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Einvironment friendly DFMA/QFD/FMEA laboratory on the University of Pannonia

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Abstract

DFMA (Design for Manufacture and Assembly) software gives a modern design tool for the product development. The DFE (Design for Environment) module also known as eco-design one considers the environmental aspects. At the University of Pannonia a modern laboratory has been established, where the engineering process from the 3D-design to the rapid proto-typing is realisable. We show the applying of DFMA to examination of the door-lock of the MTZ tractor.

1. INTRODUCTION

DFMA is designed to give engineers a structured way to evaluate ease assembly and the overall manufacturability of a product. Design for assembly requires the user to assess whether each is necessary, and to consider the time and cost of assembling the product. Design for manufacture integrates information about manufacturing processes allowing users to estimate manufacturing costs and make informed decisions about materials. Because this approach requires engineers to step back and think about the basic design concept solution, it tends to encourage focused brainstorming and collaboration among project teams and with suppliers. DFMA analysis has the potential to reduce manufacturing and other product life-cycle costs before they are locked in.

2. DFMA/QFD/FMEA LABORATORY

The alone application of CAD systems is not result automatically in competitive product. Obtaining of this target has got to apply usually methods of optimisation or analysis of DFM [1]. The DFMA tool is stand of the next software packages: DFM (Design for Manufacture), DFA (Design for Assembly), DFS (Design for Service), DFE (design for Environment. The application of this software packages make the reduction of costs, the increase of the quality of products, the fulfilment of requirement of ecological possible.

QFD (Quality Function Deployment) is widely-used tool in booth quality management and quality engineering. QFD helps to translate costumer needs and requirements into product and process design characteristics so that they can be best designed to improve costumer satisfaction. QFD was on of the driving forces that led to adoption of other Total Quality Management methods, ISO 9000, QS 9000.

FMEA (Failure Mode and Effects Analysis is a systematic analysis of potential failure modes aimed at preventing failures. FMEA is used to identify potential failure modes, determine their effect on the operation of the product, and identify actions to mitigate the failures. Constructions designed with CAD systems can be examined in the design phase prior to their physical existence. In this way the production of the prototype can be spared and the development time of the construction can be reduced.

In the DFMA laboratory there is a rapid prototyping equipment. With the rapid prototyping can automatically construct physical models from Computer-Aided Design (CAD) data. Our 3D printer build accurate models layer by layer using durable ABS plastic. Figure 1 shows the development process of the construction.

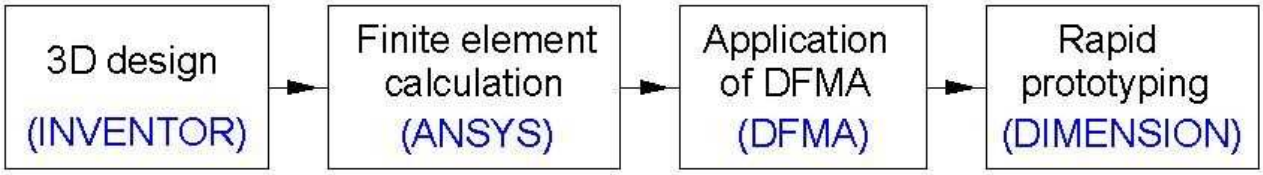

Fig. 1
The development process of the construction

Figure 1 shows the DFMA laboratory

Fig. 2
DFMA Laboratory

3. DFA ANALYSIS OF THE DOOR LOCK OF MTZ TRACTORS

The DFMA analysis allows the estimation of the assembly and manufacture regarding the costs of booth existing products and conceptions.
Figure 3 shows the flowchart of a DFMA Analysis from conception to prototype.

