A Decade of Software Design and Modeling: A Survey to Uncover Trends of the Practice

Omar Badreddin, Rahad Khandoker, Andrew Forward, Omar Masmali and Timothy Lethbridge

Presented By:
Suresh Kumar Mukhiya
Western Norway University of Applied Sciences

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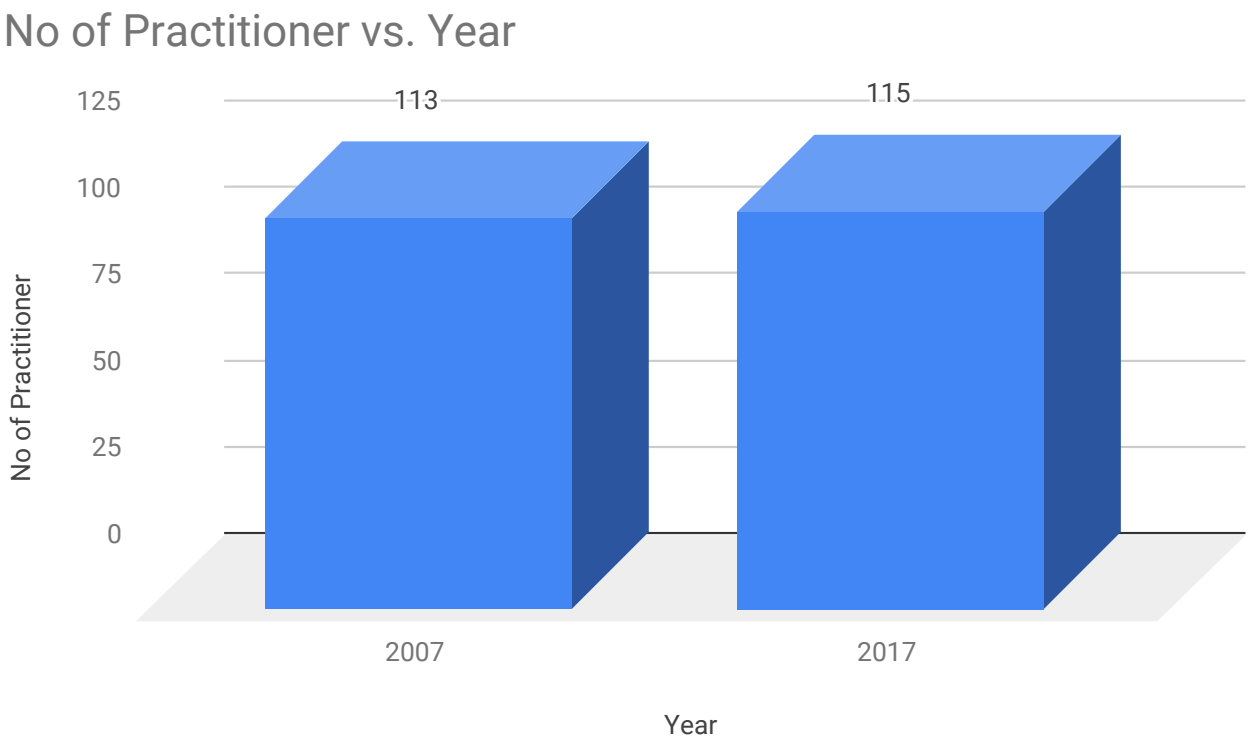
Høgskulen på Vestlandet

Outline

Survey conducted on two phases

- with 228 software paractitioner
- April-December, 2007
- March-November, 2017 [LEV80]
- 152 questions



Survey Structure

- Topic 1 - **Fundamentals** - Software design and what is software model
- Topic 2 - **Basic Characteristics of practices** - What medium and methods are used for moedling?
- Topic 3 - **Life Cycle** - Activities involved in SDLC
- Topic 4 - **Platforms** - Tools, methodologies, platforms used in SDLC
- Topic 5 - **Efficacy** - Design and development practices
- Topic 6 - **Code VS Model centrism** - Challenges in code-centric vs model centric SD
- Topic 7 - **Open ended and optinal contact info**
- Topic 8 - **Demographics**

Goal of the Survey

- Uncover **trends in the practice** of `software design` and **adaptation pattern** of `modeling language`

