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Effective Work in Design of New Product in MCAD Systems

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Abstract

The paper presents an important aspects of design in parametric 3D Mechanical CAD systems (MCAD), improving the process of new product development and its modification. The paper shows possibilities of use CAD software to increase productivity and simplify of design process of geometrical models in parts and assemblies environments.

1. Introduction

New product design process is an extremely complex process involving all operations before launch of production. The quality of this process has a significant influence on quality of the final product. Currently, because of the right use of CAx techniques, it is possible to significantly improve engineering works. These techniques allow to reduce the development time of a new product, which causes faster final product implementation on the market [Łukaszewicz, 2008]. Computer-aided design enables to transform an original idea into a three-dimensional project, make simulated actions, strength calculations, implement rapid changes in the project and create complex technical documentations [Panas, Łukaszewicz, 2012]. Optimization of the product on designing level has a big influence on the team efficiency responsible for the project. Additional tools working in environment of specific system also increase an efficiency. benefits of the use of parametric CAD systems in mechanical branch (MCAD) are connected with economic aspects. The acceleration of design works, strength and motion analysis and also the model visualization ability without its production are directly connected with significant costs reduction.

Requirements for designers force them to analyse in detail the ways of project design and to choose the best design method (Fig.1).

The proper planning of 3D model structure of constructed part and assembly provides the greatest efficiency of design process. The efficiency increasing is defined as a facilitate design changes and shortening project work time.

Fig. 1. Design methods in parametric CAD systems

2. Effective parts modelling in parametric CAD systems

All product designing generally starts in definition of 3D part model. Efficiency increasing initiates in doing correct, editable 3D model. It is mainly connected with correct fulfilment of project assumptions. Therefore, during design of 3D model it is necessary to plan the model structure in such a way, that implementation of inevitable modifications in the design process would require a minimum involvement of designer [Wełyczko, 2005].

General rules of effective parts modelling are following [Łukaszewicz, 2009a]:

- appropriate model orientation in space of predefined planes,
- correct selection of parts modelling technique (solid, multibody, surface or hybrid modelling) and applied operations,
- proper use of parts symmetry,
- uncomplicated sketches geometry,
- the use of suitable relations between geometry elements,
- fully defined sketches (relations, dimensions, equations) allowing to easily change model parameters,
- application of model simplifications, especially in case of parts selected from catalogues,
- if it's not necessary, avoiding of threads and helixes modelling.

2.1. Use of layout sketches

The work on parts or assemblies often begins with initial sketches. Parametric CAD systems offer the support of this kind of design works [Lombard, 2011a]. For this purpose layout sketches are used. They allow to create functional structure of designed mechanical devices with 2D sketches (Fig.2).

Two-dimensional sketches are easy to make and use. They allow to simulate the actions of mechanisms and also to determine components position of assembly. Using simplified components representation and relations between blocks it is possible to accelerate design process of mobile machines and mechanisms. Traction and belt/chain tools are extremely useful tools in layout sketches. Traction creates connections of blocks rotations relative to each other, belt/chain is a path representation of belt or chain with continuous joining lines and arcs

[www.help.solidworks.com]. Animation and motion analysis of the layout created with sketch blocks is an effective solution in the design of mechanisms.

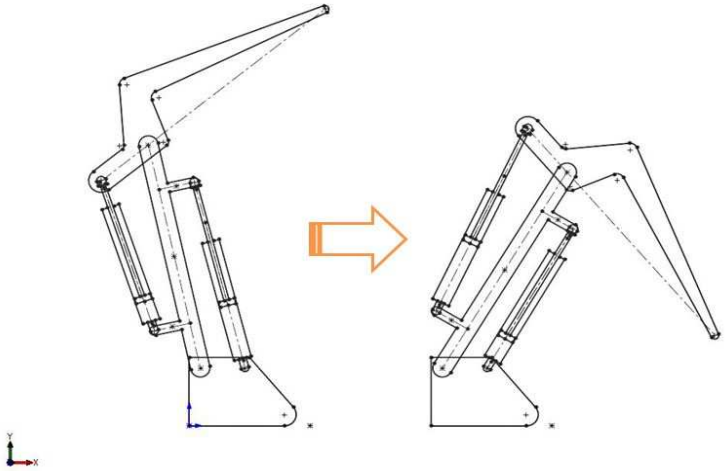

Fig. 2. Simple movement analysis using blocks in 2D sketch

2.2. Multibody modelling techniques

The concept of parametric modelling gives designers huge opportunities of creating varied geometries. Parts modelling with SolidWorks software is intended to build fully defined model with solid or surface features. Multibody modelling technique allows to expand possibility of working in part file. It includes features on more than one solid body (Fig. 3). Multibody modelling allows to get a flexible model structure. During part modification, it is possible to reduce the scope of features to specified bodies. The bodies can be freely scaled and moved. It is possible to create complicated shapes with the use of body as "tool" and interact with another. We can also use pattern and mirror features. Using bodies in patterns helps to reduce time of rebuild. In design process of the model we have to build the final part made of one body. In this case very helpful are Boolean operations: add, subtract and common [Łukaszewicz, 2009b].

