Towards Inconsistency Detection During the Design Phase of Automation Systems Engineering Projects

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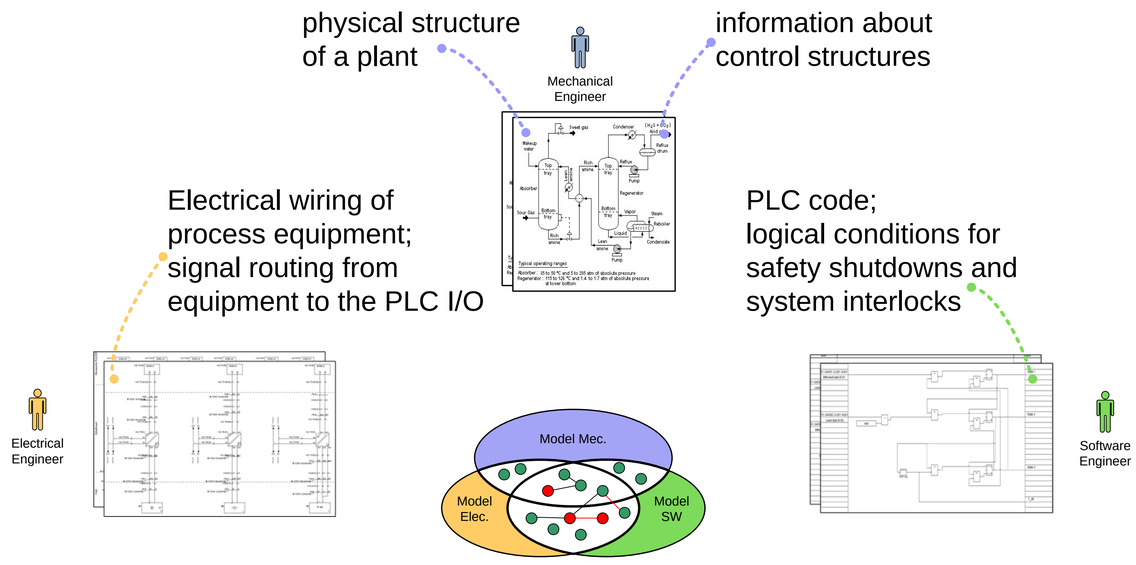
Context and Motivation

Challenges

- Complex, software-intensive and changeable environment
- Participants originate from different engineering disciplines
  - Different backgrounds
  - Dissimilar terminology and workflows
  - Various engineering tools and formats for data representation, storage and exchange
- Project data is dispersed through a variety of heterogeneous data sources
- Relations and dependencies between design artifacts are not explicitly captured



Interdisciplinary Inconsistencies in Design Data

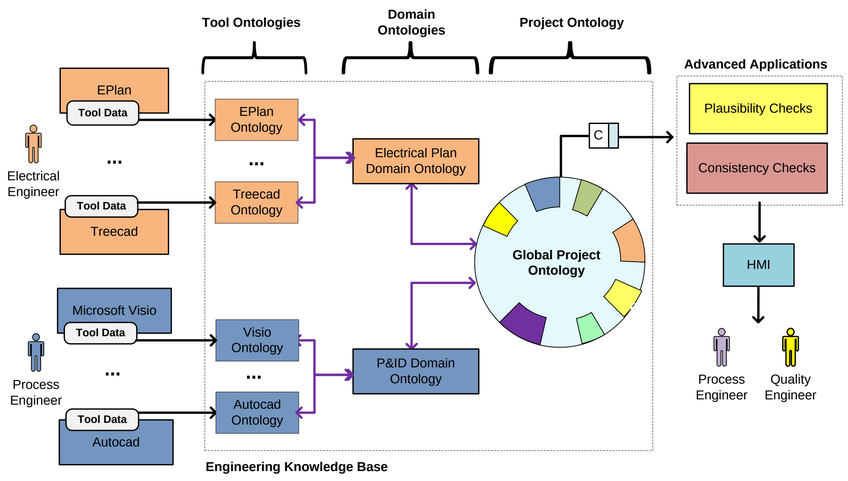
- Require analysis of heterogeneous data produced by different tools and stored in dissimilar data formats to identify them
- Usually their identification has to be done manually by project engineers, which is time and effort consuming and error-prone task
- If not identified on early stages can potentially lead to costly corrections during commission or even failures during operation

How to ensure consistency of heterogeneous design data **across the whole project**?

Solution: Knowledge-Based Approach

- Each **tool ontology** captures data format and terminology of concrete tool.
- **Domain ontologies** generalize differences between different tools used in given domain.
- **Global project ontology** contains only knowledge that is important to represent the interconnections between data from different disciplines and tools.

A **set of mappings** is determined between each tool ontology and corresponding domain ontology, as well as between each domain ontology and project ontology.



Research Contributions & Challenges

Contributions:

1. Representation of design knowledge in knowledge base, determination and explicit specification of interrelations between content of different design artefacts through mappings.
2. Providing a technique for effective querying of knowledge-base in order to check the consistency of project design data.
3. Identification of a set of checks that will be useful towards consistency checking and inconsistencies detection in a wide range of ASE projects.

Challenges:

1. Semantic heterogeneity.
2. Struggling with complexity: finding a compromise between completeness of knowledge and convenience of use.

Evaluation: Case Study Based on Data from Industry Partner

1 Background

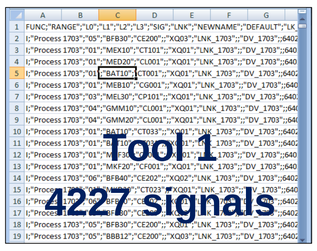
- Signals are used as common concepts that link information across different engineering disciplines.
- Signals include process interfaces (e.g., wiring and piping), electrical signals (e.g., voltage levels), and software I/O variables.
- Main target is to integrate signals from different tools and to ensure their consistency across the engineering project.

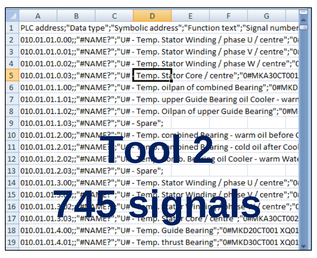
3 Possible checks

- **“Integration test”** - whether all sensors are properly wired and connected to appropriate software variables.
- **Within one signal** - e.g., identifying of missing hardware address.
- **Within set of signals** - e.g., checking whether all signals that belong to a specific device have the same value in “location” field.

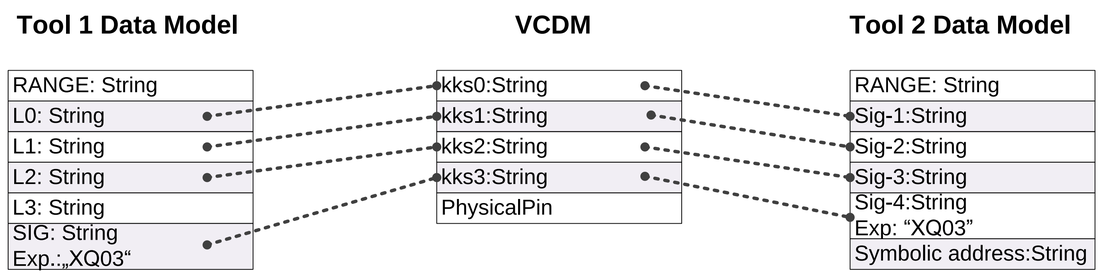
2 Input Data

- Output signals from 2 engineering tools (stored in Excel spreadsheets).





- Data transformations (based on discussion with domain experts)



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