

Engineering Design in Integrated Product Development  
Management of Design Complexity

## PARAMETRIC MODELS OF MOULD TOOLS IN CATIAV5

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**Keywords:** CAD, automating design process, parametric design, mould tools

**Abstract:** *The paper presents the results of academic and industrial project. It has been accomplished in cooperation with German company that is one of the leaders on the plumping and sanitary products market. On the basis of designing mould tools are also presented the possibilities of automation the design process in Catia V5. The four parametric start models and specialised programs were built in Catia. The customizing tools available in Catia V5 system have been discussed on the basis of this project.*

### INTRODUCTION

Although the CAD/CAE computer systems are more and more advanced, there is still a need for speeding products design. Cost reduction, shorter product development time, higher performance and high reliability are demanded [1]. Increased demands required also computer tools that store and share company knowledge. Improved efficiency and improved quality though standardisation has a great influence on cost reduction. It can be done with the help of customisation. It provides additional functionality not provided in native products and manipulates on existing function to better fit customer processes [2].

Our German industrial partner, one of the leaders on the plumping and sanitary products market, started to use Catia three years ago. The implementing of a new CAD system underwent in this company in same phases. In the first stage new system was working parallel with old 2D one. During this time a new methodologies of company's standards design process were developed and also engineers were taught Catia. In the second and the last stage, which started at the beginning of 2004, the all-technical documentation was created in Catia V5 system.

The authors support the above mentioned company on CAD field. One of our projects, presented in this paper, concerned mould tooling design in Catia, was accomplished in 2003. It consists of several parts: the first one is to develop the most optimal method-

ology of the mould tools modeling in Catia, the second is to prepare four parametric starts models for the most common structure cases of the developed mould tools, the third one is to develop tools for creating the cooling system and the last one applies an application to programming, which enables user to operate on starts models.

### 2. THE MOULD TOOLING REVIEW

Some applications for the mould tooling are available on the market. The best know, which work in the Catia V5 environment, are Catia V5 Mould tooling module and System Consult SC Tool.

Catia V5 offers a special module for the mould tools design. It is integrated with Catia environment and offers a good functionality but only for two plates tools. For other cases it is unsuitable.

The SC Tool is a more general program than Catia Mould Tooling module. It helps the user to design a mould tool from the beginning up to complete tool.

Both of the mentioned programs are integrated with the catalogues of normal mould tools. They are parametric and offer great functionality and a wide range of specialised functions. The architecture of both was not published.

Mentioned company has decided not to buy a special licence for the above presented programs because of the price and company specific standards. They have been looking for more customised solution.

## 2. PROJECT DESCRIPTION

Design of the mould tools is a complex process that requires, since the early phases, a lot of knowledge and experience. The mould tools consist of two systems: technological and mechanical. The technological depends on the moulding product and it influences on the mechanical system [3]. The technological system consists of the core and cavity plates, the injection system and the cooling system. The mechanical system consists of the leader system, the ejector system and the support plates [3].

Every month several new mould tools are developed in the design offices of the discussed company. An efficient engineer takes it approximately about 200 hours to make a complete model of the mould tool. There was a need to shorten this time, as well to standardise the design process of mould tools in Catia to allow the user to change some features of the model in shorter time. After analysing the designing process, it has been decided that the new methodology of the mould tool modeling in Catia should be developed and some of the designing activities should be automated. The following most time-consuming activities have been mentioned below:

- creating start models for the most common structure cases: two plates tools vertical and horizontal and two special cases with the slides;
- creating of the cooling system;
- programming of the applications to operate on the start models;

In order to solve the above presented problems the following goals have been presented:

- the automation of most time-consuming designing activities;
- shorter time of modeling casting tools in Catia V5;
- the standardisation of the design process of the mould tools;

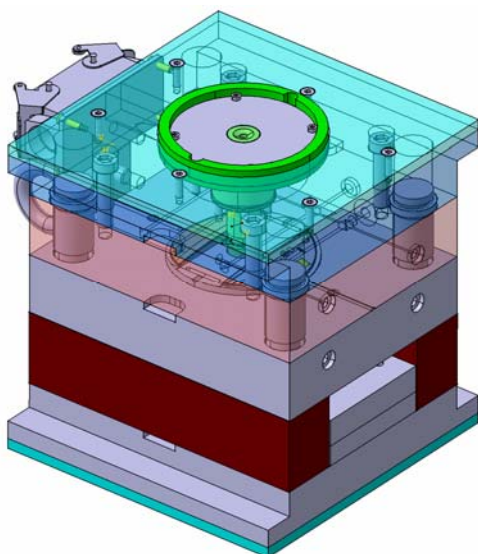


Fig. 1 An example of mould tool[4]

## 3. TOOLS AND METHODS

Catia provides the users with the wide range of tools that can be used for an automating of some phases of the design process or for building up and sharing corporation knowledge.

