

# DAIMLERCHRYSLER

## **Use of Ontologies to Support Design Activities**

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# Vehicle Engineering Goal

- To design a vehicle
  - To specifications
    - Marketing
    - Competitive benchmarking
    - Regulations
    - Standards
  - On time
    - Shortened time to market
  - Within budget



# Emerging Engineering Process: Catia V5

- Use of Catia V5 features
  - Parameterized connected templates
  - Embedded checks and validations
  - Templates' reuse
- With the 'right' usage strategy parameterized templates speed-up and simplify engineering process
- CV5 templates allow integration of best practices into design process



# Emerging Engineering Process Problems

- Digital Vehicle consists of thousands of “smart” templates and millions of associated parameters
- Relations and dependencies among templates are complex
- Complexity of management CV5 templates within design process is not 100% covered with PDM systems
- The question that we want to address is



# HOW DO WE MANAGE TEMPLATES

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**Problem: Template Management**

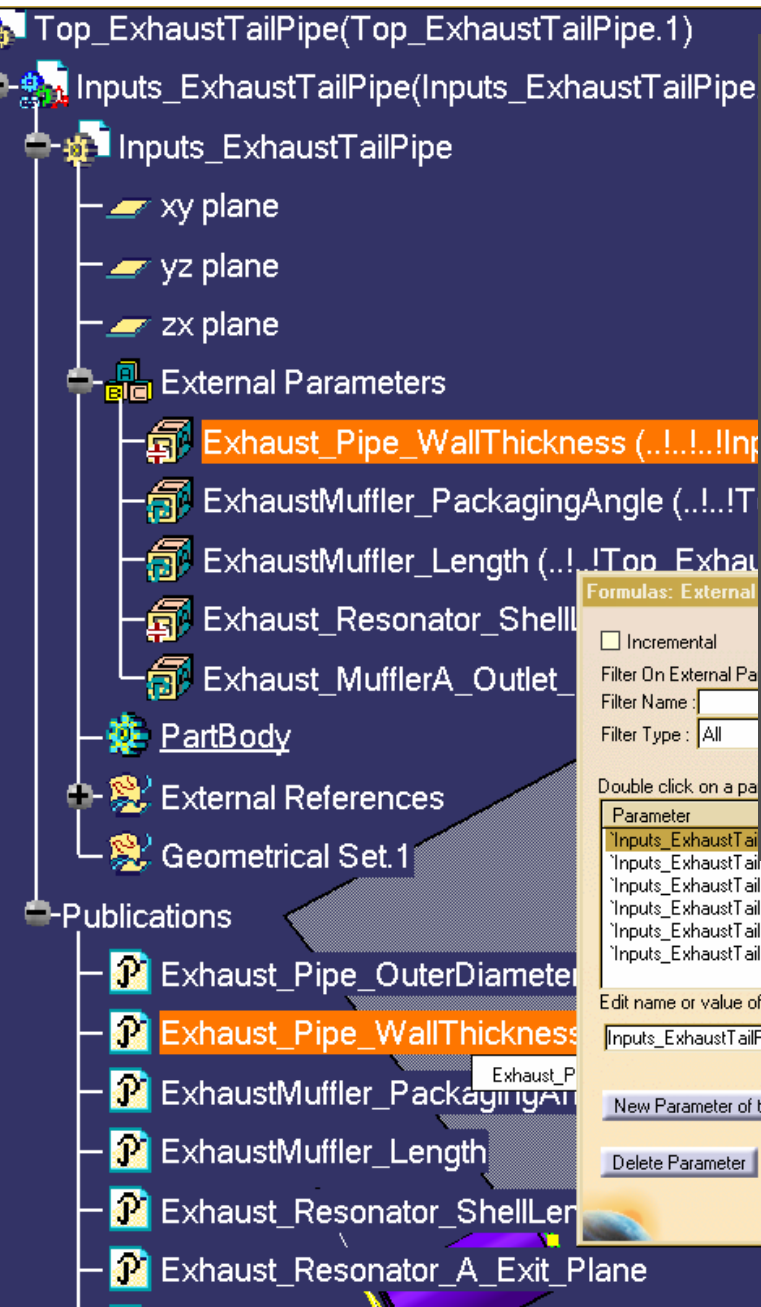
The screenshot displays the DaimlerChrysler Catia V5R13 SP3 HF8 M1 interface. The main window shows the 'TOP\_EXHAUST\_SYSTEM(TOP\_EXHAUST\_SYSTEM)' design structure tree on the left, listing various components such as Inputs\_Exhaust\_System, Processor\_Exhaust\_System, TOP\_Y\_PIPE, Top\_ExhaustResonator, Top\_ExhaustTailPipe, Top\_ExhaustCatalyticConverter, Top\_ExhaustFlexJoint\_2Bolt, Top\_ExhaustMuffler, Top\_Exhaust\_Pipe\_Routing, Top\_Exhaust\_Oxygen\_Sensor, and TOP\_EXHAUST\_SYSTEM\_CALCULATIONS. A 3D model of a purple exhaust component is visible in the center. On the right, a 'Design Objects' diagram illustrates the hierarchical structure of the TOP\_ExhaustSystem, showing connections to TOP\_Y\_PIPE, TOP\_ExhaustResonator, and an ellipsis (...).

**Design Objects**

```

graph TD
    TOP_ExhaustSystem --> TOP_Y_PIPE
    TOP_ExhaustSystem --> TOP_ExhaustResonator
    TOP_ExhaustSystem --> Ellipsis[...]
  
```

The bottom status bar indicates '1 element selected' and the taskbar shows the Start button and several open applications, including Microsoft Excel, Microsoft PowerPoint, CATIA/Enovia Startcenter, and DaimlerChrysler Catia.



## Design Object with Attributes

Top\_ExhaustTailPipe

ATTR:

Exhaust\_Pipe\_WallThickness = 1.8 mm

....

GeomAttr:

Exhaust\_Resonator\_A\_Exit\_Plane = (x, y, z) (x1, y1, z1)

...

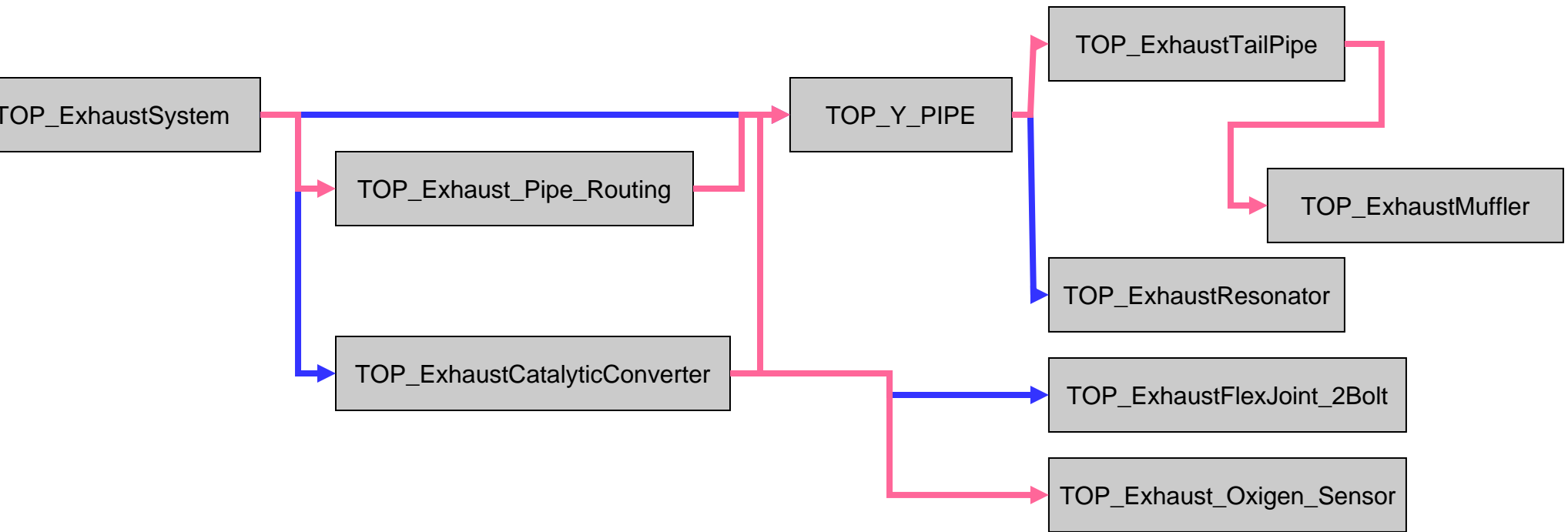
### Design Object with Attributes

```
Top_ExhaustTailPipe
ATTR:
    Exhaust_Pipe_WallThickness = 1.8 mm
    ....
GeomAttr:
    Exhaust_Resonator_A_Exit_Plane = (x, y, z) (x1, y1, z1)
    ...
```

