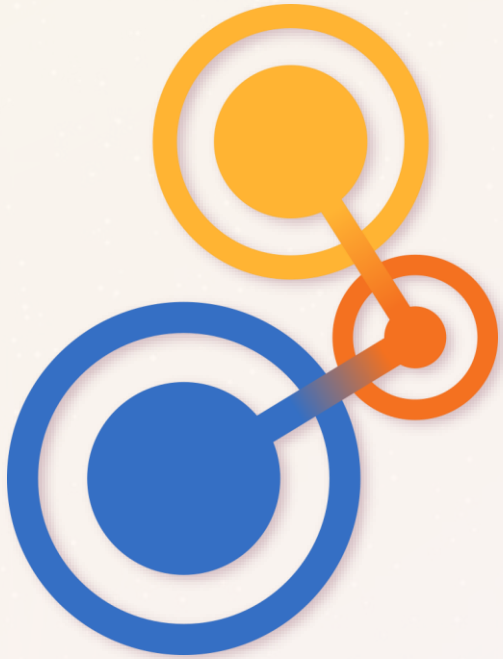


IILS

SMART.
ENGINEERING.
AUTOMATION.

IILS mbH

Ingenieurgesellschaft für intelligente Lösungen und Systeme mbH

Small and Medium Enterprise (SME)
- 14 employees
- based in Leinfelden-Echterdingen (Stuttgart area), Germany
- independent high-tech company for engineering automation

Spin-off from University of Stuttgart
- founded in July 1999
- from the Institute for Statics and Dynamics of Aerospace Structures (ISD)
- research cooperation with the Institute for Aircraft Design (IFB)

Core Business
- software development for engineering automation (*Design Cockpit 43®*)
- digitalization and engineering services
- r&d projects in digital engineering and design languages

Research & development projects
- H2020 CS2-project *PHAROS* (automated piping, routing)
- LUFO6-project *COBAIN* (airframe design & manufacturing optimisation)
- LUFO6-project *KIEZ40* (artificial intelligence certification)
- ITEA2-project *IDEALISM* (https://itea4.org/project/idealism.html)
- ZAFH-project *DIP* (digital modeling product life-cycle)
- GreenTech-project: *CERAHEAT4.0* (digital modeling product life-cycle)
- national space program: *A3-DR* & *ASHRAM* (automated HF-routing)
- BMFTR-project: *CYCLOMETRIC* (sustainable circular product devel)

Mission
- leading European think-tank for EaaS and MBSE automation
- developer of the world's most advanced engineering design compiler technology

IILS mbH
Leinfelder Straße 60
D-70771 Leinfelden-Echterdingen

The Problem in Engineering

The traditional engineering processes in many industries are plagued by **several critical issues**:

Fragmented Data
Information is spread across disconnected "data islands," making access and preparation time-consuming

Incoherent Processes
Company processes evolve organically without holistic revision, leading to inefficiencies and outdated workflows

Document-Driven Exchange
Knowledge transfer relies on manually created documents, adding unnecessary overhead

Manual Modeling
Simulation models across domains are built and updated by hand, causing slow, error-prone iterations

The Vision of IILS

At IILS, our vision is to drive the digital transformation of engineering by enabling the **full automation of design processes** across the entire product lifecycle:

Knowledge Formalization
Engineering expertise must become explicit, structured, and machine-executable

