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SOLIDWORKS MODULE FOR DFA ANALYSES USING BASICMOST SEQUENCE MODELS

ZINTEGORWANY Z SOLIDWORKS MODUŁ DO ANALIZY DFA WYKORZYSTJĄCY MODELE SEKWENCYJNE BASICMOST

Abstract

The publication describes the program to Design for Assembly (DFA) analysis, integrated with SolidWorks, called *DFAWorks*. The add-in module implements DFA methodology. *DFAWorks* combines practical iterative functionality with accuracy and ease-of-use. Fully embedded into of the SolidWorks, application is perfect for the designers, who would like to use assembly analysis ability. The module permits designers to easily gain insight into the cost-effective assembly of their designs. *DFAWorks* allows creating assembly process, detecting essential parts of analyzed product, calculating total defined assembly process time and counting DFA index based on BasicMOST sequence models.

Keywords: Design for Assembly (DFA), MOST, BasicMOST, CAD

Streszczenie

W referacie przedstawiono program do analizy technologiczności konstrukcji ze względu na montaż – *DFAWorks*, zintegrowany ze środowiskiem CAD SolidWorks. Stworzony moduł umożliwia ocenę jakościową wyrobu, w aktualnej postaci konstrukcyjnej bezpośrednio w SolidWorks. Pozwala zbudować proces technologiczny montażu, zidentyfikować zbędne części złożenia, przeliczyć czas montażu wyrobu oraz współczynnik efektywności DFA. *DFAWorks* bazuje na metodzie BasicMOST, dzięki której możliwe jest szacowanie czasu montażu.

Słowa kluczowe: Technologiczność konstrukcji ze względu na montaż (DFA), MOST, BasicMOST, CAD

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1. Introduction

Currently, the 70% of all product costs are determined at the design stage and much of this costs are incurred during assembly. Therefore the designer needs to take under consideration assembly while developing product design in order to mitigate subsequent problems. It is often applied once a complete product description is available and the potential benefits of early analysis are not realized. Designers would prefer to have such evaluations at a point when they have the most opportunity to act on the results.

Today's marketplace demands from engineers to work within extremely tight constraints and the mismatch between design, manufacture and assembly which causes rework and redesign only adds to this burden. There is the DFA - methodology which assist the designer to above mentioned issues. DFA evaluates and helps to create the most efficient design, from an assembly point of view and reduce manufacturing problems.

To increase design effectiveness and its quality, companies decide to implement DFA method into development process for the key products. It is obvious that additional effort required for DFA analyze should be minimized as well as additional tool supporting the decision making process regarding costs comparison to designed components assembly for different considered concepts should be provided [1].

The most effective program for this purpose is licensed by Boothroyd Dewhurst's DFA Software. However, due to high price, it is often unavailable for small and even medium-sized businesses. It can be observed attempting to create own applications using publicly available tools. Unfortunately, created applications have defects. Such programs can be used only for manual assembly, for product assembled on a single table, because of the algorithms, which calculate the assembly time based on time-data, shared by the DFA developers. Above mentioned problem can be solved by normalization of working time using elementary norm method by which we can precisely define the assembly time on the basis of sequences of employee movements by means of the BasicMOST system. It is possible to automatically generate the BasicMOST sequence based on finished DFA analysis from the assembly scope. The idea of integration of the DFA with the MOST method was described in [2].

Basing on this idea, an integrated with a CAD environment module called *DFAWorks* was created (Fig. 1). This is solution which uses the DFA methodology. Designer using two applications in one may spend extra time during design processes and save time when prototyping takes place.

1.1. Motives and background

The integration of product and process design through improved business practices, management philosophies and technology tools will result in:

– a more reliable product with higher quality,
– a better fulfilling customer expectations,
– a quicker and smoother transition to manufacturing,
– a lower total program/life cycle cost.

Such an enrichment of a drawing tool has many other benefits:

– assembly time calculation and DFA analysis is done faster and more automatically – integrated module with SolidWorks reduces workloads to minimum,

– support designer to imagine/understand the future assembly problems and support decision making process,
– facilitates concurrent design of product and assembly process,
– design can be tracked / measured,
– easier implementation of DFA knowledge in practice – designer's effort is more effective, they are more convinced to use DFA methods,
– subjectivism and errors of data import will be reduced.

