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The Generator Company

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Generative tools for automated software development and modernization

Delta Software Technology
provides Europe's leading companies with state-of-the-art software generator technology for more than 30 years

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OOP 2007, Munich 24. January

Process Family Engineering – Product Lines for Processes

Cord Giese
Delta Software Technology GmbH

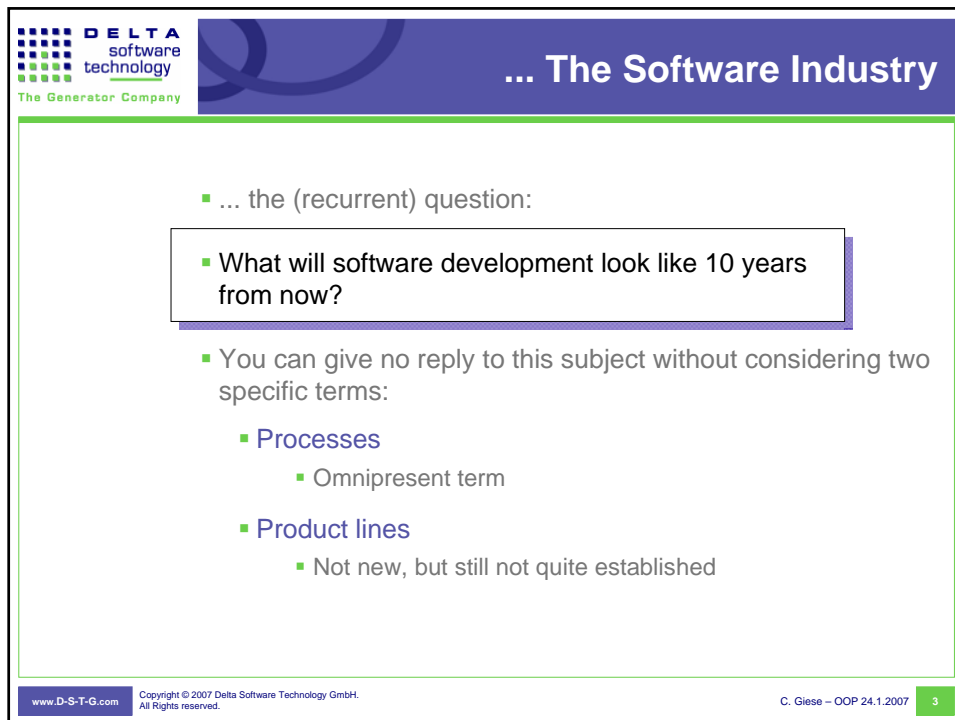
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Asking for the Future of ...



- 1974: The future of cars → absolutely misjudged
 - Joystick instead of steering wheel, bell jars, all passengers are playing cards, magnetic stripes on the streets
 - Later ...
- This shall not keep us from thinking of the future, particularly ...

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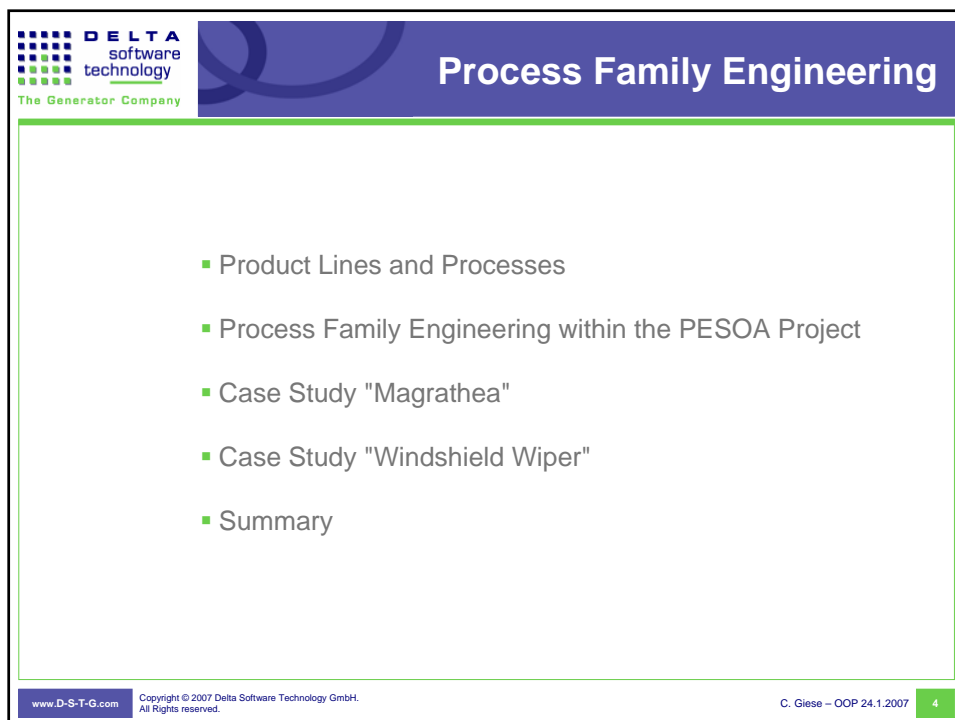