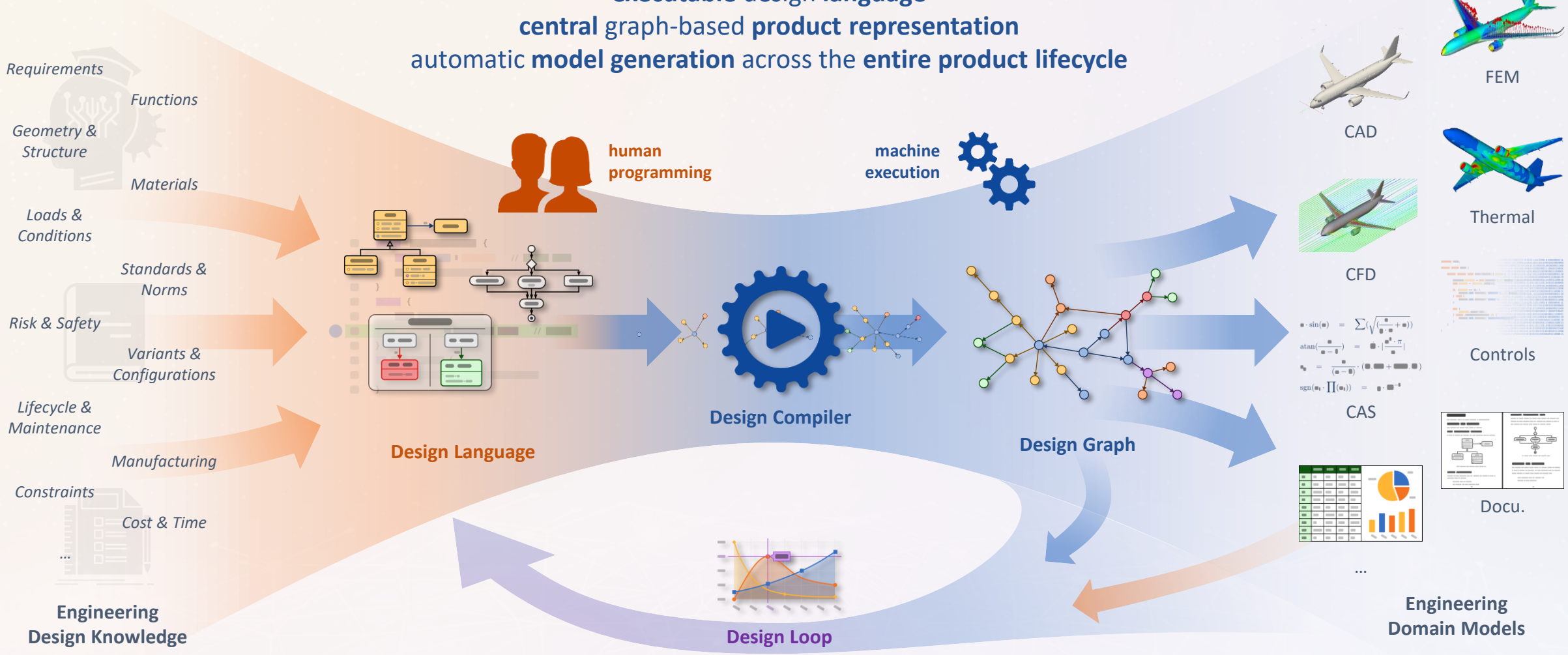
Design Compilation
Validated designs must be automatically synthesized from formal specifications through systematic rule execution

Central product model
A central, authoritative representation must capture all aspects of the product as single source of truth

Multi-Domain Integration
Each engineering domain must be supported end-to-end with consistency guaranteed across all domains

The Solution: Graph-based Design Languages

systematic methodology for **design automation**
formalized engineering **knowledge**
executable design **language**
central graph-based **product representation**
automatic **model generation** across the **entire product lifecycle**

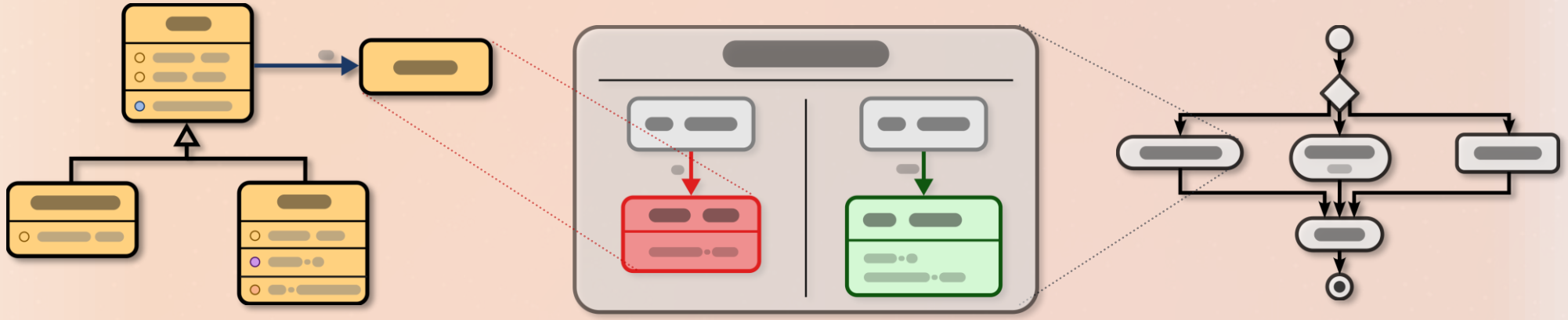


The Language: Vocabularies, Rules, Programs

Vocabularies (Ontologies) define a formal, structured knowledge of engineering concepts and their relationships, creating a shared understanding of the design domain (meta-model).

