AEDA - Advanced Engineering Design Automation
Programme: COMET – Competence Centers for Excellent Technologies
Programme line: K-Projects
COMET subproject, duration and type of project: MFP2 - Design Automation in
Integrated Virtual Product Creation, 11/2015 - 10/2018, multi-firm

Structured Procedure for Design Automation Potential Identification

The identification of Design Automation (DA) potential within industrial business processes is one of the first key steps to be performed before starting the specification and development of a computational DA system. The AEDA consortium developed a methodology that has been applied to the structural analysis process of portal cranes at Liebherr-Werk Nenzing GmbH (LWN) in a case study. The methodology combines the usage of existing Lean-6σ methods for process and problem analyses with an Enterprise Architecture (EA) modeling framework providing DA task templates, drivers and metrics facilitating the identification and specification of potentially applicable DA procedures and solutions. The case study at LWN achieved a refined enterprise architecture description of the process, a list of prioritized problems/challenges plus their causes and effects, and a set of DA task building blocks which can be applied to tackle the identified potentials. Additionally, their integration within a to-be process resulted in a DA development roadmap used for the estimation of the benefits of implementing DA.

Goal, Challenges, and Results

Reasons for limited integration of DA in industrial practice comprise a lack of understanding about what types of tasks can be automated, what methods for automation are available and what potential benefits can be expected when applying a certain method. In order to overcome these obstacles to industrial application of DA, first, categorizations and characteristics of design tasks to be automated and, second, studies of both qualitative and quantitative evaluation of DA potentials have been reviewed and analysed. Based on this, the aim of the project was the development and the validation of a methodology for the assessment of DA potential, first, with respect to metrics for the estimation of potential prior to implementation of DA solutions, and second, considering metrics for success evaluation and validation of DA solutions once they have been implemented. In a case study, the methodology was applied to the structural analysis process of portal cranes at Liebherr-Werk Nenzing GmbH (LWN). The outcomes of this project are:

- A validated methodology for DA potential identification;
- An as-is EA description of the business process
- A list of prioritized problems/challenges to address plus their causes and effects;
- DA task building blocks including metrics for potential estimation;
- To-be process and development roadmap
- A first estimation of benefits prior to DA implementation based on selected metrics.

Methodology for Metrics Definition and DA Potential Identification

Figure 1 illustrates the pursued methodology for the systematic assessment of potentials before applying DA and successes after implementation of DA. The following four steps procedure was developed and performed:

1. Definition and validation of industrial drivers for DA application by means of an online survey.
2. Derivation of the metrics library for DA potential and success quantification. To this end, first, a literature analysis regarding identification of design process performance and software quality metrics was performed. Second, the formalisation of the as-is process enterprise architecture model for identification and analysis of problems, causes and effects was defined and were leveraged for validation/adaptation of the metrics library.
3. Integration of the generic metrics and drivers with the DA task categorization and corresponding DA task templates. This resulted in an initial DA knowledge base, considering types of knowledge needed for automation, relevant application components and associated drivers and metrics.
4. DA potential assessment (prior to DA implementation) and for success evaluation (i.e. a posteriori analysis of the impact of DA solutions). This was achieved by leveraging the findings of the previous steps.
Drivers & Metrics for Design Automation

In an online survey performed within the FFG COIN project ASID (Automation Studio for Innovative Design), 36 individuals ranked a list of provided DA drivers according to their importance. The driver categories defined from this survey were taken as a starting point to derive a classification of corresponding metrics. In a second step, the metrics yielded from the case study (i.e. bottom-up analysis of the process for structural analysis of crane portals) have then been compared and matched to the metrics in the metrics library.

Impact and Effects

The systematic application of the presented methodology for the continuous improvement and monitoring of design processes and towards development and evolution of DA roadmaps results in the following positive effects:

- Process knowledge rationalization and capitalization through EA modelling;
- Increased capability of monitoring process and EA changes through definition of a process improvement roadmap and step-wise targeting of associated to-be models;
- Improved process quality assurance and increased process performance transparency through a regular measurement of the metrics;
- Better decision support regarding DA roadmap validation and for investment decisions as to DA implementation through a user-defined estimation of expected benefits.

Table 1: DA potential estimation for the case study

<table>
<thead>
<tr>
<th>Metrics</th>
<th>Variation Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent for adaptation of dimensioning parameters per project</td>
<td>+10%</td>
</tr>
<tr>
<td>Personal hours per project / average portal</td>
<td>-75%</td>
</tr>
<tr>
<td># of iterations in process</td>
<td>-90%</td>
</tr>
<tr>
<td>Average portal mass</td>
<td>-10%</td>
</tr>
<tr>
<td>Average cost reduction for manufacturing of portals / normalization factor (e.g. portal weight)</td>
<td>-5%</td>
</tr>
</tbody>
</table>

Assessment of DA Potential

After a DA potential to be targeted has been identified and a DA method to implement has been chosen, the corresponding DA task templates (including the metrics) are used to specify the to-be process architecture. Once both as-is and to-be EA models are available, the corresponding metrics are to be measured for the as-is situation and to be estimated for the to-be projection so that a variation forecast can be calculated towards the estimation of future benefits. Table 1 shows the result of the comparison of as-is and to-be processes in the context of the addressed case study. For the sake of confidentiality, only relative values are shown.

Contact and information

K-Project AEDA
V-Research – Industrial Research and Development
Stadterstraße 33, 6850 Dornbirn, Austria
T +43 5572 394159
E office@v-research.at, http://www.v-research.at/

Project coordinator
Dr. Thomas Vosgien

Project partners

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liebherr-Werk Nenzing GmbH</td>
<td>Austria</td>
</tr>
<tr>
<td>V-Research GmbH</td>
<td>Austria</td>
</tr>
</tbody>
</table>

Further information on COMET – Competence Centers for Excellent Technologies: www.ffg.at/comet

This success story was provided by the consortium leader/centre management for the purpose of being published on the FFG website. FFG does not take responsibility for the accuracy, completeness and the currentness of the information stated.