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... The Software Industry

- ... the (recurrent) question:
 - What will software development look like 10 years from now?
- You can give no reply to this subject without considering two specific terms:
 - Processes
 - Omnipresent term
 - Product lines
 - Not new, but still not quite established

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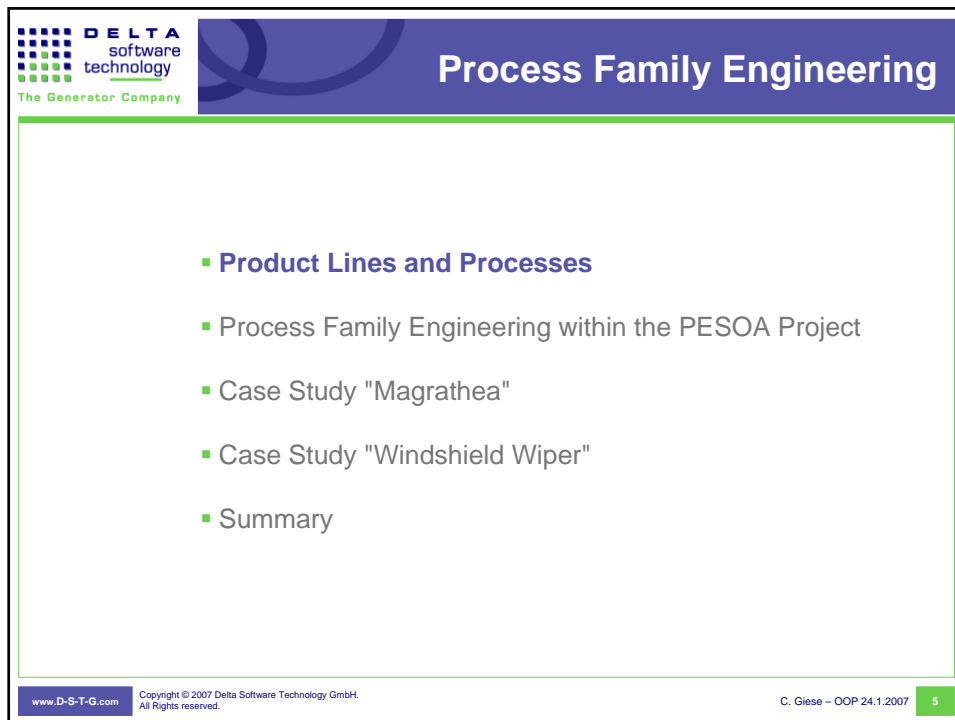


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Process Family Engineering

- Product Lines and Processes
- Process Family Engineering within the PESOA Project
- Case Study "Magrathea"
- Case Study "Windshield Wiper"
- Summary

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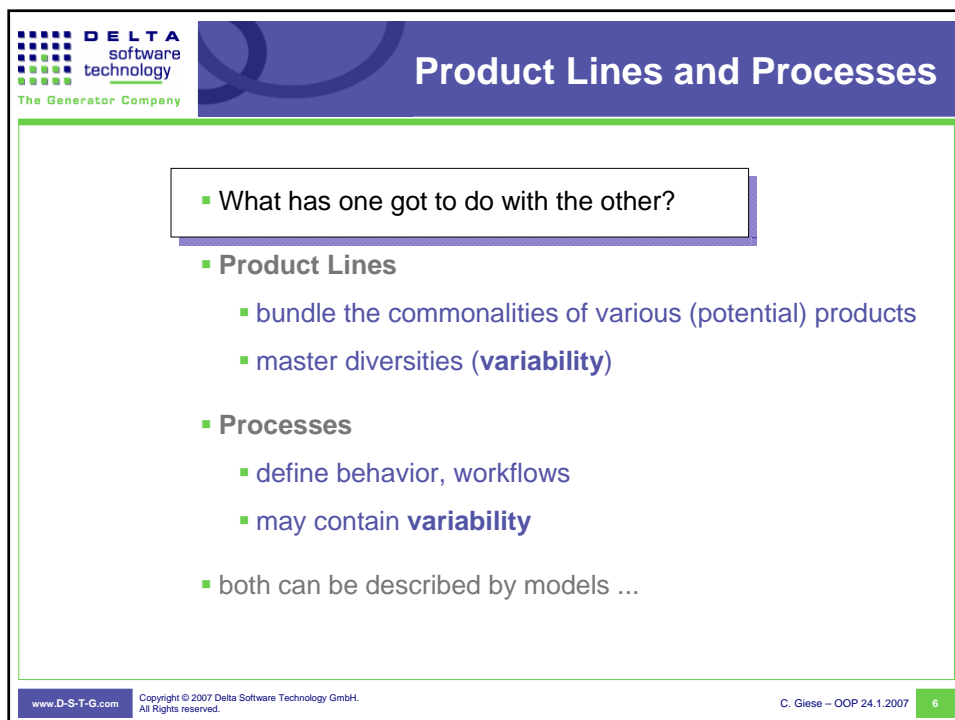