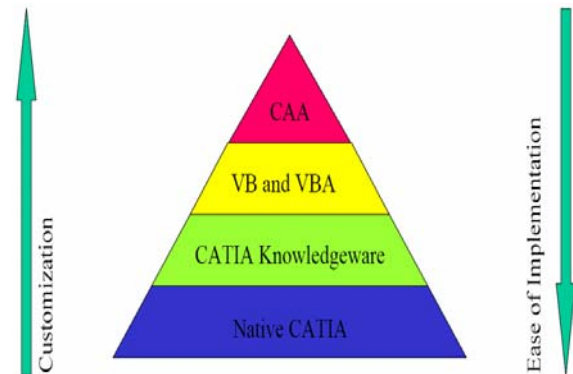


Fig.2. Catia V5 automations tiers [2]

These tools, according to ease of implementation and efficiency (Fig. 1), can be grouped as follow [2]:

- a) The native Catia automation
- b) Catia Knowledge applications
- c) Internal scripts languages: VBScript, Visual Basic for Application;
- d) External programming environment – CAA Rade

### 3.1. The native Catia automation

The native Catia environment offers some tools and functions useful for automation. They are grouped as follow [2]:

- Parameters - a feature defining object property (e.g.: geometry, material) or a document. It can also be also created by the user for a specific purpose.
- Formulas - a feature used to define or constrain a parameter. A relation between parameters, geometrical objects, features etc.
- Design Table – a table containing values to be applied to a document to manage parameter values. An associative link is created between a spread sheet (Microsoft Excel, Lotus) or a text file and Catia part or product.
- Templates (Seed Files) - a document used to store and reuse the intent. The new context is defined by modifying parameters or replacing specification geometry.
- Power Copy - a set of features (geometric elements, relations, constraints) grouped in a generic context for reusing in a specific context. The new context is defined by selecting geometric inputs and specifying public parameters. It can be stored in a feature catalogue and provided to guide a user through the selection of inputs and the valuation of parameters.

Parameters, formulas and Power Copy functions were used in the project.

### 3.2. Catia Knowledge applications

The Catia knowledgware applications allow the users to build up and share corporate knowledge. They are grouped as follow:

- Knowlegware advisor – allows the user to embed knowledge within design and leverage it to an assist in engineering decisions, in order to reduce errors or automate design, for maximum productivity. The user can embed knowledge in a design such as formulas, rules and checks and leverage it at any time when required [6].
- Knowlegware expert- a tool to analyze and manipulate features across a design, to ensure design compliance with the established standards.
- Generative Knowledge – provides an easy way to describe the data used to establish documents and to store this data in a script file.
- Product knowledge template – provides the capability to create a user defined feature. It allows the capture of the design methodology defined interactively in Catia, as well as the reuse across the extended enterprise. They can contain not only geometry, but also associated parameters, relations etc. Although the knowledge applications offer a great and interesting functionality, these tools have been rejected because of a special licence requirement.

### 3.3. Inertial scripts languages

Access to the Catia object model is provided using scripts in different ways depending on the operating system and on the applications that can share their own objects with CATIA.

The following summarizes CATIA scripting capabilities [6]:

With Windows:

- In-process access using Visual Basic Scripting Edition since CATIA hosts the Visual Basic scripting engine.
- Out-process access from Visual Basic for Applications via applications like those of Office.
- Out-process access from Visual Basic 5 Development Studio.
- Out-process access using the Windows Scripting Host and scripting languages such as VB Script or JScript
- Out-process access from a html page
- Out-process access from a COM application accessing CATIA interfaces through the Invoke method.

With UNIX

- in-process access using Summit's Basic Script.

In-process access means that the script interpretation is performed in the same process as Catia. Out-process access means running the macro from another application in another process. In this case, the macro should first be connected to CATIA then access its data.

The advantage of Visual Basic for Application is integration with Windows environment. It allows for

creating User Graphics Interface, building application integrated with Relation Databases and using other Microsoft Windows components.