Design Rules (Composition Statements) formalize how these concepts can be combined and transformed to create valid designs based on engineering principles.

Production Systems (Executable Processes) encode the engineering workflow as a sequence of rules, making the design process itself executable and automatable.



- Concept Definition
- Hierarchy and Classification
- Relationship Modeling
- Attribute and Parameter Specification
- Constraint Definition
- Units and Dimensions
- Mathematical and Logical Expressions

- Instantiation
- Composition
- Transformation
- Parameter and Data Propagation
- Constraint Enforcement
- Integration and Interface Hooks
- Validation and Verification

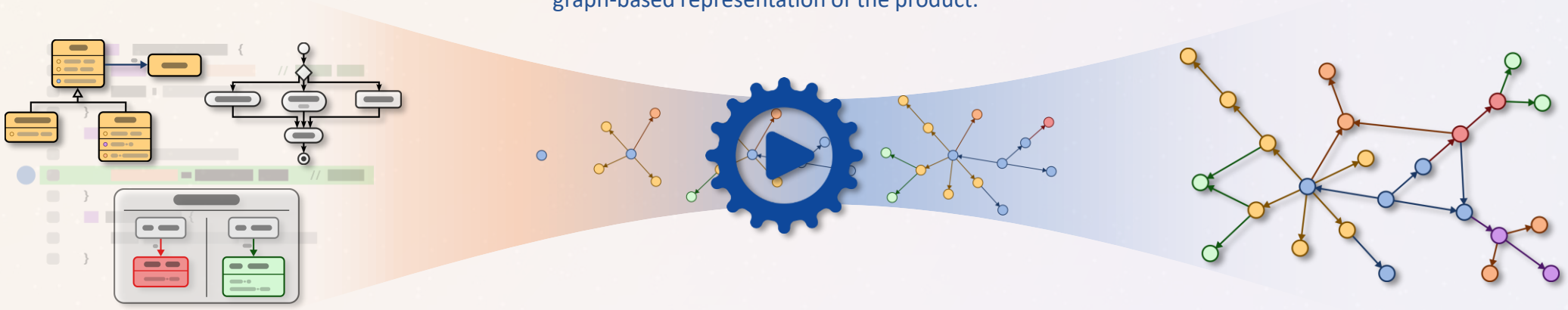
- Rule Invocation
- Workflow Sequencing
- Conditional and Iterative Execution
- Iteration and Recursion Support
- Parameter Management and Data Flow
- Hierarchical Process Organization
- Integration with External Systems

The Execution: From Design Language to Design Graph

The **Design Language** provides an *executable* formalization of engineering knowledge.

The **Design Compiler** interprets and executes the Design Language, gradually building a graph-based representation of the product.

The centralized **Design Graph** serves as a holistic and integrated representation of the generated product model, capturing all relevant aspects of the product within a unified structure.



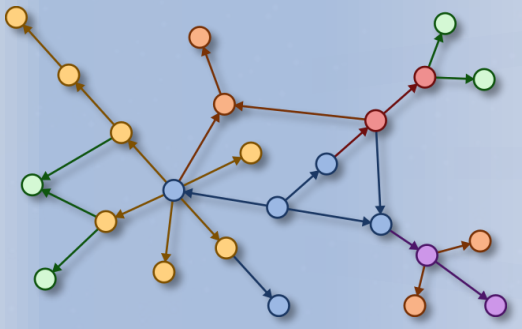
- Formalized Knowledge Representation
- Executable Semantics
- Ontology Integration
- Rule-Based Logic
- Workflow and Process Definition
- Parameter and Data Management
- Integration and Extensibility

- Executable Rule Processing
- Model-2-Model (M2M) Transformation
- Design Graph Generation
- Solution Path Generator
- Symbolic Computation Engine
- Integrated Geometry Generation
- Deterministic Execution and Validation

- Holistic Product Representation
- Node and Edge Structure
- Parameter and Attribute Storage
- Analysis and Query Support
- Scalability and Performance