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Process Family Engineering

- **Product Lines and Processes**
- Process Family Engineering within the PESOA Project
- Case Study "Magrathea"
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Product Lines and Processes

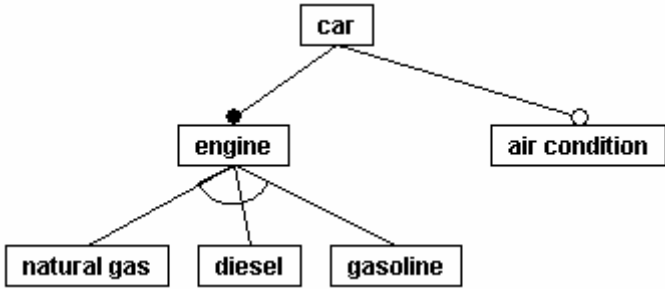
- What has one got to do with the other?
- **Product Lines**
 - bundle the commonalities of various (potential) products
 - master diversities (**variability**)
- **Processes**
 - define behavior, workflows
 - may contain **variability**
- both can be described by models ...

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Variability Model

- State-of-the-art: model-driven software product lines
 - **Variability model**, e.g. as a feature model
 - In general: Domain-specific language (DSL)



```
graph TD; car[car] --- engine[engine]; car --- air_condition[air condition]; engine --- natural_gas[natural gas]; engine --- diesel[diesel]; engine --- gasoline[gasoline];
```


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Process Models

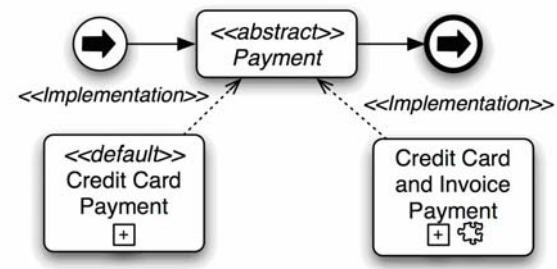
- In this case: processes implemented by software like **business processes** and **technical processes** (embedded)
 - Not: the software development process
 - UML activity diagrams (also: state diagrams)
 - BPMN (Business Process Modeling Notation)
- **Variant-rich processes**
 - Summing-up several processes without variability by variation points

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Variant-rich Process




```

graph TD
    subgraph Process
        Start(( )) --> AbstractPayment[<<abstract>> Payment]
        AbstractPayment --> End(( ))
    end
    subgraph Implementations
        CC[<<default>> Credit Card Payment]
        CCII[Credit Card and Invoice Payment]
    end
    CC -.->|<<Implementation>>| AbstractPayment
    CCII -.->|<<Implementation>>| AbstractPayment
    
```

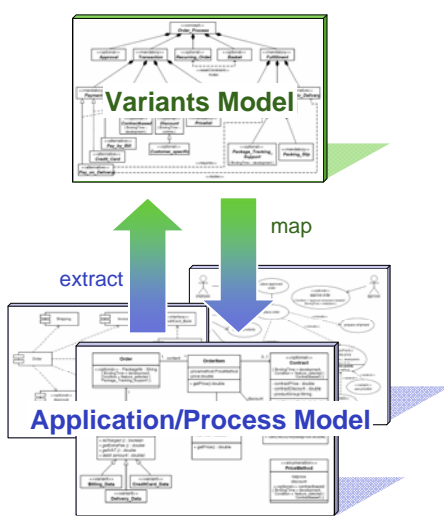
- Variation point within a BPMN process
 - Stereotypes for qualification
 - Two alternative sub-processes for resolving the variation point

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Variability Model – Process Model



- Mappings between variability model and process model can be performed in both directions
 - Mapping rules
 - Automation possible
- **n:m-relation** from variation points of the product line to the variation points of the process model

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Abstraction Gap

- Realization alternatives for product lines: framework, library, tool chain, "software factory"
- Always: mapping configuration → implementation
 - Abstraction Gap** between configuration / DSL and implementation / source code


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Interpretation or Generation?

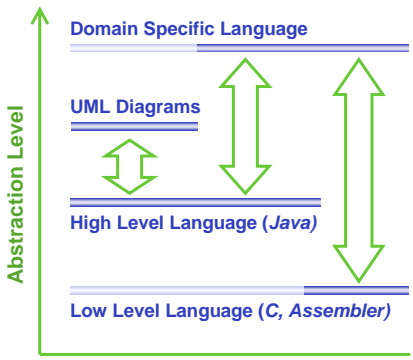
- (Crucial) Question: Interpretation or Code Generation?**
 - Code generation provides ...
 - Differentiation options concerning time and place
 - Forward displacement of computing power to the development phase (instead of runtime)
 - Interpretation provides ...
 - Configuration at runtime
 - Global decision impossible
 - In this case: Focus on optimizing the SE process
 - Focus: **Code generation**

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Domain-specific Generators



Abstraction Level


- Generator is not equal to "Generator"
- From simple syntax transformers ...
 - Universal
- ... to extensive software factories
 - Specialized
 - Optimizing
 - Domain-specific (DSG)

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Scope of a Code Generator



Trade-Off

- Another crucial question: What is variable in matters of what context?
- **Case 1: Specific Solution**
 - e.g. feature model variation points = variation points for code generation
 - High abstraction level possible
- **Case 2: Generic Solution**
 - e.g. transformation of process models into target code (notation elements = variation points for code generation)
 - Abstraction level equal to the used notation
- Examples are to come ...