Software Design

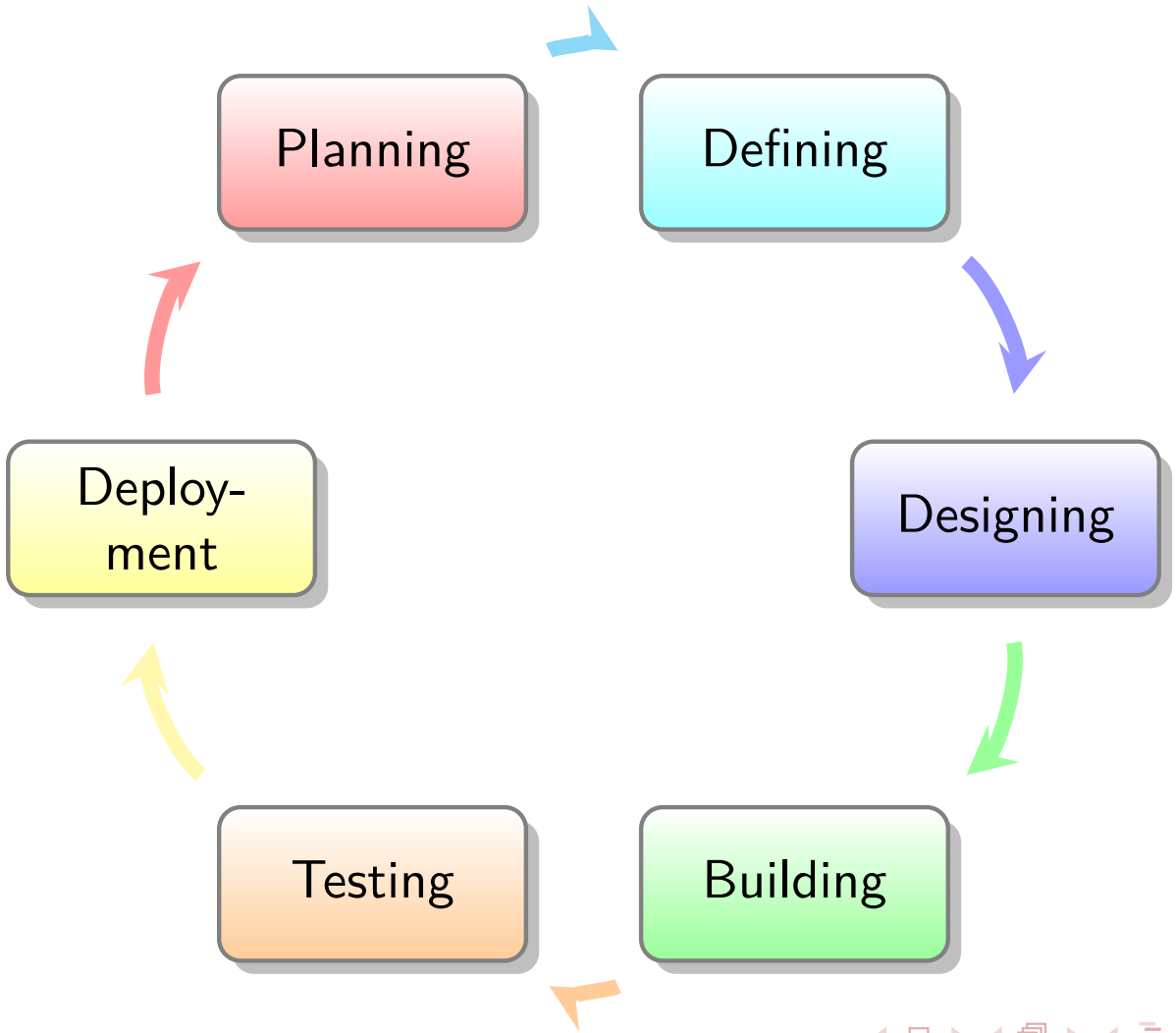
... is the process of converting users' need into a suitable form, which helps the programmar in software coding and implementation.

*... Software design is the process by which an agent creates a specification of a **software artifact**, intended to accomplish goals, using a set of primitive components and subject to constraints.*

An artifact is one of many kinds of tangible by-products produced during the development of software. Some artifacts (e.g., use cases, class diagrams, and other Unified Modeling Language (UML) models, requirements and design documents) help describe the function, architecture, and design of software. Other artifacts are concerned with the process of development itself—such as project plans, business cases, and risk assessments.

Design Concepts - SDLC

- Software Design is the first step in SDLC (Software Design Life Cycle) - defined in ISO/IEC 12207.