Besides solid modelling, the work with project is often connected with surface modelling. Then, it is necessary to combine these techniques together and use hybrid modelling and also multibody techniques [Łukaszewicz, 2009b]. We need to put together many surfaces into one solid body. Multibody modelling can't be avoided in design of weldments and molds.

Part made of many bodies shouldn't be confused with assembly. If ensuring movement possibility is required, it is necessary to use modelling in assembly [DS SolidWorks, 2012]. However, it is possible to save complex assemblies as multibody part file. Multibody modelling has its own limitations in comparison with an assembly. For this reason, during designing, it must be intentionally defined which solution will be the most effective in build of the final 3D model.

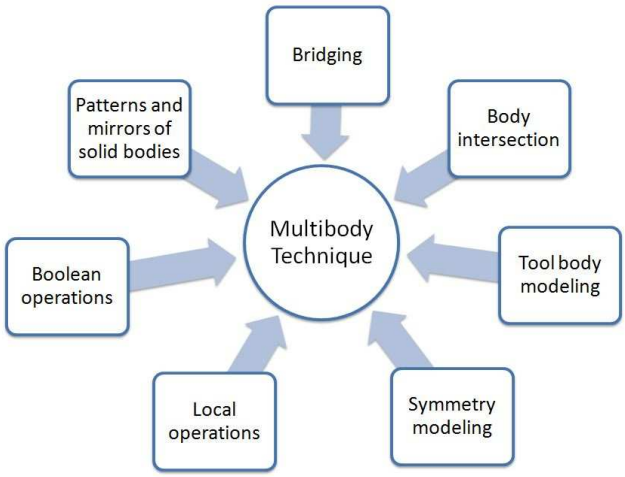

Fig. 3. Multibody modelling techniques

2.3. Master Model technique

Master Model technique is used when elements share common geometry. In design process of 3D model, reference target (master model) can be used to build new geometry [Castle, 2012]. This technique is very helpful when final model consist of parts which have to fit perfectly to each other.

Parent and child terms need to be understood to efficient use of this technique. Parent document (saved as the first) is always used as a control document. Any parent modification causes adequate changes in child.

Using Master Model Technique it is possible to create multibody model and save separate targets as individual parts files and create assembly (Fig. 4). It can be used for effective products modelling which have got complicated shapes made of plastics, e.g. devices bodies, cell phones [Lombard, 2011a].

Fig. 4. Master Model workflow (Castle, 2012)

3. Effective modelling of large assemblies

Final product is composed of many components like parts or subassemblies, as an effect of combination of many geometric elements. Therefore, in design of 3D CAD model associativity should be considered. Associative model is characterized by considered collection of linked elements which make consistent assembly [DS SolidWorks, 2011].

In difficult projects, designer must often operate on assemblies consisting of many components. It requires larger amount of data which must be loaded and converted during work, what leads to increase of using computer memory resources. Geometric complexity of components and computer hardware (processor, video card, RAM memory) determine when the assembly is treated as a large. Decrease of efficiency during dynamic view operations (rotate, pan, zoom) is a symptom of problems with large assemblies. in addition to the hardware platform parameters, display state of components, methodology of assembly designing, mates have significant influence on work efficiency. Assembly structure can be represented as a block diagram form using special tools, e.g. TreeHouse with SolidWorks software (Fig. 5).

