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SW: from Craftsmanship to Industry

The role of code generation in the industrialisation of software development

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The Market Situation

Complexity grows

Shorter TTM

15% - 25% of all software defects are delivered to customers.

Approximately 40-50% of the effort is spent on avoidable work.

Labor-intensive, requiring highly educated engineers.

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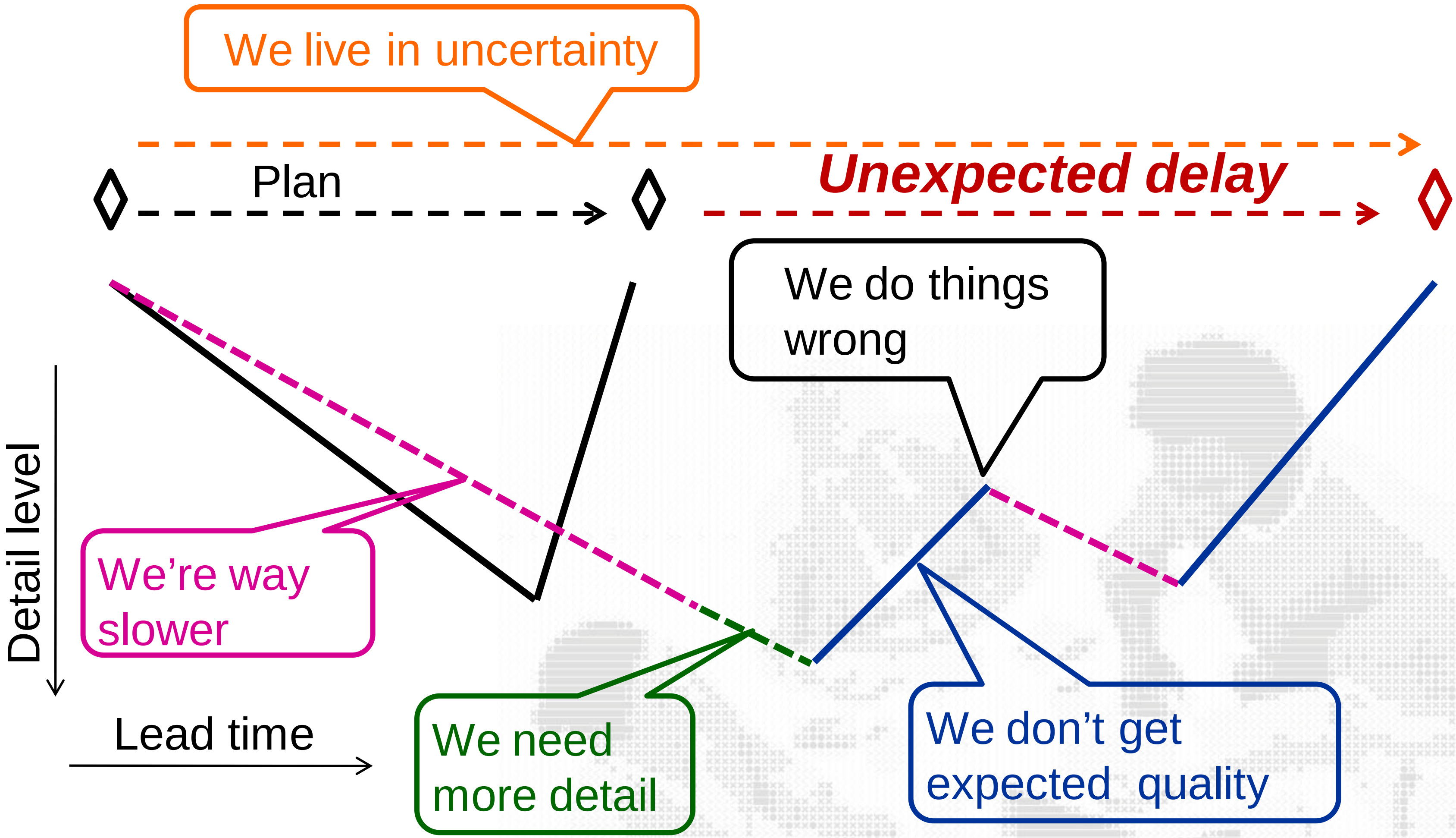
The V-model: Current practice





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Software Productivity Killers

- Poor design: Software specifications and designs are not *verified* before implementation
  - Incomplete, incorrect and ambiguous specifications and designs are only discovered during the test phases
- High Complexity: Software designs are increasingly asynchronous, concurrent, reactive and event driven
  - Complexity, Deadlocks, Races, Non-determinism, Multi-core CPUs
  - Software architects can't oversee implications of design choices
- Poor Quality: Testing is an exercise in sampling
  - Sample is small, population is very large
  - A linear increase in the probability of finding a defect requires an exponential increase in the number of test cases
- Testing is the most expensive, least certain way to detect and remove defects and has the biggest impact on T2M

Software Engineering Challenge

Product specification — Highly variable, human language based dialects

“Design Gap”

Program code — Limited variable, general applicable artificial dialects

Level of Automation

(C)OTS compilers, interpreters

Machine code — Limited variable, processor-family dependent dialects

Reduce the “Design Gap”

Product specification

“Design Gap”

Product code

Specific artificial dialect

Specific compilers, interpreters

Program code

Level of Automation

Machine code

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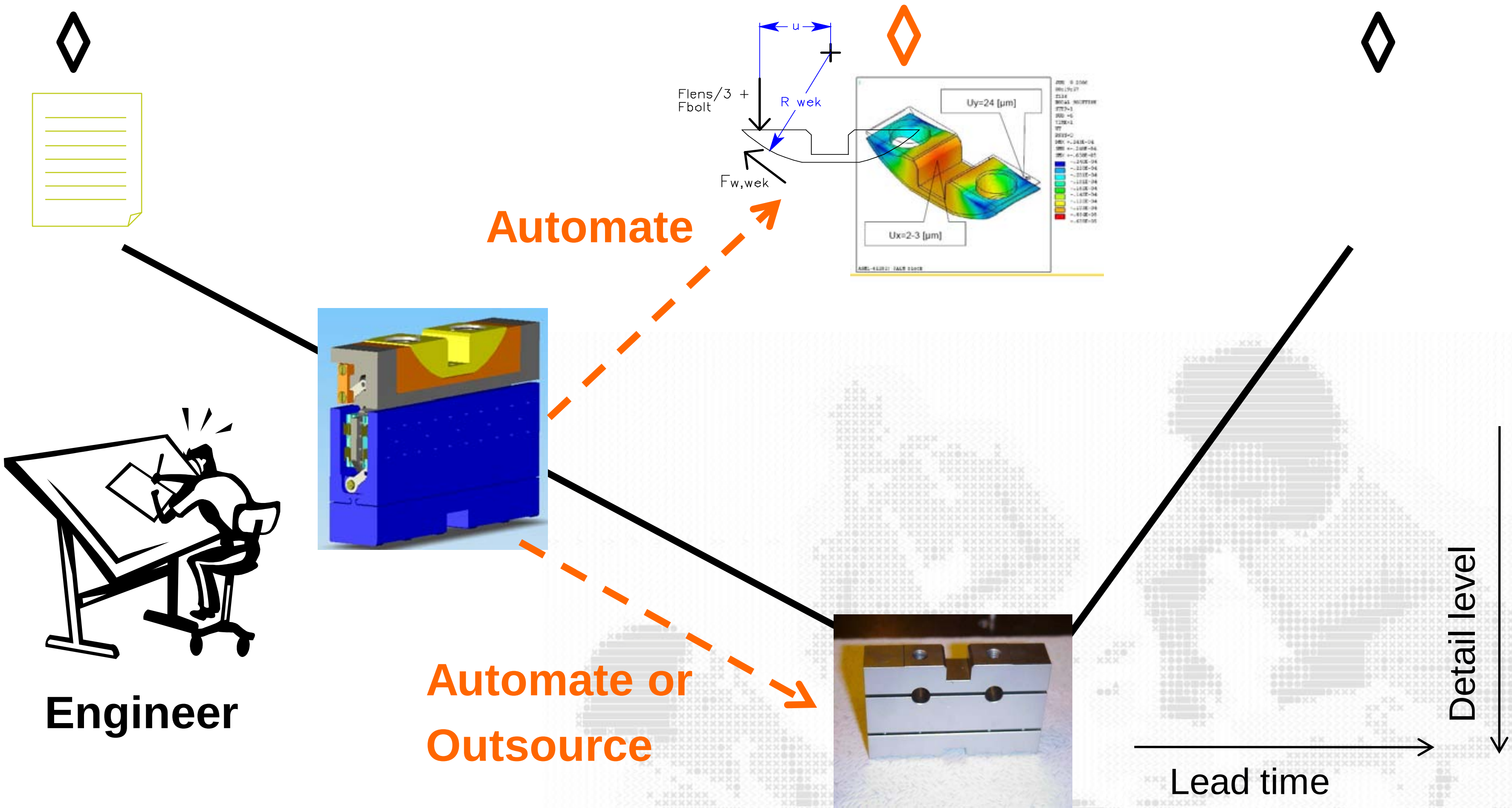
This is Mechanical Engineering