Design Concepts - Why is it required? / Design considerations

There are many aspects to consider in the design of a piece of software. The importance of each consideration should reflect the goals and expectations that the software is being created to meet. Some of these aspects are [ISO05]:

- Modularity
- Performance
- Portability
- Usability
- Trackability
- Deployment
- R3 (Reliability, Reusability and Robustness)
- Security
- Scalability
- Maintainability

Modeling languages

A modeling language is any **artificial language** that can be used to express **information or knowledge or systems** in a structure that is defined by a consistent set of *rules*.
Types of modeling languages:

- Graphical Modeling languages
- Textual Modeling languages
- More specific types

Graphical Modeling languages

- BPMN
- Flowchart
- Petri nets
- UML
- Behavior Trees
- C-K Theory (Concept Knowledge Theory)
- ORM (Object Role Modeling)
- SysML
- SOMF (Service-oriented Modeling Framework)
- DFD (Data Flow Diagram)

Textual Modeling languages

Information models can also be expressed in formalized natural languages.

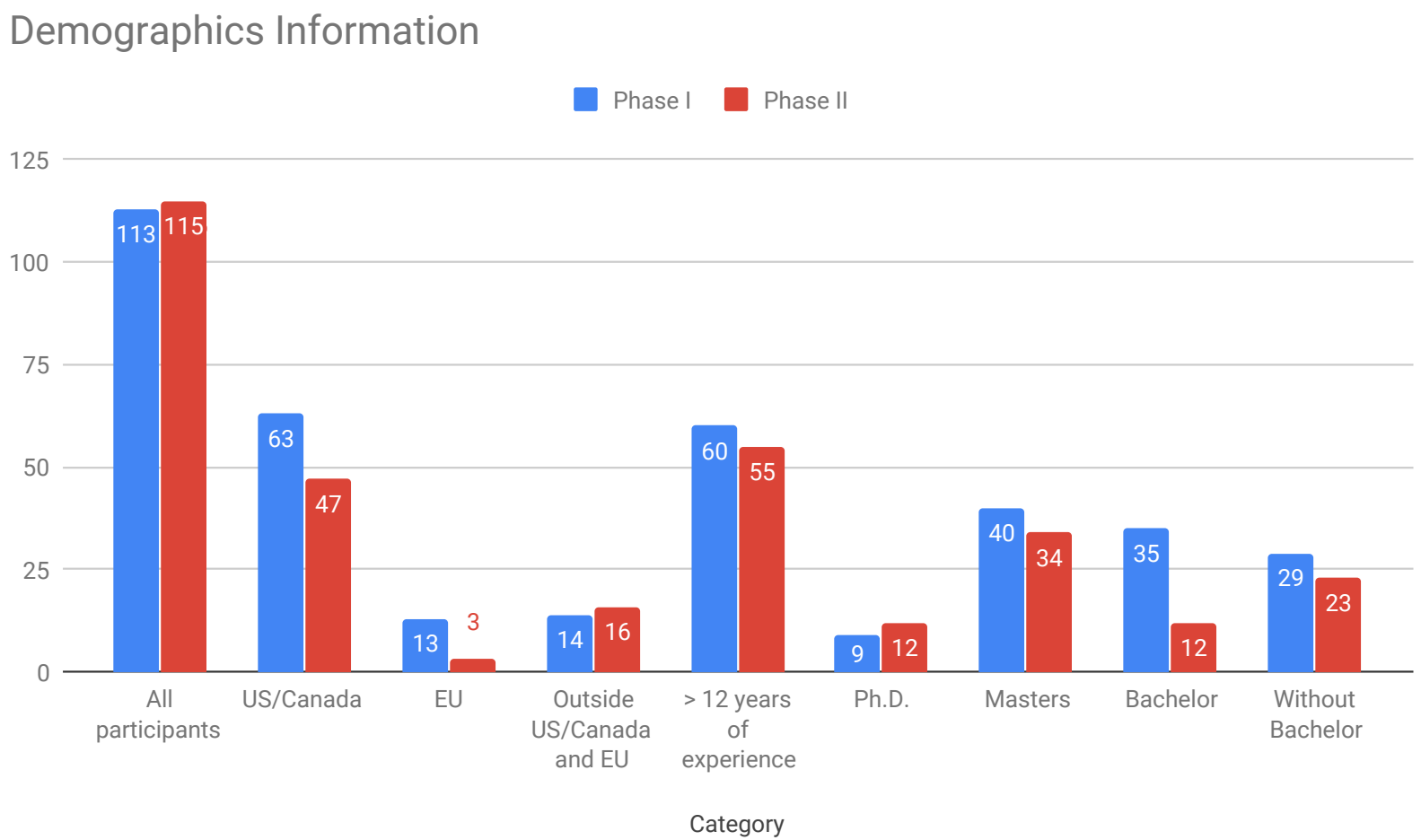
Example: Gellish

- the Eiffel tower <is located in> Paris
- Paris <is classified as a> city

More specific types

- Domain-Specific Modeling (DSM) - specialized to a particular application domain.
- Algebraic Modeling Languages (AML) - mainly in mathematical computation
- Virtual Reality Modeling Language (VRML)
- Behvioral - process calculus or process algebra for formally modelling concurrent systems.
- Information and knowledge modelling
- Object Modeling Language

Demographics



Høgskulen på Vestlandet

Topic 1: What is a software model?

