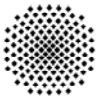

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Evaluation of Modeling Languages for Preliminary Airplane Design in Multidisciplinary Design Environments

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The coupling of physical effects and the rising complexity of modern aircraft necessitate an intense collaboration of disciplinary specialists in preliminary airplane design. Additionally, a growing number of suppliers and outsourced design activities aggravate the design processes even further. Novel multidisciplinary design environments intend to enable specialists to better integrate analysis codes and constitute the consistent technical basis for their cooperation. In this manner different technical aspects can be evaluated quickly, since the data update and analysis capabilities are available throughout the design team. The exchange of information is therefore of crucial importance in multidisciplinary design.

Due to the fact that in data exchange the number of interfaces is the critical factor for the flexibility of a design environment, a central information model is a key feature. The central information model reflects among other things the common namespace of the design team and can be seen as the meta-model for all of the deduced analysis models. The architecture of such a novel design environment is strongly linked to principles of model-based architectures and the chosen underlying software engineering techniques influence strongly the efficiency of the resulting design processes.

An information model for a design environment as described above consists of two aspects. On the one hand the elements, attributes and their structure need to be defined in a schema definition. On the other hand the explicit content has to be stored in a data set conform to the schema definition. Whereas the data set is mainly used for the exchange of information, the schema definition is utilized for documentation, model validation and model generation.

Several possibilities of attributes for a quality information model are named in the literature and are outlined in this research. These attributes or requirements include important aspects like holism, accessibility, transparency and ordering mechanisms. Additionally, several abstraction methods need to be taken into account that are mostly based on principles of object oriented modeling.

Information models commonly used in preliminary airplane design include STEP, XML and most recently the Unified Modeling Language (UML). The Standard for the Exchange of Product Data (STEP) is described in ISO 10303. STEP is widely spread in the industry. The meta-models are built up using the object flavored modeling language EXPRESS. Content models are stored either via plain text or XML formats. The Common Parametric Aircraft Configuration Schema (CPACS) is a DLR intern standard. It is used in several multidisciplinary projects that handle the scope of preliminary airplane design and further aspects like climate impact and transport systems. The standard is based on XML and benefits from a growing number of tools that are adapted to it. As UML is concerned, there is not yet a standard for the modeling of preliminary aircraft data, this work provides therefore an outlook on some of the research in this area. Traditionally, the UML is a powerful software modeling language and the only of the introduced language concepts that features a truly integrated model. The different modeling languages and approaches are reviewed in respect to the quality characteristics already mentioned. Their development history is displayed and existing approaches for the application of these techniques to preliminary airplane design in the academic as well as industrial field are shown.

An evaluation of the named modeling languages is made with respect to the existing multidisciplinary design environment at the DLR. Future developments for the different modeling languages are outlined and potential crossovers highlighted. It is shown that CPACS can be translated to an UML model. Additionally, a CPACS to STEP translator is introduced outlining the software mechanisms applied and showing a validation example using the geometry data of the VFW-614 ATTAS.

This research concludes in an evaluation of several techniques for information modeling taken from computer science to a multidisciplinary engineering design environment for preliminary airplane design. The central information model contained therein forms the basis for distributed modeling and simulation. Its proper parameterization allows therefore a more firm and consolidated assessment of known aircraft designs as well as of some of the potential aircraft technologies of tomorrow.

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