### Design Object with Attributes

```
Top_ExhaustTailJoint_2Bolt
ATTR:
    Exhaust_Pipe_WallThickness = 1.8 mm
    ....
GeomAttr:
    Exhaust_Resonator_A_Exit_Plane = (x, y, z) (x1, y1, z1)
    ...
```





TOP\_EXHAUST\_SYSTEM\_CALCULATIONS

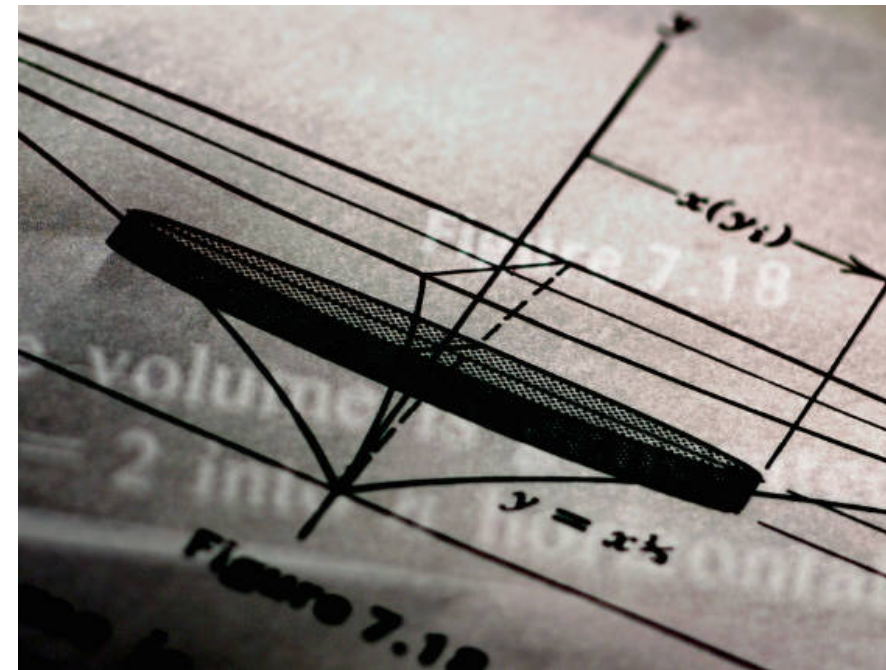
Explicit connection through named attributes/parameters

Implicit dependencies through the engineering process



# Problem Statement

- The example had 10 templates and more than 4200 parameters (~150 'user parameters')
- Thousands of templates and millions of parameters create a maintenance challenge
- Updating templates and distributing the latest versions making sure that all associated templates still work will be a full-time job
- It is necessary to develop a tool that would assist template creators and support personnel in managing templates



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**Solution**

# Ontology as a Solution

- An ontology can serve as a layer that represents the knowledge about the templates and their interconnections
- Additional development should be done to ensure the transparent interfaces with Catia V5, PDM systems and ontologies



# Why Ontologies?

- Ontologies can represent multiple type of relations among objects
- Ontologies can be integrated with CV5
- Ontologies can be managed outside of CV5
- Ontologies can be automatically processed to find dependencies and detect conflict between objects



# Critical Success Factors

- Ability to automatically transfer Catia templates into ontology
- Ability to visually represent relations among templates
- Ability to visually represent cause-effect chain of change in a template on other templates
- Stretch goals:
  - Ability to represent rules and formulae on relations among templates and parameters
  - Ability to automatically update templates where such rules or formulae are stated



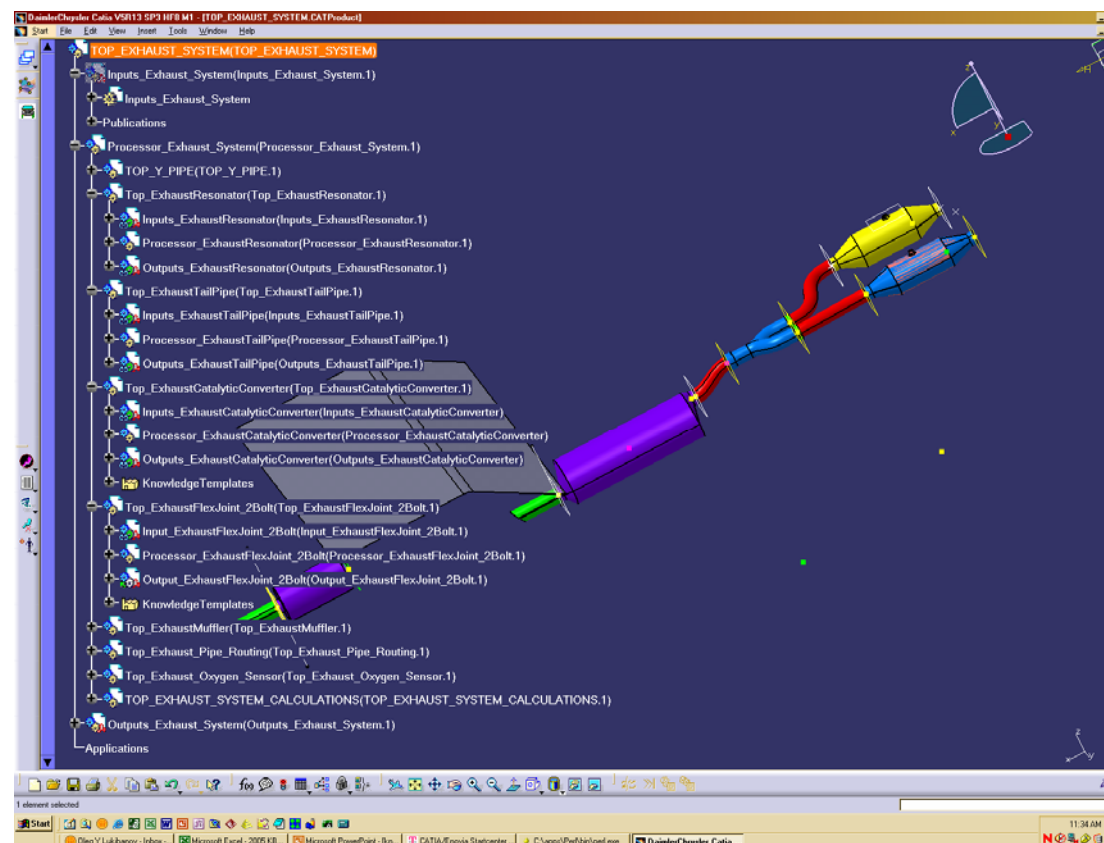
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**Approach to Building Templates' Ontologies**