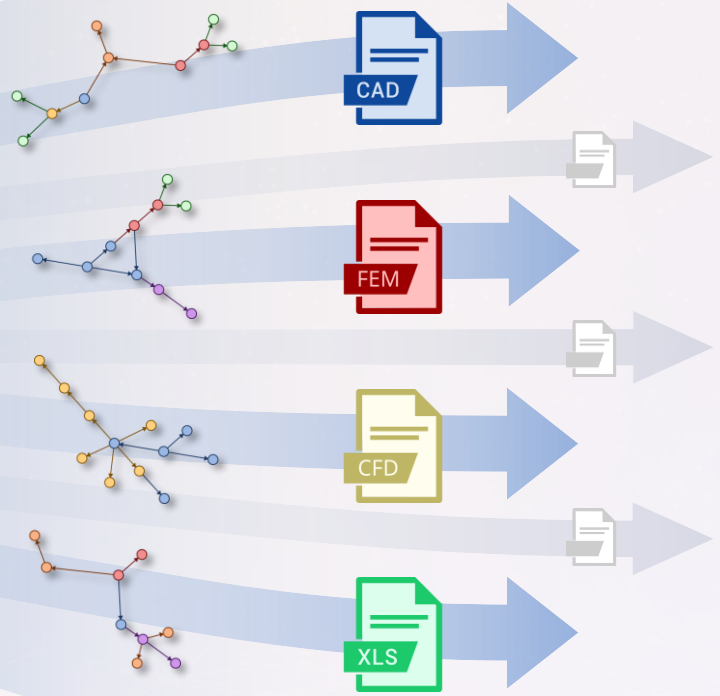
Interfaces: From Design Graph To Engineering Models

The central Design Graph acts as the **Single Source Of Truth** for domain models, providing a unified and integrated representation of the entire product



- Connectivity Across Domains
- Open and Transparent Data Format
- Traceability and Versioning

Interfaces enable the generation of consistent, domain-specific models from the Design Graph by filtering and transforming relevant information.



- Automated Model-2-Text Transformation
- Deterministic Output
- Extensible Framework

Generated **Engineering domain models** provide consistent, up-to-date representations of discipline-specific knowledge.

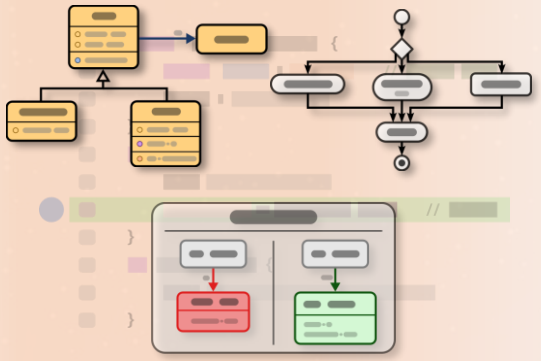
- Consistency Across Domains
- Automatic Synchronization
- Traceability and Transparency

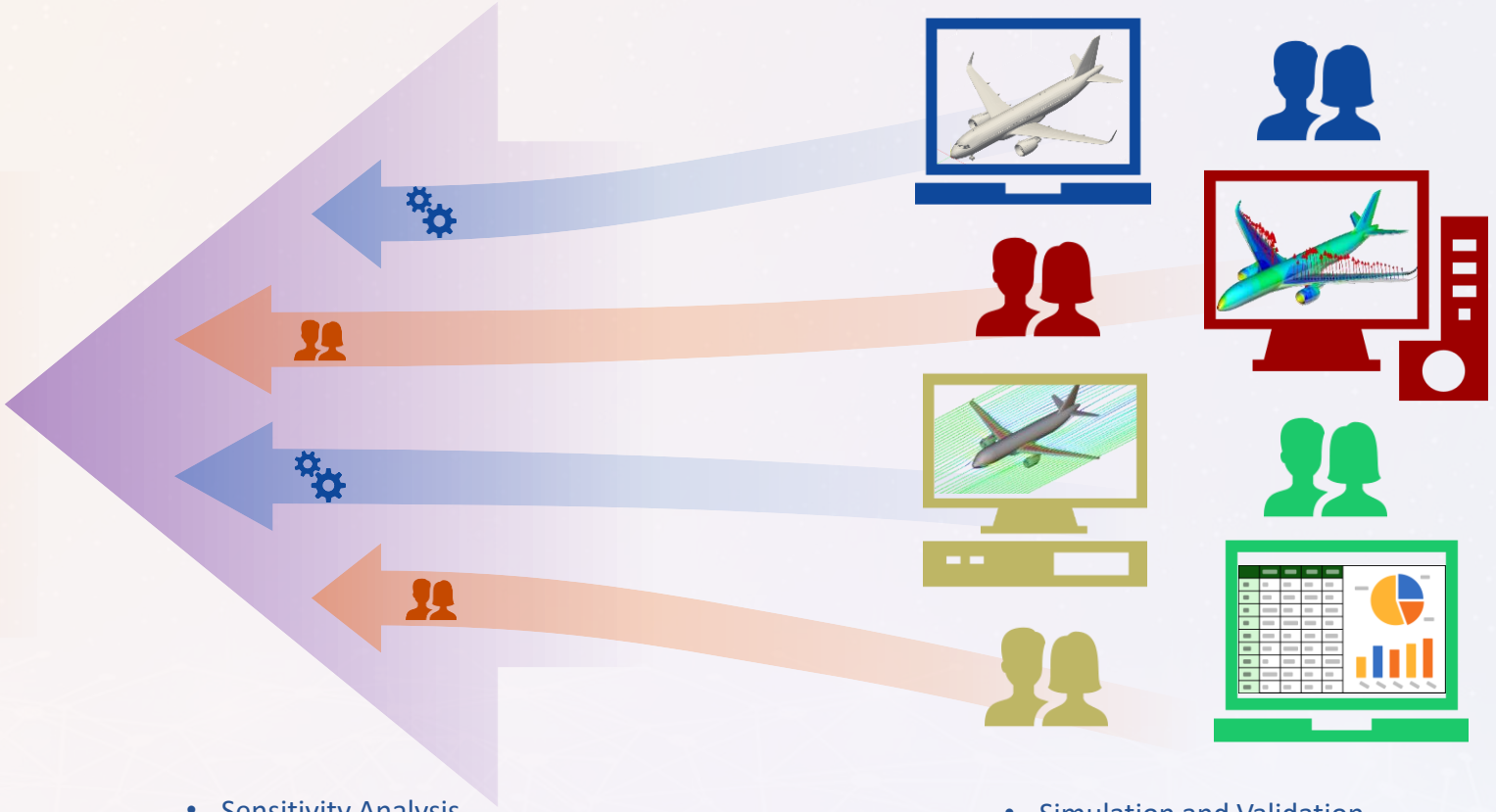
The Design Loop: Updating the Design Language