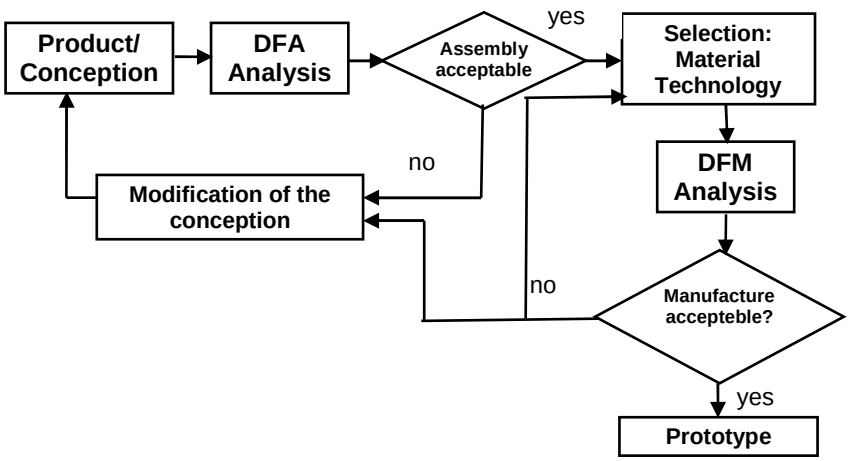

Figure 3.
Flowchart of a DFMA Analysis

In the following example is the DFA Analysis of a tractor door lock, applied the DFMA Software of Boothroyd Dewhurst Inc., presented.

The first step of the analysis is the build of the structure chart applied parts and subassemblies. Farther library operations and elements (for example screws) can be applied to build the product structure. The building-up can be performed in assembly or disassembly order.
Figure 4 shows the structure, the 3D-Model and the basic product information for the DFA Analysis.
After the building up of the product structure according to the assembly operations comes the answering of the basic DFA questions. The minimum part criteria, the securing method, the envelop dimensions and symmetry of the part as well as the handling and insertion difficulties should be given for each part or subassembly of the product (Fig. 5.).

The total assembly time, the efficiency of the assembly (DFA index) and the total labor cost are calculated by the software according to the answered questions. Beside these results are suggestions for redesign given by the software.

Because of the efficiency of the assembly is mostly influenced by the count of parts, their combination to a complex part and elimination of unnecessary parts cause a better concept.
After the modification of the conception should be again a DFA Analysis carried out, to compare the expected assembly costs.