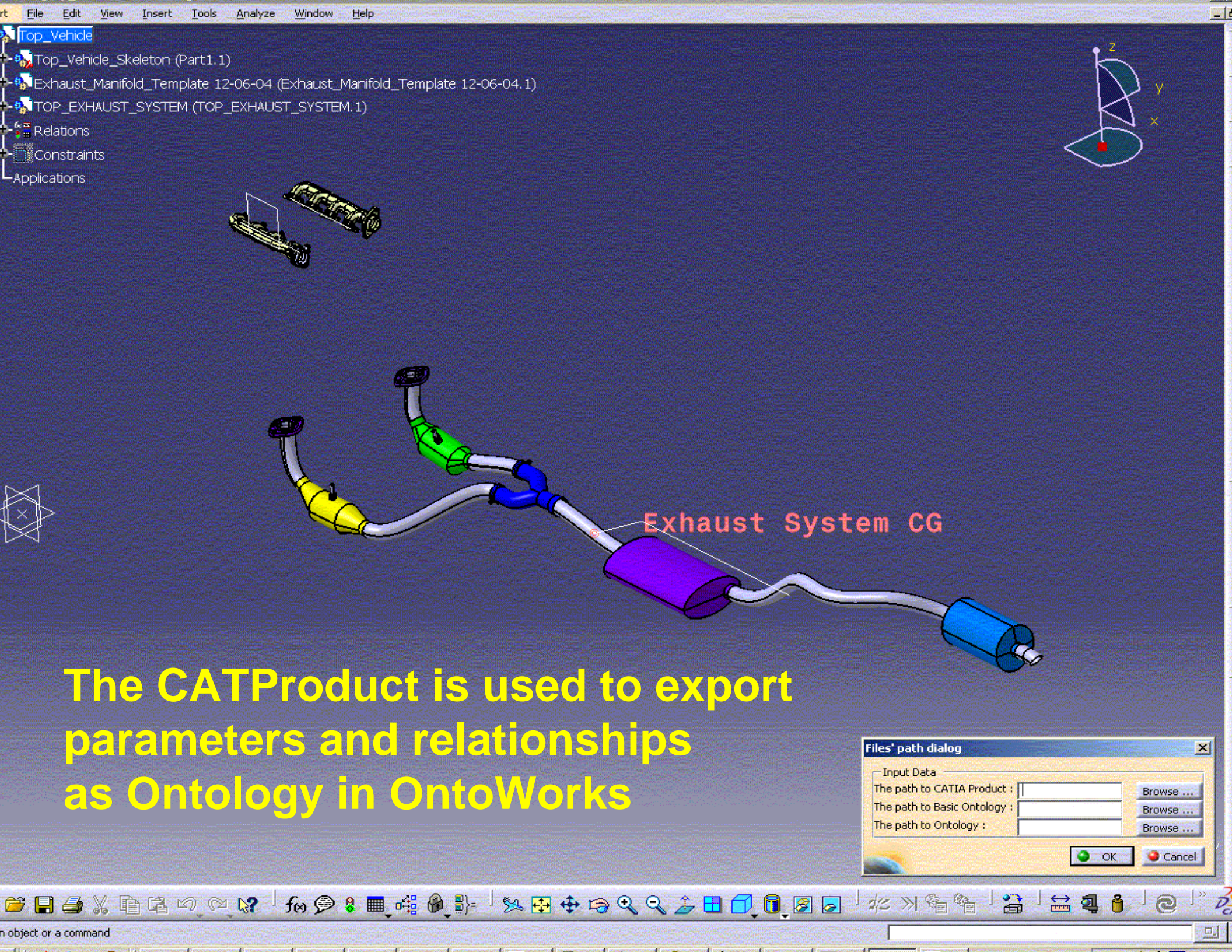


# Template Ontology Building: From the Source

- Start from already developed Catia V5 templates
- Map the templates to knowledge model
- Allow managing templates outside of CV5 Environment
- Provide mechanism to synchronize ontology to CatProducts
- CatProducts are the 'masters of information'

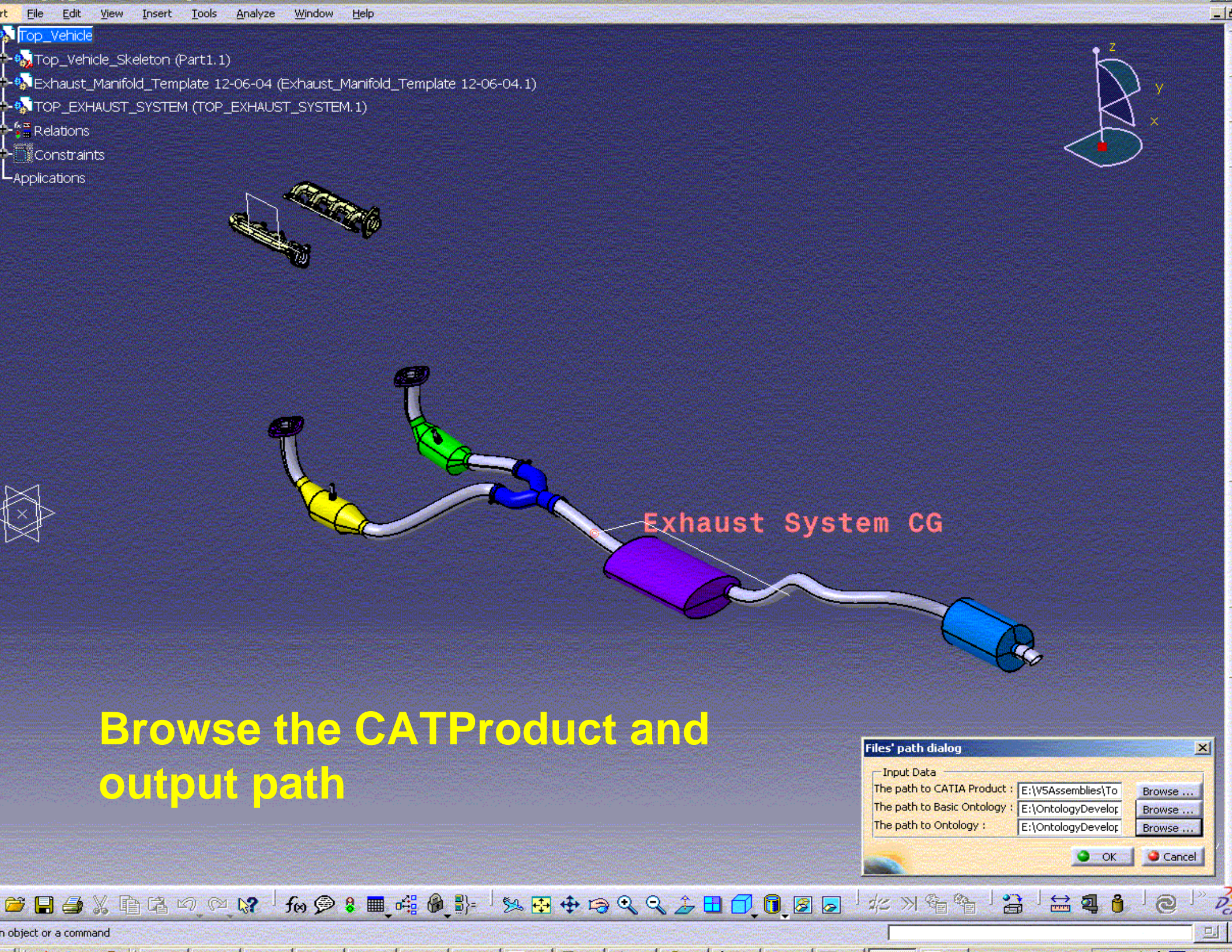






The CATProduct is used to export parameters and relationships as Ontology in OntoWorks





