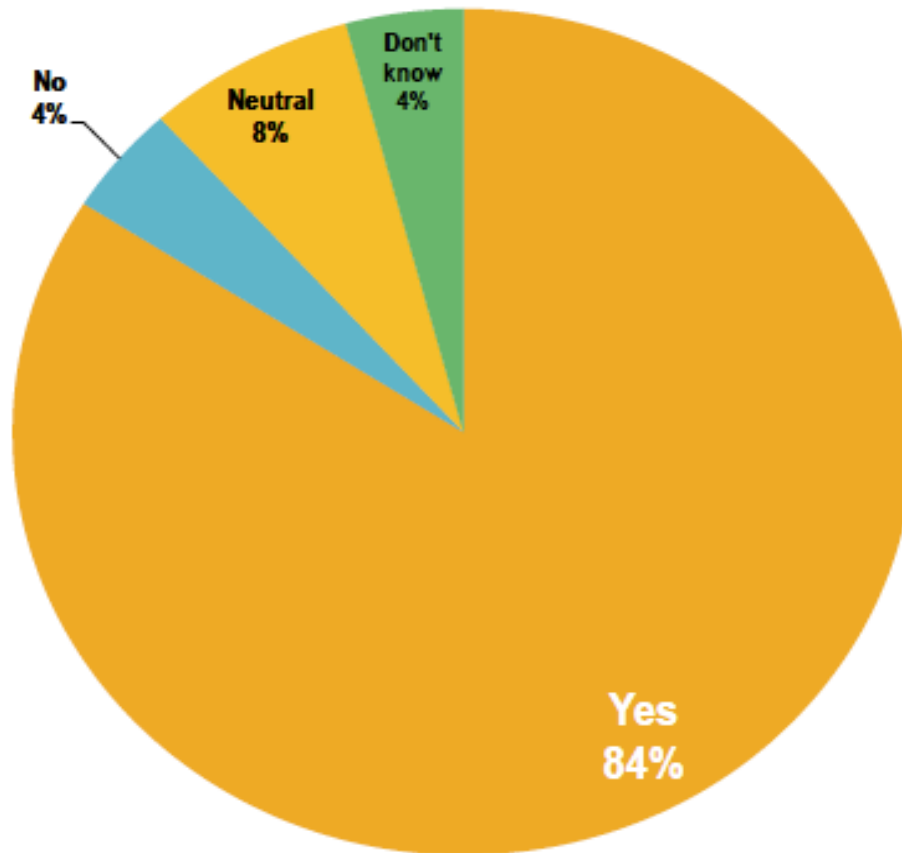
SOURCE: J. Hutchinson (thesis data: June 2011)

EA-MDE Study: MDE Experience

MDE was a success (366 respondents)

SOURCE: J. Hutchinson (thesis data: June 2011)

Influential Factors

Table 3. The impact of MDE activities on productivity and maintainability.