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Process Family Engineering

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- **Process Family Engineering within the PESOA Project**
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Research Project: P E S O A

Scoping	Domain Scoping		
Domain Analysis	Model Features ↓ Identify Processes		Application Analysis
Domain Design	Design Processes ↓ Model Configurations	Specify Product ↓ Configure Product	Application Design
Domain Implementation	Implement DS Generator ↓ Implement DS Components	Apply DS Generator ↓ Build, Integrate, and Test	Application Implementation
Project Management			

- Process Family Engineering in Service-Oriented Applications
 - Product line architecture for variant-rich processes
 - Application areas **e-Business and Automotive**
 - Tool chains
 - www.PESOA.org
- Delta Software Technology:
 - Generator concepts and technique
 - HyperSenses™

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"The Generator Company"

- 30 years of building generator-based tools
 - Software development, maintenance and modernization
 - Hundreds of installations, hundreds of thousands of generated programs
- User experiences
 - Frequently already "product lines" via generators
 - Rather often: "abusage" of standard generators for developing individual generators
- From 1997 on: new generator technology
 - For developing project-specific generators, in particular

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Domain Engineering

```
graph TD; subgraph Domain_Analysis [Domain Analysis]; A1[Model Features] --> A2[Identify Processes]; end; subgraph Domain_Design [Domain Design]; D1[Design Processes] --> D2[Model Configurations]; end; subgraph Domain_Implementation [Domain Implementation]; I1[Implement DS Generator] --> I2[Implement DS Components]; end; A2 --> D1; D2 --> I1;
```

- Scoping: Domain definition and classification
- **Domain Analysis**
 - e.g. feature model, constraints
- **Domain Design**
 - Variant-rich process models
- **Domain Implementation**
 - Generator (DSG) development
 - Generic components

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Application Engineering

```
graph TD; A[Specify Product] --> B[Configure Product]; B --> C[Apply DS Generator]; C --> D[Build, Integrate, and Test];
```

The flowchart illustrates the Application Engineering process, divided into three main phases: Application Analysis, Application Design, and Application Implementation. The steps are: Specify Product, Configure Product, Apply DS Generator, and Build, Integrate, and Test.

- **Application Analysis**
 - Product selection
 - "rudimental" feature selection
- **Application Design**
 - Complete configuration
 - Concretion/instantiation of the variant-rich process model
- **Application Implementation**
 - Execution of the DSG
 - Build and test activity

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Application Areas

- Within the project: e-Business and Automotive
 - In general: in every case in which processes are used
- **e-Business:**
 - Example: hotel reservation Web service
 - Process modeling: BPMN
- **Automotive:**
 - Example: Windshield wiper control
 - Process modeling: UML

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Process Family Engineering

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Case Study "Magrathea"

HPI Hasso Plattner Institut
IT Systems Engineering | Universität Potsdam

Bachelor Project (7 Students)

Hotel Reservation Domain
Generator Technology
Concepts, Editor "Bauhaus"
Feedback

ehotelag DELTA software technology The Generator Company HPI Hasso Plattner Institut IT Systems Engineering | Universität Potsdam

PESOA

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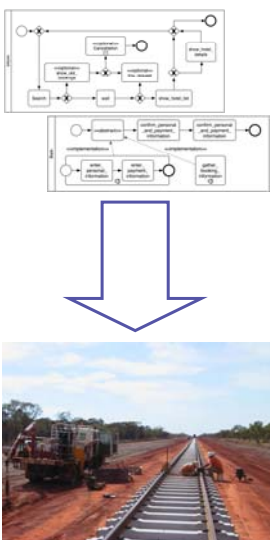
Application Partner ehotel

- Business model
 - **Hotel reservation portal** for private individuals, ...
 - ... for corporations
 - Usage for internal travel management, e.g. Merck
 - ... and affiliates
 - Arranging hotel reservations, e.g. Sixt, Map24
- → Many customers with different requirements
 - High maintenance costs
 - Solution: **Generation of the portals**