**Browse the CATProduct and  
output path**

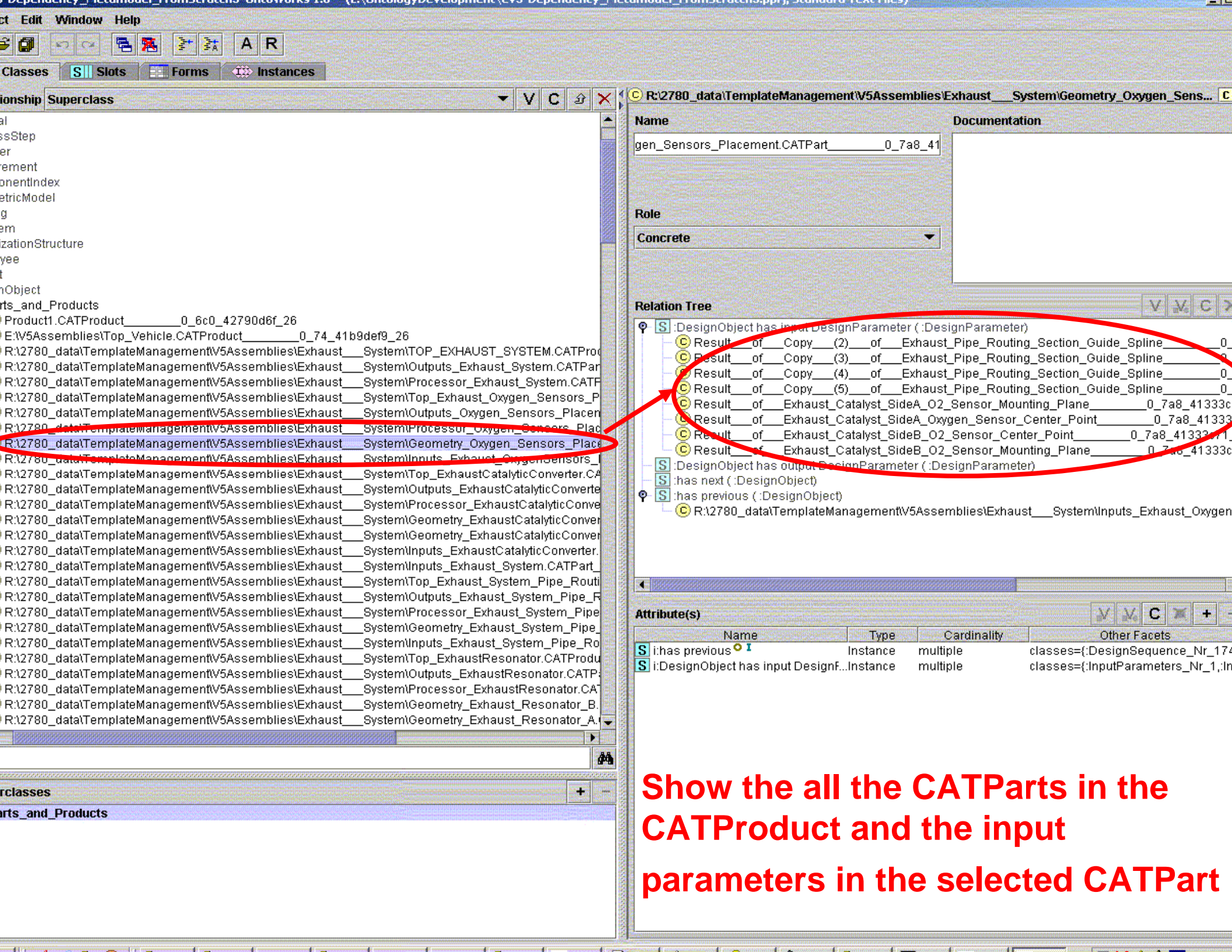
**Files' path dialog**

Input Data

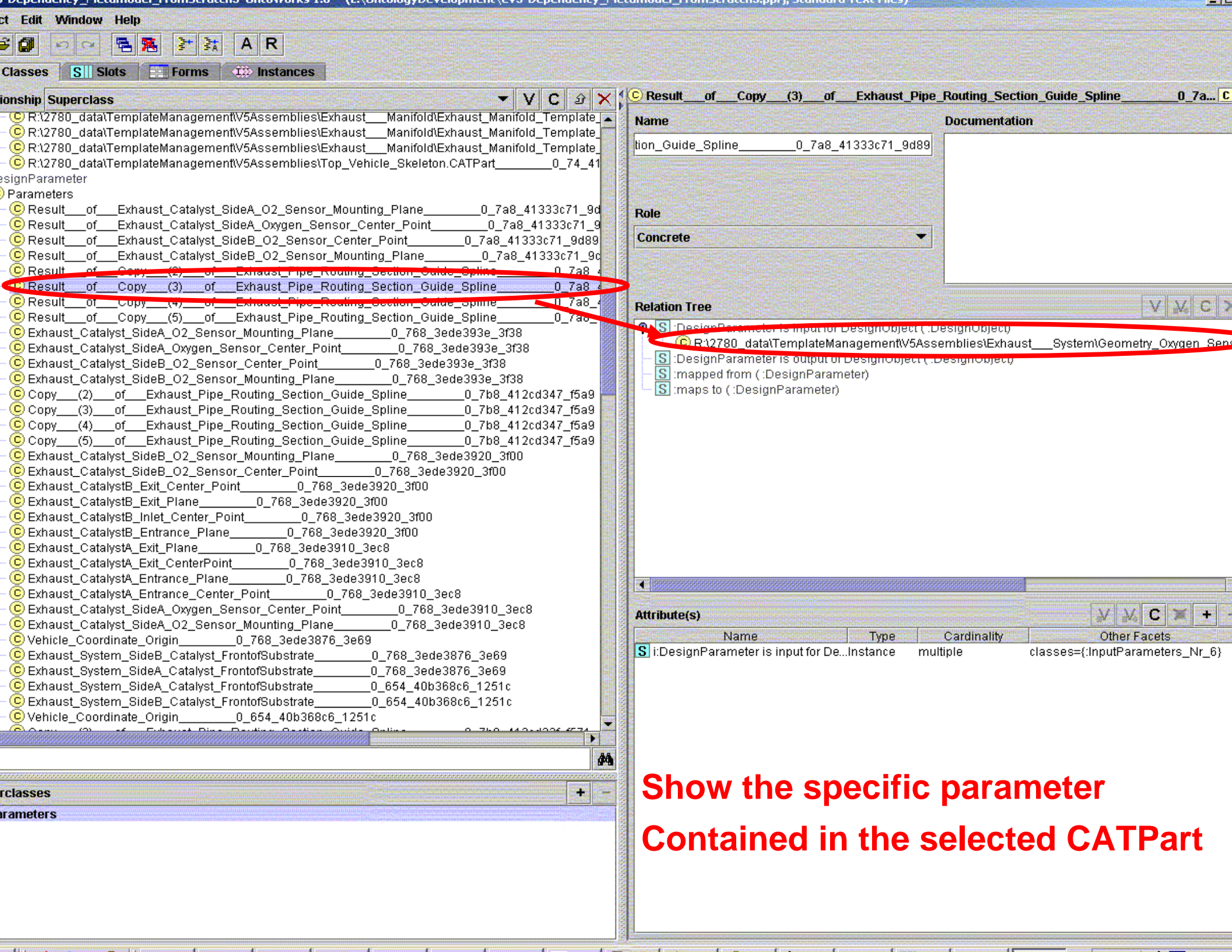
The path to CATIA Product :	E:\V5Assemblies\To	Browse ...
The path to Basic Ontology :	E:\OntologyDevelop	Browse ...
The path to Ontology :	E:\OntologyDevelop	Browse ...