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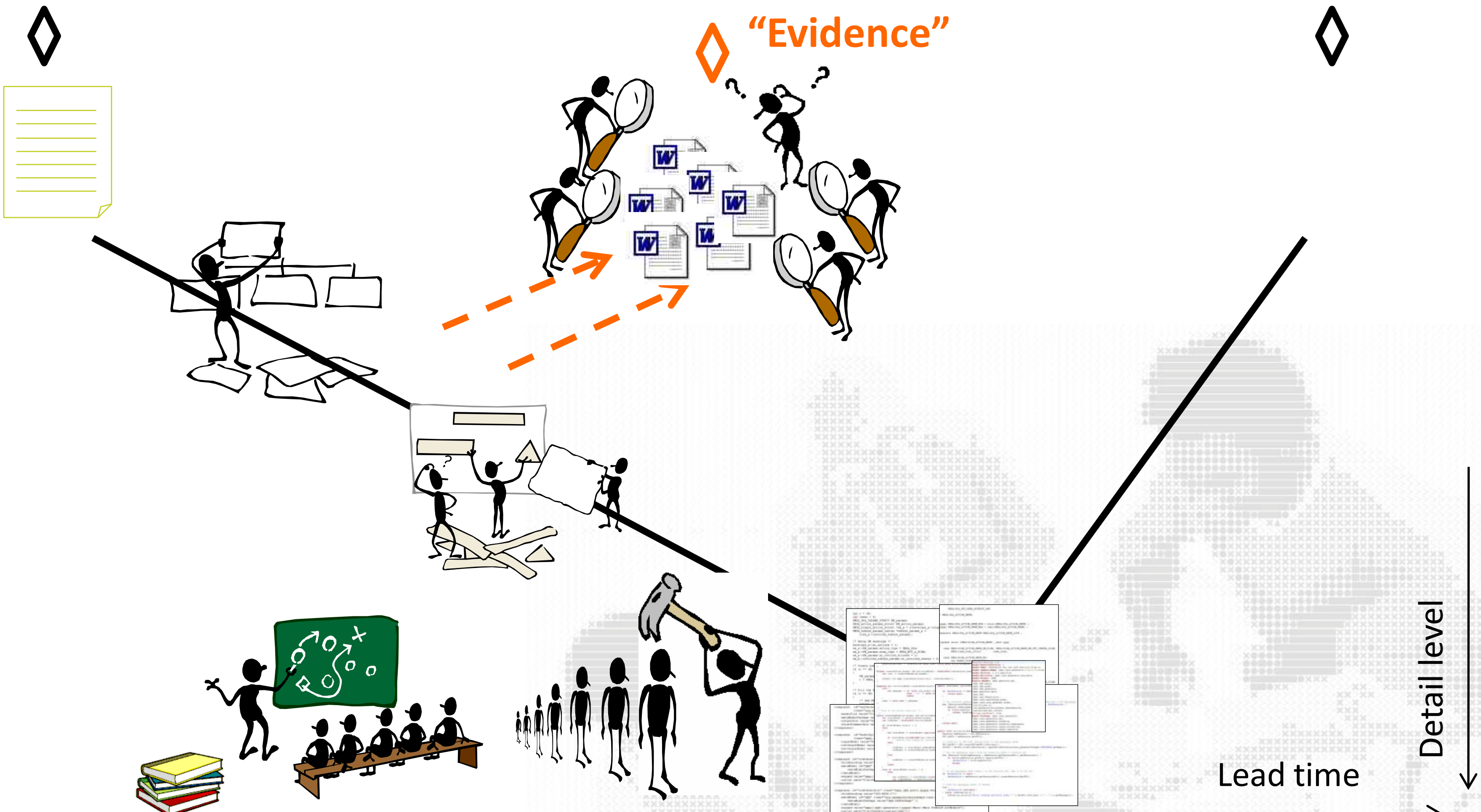
This is Software Engineering



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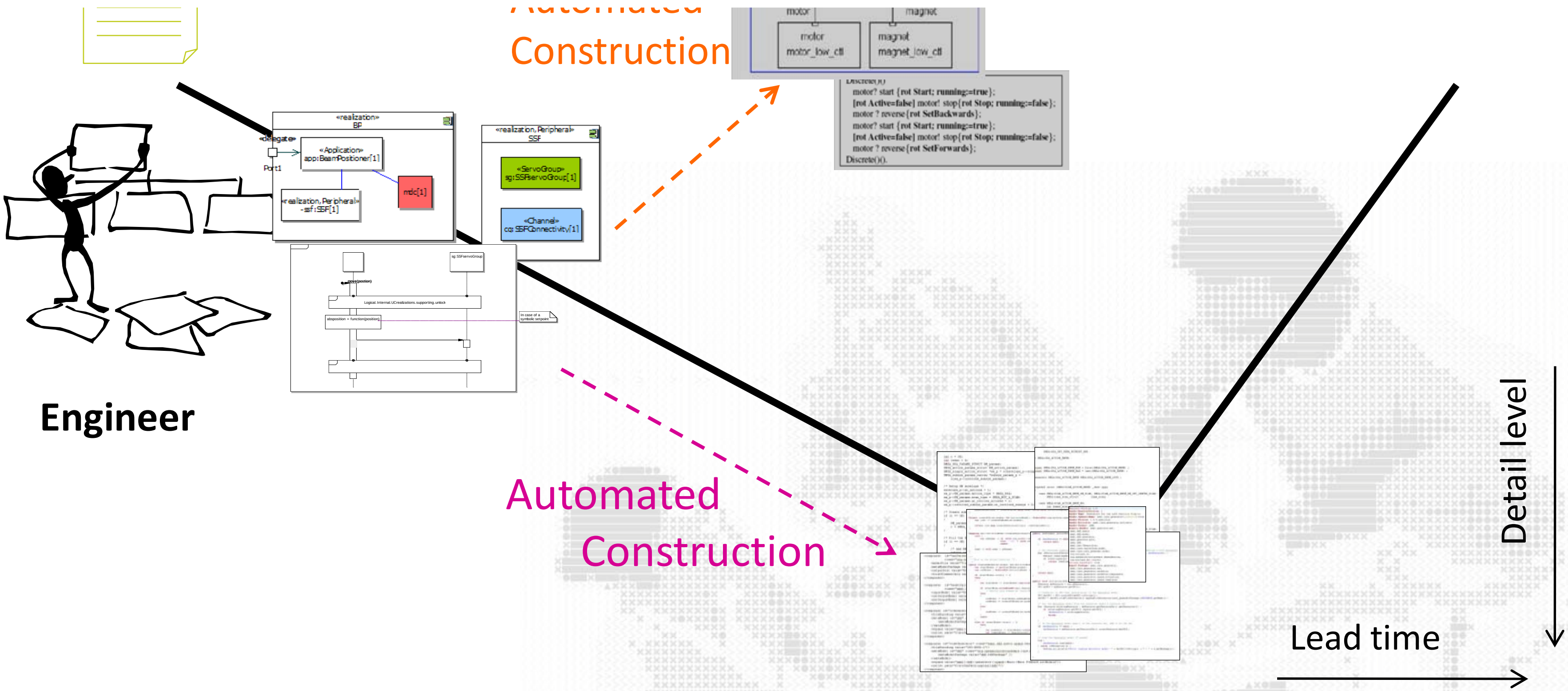
Software Engineering Should Be

- Rigorous Specification & Design: Model Driven Design using mathematics (formal verification) where possible



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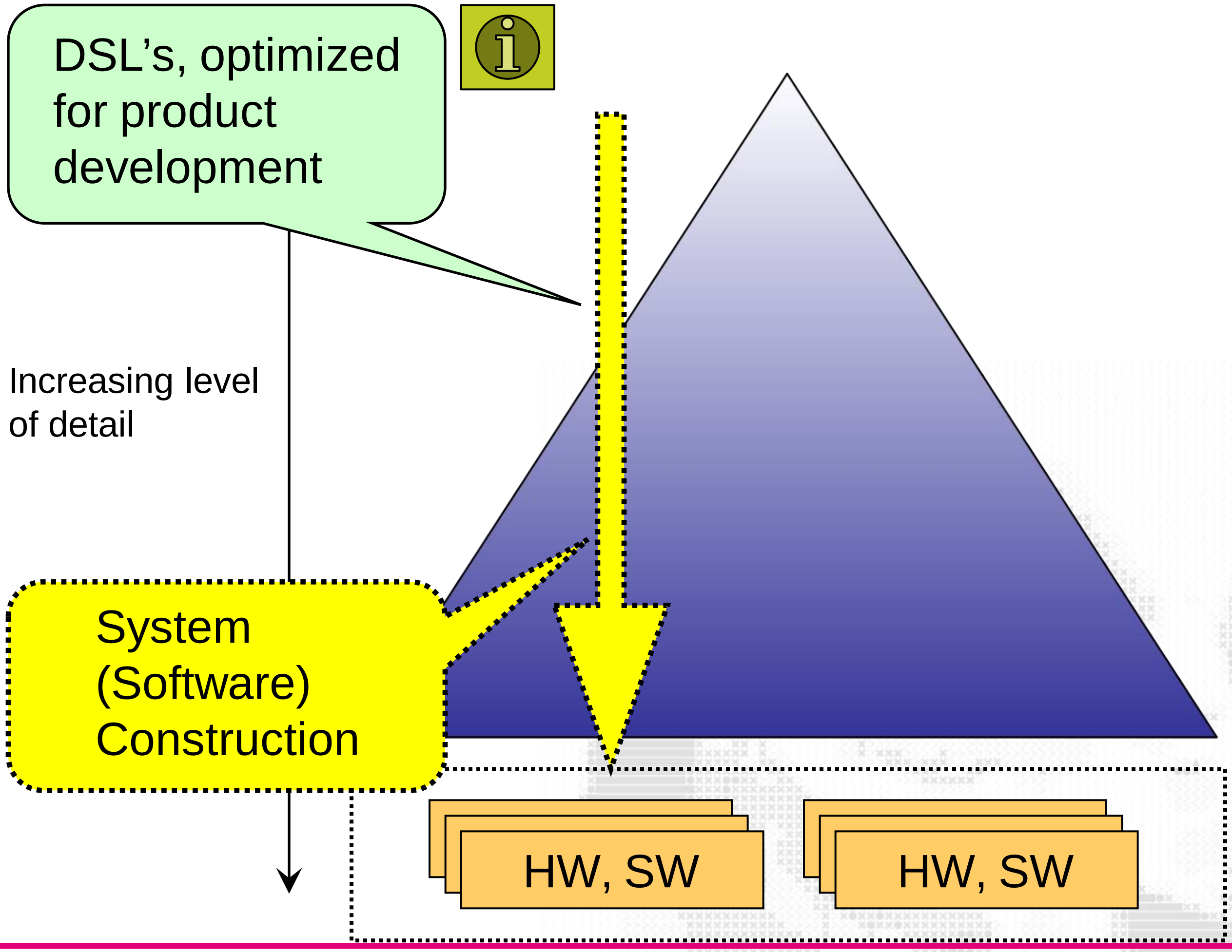
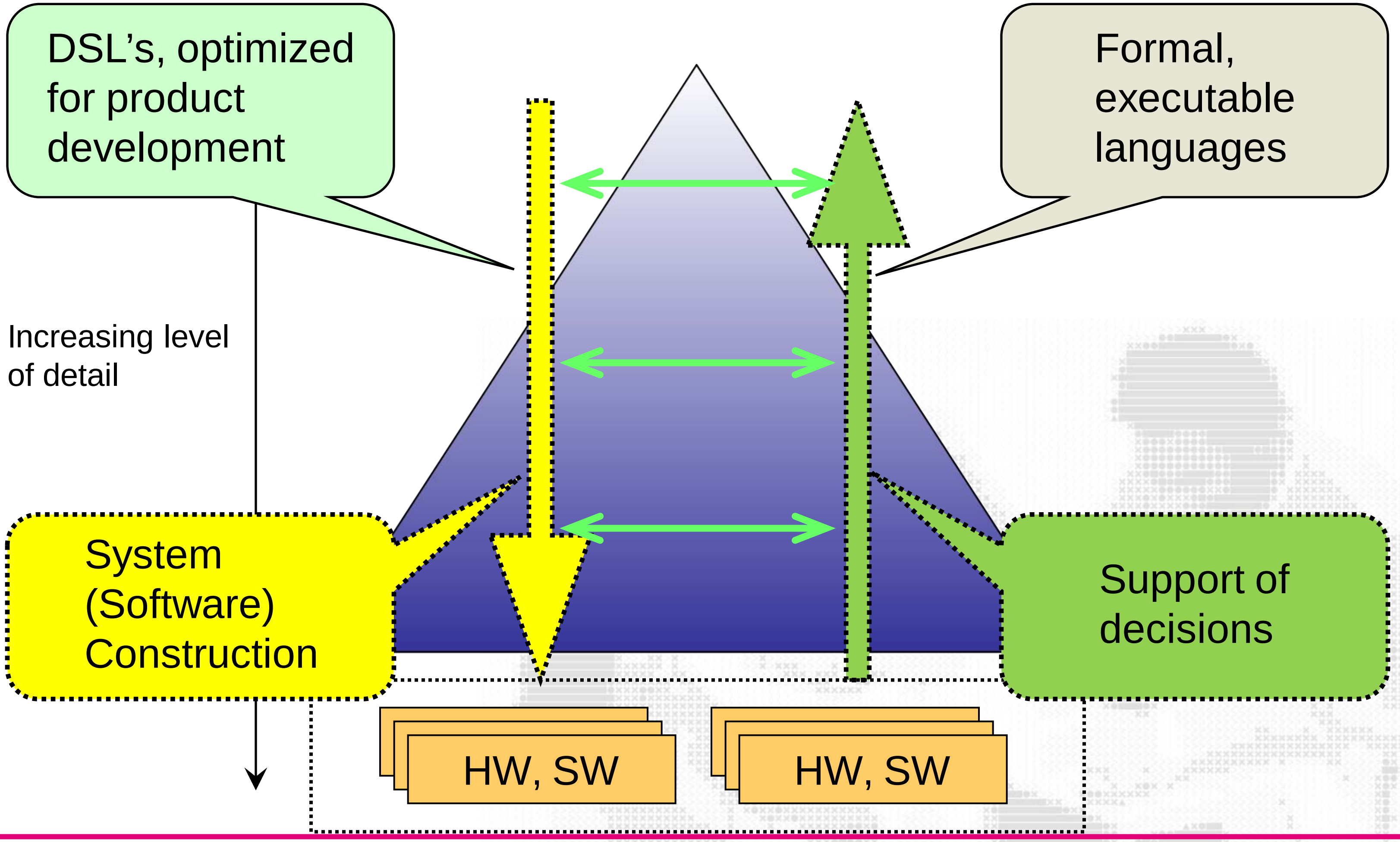
Model Streams