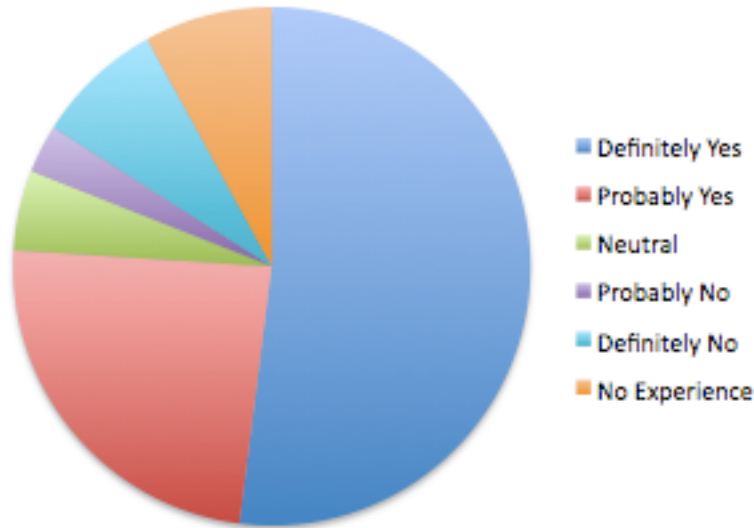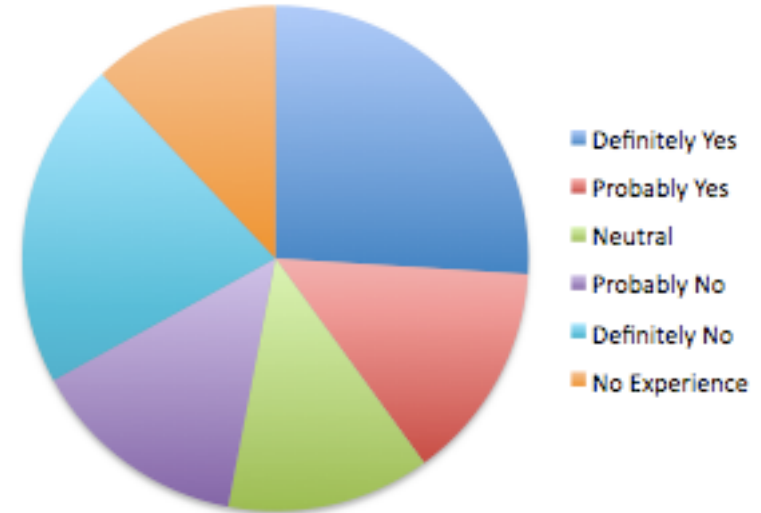| Activity	Productivity		Maintainability	
	Increased	Not Used	Increased	Not Used
Use of models for team communication	73.7%	7.0%	66.7%	6.7%
Use of models for understanding a problem at an abstract level	73.4%	4.8%	72.2%	6.1%
Use of models to capture and document designs	65.0%	9.3%	59.9%	10.7%
Use of domain-specific languages (DSLs)	47.5%	32.6%	44.0%	33.7%
Use of model-to-model transformations	50.8%	24.6%	42.6%	28.4%
Use of models in testing	37.8%	33.9%	35.2%	32.4%
Code generation	67.8%	12.0%	56.9%	12.6%
Model simulation/ Executable models	41.7%	38.3%	39.4%	35.9%

Scope of Assessment

Most questions focus on

- effect on productivity (of code development, testing)
- effect on maintainability
- effect on agility to evolve product
- skill needs / training
- impact of tools on MDE success

Effects of Code Generation
## assessed through a pair of positive / negative questions

Legend (left chart): Definitely Yes, Probably Yes, Neutral, Probably No, Definitely No, No Experience

Is your use of code generation an important aspect of your MDE productivity gains?

Legend (right chart): Definitely Yes, Probably Yes, Neutral, Probably No, Definitely No, No Experience