OK Cancel



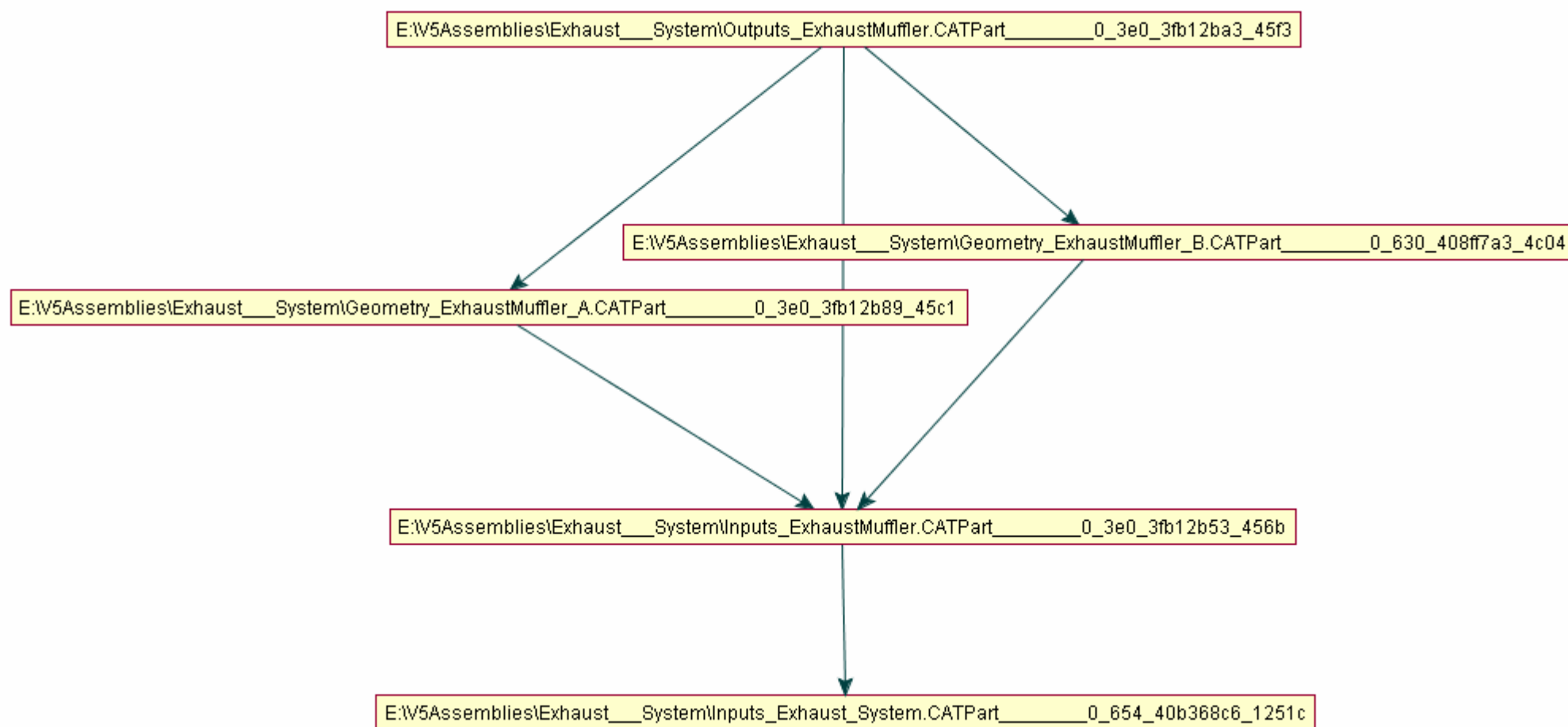




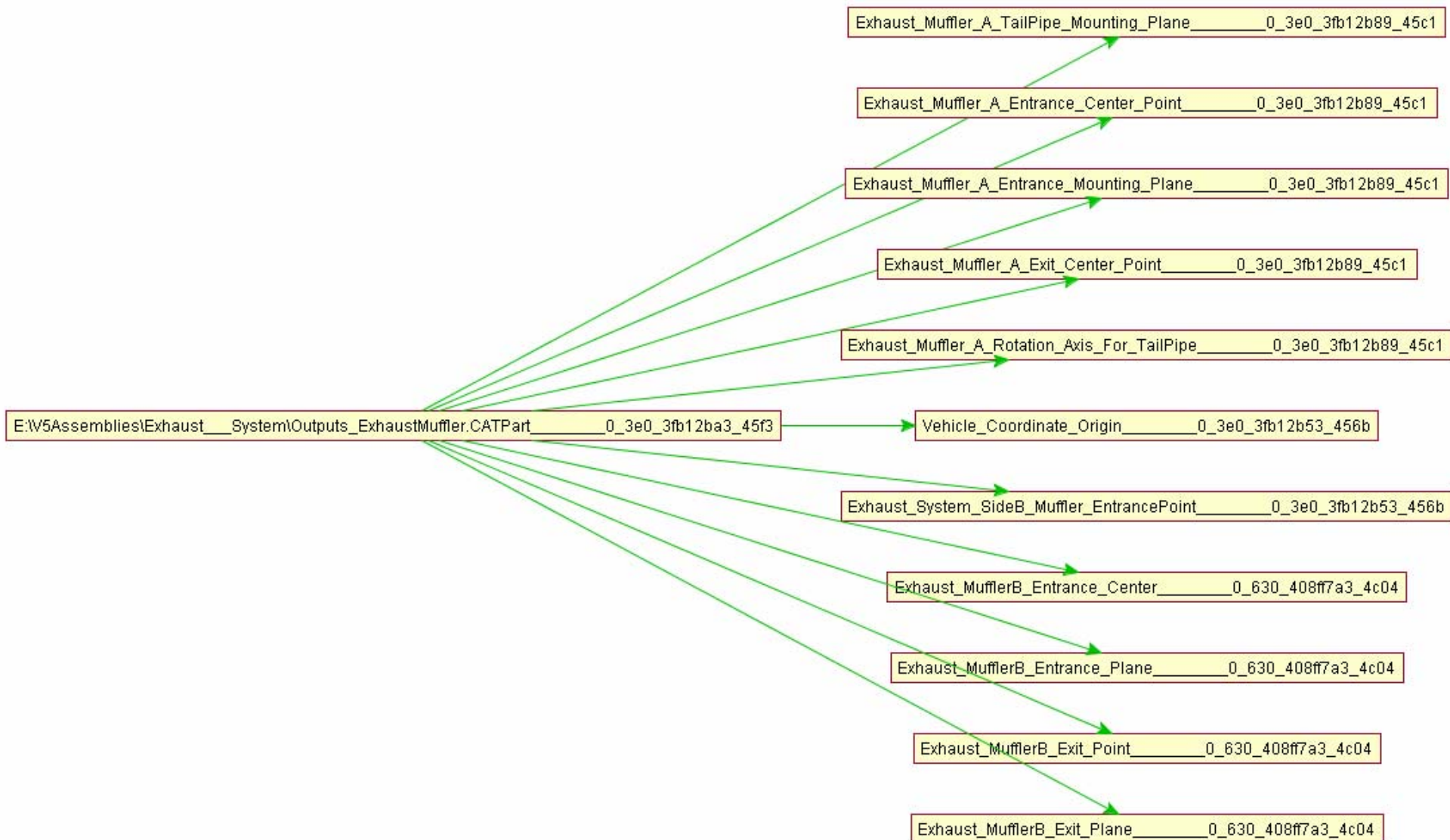


**Show the specific parameter  
Contained in the selected CATPart**

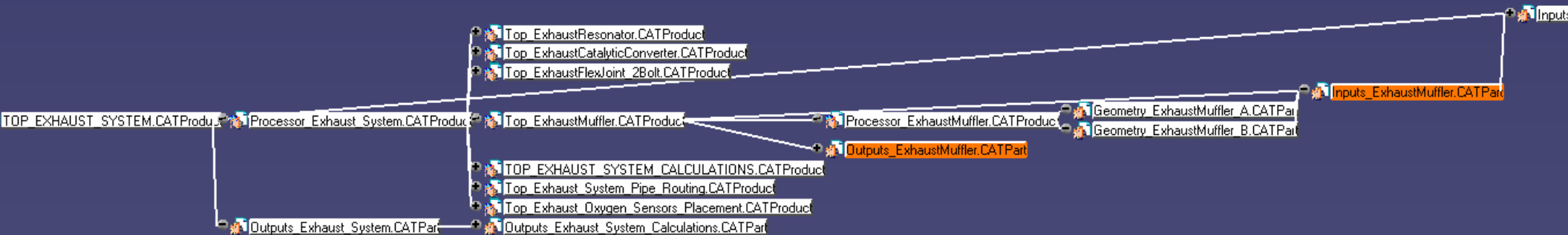
# Visualization: Next Design Object



# Visualization: Has Input Parameter



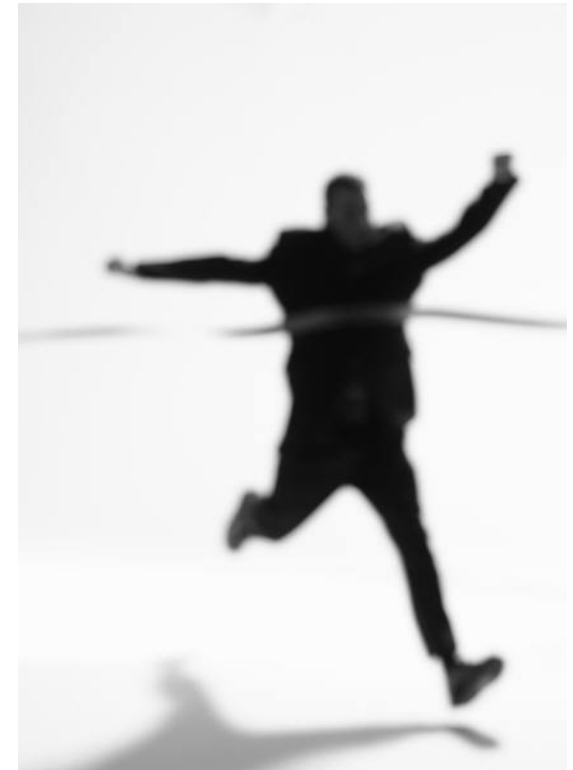
# Ontology in Catia V5





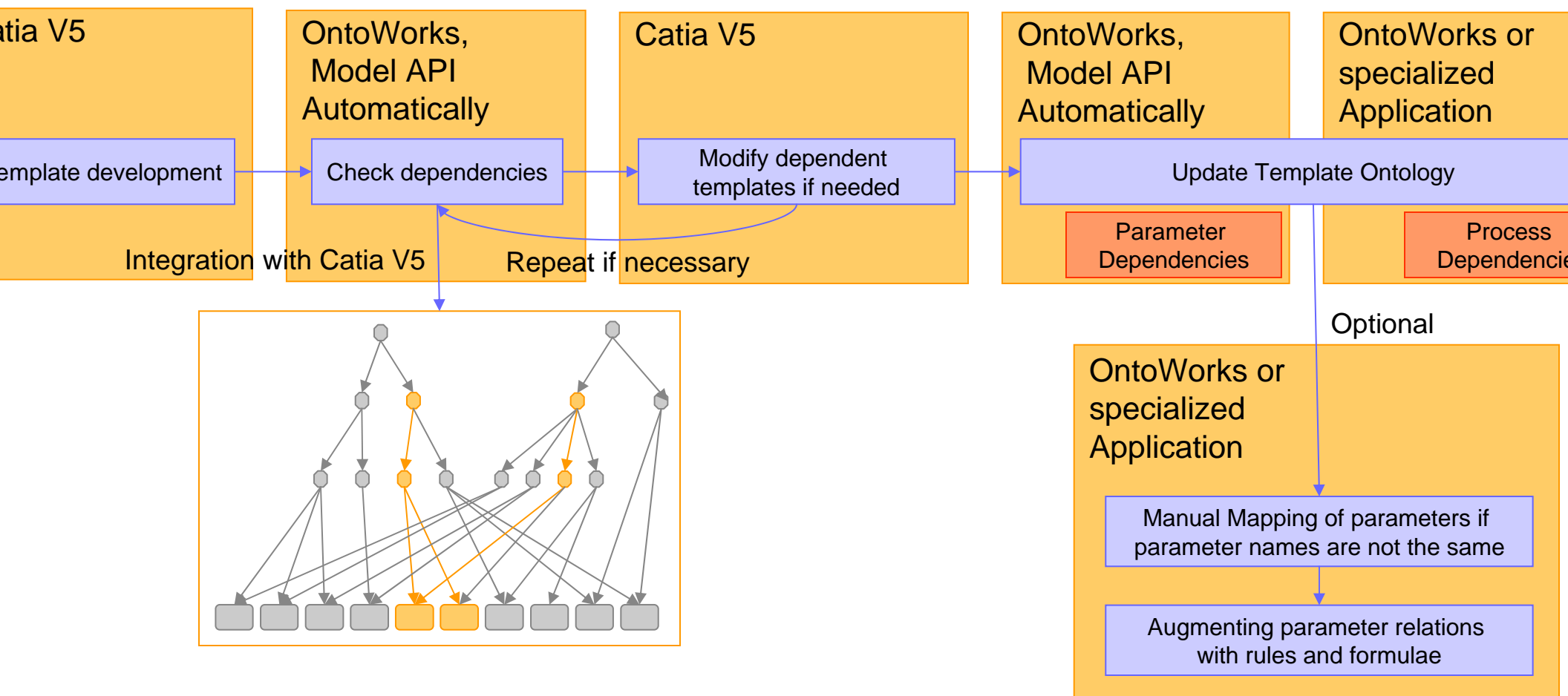
# Business Goals

- Develop business process of “how templates to be managed”
- Develop a methodology that supports business process