Updating and extending the design language closes the design loop, enabling continuous, iterative refinement of the product model.

Feedback from analysis and evaluation is incorporated into the design language, either manually or automatically by domain experts.

Domain-specific tools enable the processing of engineering domain models, supporting informed design decisions.





- Knowledge Consolidation
- Rule Refinement
- Language Extension
- Design of Experiments (DoE)
- Automated Optimization

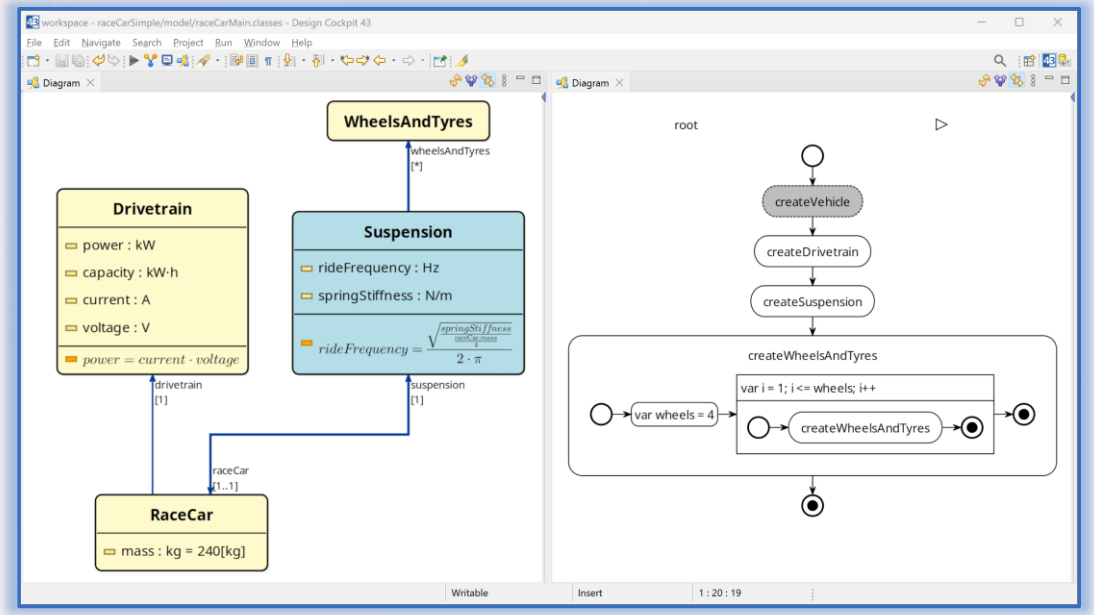
- Sensitivity Analysis
- Human-in-the-Loop Validation
- Machine-in-the-Loop Feedback