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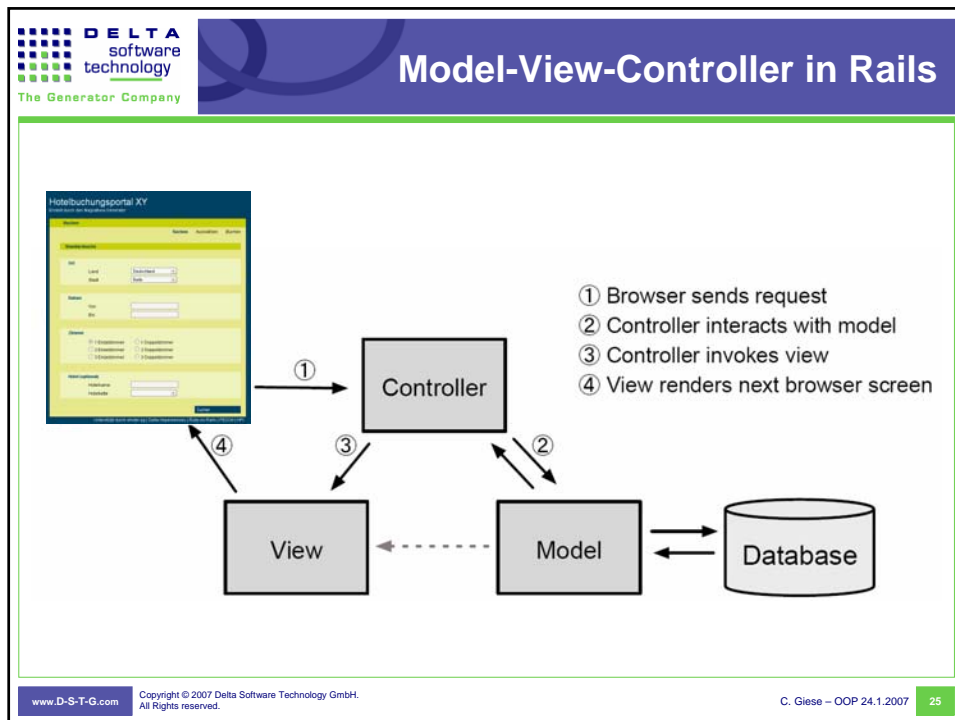
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Tool Chain "e-Business"

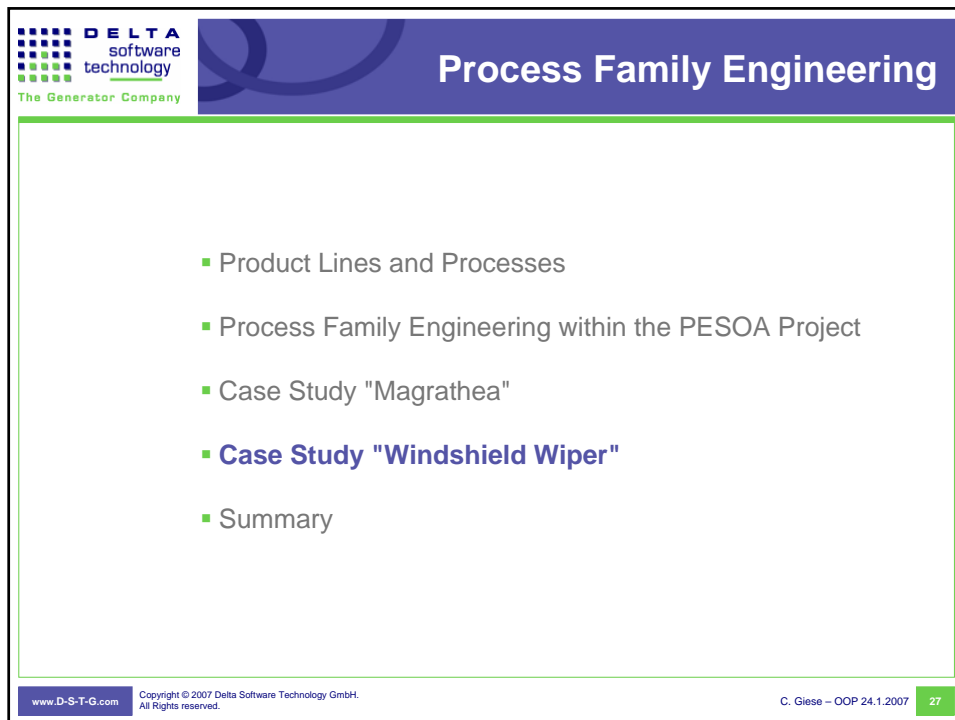


- Modeling by BPMN process models
 - Editor "Bauhaus"
 - based on Eclipse EMF
- Generation ...
 - HyperSenses as generator system
 - Import of XMI data
- ... for Web framework "Ruby on Rails"
 - Model-View-Controller concept
 - Generation of the controllers and views