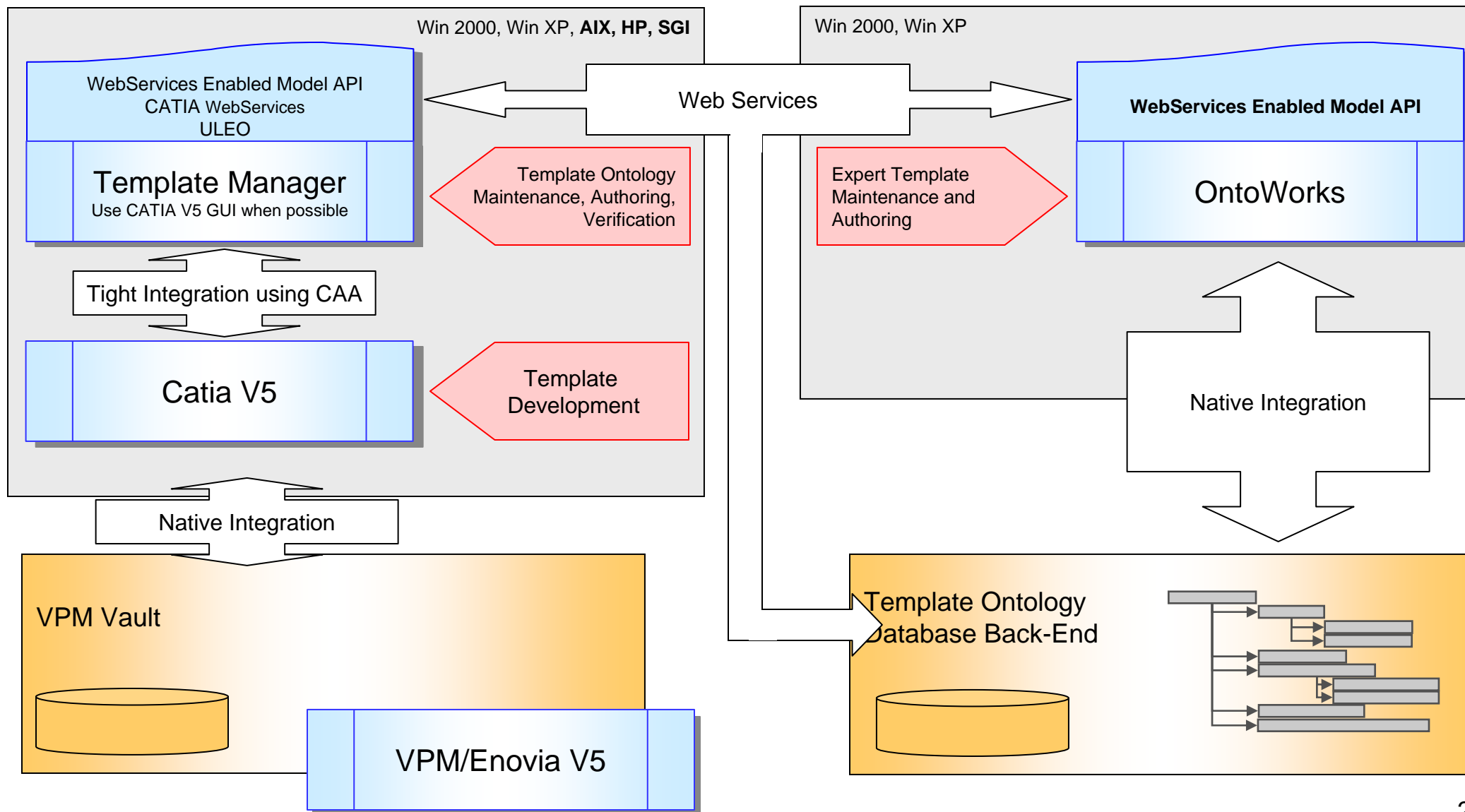




# Business Process (templates update)



# Proposed Architecture



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**Future Directions:  
How Does It Bring Us Closer To the Strategic Goal?**

**Vehicle Structure Knowledge Model**

# Development of the “Master Vehicle Ontology”

- Integrated Approach
  - Use globally and locally accepted vehicle decomposition methods and develop localized ontologies representing sub-systems working-out inter system relationships along the way



# Other Ontologies at DaimlerChrysler

- Materials' Ontology
- Fasteners and Common Components Ontology
- Ergonomics Rules Ontology
- Safety Rules Ontology
- Value Chain Ontology
- Projects and Systems Ontology
- ...



# Results of Templates Ontologies Activities

The screenshot displays the OntoWorks application window with the following components:

- Left Panel (Class Hierarchy):** A tree view showing the ontology structure. The 'Design Objects' class is highlighted in blue. Other visible classes include 'Design Object Features', 'Design Parameters', 'Geometric Features', and 'Design Constraints'.
- Center Panel (Design Object Properties):**
  - Name:** 'Design Objects' (type: DesignObject).
  - Role:** 'Concrete'.
  - Relation Tree:**
    - :DesignObject has input DesignParameter ( :DesignParameter)
    - :DesignObject has output DesignParameter ( :DesignParameter)
    - :has next ( :DesignObject)
    - :has previous ( :DesignObject)
- Right Panel (Documentation):** A text area containing a diagram of a sequence of five pink rectangular blocks connected by arrows, representing a process flow.
- Bottom Panel (Attribute Table):** A table listing attributes for the 'Design Objects' class.

Name	Type	Cardinality
DO name	String	single
DO system	String	single
DO attachment	String	single
DO last modified on	String	single
DO type	String	single
DO zone	String	single
DO author	String	single

Additional diagrams are visible in the background, including a red flowchart and a grey hierarchical tree.

