

The Potential of 3D-CAD Based Process – Optimization in the Automotive Concept Phase

Patrick Rossbacher, Mario Hirz and Alexander Harrich
Graz University of Technology

Wilhelm Dietrich and Norbert Theiss
Magna Steyr Fahrzeugtechnik AG & Co KG

Copyright © 2009 SAE International

ABSTRACT

The time reduction of the vehicle design and creation process is an important key to reduce development costs. Modern CAD systems offer a wide range of possibilities, not only in the standard field of mechanical design, but also in terms of creating advanced control mechanisms concerning part and assembly structures. Integrated design strategies include miscellaneous scripting and programming possibilities as well as implemented functions. An efficient application of these features can help to decrease the development time and to manage the growing functional complexity of automotive engineering processes. Continuously increasing product variants and functionalities call for design strategies and methods, which are capable to handle a quick data control and data transfer supporting an efficient geometry creation and evaluation.

INTRODUCTION

The early phase in automotive design processes is characterized by a wide range of variations, changes, alternating definitions, requirements and iterative actions, which are influenced by legislation boundaries and ergonomic tasks as well as interior, exterior and design requirements, crash and safety demands, customer demands and desired functionalities. The approach to an optimized vehicle development process is the minimization of iterative steps to fulfil all the targets. For that reason it is essential to generate an integrated virtual vehicle model, which includes the complex development structure of a physical concept car. The application of a car model with parameterized exterior and interior surfaces capable to define multiple vehicle types with miscellaneous features can support flexible car packaging studies very quickly in an early development phase. In addition, the integration of a control structure with CAD - external sources, like databases and script based mechanisms, states the basis for iterative, partial self controlling development processes.

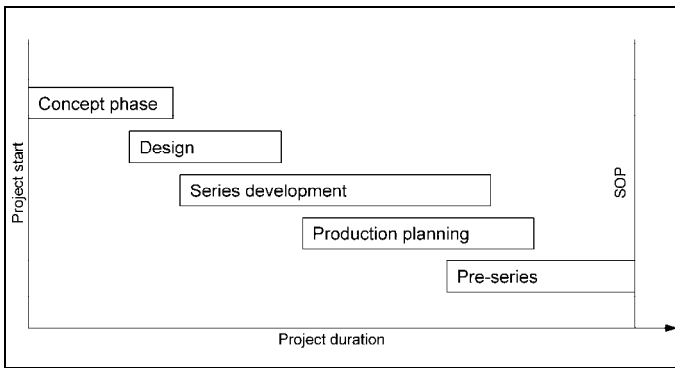


Figure 01: Exemplary steps of an automotive development process

Figure 01 shows the sequence of main steps in an automotive development process [1]. An efficient use of simultaneous engineering and front loading methods combined with linked CAE applications provides a significant time- and cost reduction. Modern development processes generate various product characteristics in early process sections to reduce the engineering effort in following (cost intensive) sequences. These methods require a powerful and easy to handle tool for the concept phase, which supports the manifold and highly integrated demands during these initial engineering procedures (Figure 02).

