Service Oriented Concurrent Engineering with Hybrid Teams using a Multi-agent Task Environment

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\textbf{Abstract.} The MDO process of products can be supported by automation of analysis and optimisation steps. A Design and Engineering Engine (DEE) is a useful concept to structure this automation. To power the automatic analysis an agent based framework has been developed to support human and agent teams. The agent-based framework seeks to integrate the human and computer engineer into a hybrid design and built team, providing engineering services to the product design team. In this perspective four levels of scoping are identified; organisational scoping level, framework or integration level, tool or engineering service level and data scoping level. These four scoping levels are a good frame of reference to link the identified actors, the four main established functions of a framework and the recent contributions in engineering framework development.

\textbf{Keywords.} Service Oriented Engineering, Multidisciplinary Design Optimisation, Design and Engineering Engine, Knowledge Based Engineering, Multi-agent Task Environment, Engineering Frameworks.

\section{Introduction}

Designing advanced engineering systems, like aircraft, is an intrinsically complicated process, essentially a lot of involved and interwoven elements. Teams of engineers need a technology that will enable them to improve virtual access to their ideas, model the multidisciplinary aspect of a product, manipulate geometry and the related knowledge, and investigate multiple what-ifs about their design.

To achieve the above in a reasonable time and with confidence in the reliability of the results, the concept of a Design and Engineering Engine (DEE) [3],[7],[14] is proposed to motor the multi-disciplinary design optimisation (MDO) of aircraft design with engineering teams. In the heart of the DEE a generative aircraft product model is implemented in a multi-model generator (MMG). This modelling tool, using Knowledge Based Engineering (KBE) methodologies, is able to...
generate many different aircraft configurations and variants, using combinations of specifically developed classes of objects, called High Level Primitives (HLP) [7]. The HLPs provide designers with a powerful concept to capture and re-use not only the geometric aspect of design, but also provide capability modules, which include rules for automatic creation of analysis models for various disciplines. Based on the research of the MMG and the HLPs in particular, a framework process primitive has been created and described by Schut et al.[11]. This so called Engineering Primitive (EP) integrates methods and knowledge needed to instantiate and Feasilize [12] a design.

All elements in the DEE can be seen as engineering services contributing to a pool of services. A human operator actor that needs to determine the behaviour of a possible product solution proposal selects the services from this services pool. An automation framework through which the behaviour of product solution proposal is evaluated is provided by the multi-agent task environment (MATE) [1][2]. This agent framework form the non-human part of the hybrid team.

A prototype framework capable of supporting such distributed and concurrent MDO analysis, using the concept of a DEE, is the TeamMate Multi-Agent Task Environment. This framework is under active development and a prototype has been implemented in several DEE projects like a what-if study of a tail-plane design being subject to dynamic loads [3], a structural optimisation of a wingbox [13], several master theses and a tool to perform design of electrical wire harnesses [4].

Since the framework is the enabler for the DEE, this concept is first explained in the next section.