Is integrating generated code into your existing projects a significant problem?
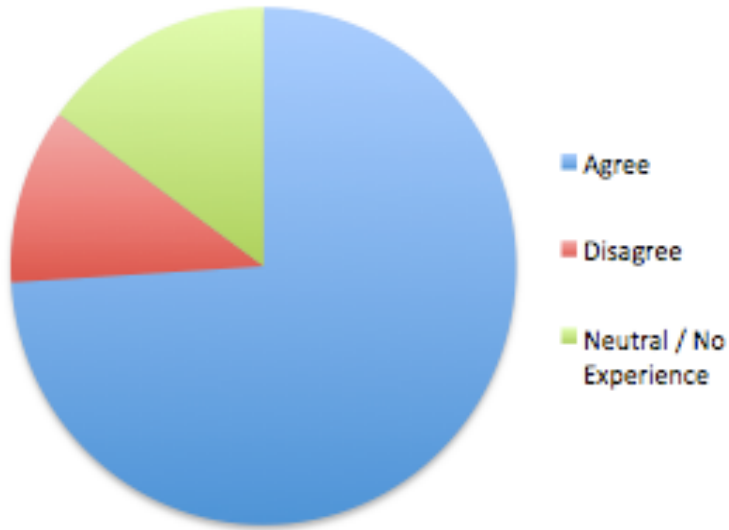
Impact on Skill Needs / Training
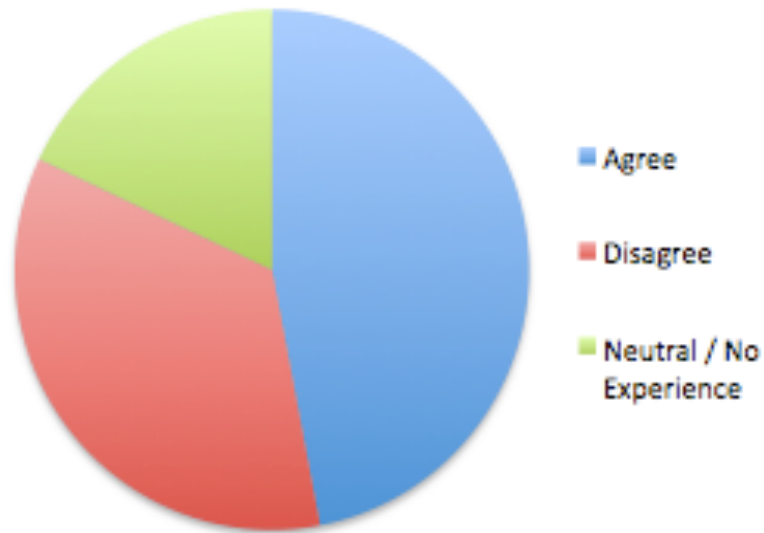
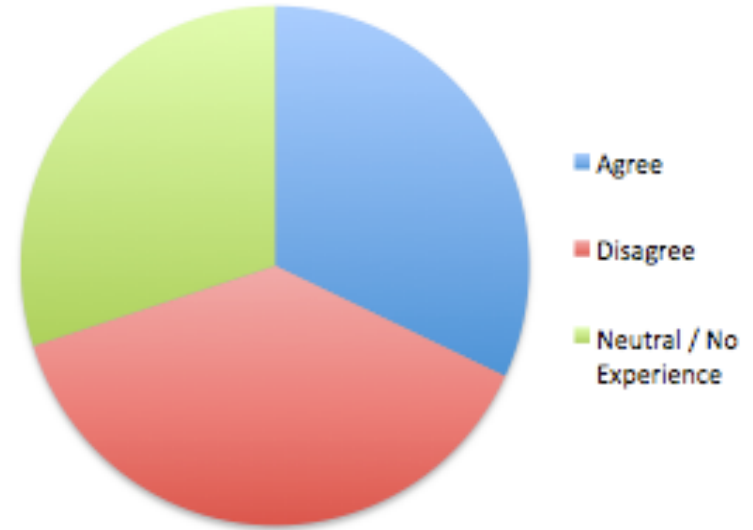Does using MDE allow you to employ developers with less software engineering experience (e.g. new graduates)?
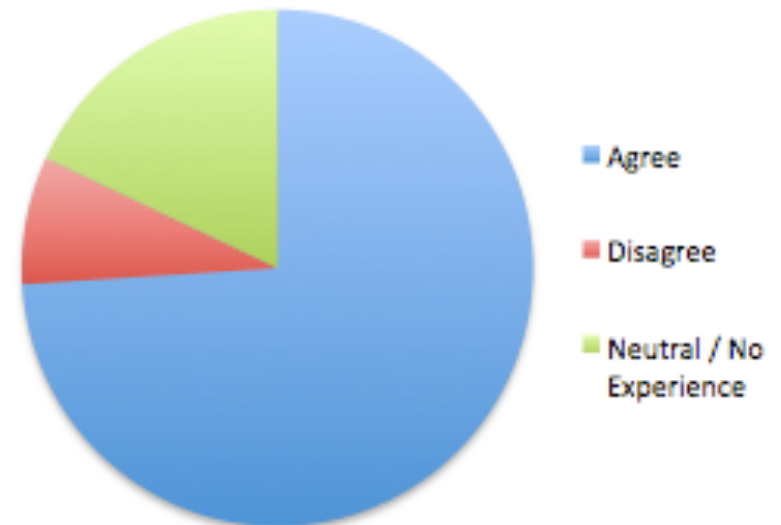
Does using MDE require you to carry out significant extra training in modeling?
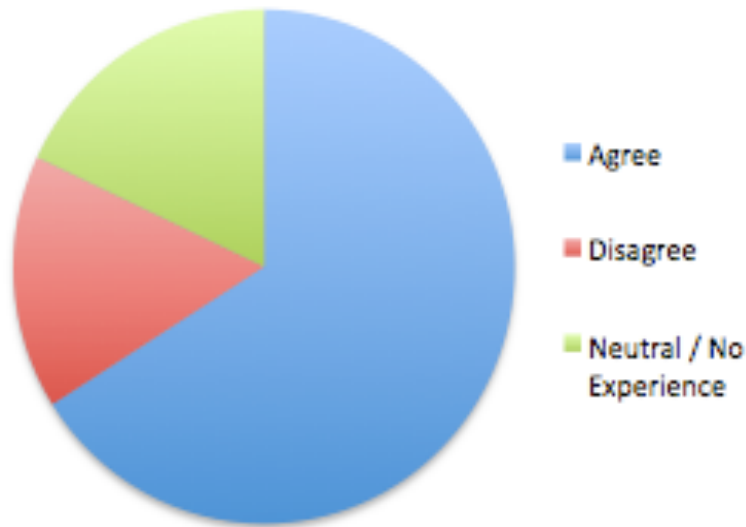
Impact on Agility