Model Streams



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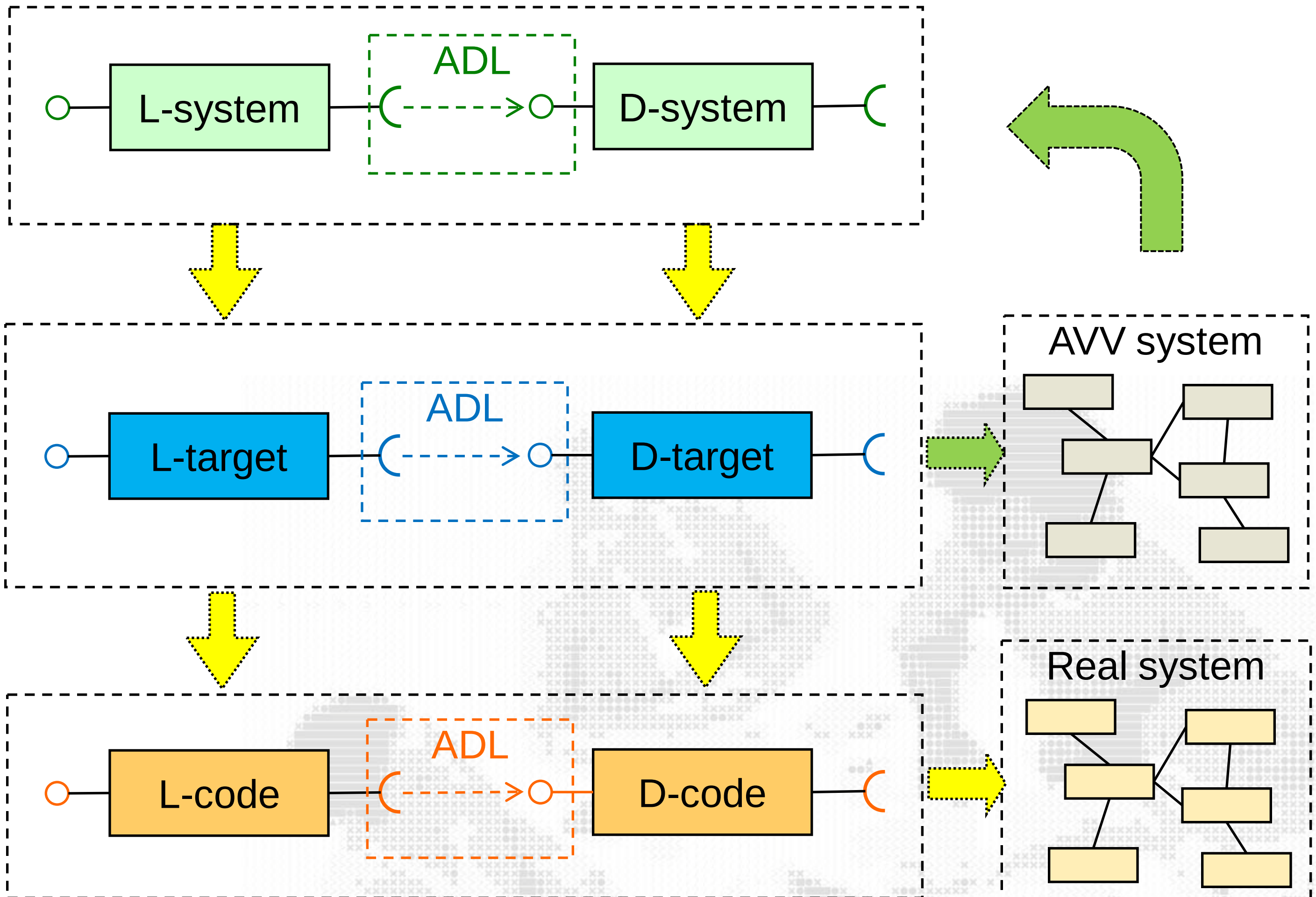
DSL Abstraction Levels

Essential level:
Specific DSL's
-Problem related
-Engineering efficiency
-Relate to problem domain

Intermediate level:
Generic DSL's
-Solution specific
-Early integration
-Relate to formalisms