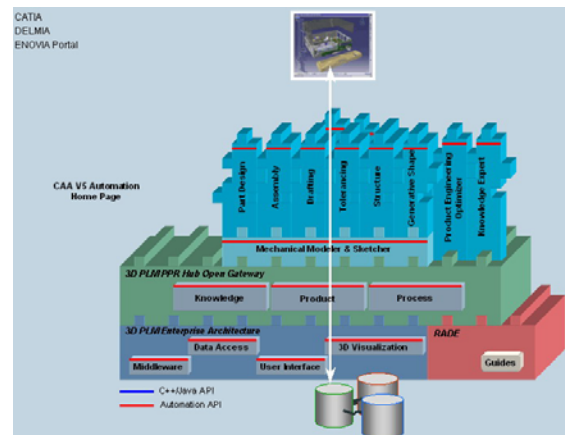


Fig.3. Automation model of Catia V5 [4, 5, 6]

### 3.4. CAA Rade applications

The programming modules offer the greatest functionality. They allow programming an efficient application also for automating company specific design process. Taking their licence prices into consideration, they find application in the most advanced projects.

In conclusion, the authors have chosen Visual Basic for Application language as the best tool for solving the problems presented in the project. Other mentioned tools (parameters, formulas, Power Copy) have been also used also in various stages of the project.

## 4. RESULTS

### 4.1. The start models

In the first stage of a project the four start models for the most common structure cases were created. The following cases were the most popular in the mentioned company: two plates mould tools: vertical and horizontal, and slides mould with two different types of slides drive. These models can be used at the beginning of the design process of the mould tools in Catia V5. The common basic features of the mould tools have been already done in the start model. Each of the start models consists of required number of the plates (some of them can be with one parameter switched off), the fixing elements on the machine, the fixing screws, the driving pivots and a number of the another features. The designer starts to create specific, new features on the basis of one of these models. It allows him to save time and also facilitates his work, because the most demanding modelling activities have been done.



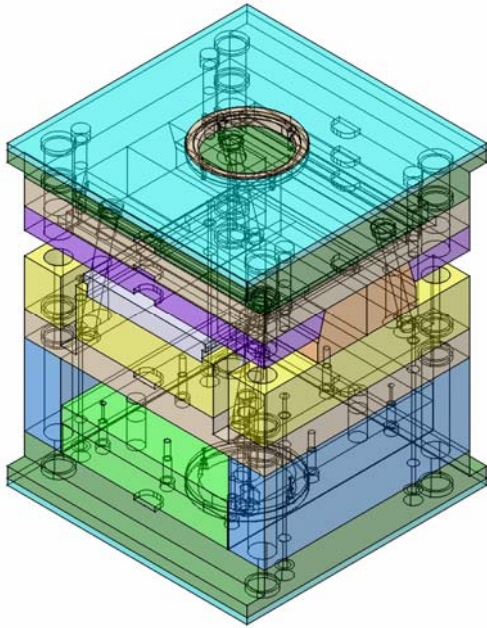


Fig.4. An example of the start model

To easily change the dimensions of the start models a number of the parameters has been developed and has been bound with model's features (fig. 5).

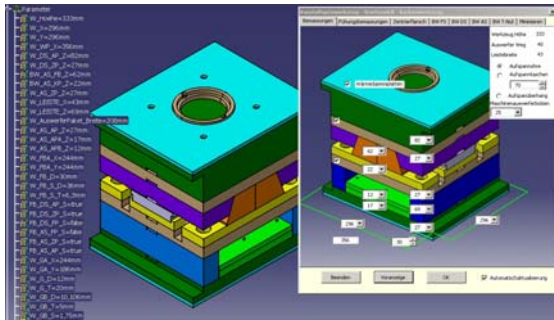


Fig.5. The parameters of the start model.

**4.2. The cooling system**

Next stage was to create an efficient tool for building the cooling system. It is a part of a technological system. Its structure depends on many technological criteria and it is limited by mechanical system. The cooling system is in every mould tool different but of course the general rules are the same. It has been created a range of typical cooling system slots using a User Define Feature function (fig. 6).