Responses for Topic 1: What is a software model							
Entity that might be a model	**Phase I**			**Phase II**			**Mean Gap**
	% SA+A	**% SD+D**	**Mean**	**%SA+A**	**%SD+D**	**Mean**	
Class Diagram	88.4	2.7	4.3	87	4.9	4	-0.3
UML Deployment Diagram	77.5	5.4	4.1	72	17.5	3.8	-0.2
Use Case Diagram	82.1	9.8	4	80	13.5	3.8	-0.3
Picture By Drawing Tool	**85.6**	**7.2**	**4**	**62**	**20.3**	**3.5**	**-0.5**
Textual Use Case	**78.8**	**10.6**	**4**	**59**	**18.4**	**3.5**	**-0.5**
Whiteboard Drawing	**78.8**	**8.8**	**3.9**	**63**	**20**	**3.6**	**-0.4**
Picture By Hand	**57.1**	**9.8**	**3.9**	**61**	**13.4**	**3.5**	**-0.4**
Source Code	46.8	38.7	3.2	47	38.7	3.1	-0.1
Source Code Comment	33.9	41.1	2.9	44	39.9	3	0.1

- Textual Use Case
- Whiteboard Drawing
- Picture by Hand
- Picture by Drawing tools

Topic 2: Characterization of Practices 1/4

- Medium and Methods used for modeling
- What models are used for?
- Reference Materials
- Participants daily activities

Topic 2: Medium and methods of modeling							
Medium or methods used to model	Phase I			Phase II			Mean Gap
	% Never&Sometimes	% Very Often	Mean	% Never& Sometimes	% Very Often	Mean	
Whiteboard drawing	33.3	45.0	3.2	40	57.9	2.9	-0.3
Diagramming tool (e.g. Visio)	42.3	36.9	2.9	43	43.2	2.8	-0.1
Word processor / text	45.5	26.8	2.8	42	55.3	2.7	-0.1
Word of mouth	**42.3**	**27.0**	**2.8**	**54**	**46.1**	**2.4**	**-0.4**
Handwritten material	51.4	22.5	2.6	49	**51.3**	2.6	0.0
Comments in source code	51.4	21.6	2.5	49	37.8	2.6	0.1
Modeling tool/CASE	58.9	29.5	2.4	55	29.0	2.5	0.1
Drawing software	72.1	12.6	2.1	68	29.0	2.3	0.2

Characterization of Practices 2/4

Topic 2: What models are used for?							
Activity	Phase I			Phase II			Mean Gap
	% Never & Sometimes	% Very Often	Mean	% Never & Sometimes	% Very Often	Mean	
Developing a design	26.6	48.4	3.3	28	55.1	3.2	-0.1
Transcribing a design into digital format	32.8	39.1	3.1	41	51.7	2.9	-0.2
Prototyping a design	53.1	32.8	2.7	24	32.2	2.2	-0.5
Brainstorming possible designs	54.7	23.4	2.6	34	44.8	3	0.4
Generating code (code editable)	65.1	17.5	2.2	66	34.4	2.2	0
Generating all code	76.6	14.1	1.8	66	31	2.1	0.3

- Developing a design
- Converting a design to digital format
- Prototyping a design
- Brainstorming possible designs

Høgskulen på Vestlandet

Characterization of Practices 3/4

Responses for Topic 2: Reference materials							
Refer to material created by/as	Phase I			Phase II			Mean Gap
	% Never and Sometimes	% Very Often	Mean	% Never and sometimes	% Very Often	Mean	
Word of mouth	22.3	54.5	3.4	40	60.5	3.1	-0.3
Word processor / text	30	48.2	3.3	29	54	2.9	-0.4
Diagramming tool	32.4	42.3	3.1	70	36.9	2.7	-0.4
Whiteboard drawing	34.5	41.8	3	37	48.6	2.7	-0.3
Comments in source code	42	30.4	2.9	55	47.3	2.7	-0.2
Drawing software	57.8	13.8	2.6	32	39.5	2.4	-0.2
Modeling tool/CASE	55.9	31.5	2.5	85	28.9	2.3	-0.2
Handwritten material	56	20.2	2.4	27	29.7	2.3	-0.1