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-
- The slide is titled 'Experiences' and contains a bulleted list under the heading 'Generic Approach'. The list describes the challenges and success factors of processing BPMN models for web services.
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- ## Experiences
- **Generic Approach**
 - Processing of all BPMN models describing Web services
 - **Direct processing of process model data** by HyperSenses
 - Rather much expenditure for developing the generator
 - 3 students / 8 weeks / 30 hours per week
 - Was possible just because of
 - little gap in abstraction from BPMN to Ruby
 - Definition of a BPMN subset
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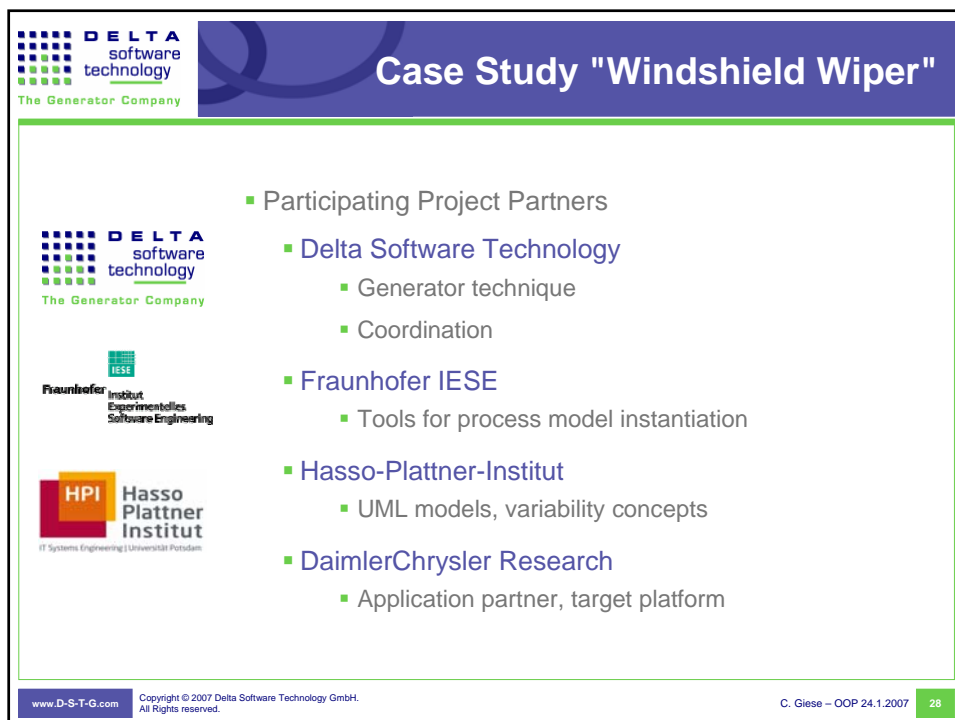


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Process Family Engineering

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- **Case Study "Windshield Wiper"**
- Summary

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Case Study "Windshield Wiper"

- Participating Project Partners
 - Delta Software Technology
 - Generator technique
 - Coordination
 - Fraunhofer IESE
 - Hasso-Plattner-Institut
 - UML models, variability concepts
 - DaimlerChrysler Research
 - Application partner, target platform

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Fraunhofer IESE
Institut Experimentelles Software Engineering

HPI Hasso Plattner Institut
IT Systems Engineering | Universität Potsdam

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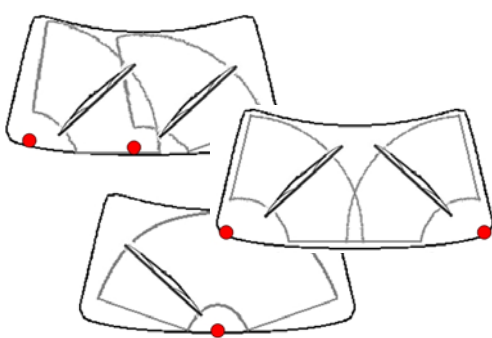
Automotive Product Lines

- High number of product variants typical for automotive domain → necessity of product lines
- Fulfilling quality standards
 - SPICE – *Software Process Improvement and Capability Determination*
 - Measures the process maturation stage
 - (A)SIL – *(Automotive) Safety Integrity Level*
 - Measures the reliability; hazard rating
- Increasing quality through less manual processes
 - Reproducibility, traceability

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Windshield Wiper Control System



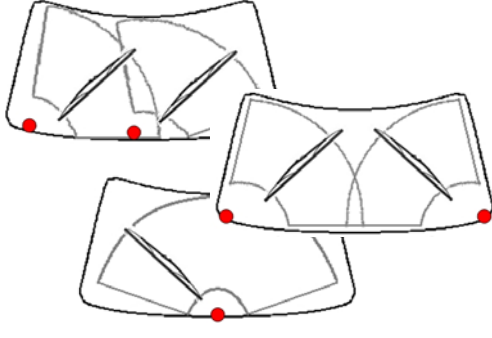
- Example: Windshield wiper control system
- Microcontroller
 - 8-bit RISC processor
- Operating system PURE
- C++ source code
- **Generation of several variants**

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Windshield Wiper Options



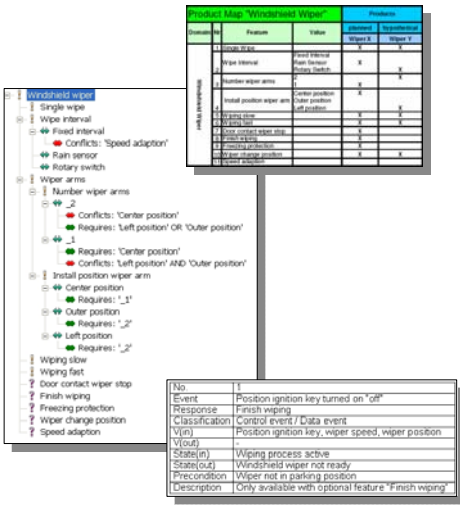
- 1 or 2 wiper arms
- Install positions
 - Left or outer
- Intervals fixed or adaptable
- Rain sensor
- Freezing protection
- wiper stops automatically as soon as the front doors are opened

