The Design Guidelines Collaborative Framework

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A Design for Multi-X Method for Product Development

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Preface

In the industrial design and engineering field, product lifecycle, product development, design process, Design for X, etc., constitute only a small sample of terms related to the generation of quality products. Current best practices cover widely different knowledge domains in trying to exploit them to the best advantage, individually and in synergy. Moreover, standards become increasingly more helpful in interfacing these domains and they are enlarging their coverage by going beyond the single domain boundary to connect closely different aspects of the product lifecycle. The degree of complexity of each domain makes impossible the presence of multipurpose competencies and skills; there is almost always the need for interacting and integrating people and resources in some effective way. These are the best conditions for the birth of theories, methodologies, models, architectures, systems, procedures, algorithms, software packages, etc., in order to help in some way the synergic work of all the actors involved in the product lifecycle.

This brief introduction contains all the main themes developed in this book, starting from the analysis of the design and engineering scenarios to arrive at the development and adoption of a framework for product design and process reconfiguration. In fact, the core consists of the description of the Design GuideLines Collaborative Framework (DGLs-CF), a methodological approach that generates a collaborative environment where designers, manufacturers and inspectors can find the right and effective meeting point to share their knowledge and skills in order to contribute to the optimum generation of quality products. The DGLs-CF integrates several tools to achieve this goal: a method to evaluate the compatibility between the products and the processes adopted to manufacture and verify them, a language and a data structure to formalise the knowledge about products, processes and so on, some procedures to infer new information from the gathered knowledge and, finally, a usable way for information sharing among the different domains. As a result, the DGLs-CF gives the users a sort of to-do list for modifying the product model and/or the physical representation of it through the whole development process, in order to achieve the best compromise between product functionalities and the characteristics of the available technologies.

The first chapter deals with the need to clarify the concepts and terms related to the product lifecycle, regarding the context where this project develops. The concepts like the product lifecycle itself, the engineering design process, the Design for X, Concurrent Engineering, the Standards, the design methods, etc., are related to each other like some sort of Chinese boxes. The state of the art of each of them is described and a wide range of references is added to help in detailing further understanding of the topics.

The second chapter starts to describe the DGLs-CF by introducing the previous work related to it. The project started around the year 2002 and up to now four releases of design guidelines have been developed. The chapter describes in detail this course for many reasons. First, the DGLs-CF is so complex and articulated that there was the need for this sort of background information to get all the details of it at best. Second, the DGLs-CF development trail put to evidence time by time different aspects, sometimes unexpected, of the product lifecycle management; this has been really valuable in targeting and tuning the authors' competencies and skills and, hopefully, could be of help to the reader for the same reasons. Third, the examples of the application of the different releases in the field could help in gradually understanding the adoption of this sort of tool in the everyday work of designers, manufacturers and inspectors.

The third chapter describes the DGLs-CF in detail. A simple formalism, the IDEF0 — Integration DEFinition — diagrams, has been used to keep track of the development and adoption of the framework. This choice allowed one to describe in a really clear way all the activities required by the DGLs-CF, the interfaces between them in terms of input, output, controls — the standards, other guidelines and, in general, any references used in performing the activities — and, finally, mechanisms — the resources expressed in terms of humans, procedures, software packages, etc.

The fourth chapter describes the experiences in applying the DGLs-CF in the field. Some industrial products, together with the available technologies in their design, manufacturing and verification domains, have been evaluated using the DGLs-CF. The redesign/reconfiguration packages, the lists of actions to perform on the product coming as a result from the DGLs-CF elaboration, have been considered and applied.

The fifth chapter acts as the final discussion about the project. Now the DGLs-CF presents a good level of maturity concerning the methodological aspects and the most of the procedures used in the activities have been detailed as well; nevertheless, much work still remains to be done, especially on implementation and usability issues. This chapter summarises the hints coming from the different releases of the design guidelines and describes if and how the DGLs-CF matches them. These considerations lead to a list of suggestions for future work.

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Contents

Abbreviations

ABS	Acrylonitrile Butadiene Styrene
API	Application Programming Interface
ASME	American Society of Mechanical Engineers
CAD	Computer Aided Design
CAD/CAM	Computer Aided Design/Computer Aided Manufacturing
CE	Concurrent Engineering
CMM	Coordinate Measuring Machine
D4V	Design for Verification
DBMS	Data Base Management Systems
DfA	Design for Assembly
DfE	Design for Environment
DfM	Design for Manufacturing
DfMA	Design for Manufacturing and Assembly
DfR	Design for Reliability
DfTM	Design for Test and Maintenance
DfV	Design for Verification
DfX	Design for X
DGLs	Design Guidelines
DGLs-CF	Design Guidelines Collaborative Framework
DMLS	Direct Metal Laser Sintering
DOE	Design Of Experiments
DPs	Design Parameters
DSM	Design Structure Matrix
EDM	Electrical Discharge Machining
FDM	Fused Deposition Modeling
FEM	Finite Element Method
FMEA	Failure Modes and Effects Analysis
FRs	Functional Requirements
GPS	Geometrical Product Specifications
ICOM	Inputs, Controls, Outputs, Mechanisms
IDEF	Integration DEFinition

ISO TC	International Organization for Standardization Technical Committee
ISO	International Organization for Standardization
ISO/TR	International Organization for Standardization Technical Report
MET	Materials, Energy, Toxicity
MTBF	Mean Time Between Failure
NC	Numerical Control
OpenADE	Open Assembly Design Environment
PERT	Project Evaluation and Review Technique
RP	Rapid Prototyping
SADT	Structured Analysis and Design Technique
SLA	Stereolithography
SLS	Selective Laser Sintering
STL	Stereolithography file format
TRIZ	Teoriya Resheniya Izobretatelskikh Zadatch (Theory of Inventive Problem Solving)
UML	Unified Modelling Language
UV	UltraViolet