Characterization of Practices 4/4

Responses for Topic 2: Daily activities of participants							
Available tasks	Phas I			Phase II			Mean Gap
	% Never&Sometimes	% Very Often	Mean	% Never& Sometimes	% Very Often	Mean	
Think about s/w system	9.4	77.1	4.1	12	41.2	4.1	0
Run / attend meetings	19.8	60.4	3.6	14	68.6	3.5	-0.1
Explain s/w design to others	15.8	51.6	3.5	26	65.7	3.2	-0.3
Design a s/w system	18.8	57.3	3.5	34	54.3	3.3	-0.2
Lead software project	29.2	53.1	3.3	23	65.7	3.2	-0.1
Search about s/w system	31.2	46.2	3.2	31	51.4	3.2	0
Model a s/w system	30.2	45.8	3.2	37	45.8	3.1	-0.1
Write new code	37.5	49	3.1	29	54.3	3.3	0.1
Maintain existing code	37.5	40.6	3	26	60	3.3	0.3
Fix bugs	**39.4**	**39.4**	**3**	**23**	**48.6**	**3.5**	**0.5**
Perform manual testing	35.1	34	2.9	37	51.4	3.1	0.2
Write / maintain requirements	41.1	40	2.9	34	48.6	3.1	0.2
General administration	40.4	29.8	2.8	43	54.3	2.8	0
Write / maintain test scripts	**58.3**	**17.7**	**2.4**	**47**	**44.1**	**2.8**	**0.4**

Høgskulen på Vestlandet

Topic 3: Life Cycle - 1/2

Activivties invovled in various development phases of Software Development Life Cycle (SDLC)

Topic 3: When do you perform the following tasks?					
Available tasks	Phase I		Phase II		% Gap
	Mode	%	Mode	%	
Searching	Constantly	64.5	Constantly	36.1	-28.4
Requirements	Start	60	Start	72.2	12
Design	Start	53.8	Start	44.4	-9.4
Modeling	Start	46.5	Start	66.7	20.2
Perform testing	Constantly	44.1	Constantly	42.9	-1.2
Coding	Constantly	41.7	Constantly	31.4	-10.3
Knowledge transfer	Constantly	41.7	Constantly	30.6	-11.1
Develop tests	Constantly	40.2	Constantly	34.3	-5.9
Documentation	End	38.7	End	27.8	-10.9

Life Cycle 2/2

Topic 3: When is modeling performed?							
Timeline	Phase I			Phase II			Mean Gap
	% Never&Sometimes	% Very Often	Mean	%Never & Sometimes	% Very Often	Mean	
Before coding	18.8	59.8	3.7	16	54	3.7	0
During coding	33.3	36	3.1	41	51.3	2.8	-0.3
After coding	60.4	19.8	2.5	54	37.8	2.5	0
Only on request	**78.5**	**10.3**	**1.9**	**59**	**32.4**	**2.3**	**0.4**

Topic 4: Platforms

Topic 4: Modeling notations and tools							
Modeling notations	**Phase I**			**Phase II**			**Mean Gap**
	% Never&Sometimes	**% Very Often**	**Mean**	**% Never & Sometimes**	**% Very Often**	**Mean**	
UML (any version)	30.9	51.8	3.3	46	33.4	2.9	-0.4
UML 2.*	52.1	34.4	2.6	53	34.4	2.5	-0.1
SQL	55.6	29.6	2.5	49	34.3	2.7	0.2
Structured Design models	58.8	21.6	2.5	50	38.2	2.7	0.2
UML 1.*	**54.8**	**28**	**2.4**	**73**	**26.7**	**1.9**	**-0.5**
ERD	**63.2**	**20.8**	**2.3**	**46**	**40**	**2.9**	**0.6**
Well-defined DSL	**78.8**	**5.8**	**1.7**	**62**	**32.3**	**2.4**	**0.7**
ROOM / RT for UML	85.9	7.1	1.5	79	15.2	1.8	0.3
SDL	**89.2**	**3.2**	**1.3**	**68**	**25.8**	**2.2**	**0.9**
Formal (e.g. Z, OCL)	**93.9**	**2**	**1.3**	**75**	**18.8**	**1.9**	**0.6**
BPEL	92.8	3.1	1.3	87	13	1.6	0.3

Technology options	**Phase I**			**Phase II**			**Mean Gap**
	% Never& Sometimes	**% Very Often**	**Mean**	**%Never & Sometimes**	**% Very Often**	**Mean**	
Java	**46.3**	**31.6**	**2.4**	**80**	**11.5**	**1.8**	**-0.6**
PHP / Perl	74.2	19.4	2	74	14.3	2.2	0.2
ASP.Net	79.4	14.4	1.8	74	14.3	2	0.2
Ruby / Python	**88.3**	**8.5**	**1.6**	**77**	**17.2**	**1.9**	**0.3**
C / C++*	60	30	2.4	65	25	2.3	-0.1