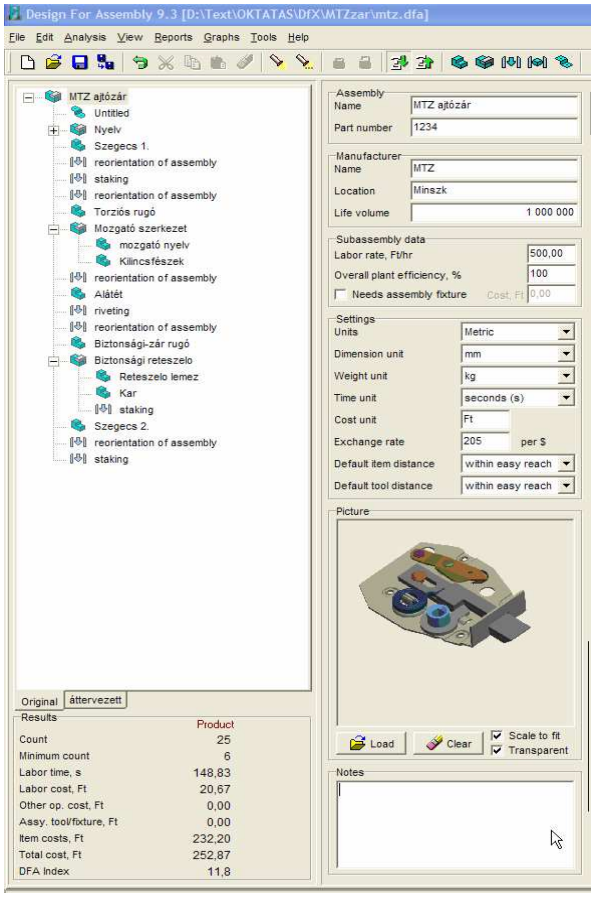

Figure 4.
Analysis of a tractor door lock applied the DFMA Software

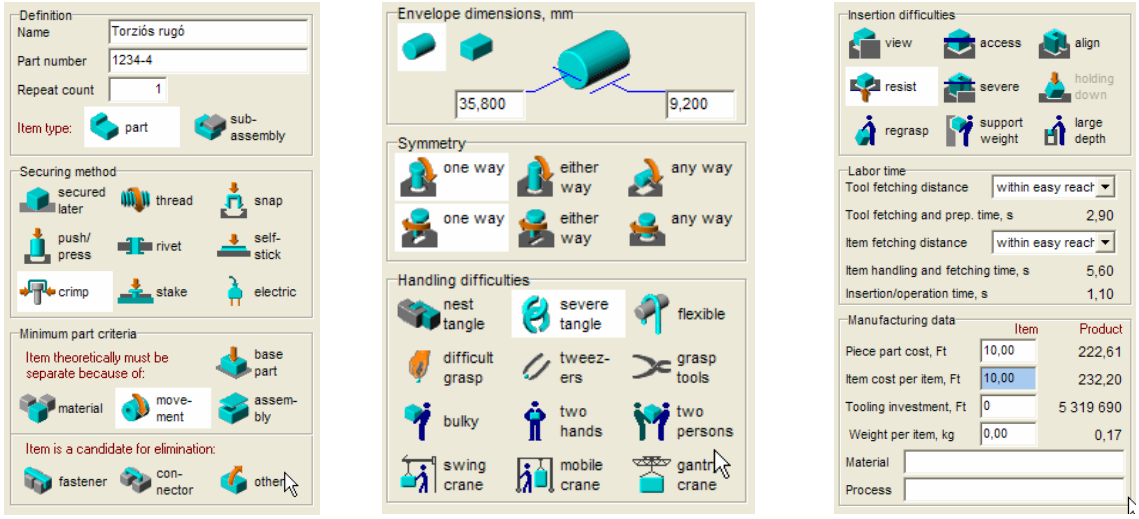

Figure 5.
Answering of the DFA questions

Figure 6 shows the comparison of the assembly costs of the original and the redesigned door lock. After the redesign was the count of parts from 25 to 20 reduced and a cost reduction by 27 HUF/piece achieved. Necessarily not only the reduction of the part count

but also the optimisation of assembly conditions and the change of the securing method are able to reduce the cost.

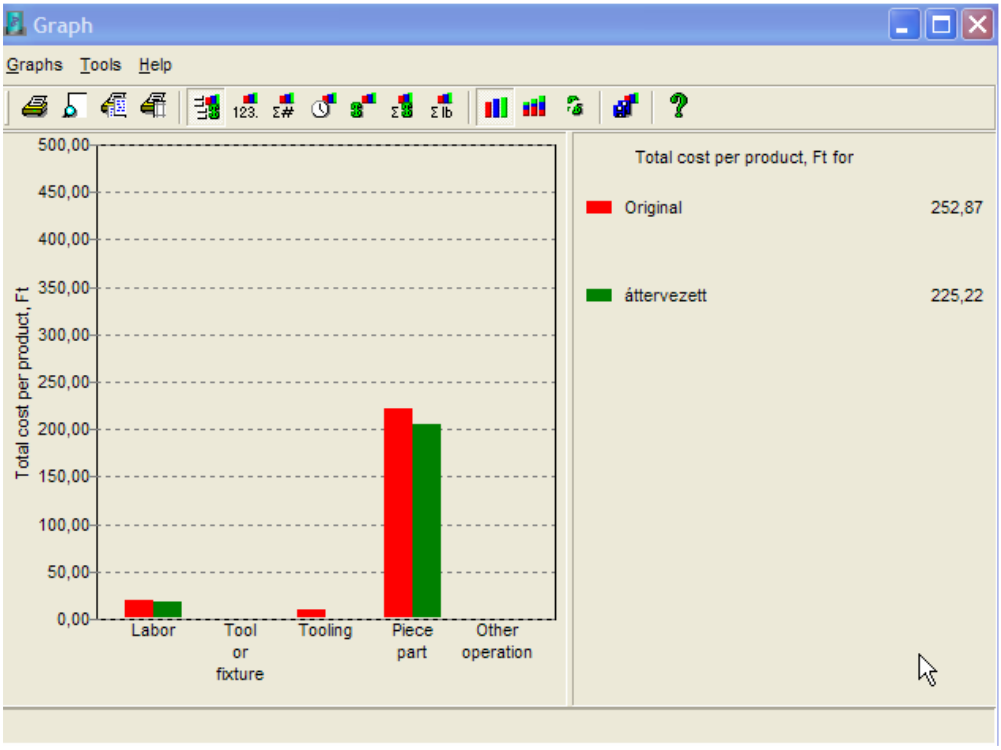

Figure 6.
Comparison of the assembly costs

4. SUMMARY

The engineers's main task is to apply his scientific knowledge to the solution of technical problems and then to optimise that solution within the given material, technological and economic constraints. To this task the designer makes a highly important contribution, his ideas, knowledge and abilities have a fundamental effect on the nature of manufactured products, their customer appeal and their overall profitability [2].

It is now well recognized that more then 70% of all manufacturing costs are "committed" at the early stages of the product development cycle (VDI Guideline 2235). It is no wonder that today the design phase is seen as a window of opportunity for cost reduction and productivity improvement strategies.