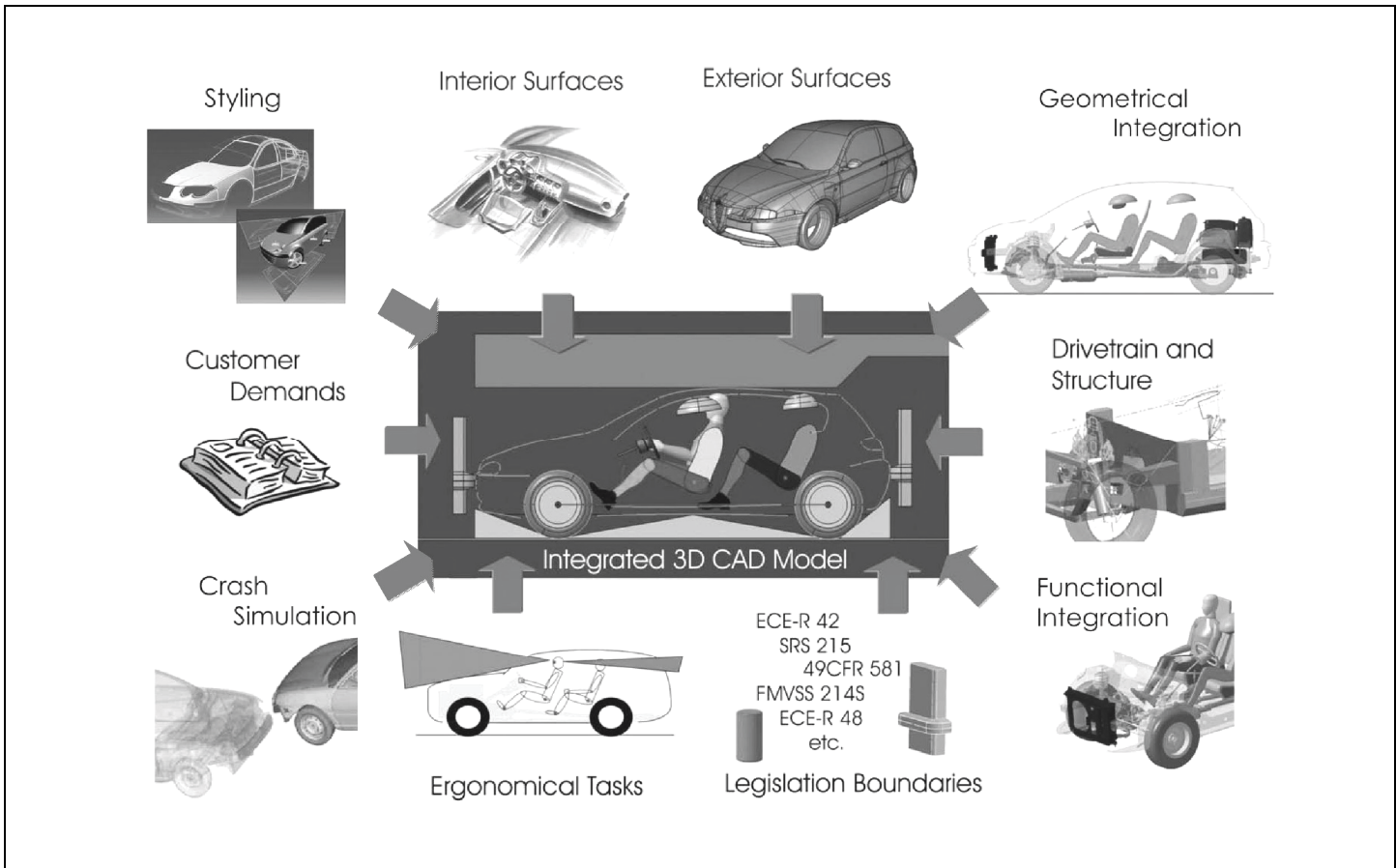


Figure 02: Influencing parameters of an integrated 3D-CAD model for the early development phase [1]

ARCHITECTURE OF A SUPPORT TOOL FOR AUTOMOTIVE CONCEPT PHASE

During the initial design and layout phase of a new car, an optimal interaction between the styling process and technical engineering operations states an important factor for an efficient predevelopment process. Influencing parameters of the early development phase predefine the structure of an integrated 3D-CAD model, which forms the core of a supporting tool for the concept phase of automotive development projects. This concept tool consists of a data base including a logical order of

data - modules and a linked 3D-CAD model. An externally controlled 3D-CAD based development strategy simplifies the conceptual design and packaging process by use of an external data base, which controls the parameterized model. The external data collector includes a key collection of relevant dimensions, positions and / or ergonomic viewpoints. The data sheets permit modifications and variant studies of the virtual car by project partners, who are not primarily specialized in the applied 3D-CAD design software, enabling a direct access to the relevant information on vehicle geometry.

Figure 03 includes the data flow of the concept car tool, which is arranged in two main areas. The data base includes a user interface, additional data, calculations and a data storage system. In addition, predefined data can be transformed into the 3D-CAD system to control the parameterized virtual car model. If required, the virtual car model is directly controlled by the user to enable a quick and easy handling. The parameters and relations of the 3D-CAD model are directly accessible, supporting a visual optimization of different geometrical components.