Realization level:
GPL's



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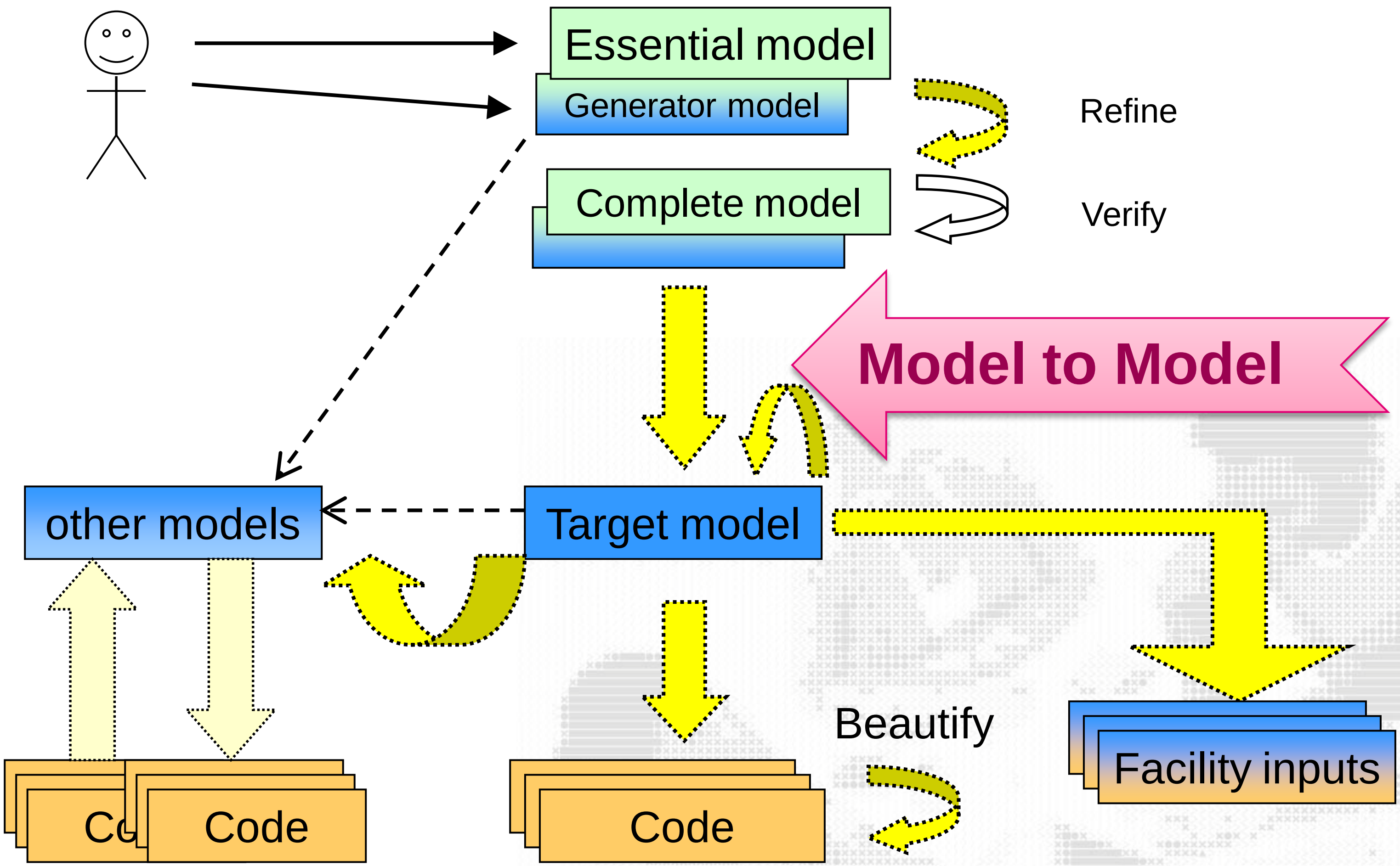
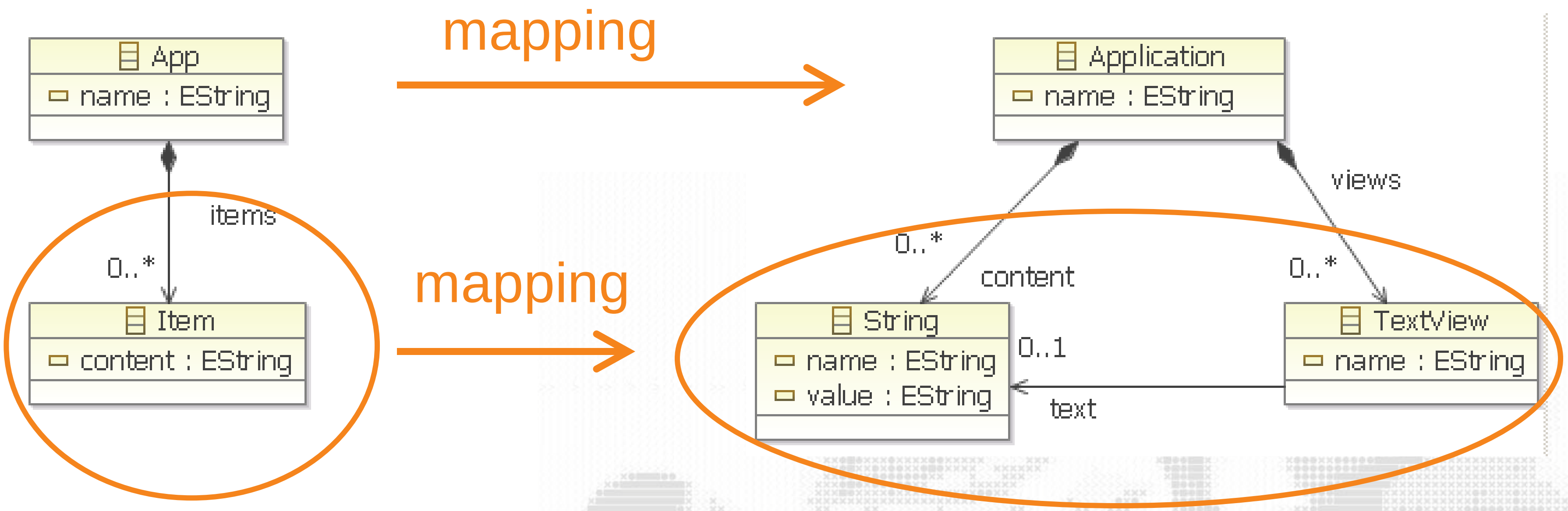
Generator Architecture: Overview



Model to Model



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Model to Model: QVTO transformation

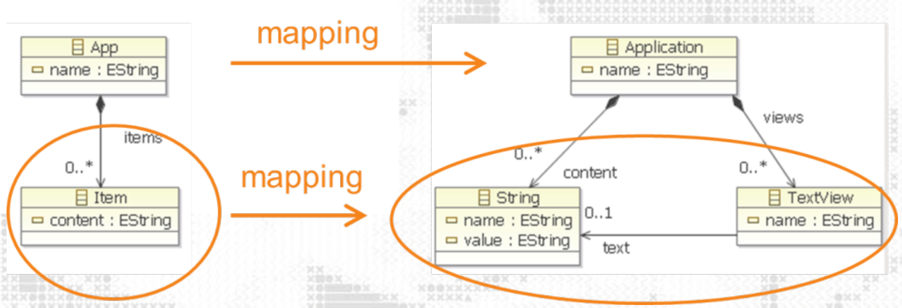
```
modeltype app "strict" uses myapp('http://myapp/1.0');
modeltype android "strict" uses myandroid('http://myandroid/1.0');

transformation App2Android(in appmodel : app, out androidmodel : android);

main() {
    appmodel.rootObjects()[app::App]->map App2Application();
}

mapping app::App::App2Application() : android::Application {
    name := self.name;
    content += self.items.map item2StringView(self).str;
    views += self.items.map item2StringView(self).tv;
}

mapping app::Item::item2StringView(in papp : app::App) : str: android::_String,
                                                         tv : android::TextView {
    init {
        var index := papp.items->indexOf(self);
        var string_name := 'string' + index.toString();
    }
    str.name := string_name;
    str.value := self.content;
    tv.text := str;
}
```



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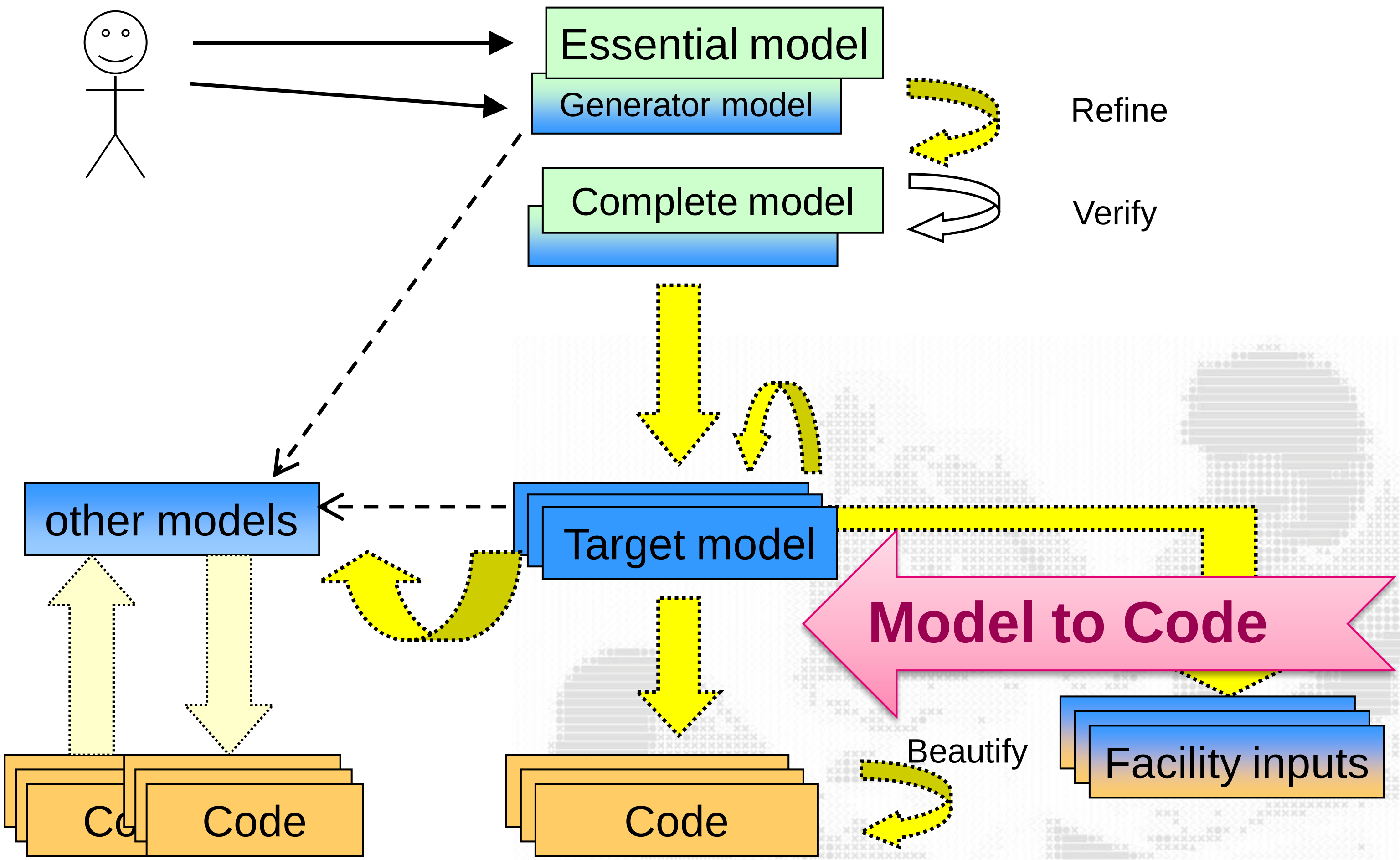
Generator Architecture: Overview



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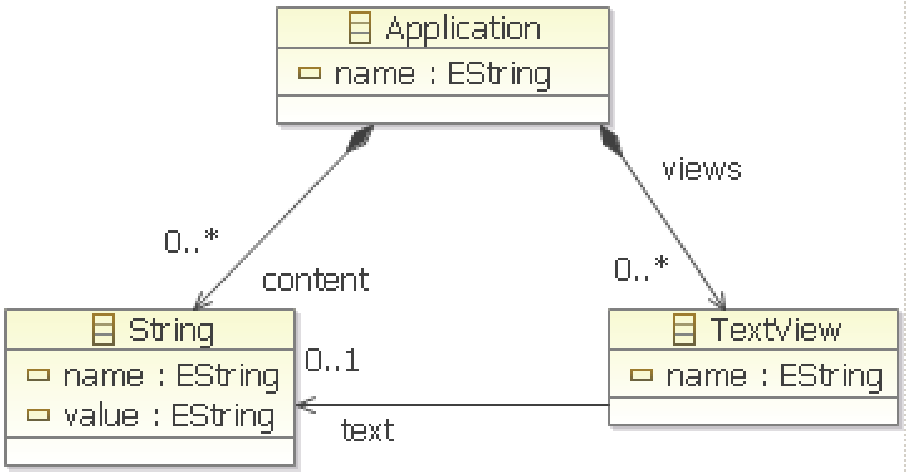
Model to Code




```
[template public generate_values(app : Application)]
    [file ('/res/values/strings.xml', false, 'Cp1252')]
<?xml version="1.0" encoding="utf-8"?>
<resources>
    <string name="app_name">[app.name/]</string>
    [for (s : String | app.content)]
    <string name="[s.name/]">[s.value/]</string>
    [/for]
</resources>
    [/file]
[/template]
```