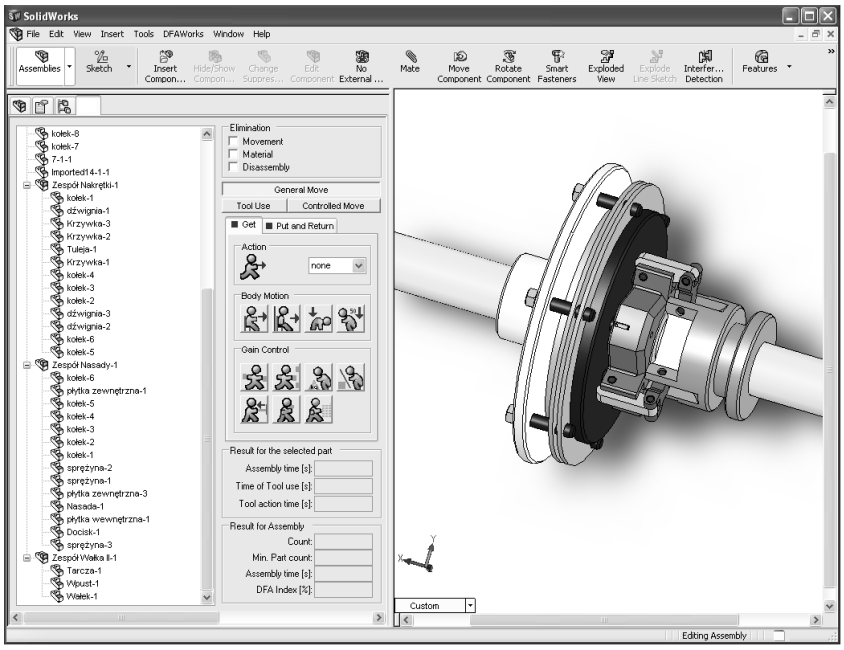

Fig. 1. SolidWorks integrated DFA module

Rys. 1. Zintegrowany z SolidWorks moduł do analizy technologiczności konstrukcji ze względu na montaż

1.2. Main technical requirements

To prepare the module for SolidWorks, except the specific user interfaces that should be created, the components specified below were used:
– SolidWorks 2006,
– Microsoft Visual Studio .NET 2003,
– SolidWorks SDK – SolidWorks API.

SolidWorks can be easily adapted for this purpose because it gives programming facility by API (Application Programming Interface). It is possible to design custom applications to increase workflow and reduce common SolidWorks tasks and enhance SolidWorks tools to better suit specific needs.

The integration of specialized numerical routines into CAD software uses the Software Development Kit (SDK) provided with the software. The SolidWorks SDK contains all of

the functionalities needed to develop SolidWorks API applications. Wizards for creating SolidWorks add-ins are also included [3]. Without the SDK we won't have access to the code that allows the connection between the add-in and the host. For our implementation the synthesis algorithm is written in Visual Basic, using the Windows Application (COM) template from Microsoft's Visual Studio.NET 2003 [3].

Thanks to the SolidWorks API we can automate and customize the SolidWorks software. The API contains hundreds of functions that can be evoked from Visual Basic. NET. These functions provide direct access to SolidWorks functionalities such as creating a line, inserting an existing part into a part document, or verifying the parameters of a surface. Every object is available in the SolidWorks API, including its associated properties and methods [3, 4]. The SolidWorks API software must be installed so that the Type Libraries would be registered in the Windows Registry. This enables the programming software (Visual Studio.NET) to present a programmer with a list of type libraries on the current computer.

2. *DFAWorks* – how to use

Created module is an add-in application that allows SolidWorks software users to execute DFA analysis and calculate assembly time, combines practical iterative functionality with accuracy and ease-of-use. Moreover, *DFAWorks* allows creating assembly process, detecting of essential parts being within analyzed product, calculating total defined assembly process time and counting DFA index based on BasicMOST sequence models.