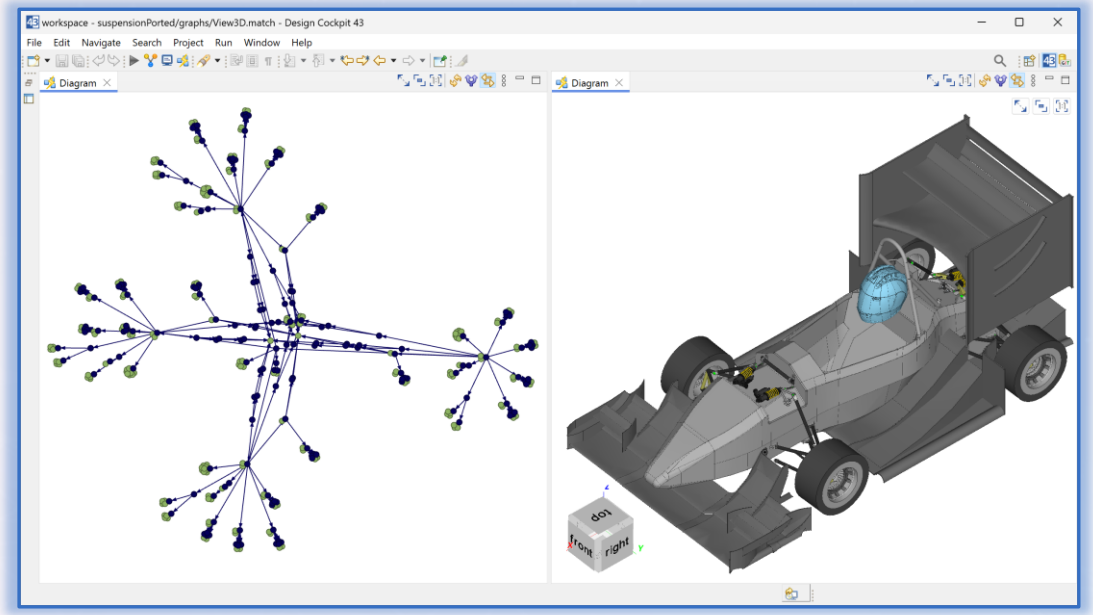
- Simulation and Validation
- Performance Evaluation
- Scenario Comparison

Design Cockpit 43®

Engineering Automation by Design Compilation

- integrated **engineering software platform**
- supports **Graph-based Design Languages**
- enables the design of **complex engineering products**
- provides full **multi-domain engineering automation**
- built on the powerful **Eclipse® framework**
- **flexible**, **extensible**, and **collaborative**





DC43®: Features & Capabilities (1/2)

DC43® Language

- simple, intuitive engineering **code syntax**
- unified definition of **ontologies**, **rules**, and **processes**
- **automatic visualisation** of all code models

DC43® Geometry

- **sketches**, **parts**, and **assemblies** with **constraint solving**
- integrated **CAD kernel** (OpenCascade®)
- **live visualisation** and navigation of CAD geometry

DC43® Math

- embedded **mathematical relationships** with **physical units**
- **automatic equation solving** during compilation (CAS)
- **sensitivity analysis** and parameter influence visualisation

DC43® Engine

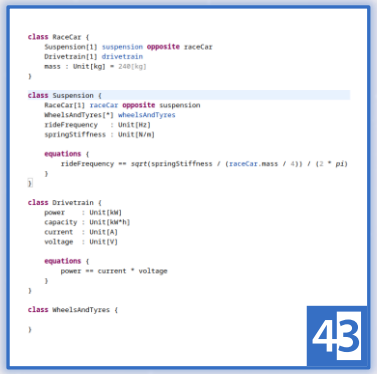
- high-performance **rule engine** for design compilation
- integrated **debugger** with runtime inspection
- **automated validation** against logical constraints

DC43® Product Model

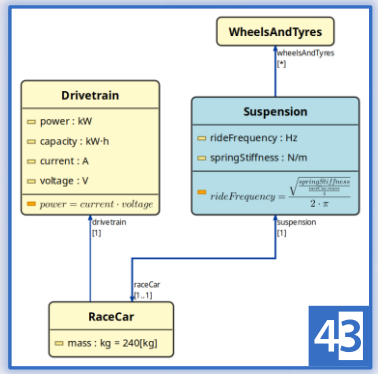
- **design graph** as single source of truth
- integrated 2D/3D **geometry visualisation**
- **built-in plotting** for data and statistics