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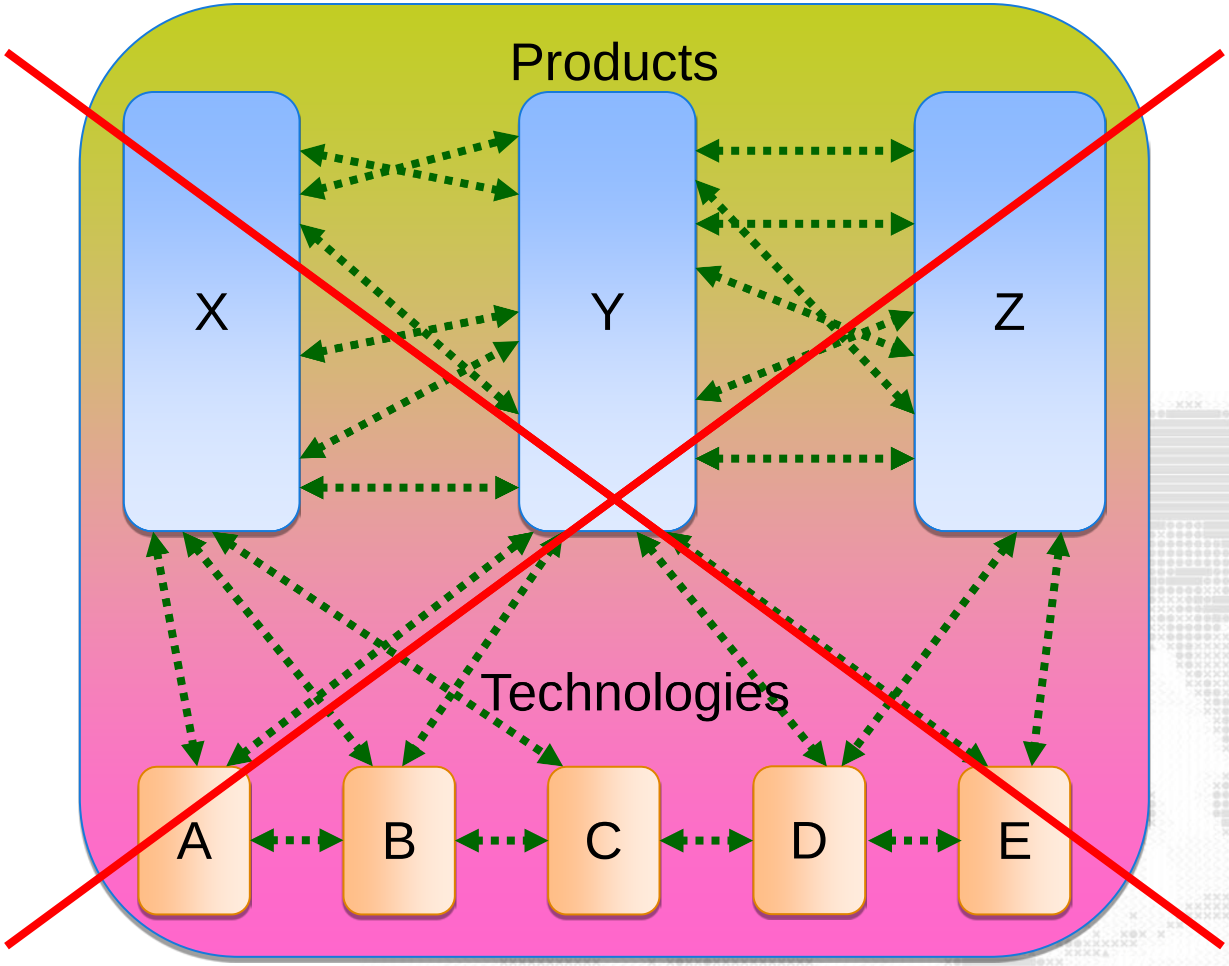
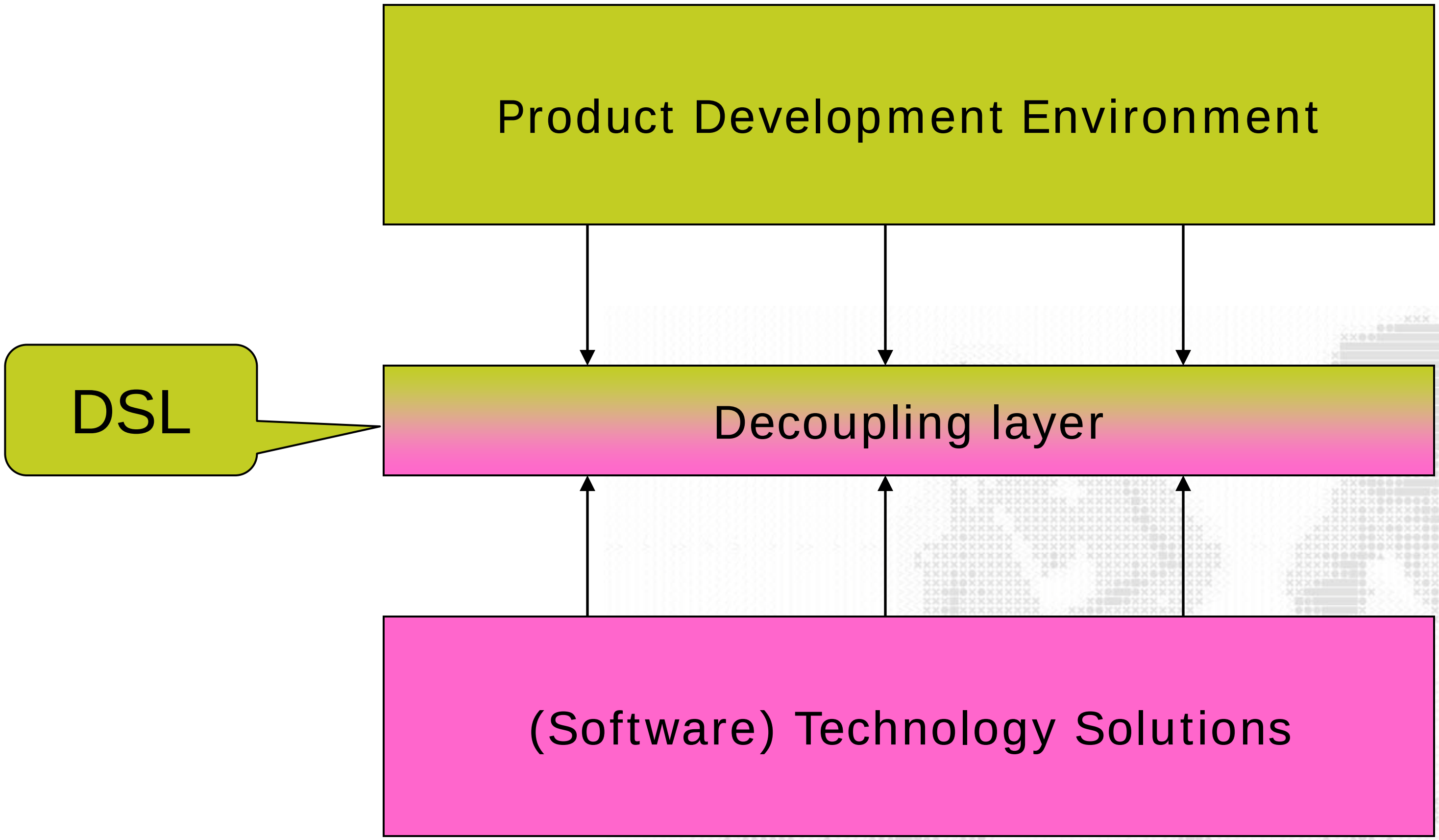
Current Software Environment



Decoupling from Technology





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Industrialization: Factories!

Primary Process

Focus on building products in the factory

Secondary Process

Focus on building and maintaining the factory

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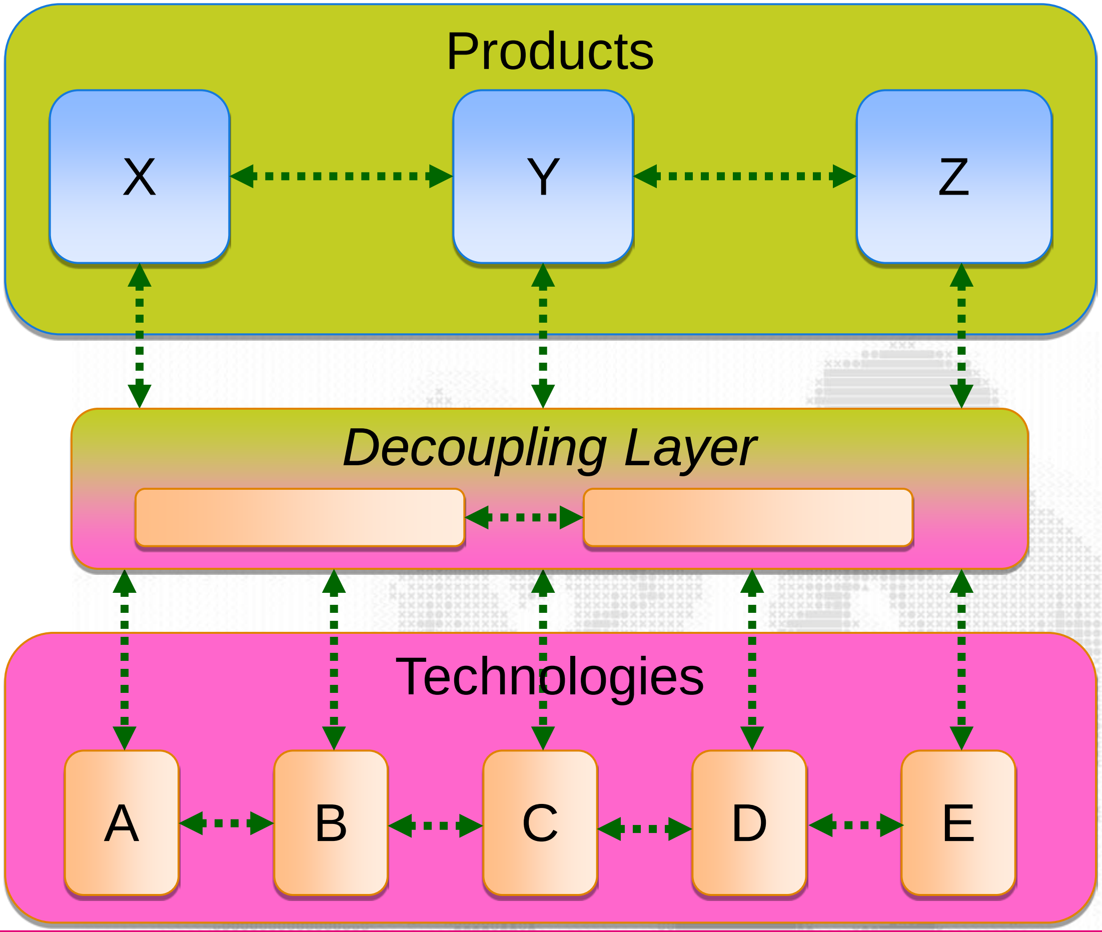
Software Factory!