Agree · **Disagree** · **Neutral / No Experience**

Does MDE make you faster at implementing new requirements?

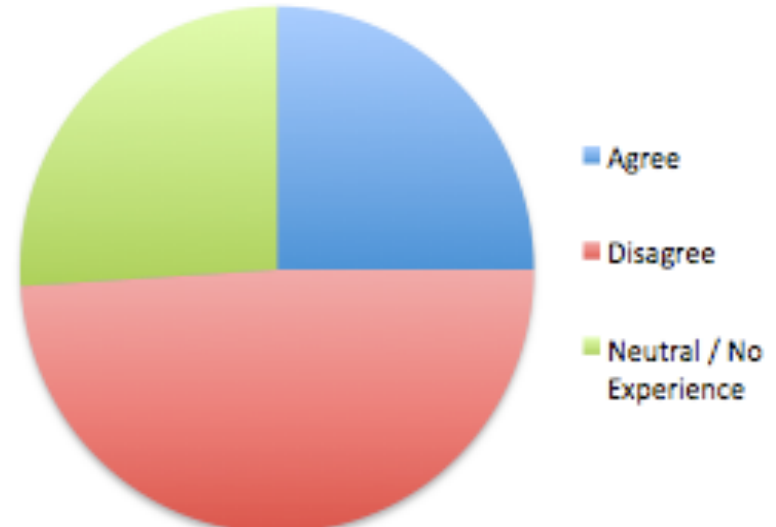**Agree** · **Disagree** · **Neutral / No Experience**

Does MDE prevent you from responding to business opportunities?

Impact on Understandability

Does your use of MDE lead to better understanding between stakeholders?

Does your use of MDE result in unexpected confusion and/or misunderstandings between stakeholders?

If MDE is so good,
why isn't everyone using it?