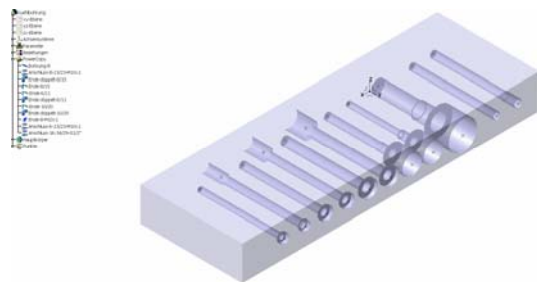


Fig.6. The cooling slots.

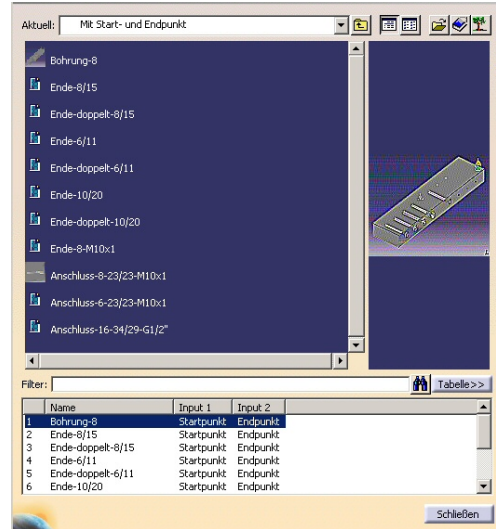


Fig.7. The cooling system catalog.

On this base a new catalogue with a cooling system was created (fig. 7). The user defines now a central line for each slot and selects form the catalogue a type of slot. The all required features will be done automatically and the complete cooling system can be modeled much faster than using the basic function of Catia V5. The next advantage is that each of created slots is completely parametric and associative to the line established by a user. It allows him to change them any time.

**4.3. The application**

Each of the start models consists of minimum 120 parameters. Each of them stores for example the dimension value of plates, the Boolean value of existing of the same features, material description etc. It was difficult for the user to change all this parameters in the Catia environment without any application. It has been decided to build a computer program which is working in the Catia environment and which allows the user to easily operate on parameters. The Visual Basic for Application language was used for it, because of the above mentioned advantages.

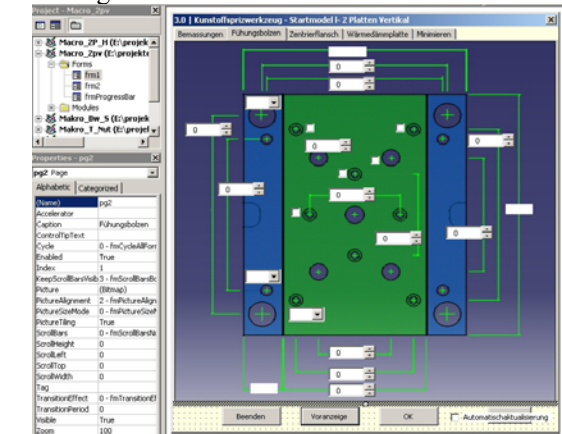


Fig.8. The Visual Basic for Application editor in Catia V5.

The program architecture is showed below (fig.9). The basis for this program is a Relation Data Base of Microsoft Access, which stored all the dimension data from the Hasco catalogue [8]. The ADO model has been used for communication with the data base.

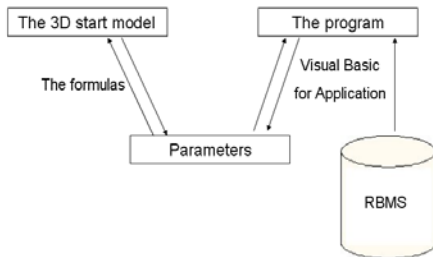


Fig.9. The data flow scheme.

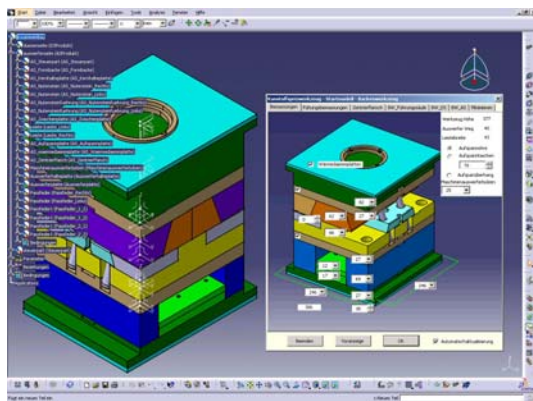


Fig.10. The application GUI overview [4].