Primary Process

Focus on building products in the factory

Secondary Process

Focus on building and maintaining the factory



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Vragen?

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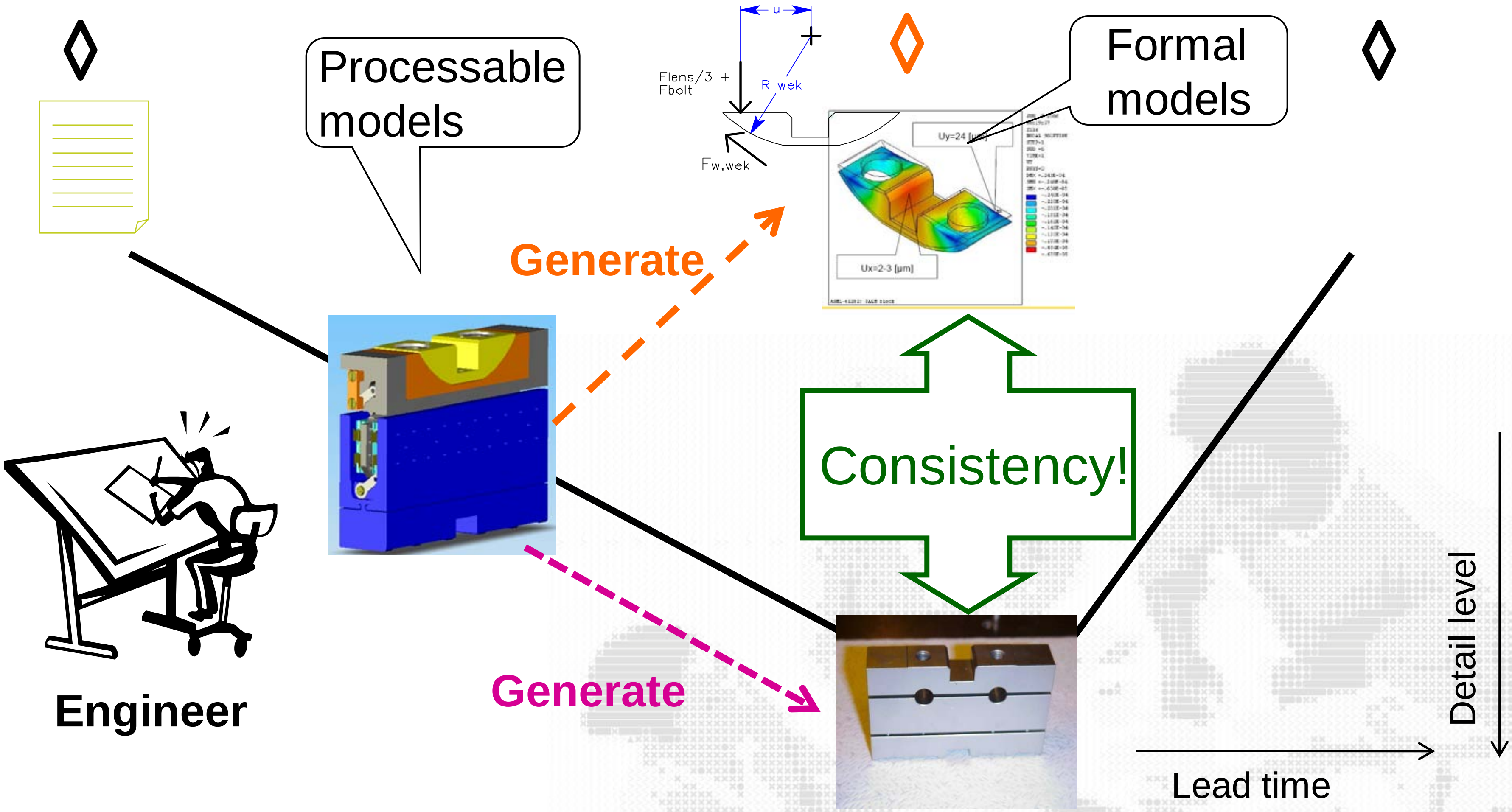
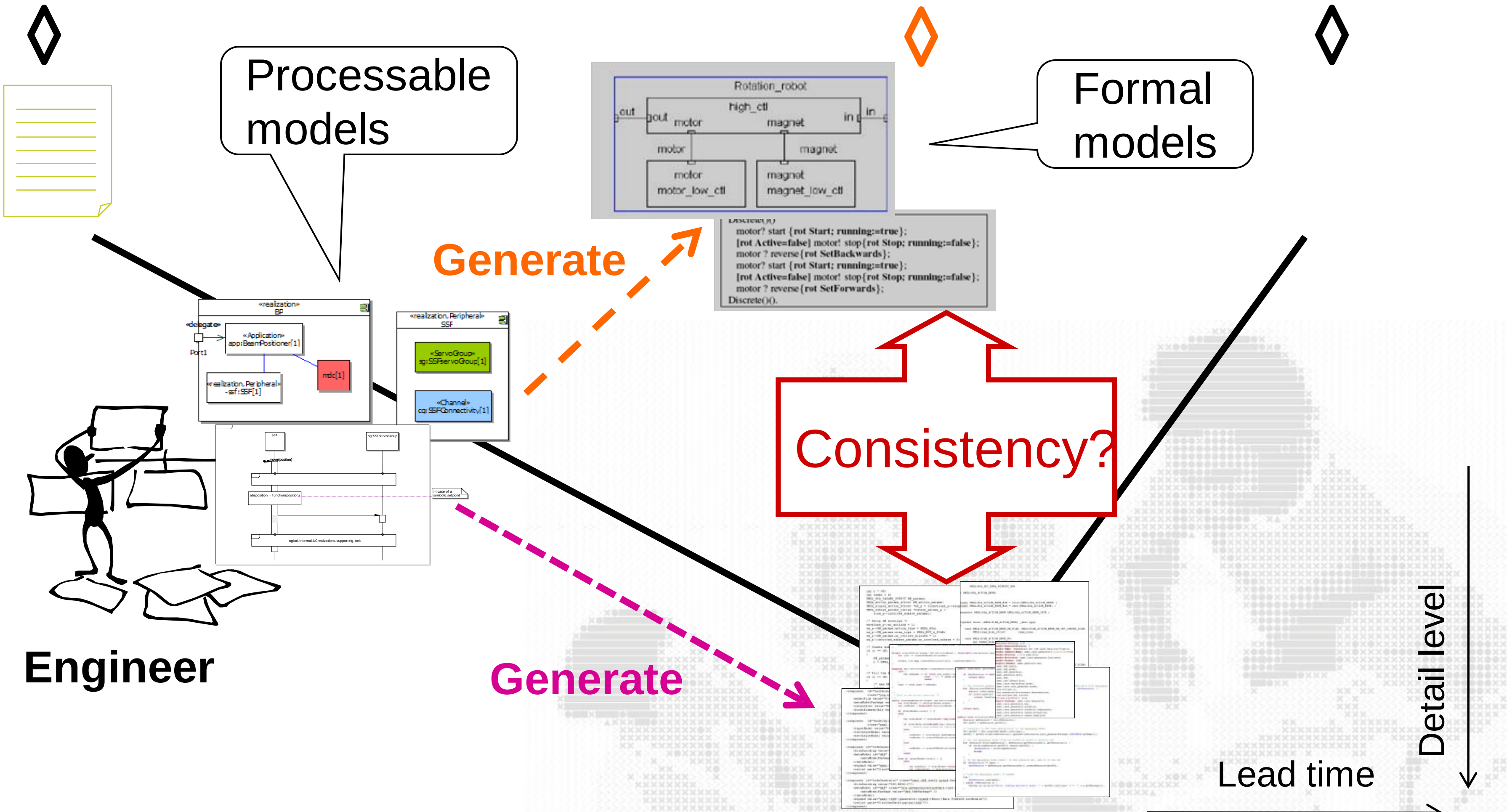
BACKUP