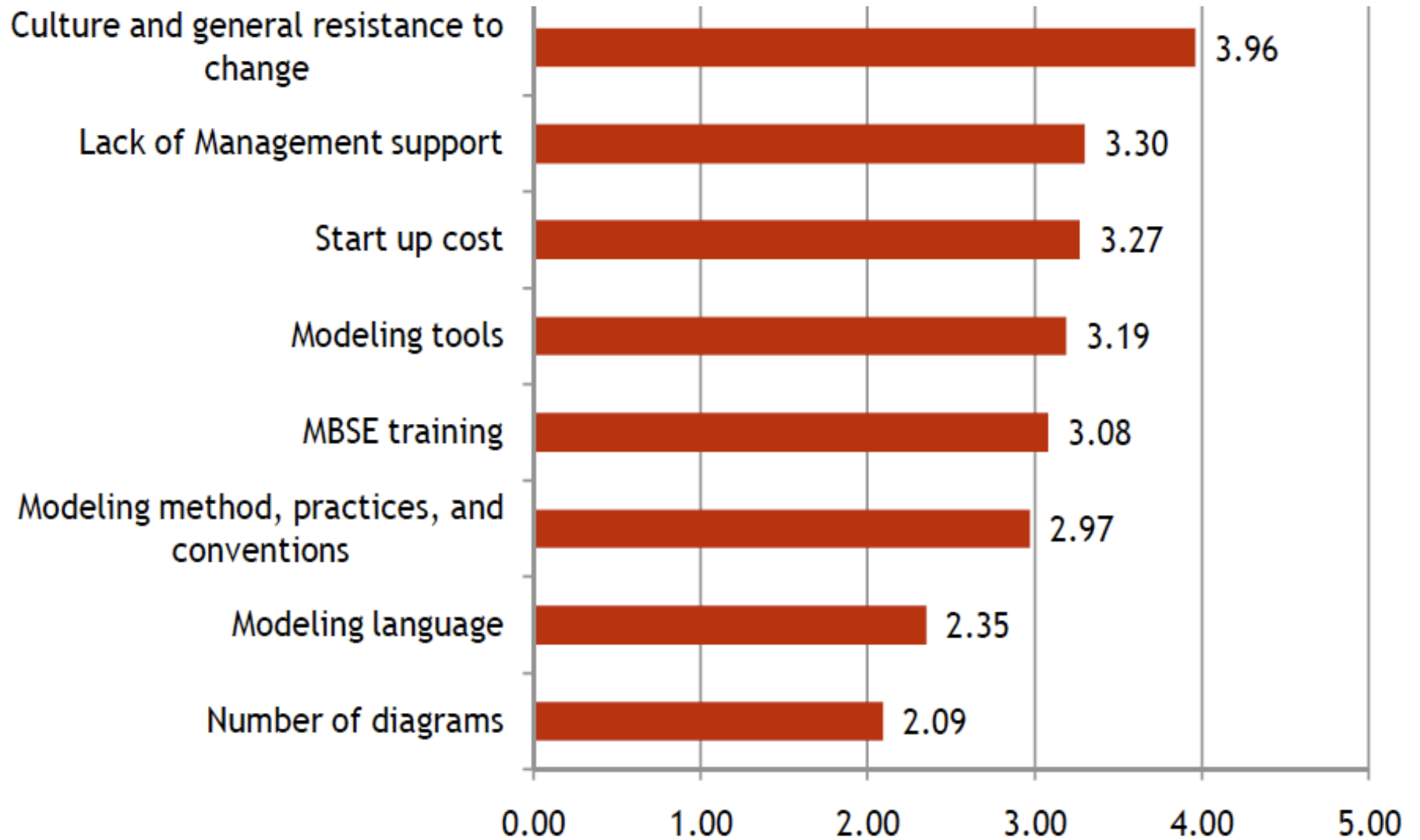# Factors Correlated with (Un)Successful Adoption