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Scoping + Domain Analysis




- Scoping
 - Product map
 - Variants, features
 - Event list
 - "Outside-In Modeling"
- Domain Analysis
 - Feature model
 - Constraints

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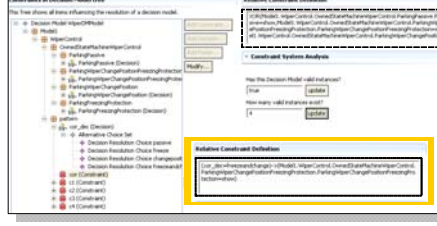


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Domain Design



The diagram shows a state machine for 'IgnitionOff' with various states and transitions, including variant elements like 'ParkingProtection' and 'ParkingChangePosition'.



The Decision Model shows a tree structure of decision nodes. The Constraint System Analysis window displays a table of constraints and their definitions.


- UML State Machines and Activity Diagrams
 - Variant-rich
 - Variation points and variant elements
- Decision Model
 - Constraints
 - Derived from feature model (automatically)
 - Considering items of the UML model

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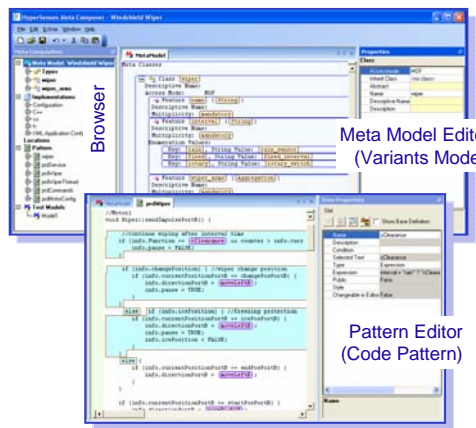
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Domain Implementation



The screenshot shows the HyperSenses Meta Composer interface. It includes a 'Browser' on the left, a 'Meta Model Editor (Variants Model)' in the center, and a 'Pattern Editor (Code Pattern)' at the bottom. The Meta Model Editor shows a class hierarchy, and the Pattern Editor shows code snippets for implementing a Design Structure Generator (DSG).


- Separation of generic and variant implementation parts
 - Domain-specific components
 - Hardware abstraction layer
 - Domain-specific generator (DSG)
- HyperSenses Meta Composer™
 - Design and
 - Implementation of a DSG

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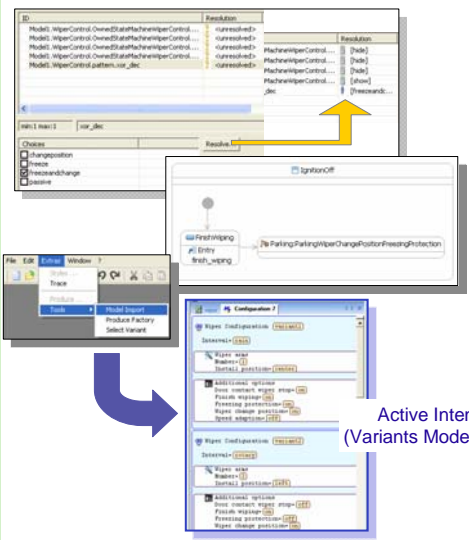
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Application Engineering




- Interactive, guided configuration → “Resolution Model”
- Instantiation of variant-rich UML model
- HyperSenses Active Intent™
 - In general: product configuration – here:
 - Model Import
 - (Data verification)
 - Produce Factory