Topic 5: Efficacy

- Questions related to suitability of the modeling tools
- Participants' perceptions of key characteristics of modeling tools

How good are modeling tools for ?							
Available activities	Phase I			Phase II			Mean Gap
	% Poor	% Good	Mean	% Poor	% Good	Mean	
Developing a design	**16.9**	**47.9**	**3.4**	**11**	**53.6**	**2.9**	**-0.5**
Transcribing a design into digital format	24.6	42	3.2	25	60.7	3.3	0.1
Generating code (code is editable)	39.1	29	2.9	32	64.3	3	0.1
Prototyping a design	41.2	29.4	2.9	25	71.4	3.1	0.2
Brainstorming possible designs	45.1	32.4	2.8	18	74.7	3.1	0.3
Generating all code (no manual coding)	**79.7**	**8.7**	**1.9**	**50**	**42.9**	**2.5**	**0.6**

Topic 6: Code VS Model centralism - 1/2

Topic 6: Available activities	Phase I			Phase II			Mean Gap
	% Easier in Models	% Easier in Code	Mean	% Easier in Models	% Easier in Code	Mean	
Fixing a bug	28.9	43.3	3.2	19	40.6	3.2	0
Creating efficient software	35.9	43.5	3.1	27	50	3.2	0.1
Creating a system as quickly as possible	46.7	42.4	3	31	56.2	3.2	0.2
Creating a prototype	43	32.6	2.9	44	37.5	2.7	-0.2
Creating a usable system for end users	42.4	22.8	2.7	49	27.3	2.4	-0.3
Modifying a system when requirements change	54.9	24.2	2.5	41	37.5	2.8	0.3
Creating a system that most accurately meets requirements	67	19.8	2.2	56	26.4	2.3	0.1
Creating a re-usable system	**63**	**15.2**	**2.2**	**42**	**30.4**	**2.6**	**0.4**
Creating a new system overall	68.5	20.7	2.2	64	24.2	2.3	0.1
Comprehending a system's behaviour	71.9	15.7	2	75	15.7	1.9	-0.1
Explaining a system to others	81.8	7.6	1.7	66	15.6	1.9	0.2

- Results show it is easier to create a prototypes, modify the system, create a reusable system and explain system to others in the form of model
- It is easier to debug, create effecient software system, create a system as soon as possible in code.

Topic 6: Code VS Model centralism - 2/2

Topic 6: Problems with Model-Centric Approaches	Phase I			Phase II			Mean Gap
	% Slight Problem	% Bad Problem	Mean	% Slight Problem	% Bad Problem	Mean	
Models become out of date and inconsistent with code	**16.3**	**68.5**	**3.8**	**25**	**40.6**	**3.2**	**-0.6**
Models can not be easily exchanged between tools	26.4	51.6	3.3	19	40.7	3.3	0
Modeling tools are 'heavyweight'(install,learn,configure,use)	31.5	39.1	3.1	41	37.6	3	-0.1
Code generated from modeling tool not of the kind kind I would like	39.6	38.5	3	44	31.3	2.7	-0.3
Cannot model in enough detail-must write code	43.8	36	2.8	47	28.1	2.6	-0.2
Creating and editing model is slow	43.5	22.8	2.7	38	34.4	3	0.3
Modeling tools change, models become obsolete	44.6	32.6	2.7	31	34.4	3	0.3
Modeling tools lack features I need or want	44.9	21.3	2.6	44	18.8	2.6	0
Modeling tools hide too many details(fully visible in source)	44.6	23.9	2.6	34	31.3	2.9	0.3
Modeling tools are too expensive	46.7	26.7	2.6	38	15.7	2.7	0.1
Modeling tools cannot be analyzed as intended	51.1	25.6	2.5	56	21.9	2.5	0
Semantics of models different from prog. language	56.7	23.3	2.4	48	16.2	2.5	0.1
Modeling languages are not expressive enough	54.9	17.6	2.4	50	15.7	2.5	0.1
Modeling languages are hard to understand	62.6	9.9	2.2	58	15.2	2.3	0.1
Have had bad experience with modeling	63.7	16.5	2.2	61	16.2	2.2	0
Do not trust companies will continue to support their tools	**67.4**	**10.1**	**2**	**41**	**15.7**	**2.6**	**0.6**