Successful Adoption

- Real business need for experimenting with new development processes

- Commitment of team, management

- Incremental adoption

- Process is adapted with experience

- DSL tailored to narrow domain

- Software is component of larger product

Unsuccessful Adoption

- Adoption motivated by MBSE claims rather than by real need

- Commitment of management or team, but not both

- Wholesale adoption of MBSE
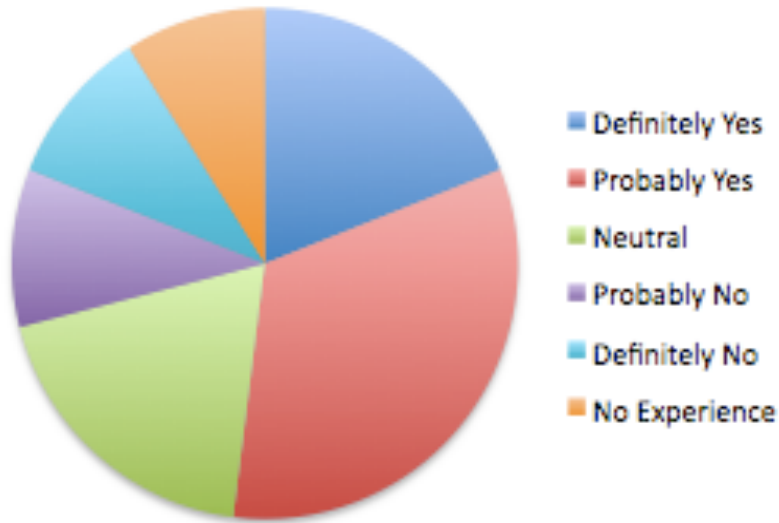
- Process is rigid, uniform

Factors that *Inhibit* Successful MBSE

Cloutier, Bone, "Compilation of SysML RFI - Final Report", OMG Document: syseng/2009-06-04

Factor	Value
Culture and general resistance to change	3.96
Lack of Management support	3.30
Start up cost	3.27
Modeling tools	3.19
MBSE training	3.08
Modeling method, practices, and conventions	2.97
Modeling language	2.35
Number of diagrams	2.09

Reasons to Model

- Definitely Yes
- Probably Yes
- Neutral
- Probably No
- Definitely No
- No Experience

Do organisations adopt MDE for its technical merits?
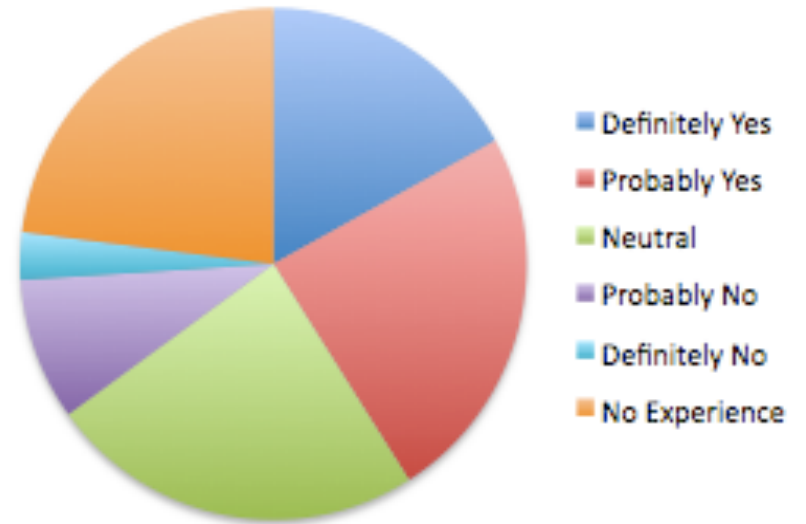
Do organisations adopt MDE to "jump through hoops" or appear to do so?

Summary
First step of an empirical assessment of MDE

How MDE is being applied in industry
- modelling for team communication
- modelling for problem solving
- modelling for documentation
- use of DSLs
- model-to-model transformations
- code generation
- model-based testing
- model simulation

Assessment of benefits of successful MDE

Factors that affect MDE's success or failure
- business need
- commitment of MDE users as well as management
- incremental adoption
- adaptable process

References

- R. Cloutier and M. Bone, "Compilation of SysML RFI – Final Report," Stevens Institute of Technology, 2010

- J. Hutchinson, et al., "Empirical Assessment of MDE in Industry," in ICSE 2011

- J. Hutchinson, et al., "Model-Driven Engineering Practices in Industry," in ICSE 2011

- J. Hutchinson, thesis data, June 2011.

- P. Mohagheghi and V. Dehlen, "Where is the Proof? – A Review of Experiences from Applying MDE in Industry," in ECMDA 2008

- Selic, "Personal reflection on automation, programming culture, and model-based software engineering," in ASE 2008