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Experiences

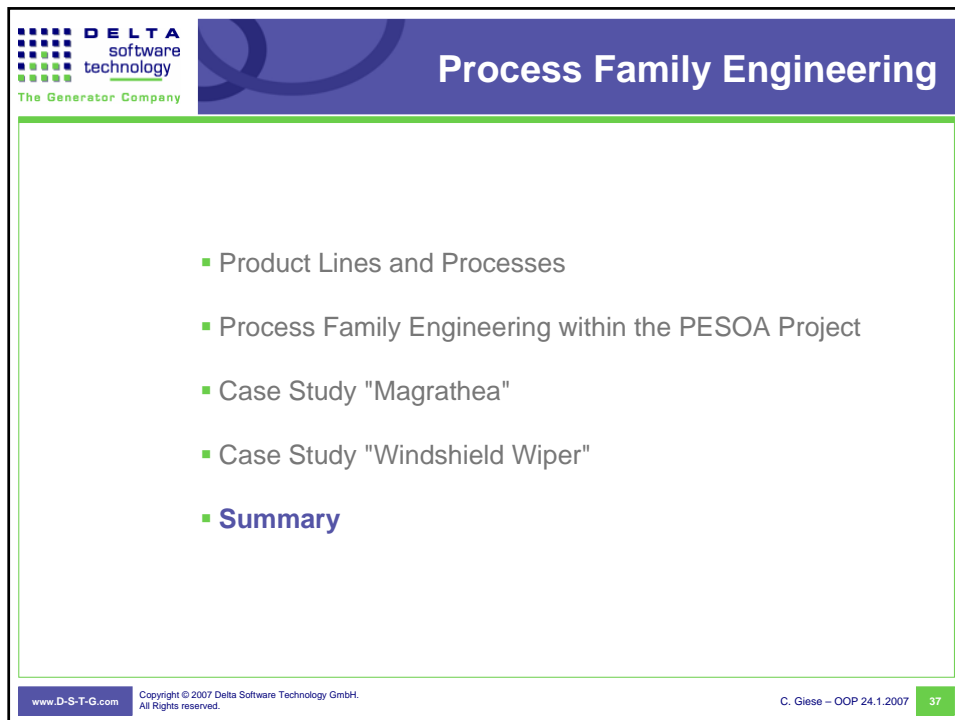
▪ **Specific Approach**

- Processing of configuration data for resolving the variant-rich UML process model
 - Created by the "Resolution Wizard"
 - Reference to: process model variation points
- Less expenditure for generator development
 - despite **handling a large gap in abstraction** from configuration to the generated C++ code
- New implementation of the DSG when selecting a new (even related) domain

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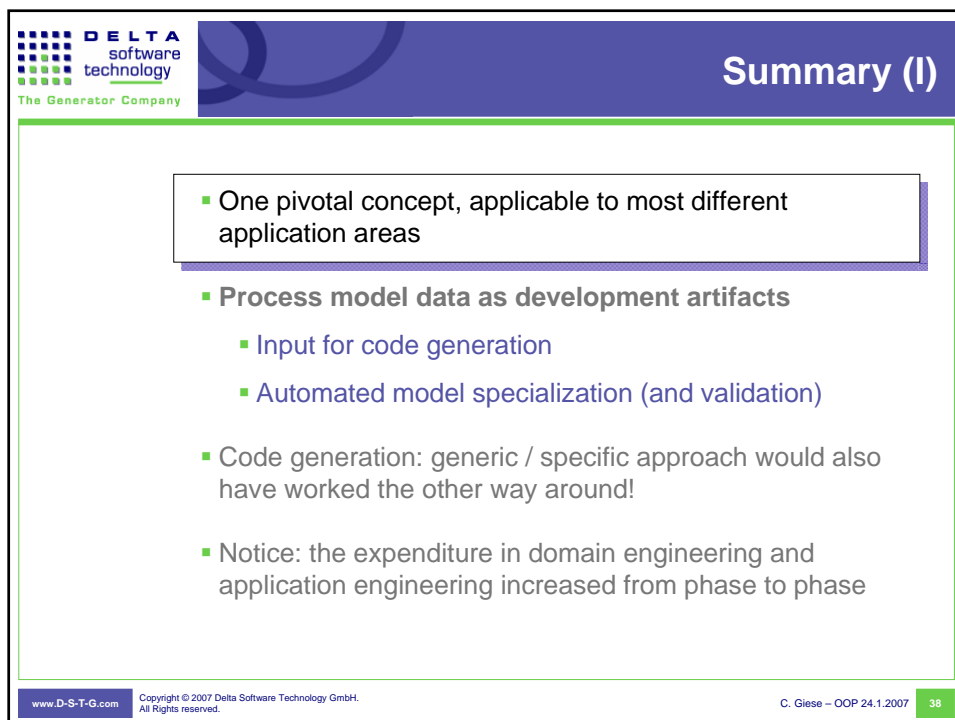
The slide features a blue header with the Delta Software Technology logo on the left and the title 'Process Family Engineering' on the right. The main content area is white with a green border. It contains a bulleted list of topics. The footer includes the website 'www.D-S-T-G.com', copyright information for 2007, and the slide number '37'.

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- **Summary**

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The slide features a blue header with the Delta Software Technology logo on the left and the title 'Summary (I)' on the right. The main content area is white with a green border. It contains a bulleted list of summary points. The first point is enclosed in a box. The footer includes the website 'www.D-S-T-G.com', copyright information for 2007, and the slide number '38'.

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Summary (I)

- **One pivotal concept, applicable to most different application areas**
- **Process model data as development artifacts**
 - Input for code generation
 - Automated model specialization (and validation)
- Code generation: generic / specific approach would also have worked the other way around!
- Notice: the expenditure in domain engineering and application engineering increased from phase to phase

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Summary (II)

- Necessity for tool support for developing generators
 - Generic approach complex
 - Specific approach leads to multiple new implementation
- Altogether: linkage of important artifacts:
 - Variability Model + Process Model + Tool Chain = Model-driven, Process-based Product Line Architecture

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Let's Return to the Future of Cars



- Was it really absolutely misjudged?
- No!
 - It happened later and somehow different:
 - steering will rather soon be handled electronically instead of mechanically
 - in fact larger car windows are used today
 - navigation systems, magnetic stripes (still) not

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The End

- Once again:
 - What will software development look like 10 years from now?
- We are all no fortunetellers – but we can give a realistic idea of the future.
- Let's hope that the reality will be as thrilling as the "car future prophecy" in the mentioned book:
 - Somehow different but something like that ...
- Thank you very much!
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