DFA analysis with the use of *DFAWorks* is very simple. First, the assembly process should be defined. The SolidWorks assembly model is not the same as the sequence of assembly process, so the user should define the assembly sequence supplemented by the assembly operation. Then, for each part the assembly conditions should be set. The way how the assembly process is realized depends on components design and interfaces between parts. Therefore, by analyzing the construction characteristics of particular component related to the assembly process type, handling and insertion of parts or modularization and needed adjustments it is possible to gather some inputs for assembly time reduction. To quantify the feasibility of design to assembly process all parts can be evaluated.

DFAWorks can also generate reports, when DFA analysis is completed. For example *Summary Report* summarizes assembly time, assembly ability estimation data, total time per part and other data in the Microsoft Word document.

2.1. *DFAWorks* interface

DFAWorks gives to the users following elements of interface, including Main Menu, Properties Main Windows, Context Menu, Assembly Tree, Elimination Area and DFA Tabs (Fig. 2).

Main Menu provides convenient access to tools and commands e.g. creates new DFA project, loads existing project, saves opened project, saves opened project as new file, loads database and opens DFA for SolidWorks help.

Properties Main Window allows user to create assembly process, execute DFA analysis, detect of essential parts being within analyzed product, calculate total defined assembly process time and count DFA index based on BasicMOST sequence models.

Assembly Tree presents assembly process for DFA analysis, created by user. **Context Menu** provides convenient help to create assembly process.

In **Elimination Area**, the user has to answer three DFA fundamentals questions for each defined Part:

– if there is a movement between interfaced parts, then it is likely that those parts must be separate,
– if interfaced parts must offer totally different material properties, then they have to be made of different materials and should be separate,
– if analyzed part must be a commercial/standard part or serviceable in future or without disassembling this part the other interfaced essential component can not be mounted or dismounted, then part must be capable to be disassembled.

After completing **Elimination Area** for each part, assembly processes have to be evaluated. DFA analysis requires inputting data for each component and sub-assemblies as well as assembly technology such as for example component dimensions, part functionality, part access and orientation ability, handling and inserting difficulties etc. Assembly time for every part in product relies on setting of **DFA Tabs**.

Result for the Selected Part Area gives to the user information about the most important results of DFA calculation for selected Part and **Data for Assembly Area** gives to the user information about results of calculation for analyzed assembly.

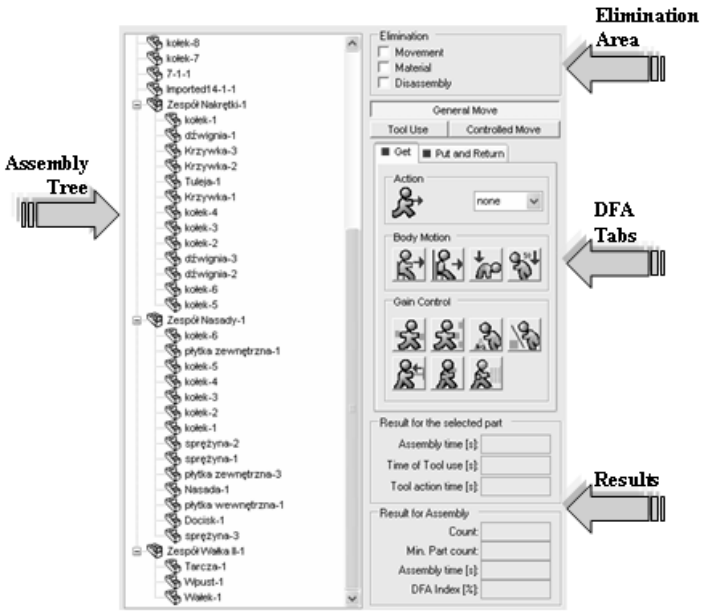

Fig. 2. Main window of the DFAWorks module

Rys. 2. Główne okno modułu DFAWorks

3. Conclusions

In order to make the designers work more efficient and where assembly aspects can be considered, DFA module integrated with a CAD environment was created. This allows the designers to use one software package only instead of two or more. The whole drawing work, assembly analyses can be hold inside CAD platform what is in line with modern style of product development.

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