How to Analyze and Quantify Similarities between Configured Engineer-To-Order Products by Comparing the Highlighted Features Utilizing the Configuration System Abilities

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Agenda

• Problem statement
• The benefits from further research
• Related previous researches
• The suggested framework
• Ongoing case study
Problem Statement

“Lessons learned” is becoming a key factor for the improvement, in time and in quality, of operational processes.

1. Excessive errors, too long time between sales and installation due to inadequate product information supply to the sales office, an excess of repetitive activities within the technical office, and a high rate of configuration errors in production [1].

3. According to Hvam et al. [2], price curves are not always beneficial.

Benefits of Reusing Previous Projects

<table>
<thead>
<tr>
<th>Area</th>
<th>Benefits</th>
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</thead>
<tbody>
<tr>
<td>Management</td>
<td>1. Lean management by avoiding all the pre sales, production and sales activity that have been performed before.</td>
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<tr>
<td>Configuration system development</td>
<td>2. Reducing errors and increasing reliability of the configuration system.</td>
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<td></td>
<td>3. Facilitating the testing process for the configuration systems development.</td>
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<tr>
<td>Standardization, Product planning, Configuration system</td>
<td>4. Recommending previous successful projects to the end users.</td>
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<td></td>
<td>5. Basis for product standardization.</td>
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<td>Product planning, management</td>
<td>6. Statistical approach to the products’ information and market requirements.</td>
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<tr>
<td>Product planning, Configuration system</td>
<td>7. Improve the quality of the configuration system, lead time, manufacturing, sales engineering, etc.</td>
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Related previous researches

- Inakoshi et al. [1] propose a framework for product configuration that integrates a constraint satisfaction problem with a Case-based Reasoning tool (CBR):

1. Case retrieval
2. Requirement formalization
3. Requirement modification
4. Parts database
5. CSP solver

The Suggested Framework

- The framework provides a systematic way in order to create a database for the comparison based on the currently available methods and tools

<table>
<thead>
<tr>
<th>Phase</th>
<th>Activity</th>
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<tbody>
<tr>
<td>1</td>
<td>Identify relevant product features from configuration system</td>
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<tr>
<td>2</td>
<td>Retrieve specifications on previous designed products from ERP/PLM system</td>
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<tr>
<td>3</td>
<td>Identify relevant features to look for in the retrieved specifications and the features from configuration model and retrieve the values of the features from product files</td>
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<tr>
<td>4</td>
<td>Classification of products based on features</td>
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<tr>
<td>5</td>
<td>Set up database with previous products design</td>
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<td>6</td>
<td>Comparing the new order products with the previous designed products in the ERP/PLM system</td>
</tr>
<tr>
<td>7</td>
<td>Integration of the data base and Configuration system</td>
</tr>
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Framework

**Phase 1: Identify relevant product features from configuration system**

According to Ulrich, if an existing product has standardized and decoupled interfaces, the design of the next product can borrow heavily from the components of the previous product [1]

- Thevenot and Simpson [2] discuss a framework where commonality indices are used for redesigning the product families to align with cost reductions in the product development process
- E. Lopez-Herrejon et al. [3] introduce Software Product Line Engineering (SPLE) to represent the combinations of features that distinguish the system variants using feature models

Framework

**Phase 2:** Retrieve specifications on previous designed products from ERP / PLM system

- **Knowledge Discovery (KD) process elements:**
  - Task discovery, data discovery, data cleansing, data segmentation
  - Model selection, parameter selection, model specification, model fitting
  - Model evaluation, model refinement, output evaluation

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**Phase 3:** Retrieve features from product files and determining the values

**British classification** ➔ **Applicable in high level of similarities**

### Framework

**Phase 4: Classifying the products based on features**

- **Group Technology (GT) method [1]:** how to classify the needs for the product components and coding them.

- **C4.5 algorithm [2]:** It is used to generate a classification in form of a decision tree that is either a leaf indicating a class or a decision node that specifies some test to be carried out on a single attribute value.

  1. All the samples in the list belong to the same class.
  2. None of the features provide any information gain.
  3. Instance of previously unseen class encountered. Again, C4.5 creates a decision node higher up the tree using the expected value.

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<table>
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<tr>
<th>OSHAM systems</th>
<th>• Is generated in hierarchical graphical browser [1].</th>
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</table>
| Unified Modelling Language (UML) | • Commonly used to represent domain experts knowledge.  
• Exploitation of the object modeling as an indexing base is suggested to allow a fast selection of potentially interesting objects during the similar case search [2]. |
| Six Heuristics | • Is used for clustering and weighting the logical, syntactical and semantical relationships between feature names [3]. |
| Product Comparison Matrices (PCMs) | • Can help to make a choice, where the aim is to visualize all the products characteristics through a metrical representation [4]. |

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Framework

**Phase 5: Set up database with previous products design**

Overview of database design in the following three steps [1]:

- **Requirement analysis**: Understanding of what data is to be stored in the database, what applications must be built on top of it, what operations are most frequent and subject to performance the requirements

- **Conceptual database design**: The information gathered in the requirements analysis step is used to develop a high-level description of the data

- **Logical database design**: Database Management System (DBMS) has to be chosen to implement the database design, and convert the conceptual database design into a database schema in the data model of the chosen DBMS

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**Framework**

**Phase 6: Comparing the new order products with the previous designed products in the ERP/ PLM system**

- **Case-based Reasoning tool (CBR) methodologies**
  - Are based on four tasks: Retrieve, Reuse, Revise and Retain [1].

- **Constraint Satisfaction Problem (CSP)**
  - Contextual knowledge corresponding to past cases
  - Regarding general knowledge corresponding to relations, rules or constraints that link design variables [2].

- **CYCLOPS**
  - First system to explore CBR in interactive design [3].

- **Fuzzy Search**
  - Method to define the neighborhood of the retrieved case to propagate domain constraints [4].

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Framework

**Phase 7: Integration of the database with the product configuration system**

- There is the possibility to integrate a constraint satisfaction problem (CSP) with Case-based Reasoning (CBR) tools for a product configuration system [1].

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Ongoing Project at the company

Investigating about the available theories and methods:
- K-means method

Phase 1: Identify relevant product features from configuration system

Making a Product Variant Master (PVM) and the available variants from the configuration system
Ongoing Project at the company

**Phase 2:** Retrieve specifications on previous designed products from ERP / PLM system

**Phase 3:** Retrieve features from product files and determining the values

To be continued
Thank you for listening