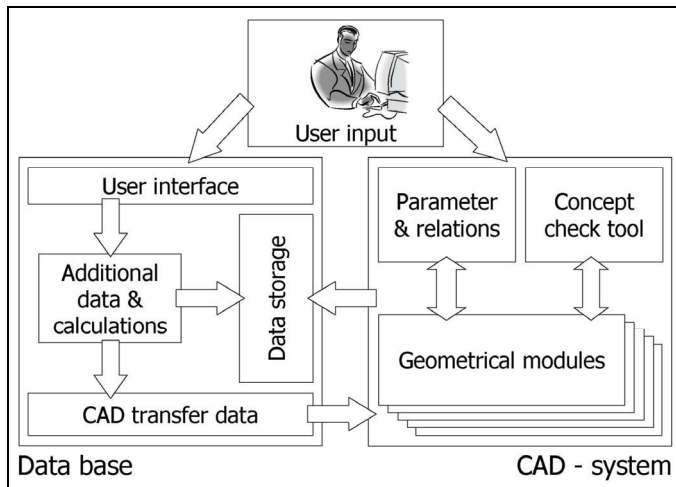


Figure 03: Data flow and parameter control

WORKING PROCESS AND DATA FLOW

The present tool meets two application fields; on the one hand, the quick possibility of generating a package model, and on the other hand the analysis of studies with respect to boundary conditions (specified definitions or legislation limits). The first task is covered via the provided CAD body geometries; the second is fulfilled by the body boundary geometry modules (see Figure 06).

The two main elements of the application are a database capable of handling multiple parameters and a CAD system able to generate associative parameterized assemblies and a programmable interface (any script language to communicate with exterior applications). The dimensions of the entire vehicle's main geometry are defined according to the GCIE standardization. GCIE ("Global Cars Manufacturers Information Exchange Group") is a federation of automotive manufacturers and describes interior and exterior car dimensions [2]. The legally based geometrical values contain crash and safety, visual regulations, lighting equipment, ergonomic data and other areas.

A bidirectional information flow from the data base to the parameters of the virtual car model and from the CAD system back to the data pool efficiently supports conceptual working steps. An advanced data structure organizes the input of relevant parameters and the data

transfer to each component of the tool. Beside the information transfer from the input and data organizing tool to the 3D-CAD system, the reverse data exchange from the 3D-CAD system to the data pool guarantees an efficient data flow during the entire development processes.

DATABASE

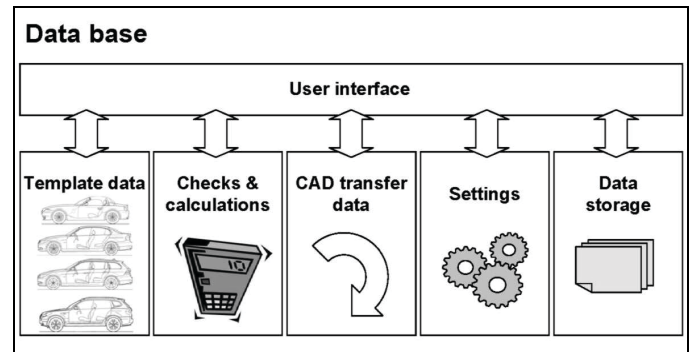


Figure 04: Configuration of the data base

The data base architecture consists of five main sections (Figure 04), which include a user interface, template data, checks and calculations, settings, the data storage and an export area connected to the CAD system.

The possibility of presetting the desired vehicle classes based on template data supports the engineering process during initial steps. Thereby preliminary car geometries of the desired vehicle type (micro car, compact car, lower middle class, middle class, upper middle class, luxury sedan, van, and SUV) are able to be generated automatically. Still it is possible to alter the vehicle's dimensions manually in the work range.

The input templates include information concerning the positioning coordinate system, wheel dimensions, seat orientation, load conditions, approximated spring constants, axle load distribution and position of the pedal points etc. based on the GCIE-standardization. Parameter values represented in these tables are accessible for explicit editing. Concurrently, the inserted values are surveyed with regard to their plausibility by the help of predefined borders. The current range of the input area displays the values rewritten by the CAD system and is the source for the export and save function. The data will be stored into the application's tracking system, labeled with the current working date, to provide a future loading of the data sets by the user. The checks & calculations data sheet enables a definition of control mechanism, different check geometries and the accomplishment of mathematical operations. The data transfer area is responsible for the translation of geometrical basic information to fulfill the requirements of the parametric associative 3D-CAD model. A specific setting area enables predefinition of project related main data and adjustments. And finally, the data storage system serves as a **Documents**