DC43® AI

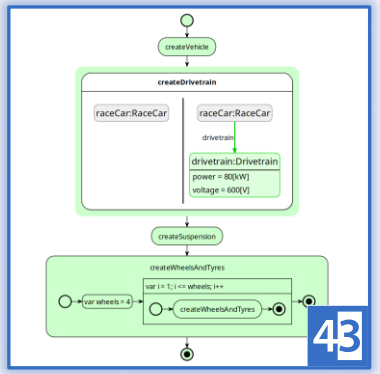
- LLM-assisted **ontology** and **rule modelling**
- ready-to-use **code generation** in DC43 syntax
- **natural language analysis** of complex product models



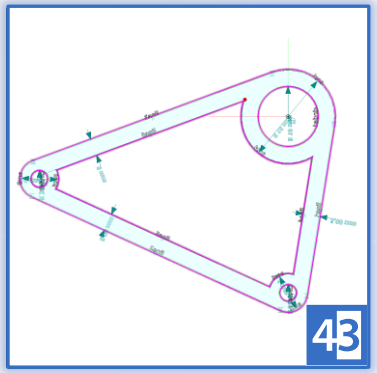
DC43® Syntax



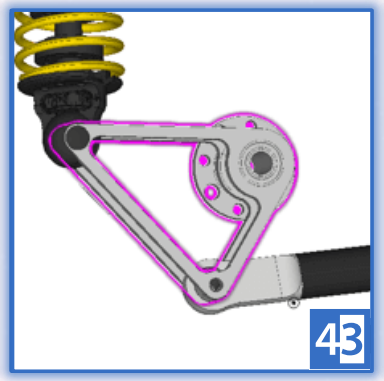
DC43® Ontologies



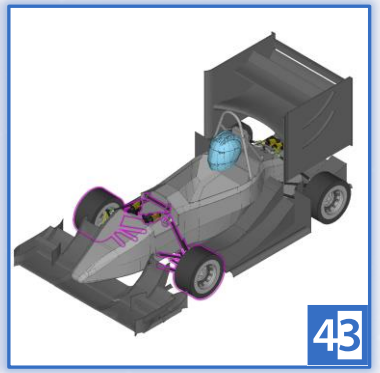
DC43® Programs



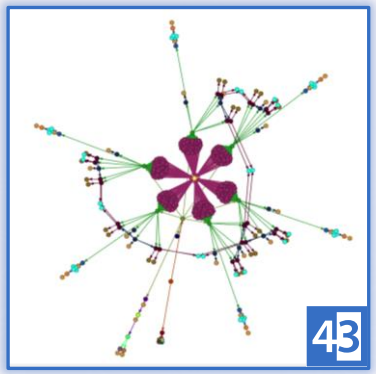
DC43® Sketches



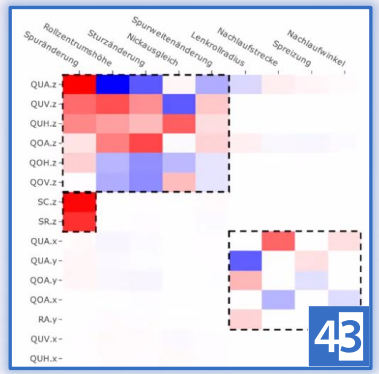
DC43® Parts



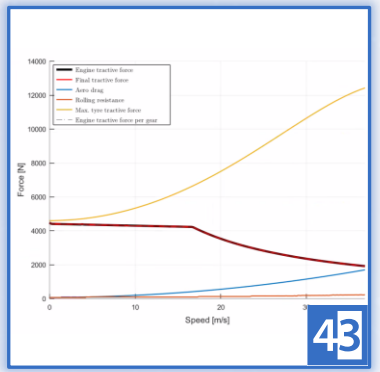
DC43® Assemblies



DC43® Graph



DC43® Sensitivity



DC43® Plots

DC43®: Features & Capabilities (2/2)

DC43® Engineering

- built-in **mesher** for complex geometry
- integrated **FEM**, and **thermal solvers** (Elmer®)
- static and dynamic **collision checking**

DC43® Harness

- **automated 3D wire harness** layout and routing
- **unified** schematic and geometry **data integration**
- **real-time 3D visualization** and STEP export

DC43® Piping

- **automated** component **packing** algorithms
- optimised **pipe bend design** with manufacturing constraints
- **bending table generation** and CAD export