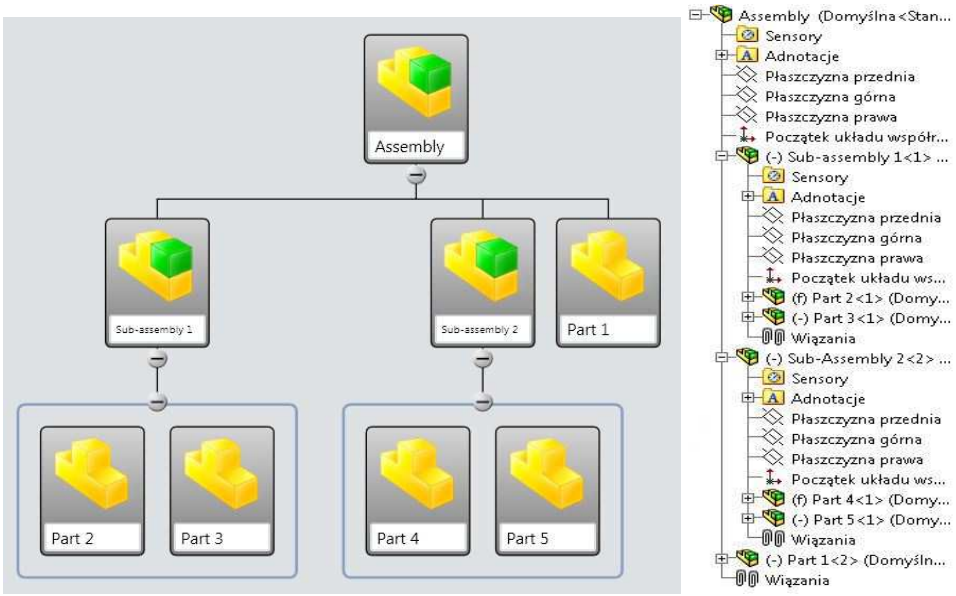

Fig. 5. Assembly structure and assembly design tree

3.1. Using special techniques to improve large assembly design

Large and complex assemblies can cause long rebuild time of model and reduce efficiency of designer work. It is important to use some techniques to improve the performance when working with large assemblies [Lombard, 2011b]:

- working locally,
- organizing data into subassemblies,
- avoiding in-context references,
- avoid fancy display settings (transparent parts, edges in shaded mode),
- repairing errors,
- avoiding unnecessarily complex geometry,
- using special tools to improve large assembly performance
- using simplified configurations and SpeedPak,
- using display states instead of configurations,
- lightweight options,
- using Large Assembly Mode,
- detached drawings,
- suspending automatic rebuilds.

3.2. Components suppression state

In order to improve work efficiency with large assembly, it is possible to determine a suppression state of components. As a result, efficiency of the use of computer memory increases. Reducing amount of loaded and calculated data reduces the time of rebuilding and assemblies viewing. Assembly components can be loaded in three states: in full memory, suppressed, lightweight. A detailed comparison of suppression states is shown in Table 1.

Table 1. Characteristic of suppression states (www.help.solidworks.com)

	Resolved	Lightweight	Suppressed	Hidden
Loaded in memory	✓	*Partially*	✗	✓
Visible	✓	✓	✗	✗
Available Features	✓	✗	✗	✗
Acces for adding mates	✓	✓	✗	✗
Editing in-context	✓	✓	✗	✗
Load and rebuild speed	*Normal*	*Faster*	*Faster*	*Normal*
Display speed	*Normal*	*Normal*	*Faster*	*Faster*

4. Configurations and display states

Configurations and display states are very helpful with design of new product. Thanks to them it is possible to make several versions of product or control assembly transparency. Effective use of these tools allows to adapt product to customers' requirements and compare the different designs without the rebuild of the model. Display states makes model easy to work with and gives an opportunity to show important components in right way. Configurations and display states are very powerful tools which control how your SolidWorks assemblies look [Lombard, 2011b]. It is important to understand the differences of what you can control with each of them (see Table 2).

Table 2. Configurations and Display States [Cote, 2011]

Configurations	Display States
✓ slow switching	✓ fast switching
✓ require rebuilds	✓ do not requite rebuilds
✓ different part size, position, components	✓ change appearance (color, transparency, texture)
✓ simplified configurations	✓ show or hide components
✓ create design variations	

Configurations are a convenient way to design a 3D model. Thanks to them parts or assemblies are designed using different dimensions, parameters or combination of elements. Every configurations is a different version of component. Different sizes, materials and localization of parts can be included during designing. Design tables are very interesting option to build trade parts in different sizes. Design tables allow to control various part versions based on the data entered into the Excel. The possibility to use configuration with simplified assembly is very useful during the work with large assembly. It allows to economize memory of computer system [DS SolidWorks, 2011].

Configurations and display states make a great convenience in designing of parametric 3D model. Possibility to show different design solutions allow to compare them and choose the best idea. Simplified configurations increase design efficiency with large assembly. Display states provide a convenient possibility of controlling the way in which elements of the model are visible. Skilful use of these tools significantly facilitates engineering work and improves efficiency of design.

5. Conclusions

Efficiency increase in new product design is connected with creation of correct, editable 3D CAD model. The quality of design process reflects the subsequent

success on the market. Parametric CAD systems have to deal with changing market and client requirements in much shorter time. They offer for users different tools. Proper use of these tools provide increasing efficiency of design process. The time investment in understanding design intent and encoding that intent into an analytically driven CAD model ultimately saves time, improves efficiency, and gives more control to the user [Diamond, 2010].

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