The program operates on the parameters of the start models bound with the model features with the help of formulas. The functions for reading and changing a parameter value have been programmed. The engineer changes the value in the GUI and all linked dimensions are automatically updated [4]. There is a possibility to change it manually and to bring another dimension value then in the Hasco catalogue. The examples of the GUI are showed bellow. The entire features are visualised, because one can easily find them.

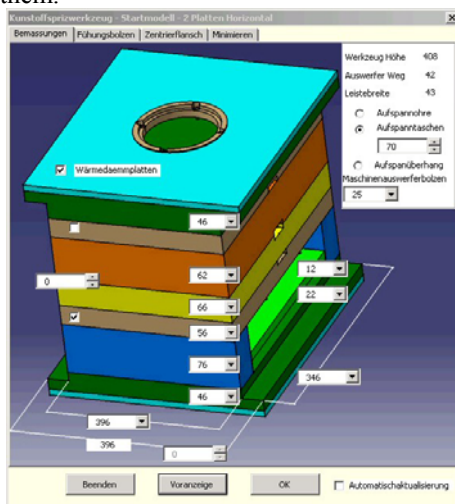


Fig.11. An example of the GUI [4].

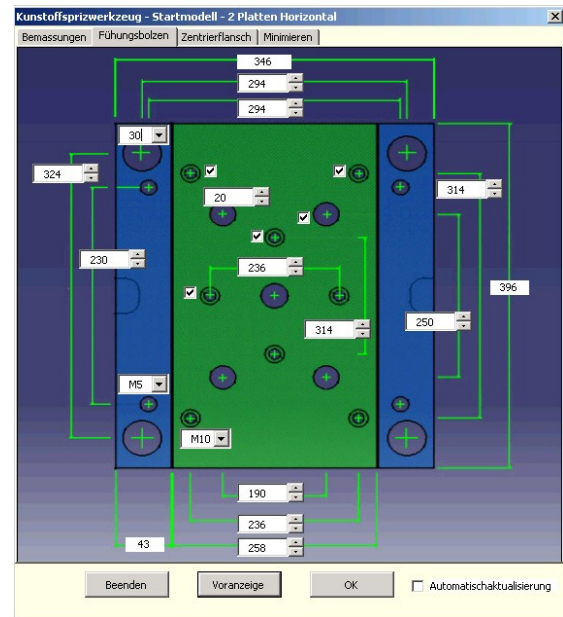


Fig.12 An example of the GUI [4].

## 5. CONCLUSION

The above-mentioned parametric models and programs were presented in the company. After the test stage they were applied and it can be concluded that they fulfilled a project assumption. The parametric models and programs allow for minimising time needed for designing models of mould tools in Catia V5 system. Improved efficiency and standardisation facilitated the design engineer work and improved the quality of the products.

Thanks to capture company know-how into programmed tools their great functionality has been reached. Customization provides an additional functionality into native system and allows a better fitting into company design process.

The automating functions and Visual Basic for Application implemented in Catia V5 system showed that the expanding of the native system functionality was possible. They can be considered as a suitable tool for automating designing process in that system. The presented methodology can be applied also in other CAD/CAE/ systems.

## References

- [1] N. F. Knight, Jr., and T. J. Stone: *Rapid Modeling and Analysis Tool; Evolution, Status, Needs and Direction*, <http://techreports.larc.nasa.gov/ltrs/PDF/2002/cr/NASA-2002-cr211751.pdf>, 2002
- [2] J. Hicks, T. Toomey, L. Encapera: *Catia V5 Knowledgeware & Automation*, Nord Texas Regional User Group, 2002
- [3] Praca zbiorowa pod redakcją K. Wilczyńskiego: *Przetwórstwo tworzyw*

- szucznych*, Oficyna wydawnicza Politechniki Warszawskiej, Warszawa, 2000
- [4] M. Laudański, M. Ruschitzka, J. Wróbel: *Automatyzacja procesu projektowania form wtryskowych w programie Catia v5*, Computer Aided Engineering, Polanica Zdrój, 2004
- [5] M. Laudański, M. Ruschitzka, J. Wróbel: *Designing of casting tools in Catia V5*, XVIth Polish – German Seminar, Warsaw, 2004
- [6] *Catia Version 5 Release 11 User's Documentation*, IBM Corporation, 2003
- [7] D. R. Ziethen: *CATIA V5 – Effiziente Konstruktion mit Makros*, Carl Hanser Verlag München Wien, 2003
- [8] *www.hasco.de*, 2004