Mechanical Engineering



Engineering with models: Software MDE



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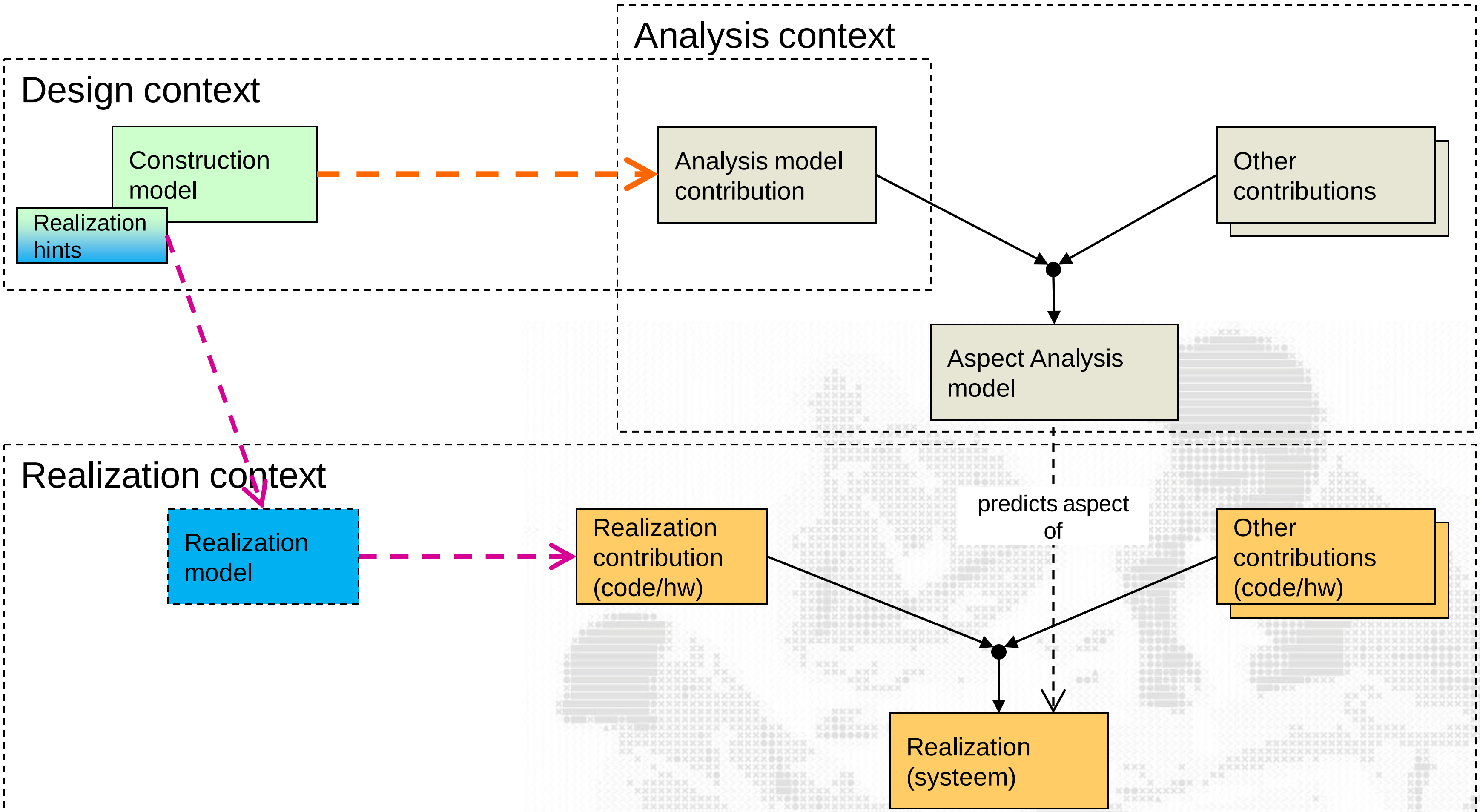
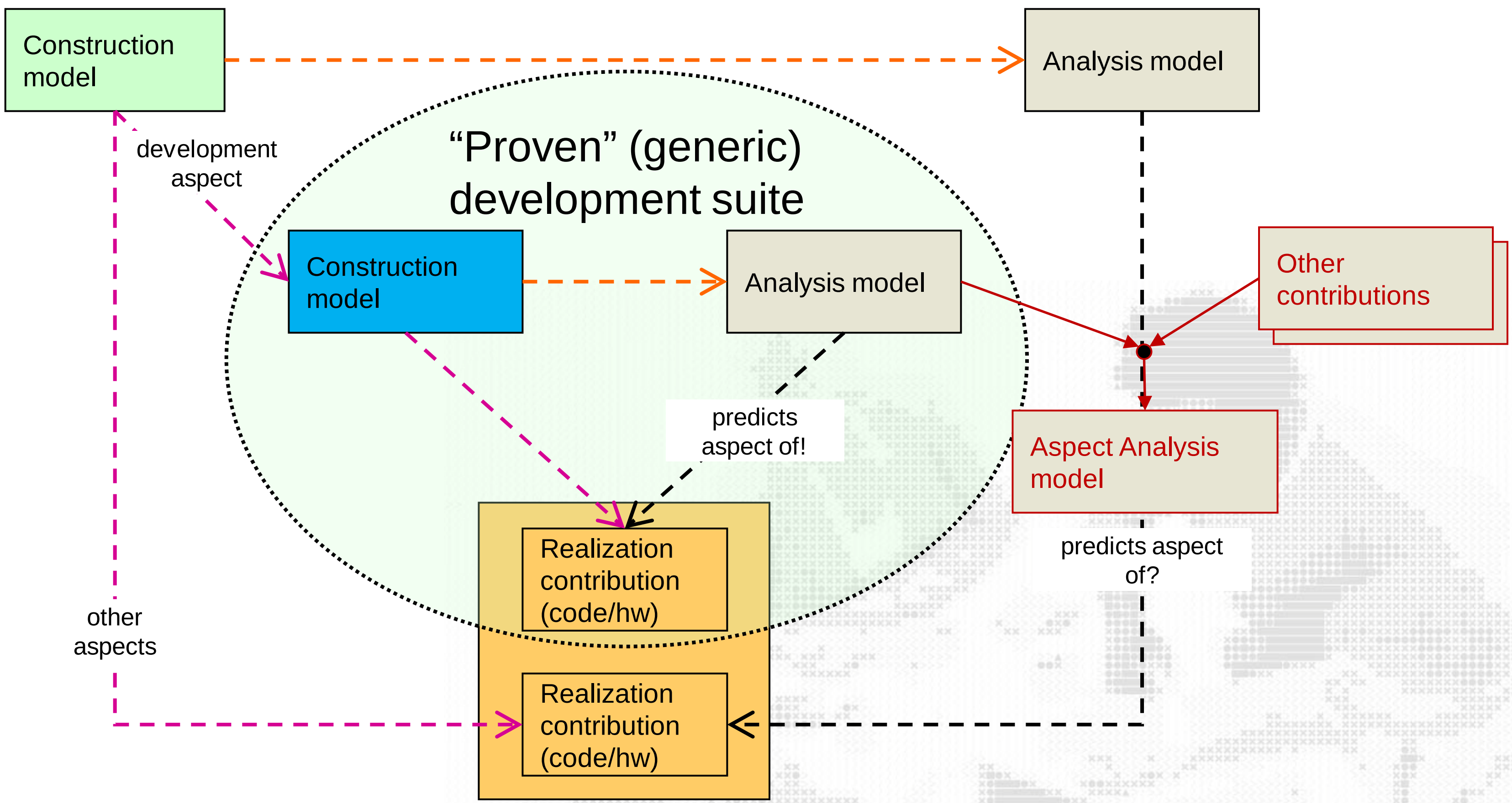
Analysis Models



Embedding Proven Suites



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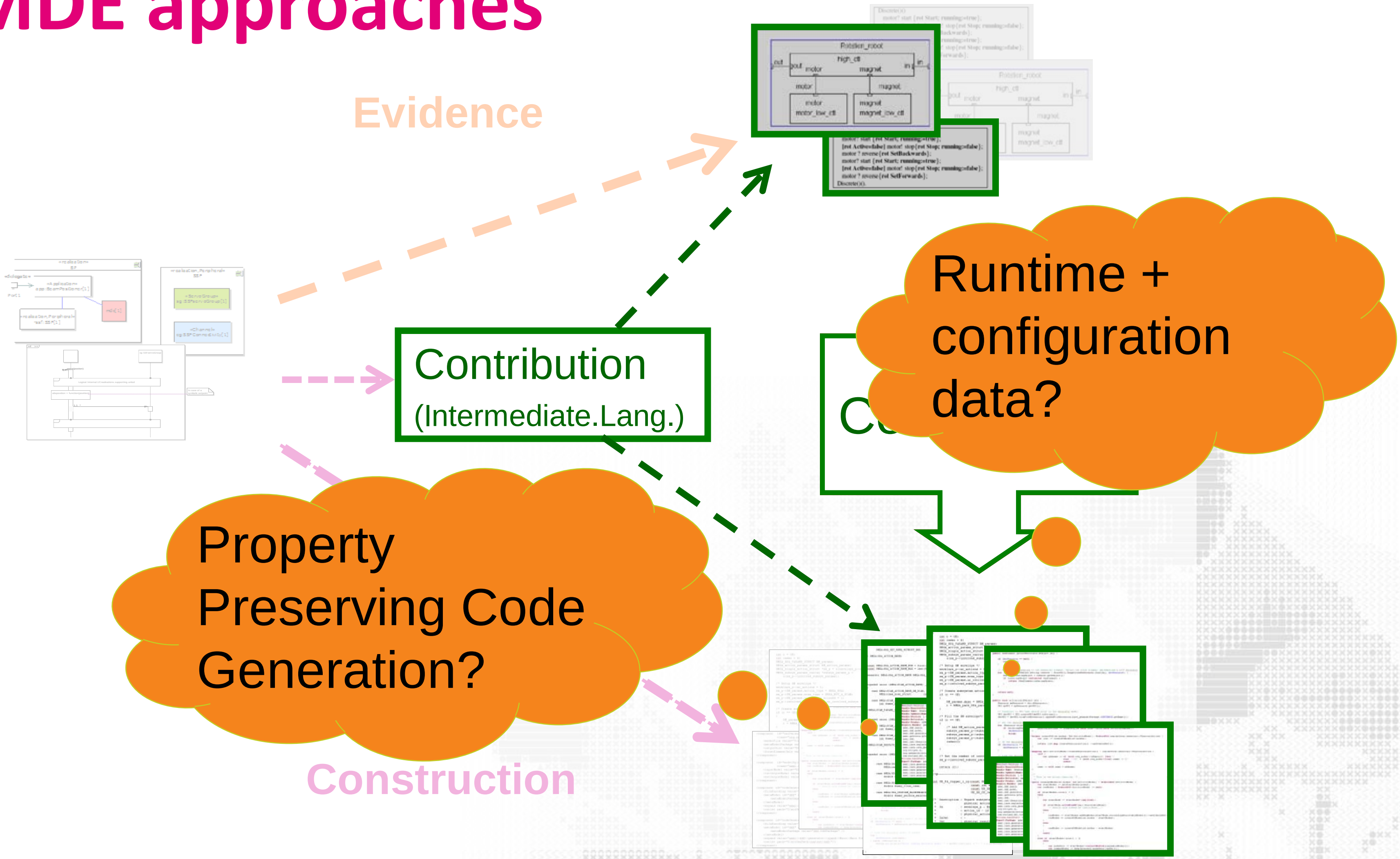
MDE approaches