With DFMA, engineers can quantify manufacturing and assembly costs in the development process to improve assembly efficiency, reduce part count, cut costs and benchmark competitive designs.

The application of DFMA has led to quantum leaps in productivity that are typically reflected in savings such as:

program timing reductions of > 50 %,

assembly time reductions of > 63 %,
assembly defects reduced by >68 %,
separate parts reduced by > 50 %.

Figure 1 shows the shortened design process.

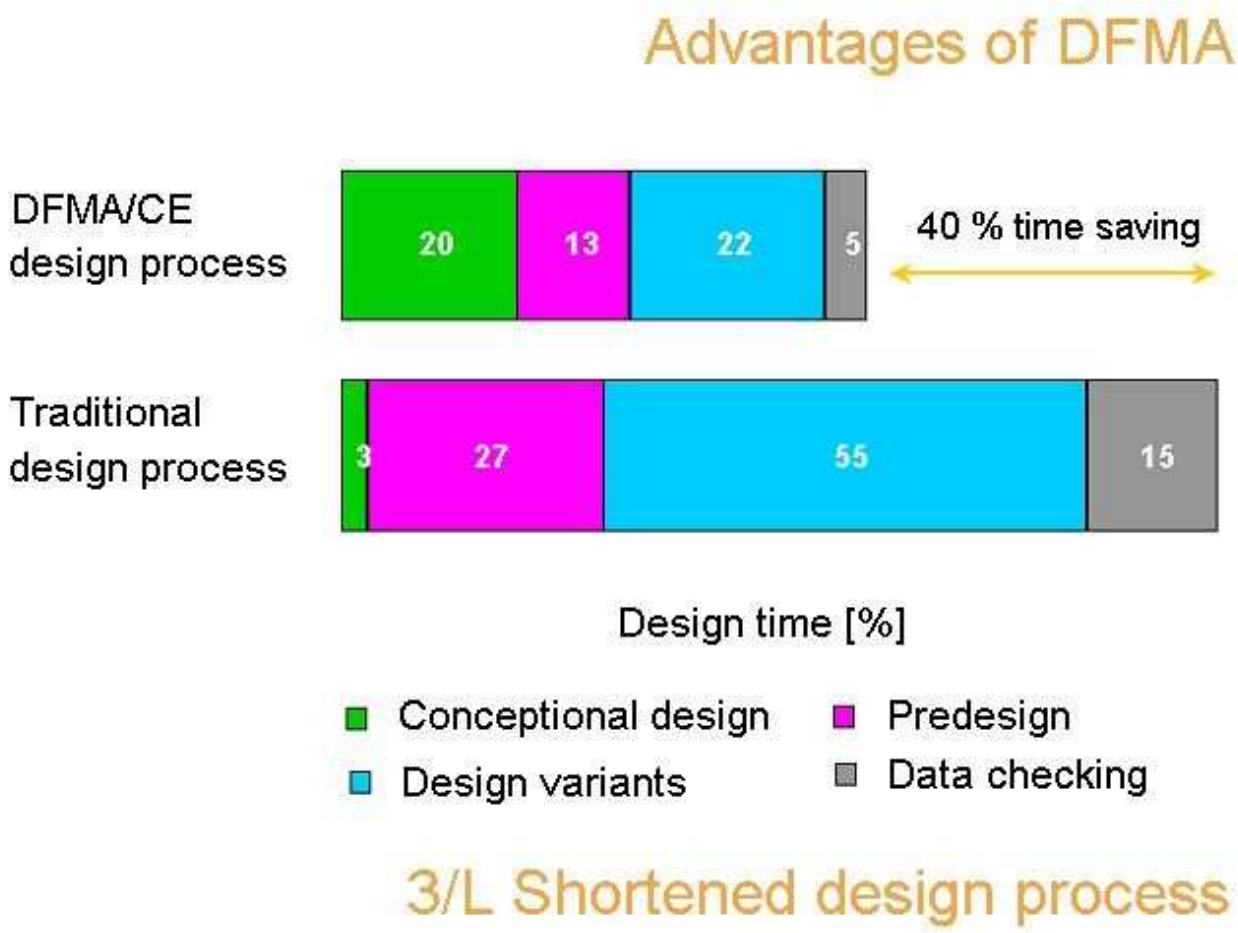

Fig. 7
Shortened design process

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Literature

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[2] Pahl G., Beitz W.: Engineering Design. The Design Council, London, 1988.