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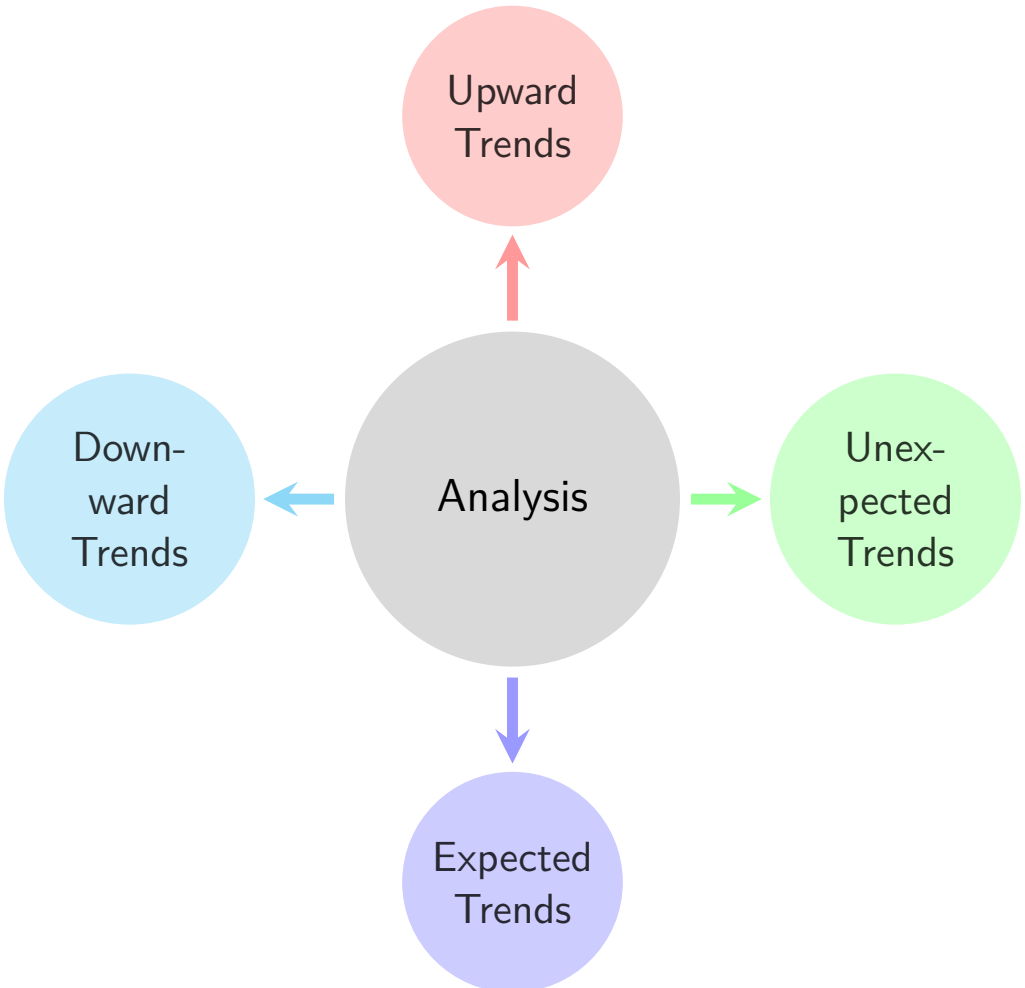
- Models become out of date and inconsistent with code
- Models can not be easily exchanged between tools