DC43® Interfaces

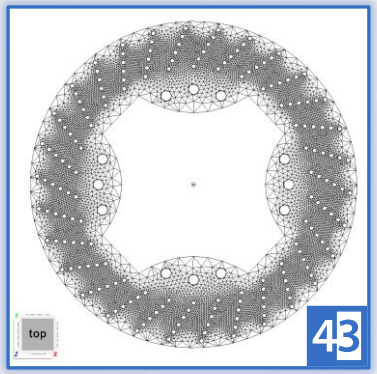
- seamless **integration of Java** and **Python** code and libraries
- bidirectional **spreadsheet integration** (xlsx, ods, csv)
- **native** CAD export to **CATIA**, **NX**, and **STEP**

DC43® Collaboration

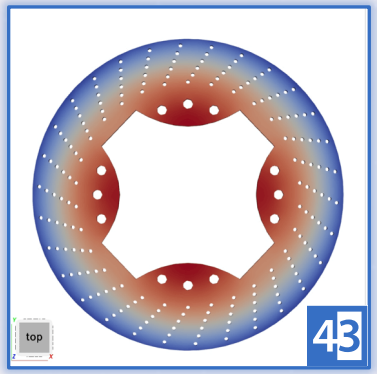
- integrated **version control** with full audit trail
- **side-by-side comparison** of design versions
- **automated documentation** generation from models

DC43® Platform

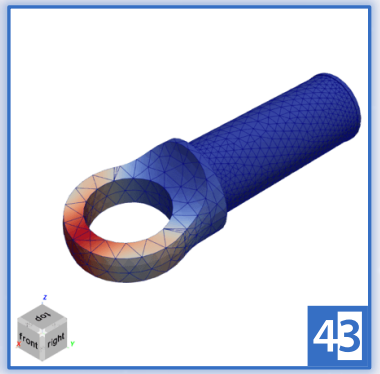
- **standalone executables** for headless deployment
- **REST API** for system integration
- extensible **plugin architecture**



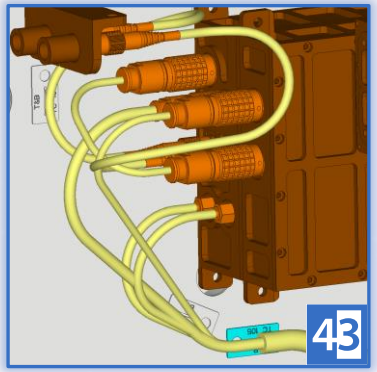
DC43® Mesher



DC43® FEM

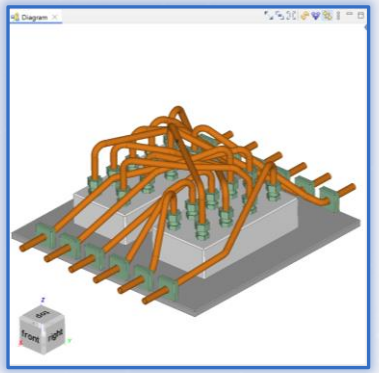


DC43® Thermal



DC43® Harness

DC43® Interfaces



DC43® Piping

DC43® Versioning

DC43® Compare

DC43® ChatBot

DC43®: Benefits & Impact

Efficiency & Automation

accelerates design and analysis cycles

enables **systematic exploration** of thousands of variants

reduces errors through automated validation

preserves engineering **knowledge** as reusable assets

Collaboration & Integration

ensures **consistency** across multi-domain models

supports team **collaboration** with version control

integrates with existing CAD, CAE, and simulation tools

scales from individual to multi-program applications

Industry Partners

AIRBUS

FORVIA HELLA

KNORR-BREMSE

SHW Automotive

EKS InTec GmbH

Research Partners

DLR Deutsches Zentrum für Luft- und Raumfahrt – Institut für Elektrifizierte Luftfahrtantriebe

Fraunhofer IGCV

University of Stuttgart Germany

Universität Augsburg University

THA Technical University of Applied Sciences Augsburg

RWU Hochschule Ravensburg-Weingarten University of Applied Sciences

Fachhochschule Kiel – Hochschule für Angewandte Wissenschaften

Forschungs- und Entwicklungszentrum Fachhochschule Kiel GmbH

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Leinfelder Straße 60,
D-70771 Leinfelden-Echterdingen

https://www.iils.de

Dr.-Ing. Roland Weil (CEO)

roland.weil@iils.de

+49 711 217 210 18

www.linkedin.com/in/roland-weil/

www.iils.de