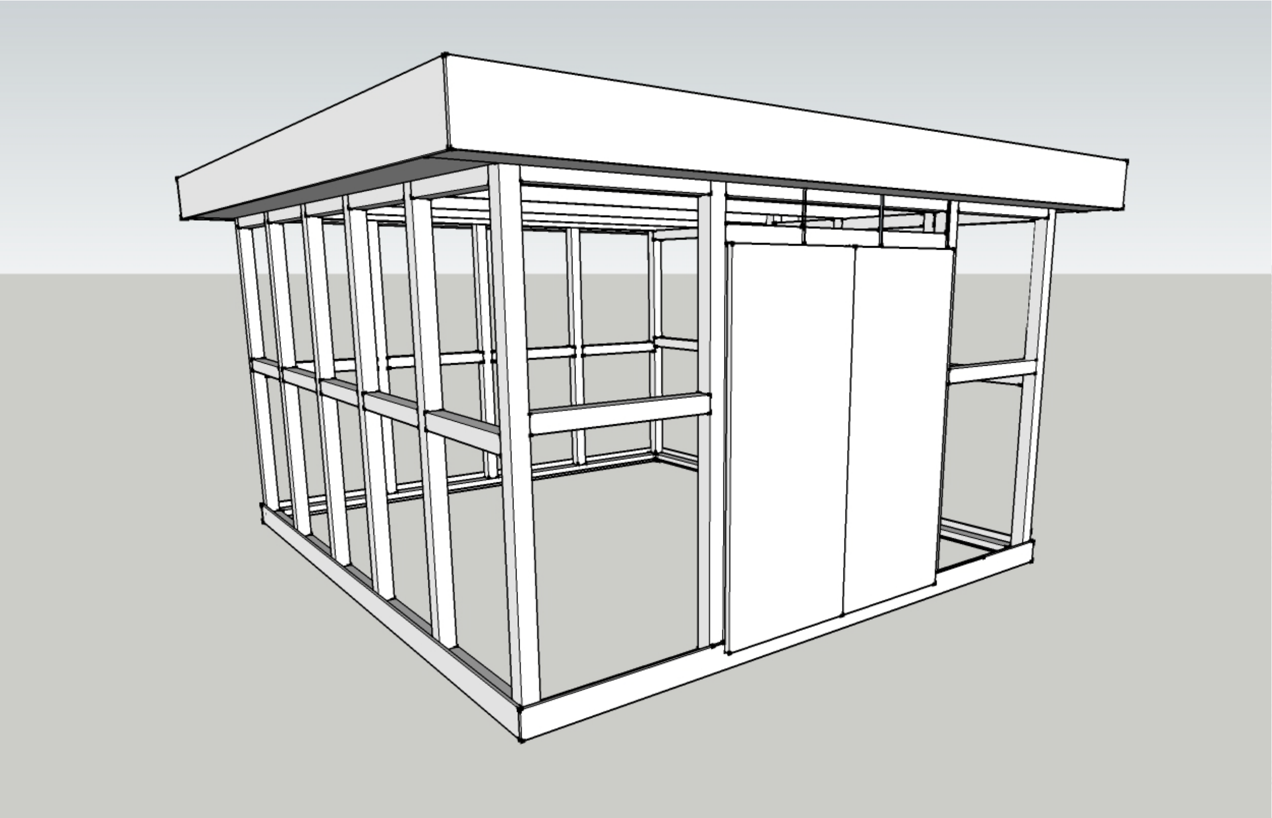


Tuinhuis (1) Garden shed

- “Blokhut” model: b x l x h = 4m x 4,5m x 2,5m.
- Houten frame 9cm op betonnen plaat 10cm.
- Dubbele deur aan voorkant: 1,40m

- Flat roof model: w x l x h = 4m x 4,5m x 2,5m.
- Wooden frame 9cm on concrete slab foundation
- Double door in front: 1,40m

Tuinhuis (2)



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Domain Specific Modeling

- Awareness of Concepts in the target domain
  - Meta-models define these concepts

➔ Domain Specific Language

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Example: 3D Drawing

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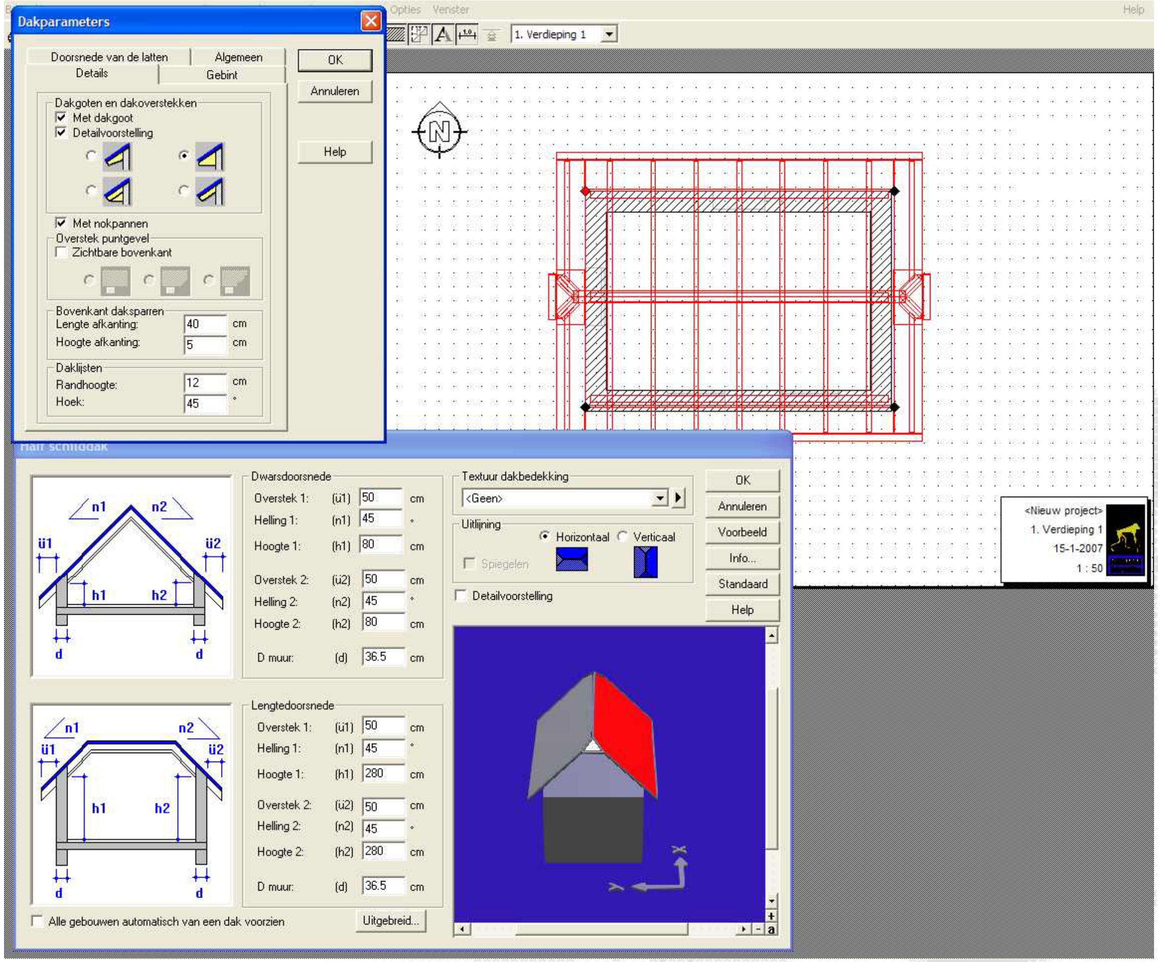
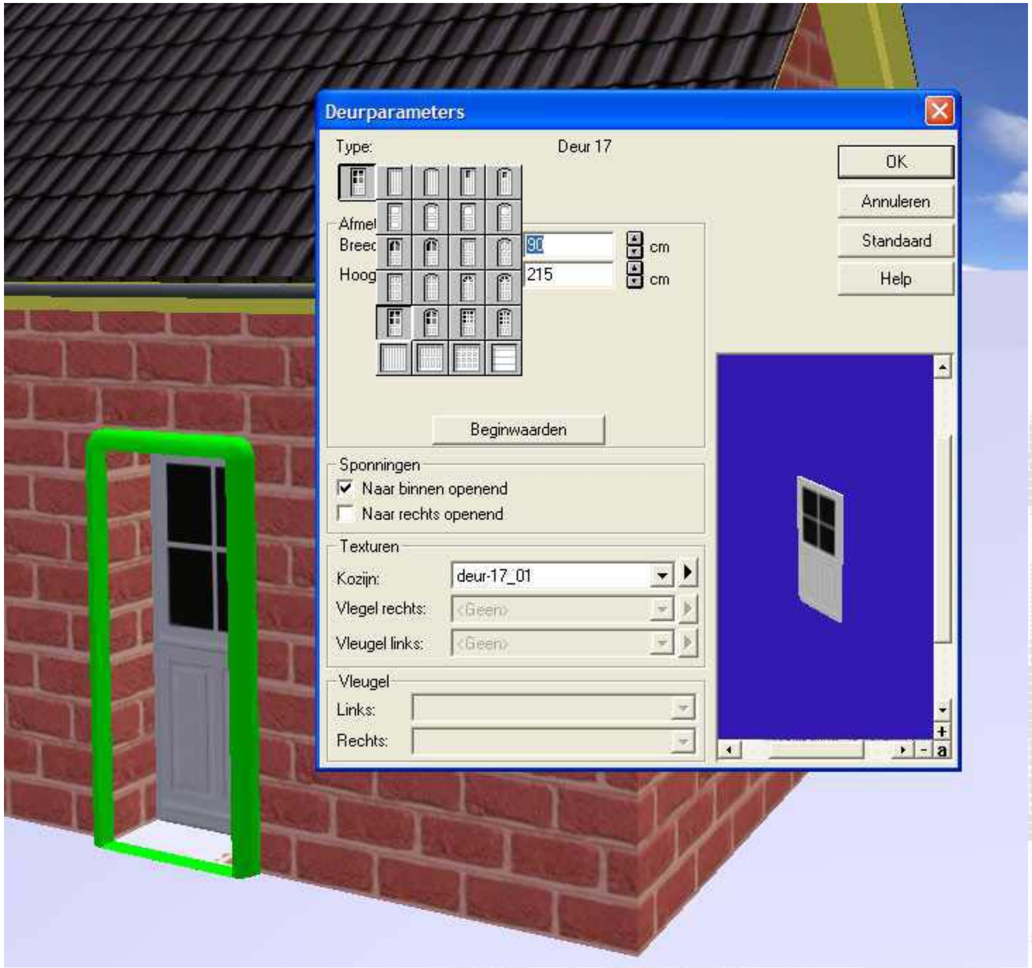
Example: 3D Drawing



Example: 3D Drawing



Example: 3D Drawing