Analysis


Upward Trends
Down-ward Trends
Analysis
Unex-pected Trends
Expected Trends

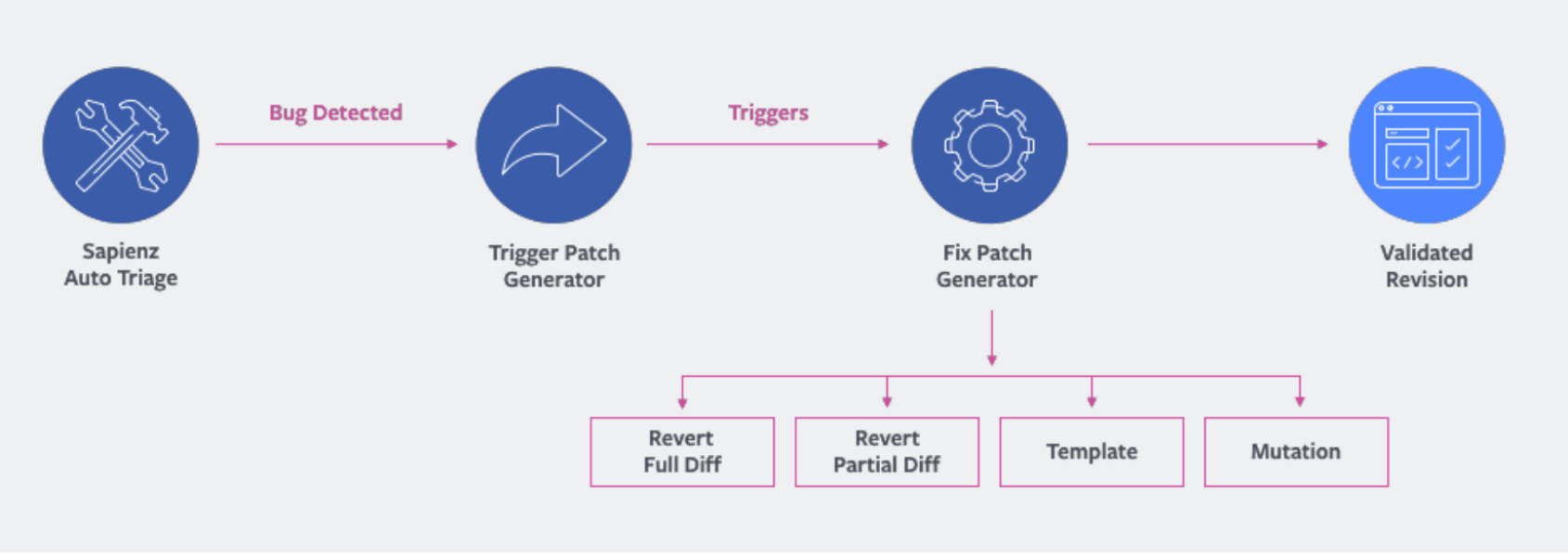
Upwoard Trends

- Increase in use of DSLs and Formal modeling languages
- Use of models
  - Provide high level of **information density**
  - Brainstorming session and redesigning process
- Increase use of ERD tools
- Scaffolding- forward engieering ie partial code generation. Why:?
  - Increase adoption of DSL and its customization ability
  - Modeling tools have better code generation ability
- Examples: Papyrus, PlantUML, txtUML, MagicDraw, LucidChart etc

Upwoard Trends - very disturbing claim

Another important trend is the increase in recognition that **`programming languages and related technologies and platforms could become quickly obsolete.`** This trend is particularly positive as it is a motivation for adopting model-centric approaches that tend to provide better support for platform independence.

SapFix and Sapienz



SapFix and Sapienz

- A new AI hybrid tool created by Facebook to automatically generate fixes for `specific bugs` [OBL]
- Proposes them (fixes) to engineers for approval and deployment in the production
- Has already been used to accelerate the process of shipping reobust, stable code updates to millions of devices using Facebook Android application

Does this mean ***`programming languages and related technologies and platforms could become quickly obsolete.`****?*

Downwards Trends

- Inadequate support for maintaining code of the modeling tools
- Decreased user satisfaction
  - Overly complex
  - Significant learning curve
  - Decreased usability
- Inadequate support for `prototyping`
- Decline in perception of modeling tools
  - Investment of time in model creation and model maintenance is not justified
- Less support for communication with other developers and designers
- `Eclipse, the open source development platform, demonstrated significant decline in use by the survey participants.`

Expected Trends and Unexpected Trends

- Declined in the use of older version of UML
- Increased trends in use of Formal modeling languages and DSLs

Unexpected Trends:

- Increase in the practices of modeling and design despite of **many participants satisfaction**

The State of Practice in Model-Driven Engineering

- Authors: Jon Whittle, Jon Hutchinson, and Mark Rouncefield,
- Published in IEEE Software Design, 2014
- A new study that surveyed 450 MDE practitioners and performed in-depth interviews with 22 more from 17 different comparnies representing 9 different sectors suggests that MDE might be more widestpread than commonly believed.
- Developers rarely use it to `generate whole systems`. Rather they apply MDE to developer `key parts of a system.`
- Companies that target a particular domain are more likely to use MDE than companies that develop generic software.

The Effects of Education on Students' Perception of Modeling in Software Engineering

- Authors: Omar Badreddin, Arnon Sturm, Abdelwahab Hamou-Lhadj, Timothy Lethbridge,Waylon Dixon, Ryan Simmons.
- collected 195 student responses from seven programs at four higher education institutions in Canada, Israel, and the U.S.
- The goal was to investigate the effects of education on students' perception of modeling.
- The authors found consistent downward trend in how students perceive UML effectiveness as they progress towards their degree.
- Reasons include: complexity of modeling tools, lack of integration of modeling tools with existing environment, lack of education about value of modeling tools and techniques.

Summary

- Increase in use of DSLs and Formal modeling languages
- Use of models
  - Provide high level of **information density**
  - Brainstorming session and redesigning process
- Inadequate support for maintaining code of the modeling tools
- Increase in the practices of modeling and design despite of **many participants satisfaction**

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