# Vehicle Structure 1

Body in White

Interior

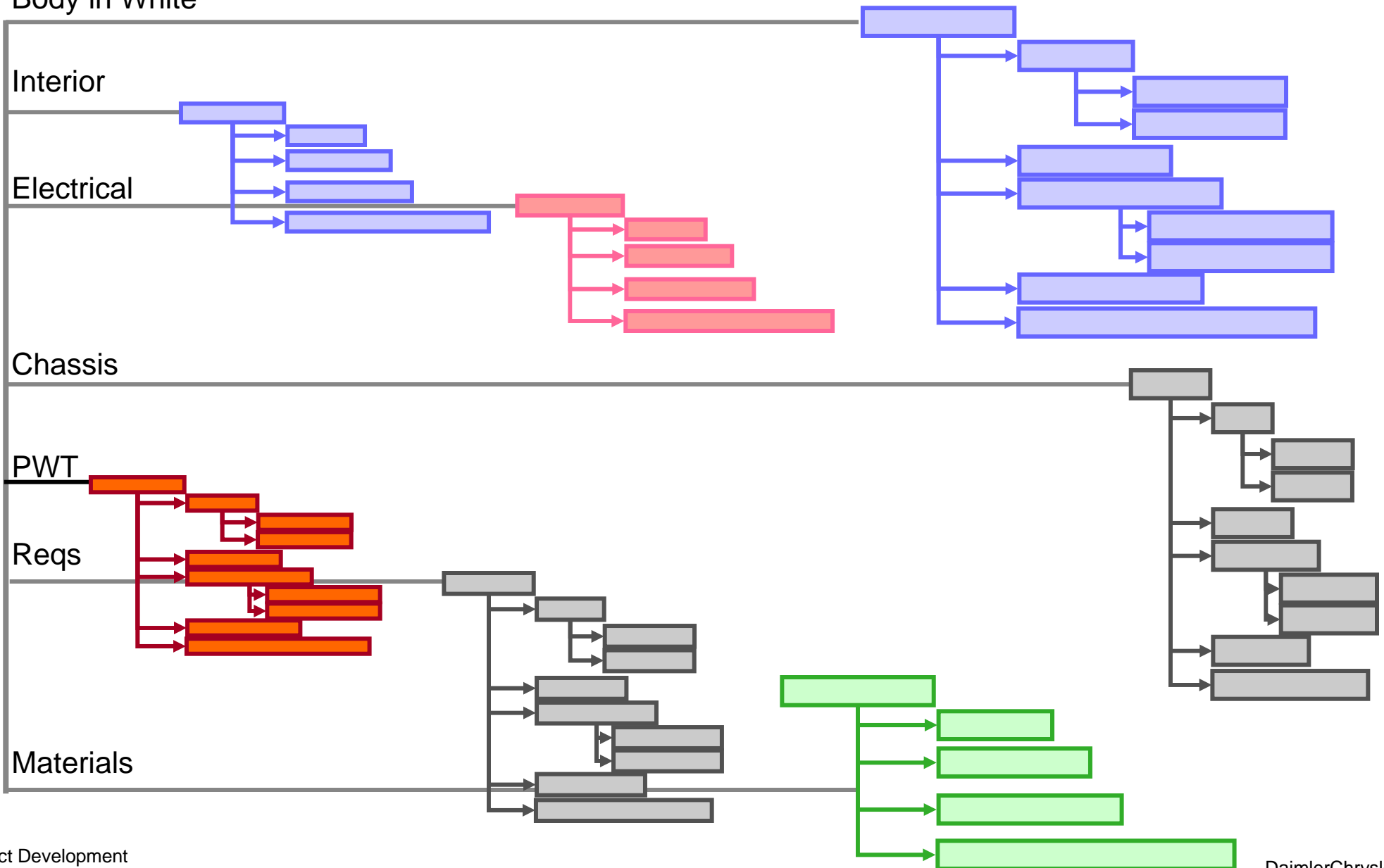
Electrical

Chassis

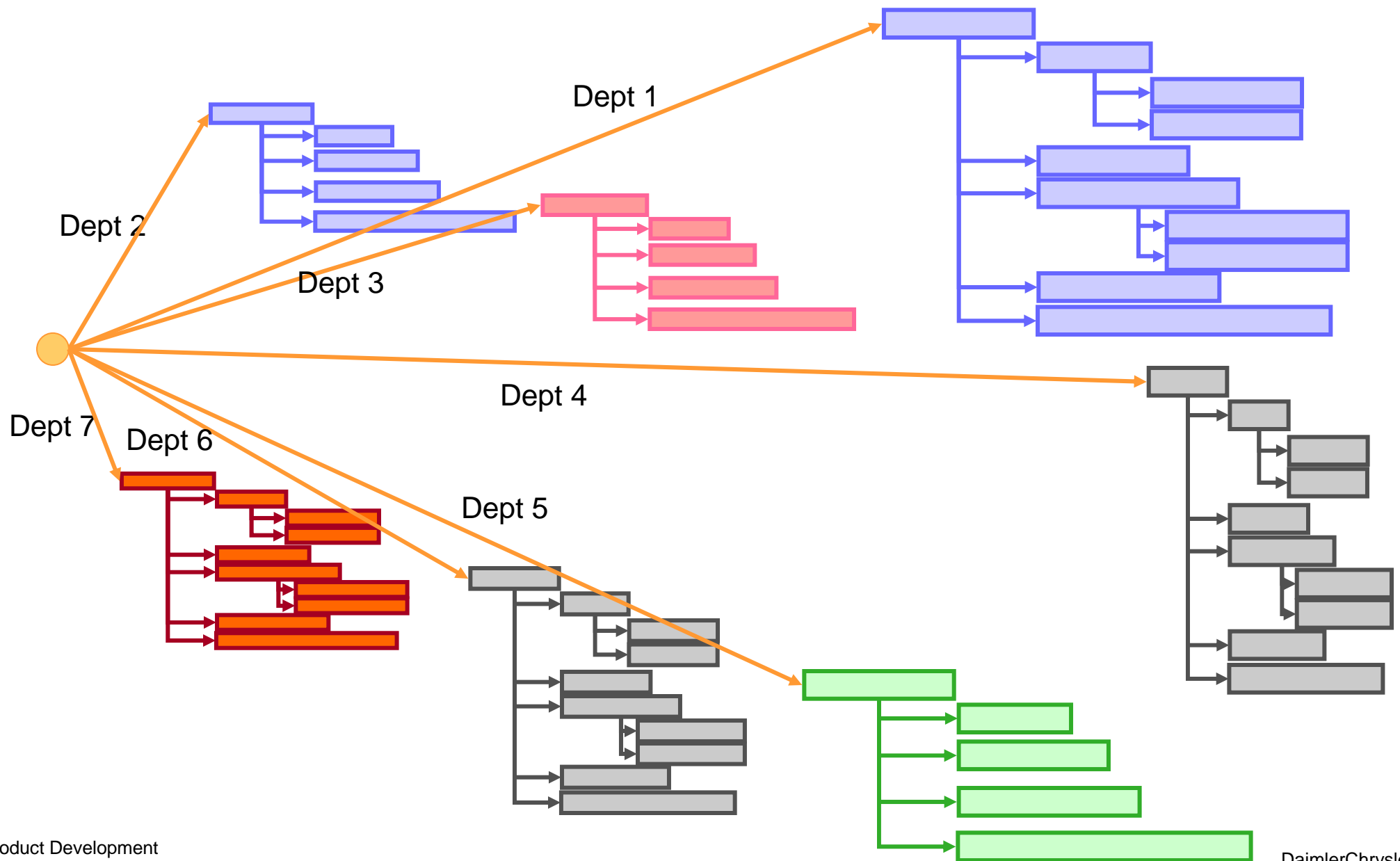
PWT

Reqs

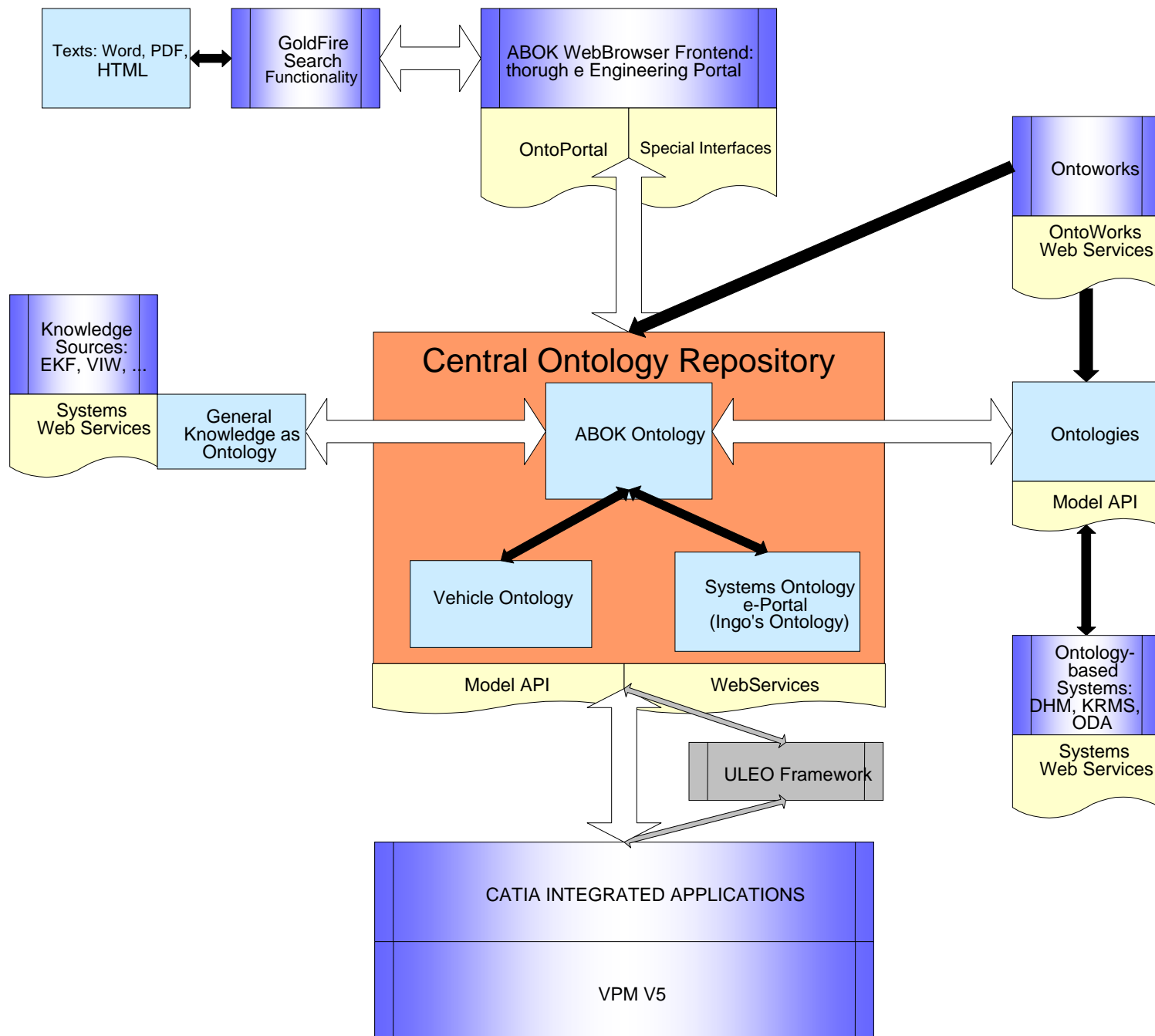
Materials



# Vehicle Structure 2







# Questions

