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Faculty of Mechanical Engineering

THE INTERNATIONAL CONFERENCE

Mechanical Engineering in XXI Century

PROCEEDINGS

Niš, Serbia, 25 - 26 November 2010.

UNIVERSITY OF NIŠ
FACULTY OF MECHANICAL ENGINEERING

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Machine constructions, development and engineering

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AUTOMATISATION OF BELTED POWER TRANSMISSION'S DESIGN PROCESS

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Abstract: *Paper present applicative software for belt transmissions design, developed in Visual Basic 6 application. This is software module within software system for power transmission design PTD, developed at University Nis - Faculty of Mechanical Engineering. Applicative software is dynamically connected with CAD software Solid Works and generates 3D models of drive and driven belt.*

Key words*: product development, belt transmissions design, applicative software, CAD*

1. INTRODUCTION

Product development is:
- a process consisting of a sequence of steps or activities that a company uses to conceive, design, develop and commercialize a product,
- a part of the product life cycle,
- an organizational unit within a company.

Product development includes all activities from an initial idea for a product through to the market launch of a product. Main phases of product development are:
- conceptual design, system-level design, detail design, testing and refinement and production.
- Virtual product development enables high speed innovations and manufacturing, high quality products and economic production.

Software applications for virtual product development should to enable and ease:
- Static and dynamic calculations,
- Element modeling, including complex shapes and three dimensional (3D) curves or faces,
- Elements assembling into precisely defined relations and shapes,
- Application of standard elements, generated from adequate databases or part libraries (springs, bolts, bearings etc.),
- Automatic development of technical documentation as product of modeling and assembling,
- Automatic creation part lists,
- Simulation of movements and monitoring in working condition,
- CNC code generation, in order to automate manufacturing process,
- Sheet metal design support, mold base, for metals and plastics etc.,
- IGES i STEP database generation and usage in other CAD and CAM systems,
- Constructive optimization,
- Mechanism analysis,
- Analysis of experimental data derived from prototype testing,
- Marketing support – easy presentation making, realistic rendering, animation.

Application of computers in product shaping process includes Computer Aided (CA) technologies – Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE).

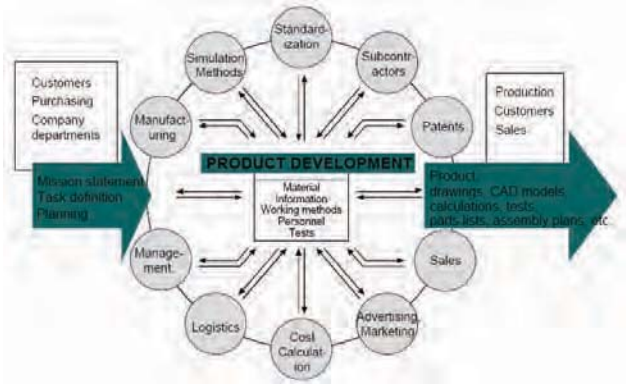

Fig. 1. Flow of Information in Product Development

Corporation's concurrence and quick accommodation to market requests require software for calculations of mechanical parts and tools which will enable easy 3D modeling and other automatisation (CAD, CAD/CAM or CAD/CAM/CAE tools).

Faculty of Mechanical Engineering Nis is working long time period on development of integrated computer program for complete design of power transmission – **P**ower **T**ransmitter **D**esign (PTD) Software. Architecture of integrated system for Power Transmission Design (PTD) is shown in Figure 2. Integrated program system PTD, has three main parts:
1. Program modules for power transmission element's calculation,
2. Program modules for calculation of rotation elements,
3. Program modules for calculations of mechanical connections.

User interface of the PTD software is shown in Figure 3.

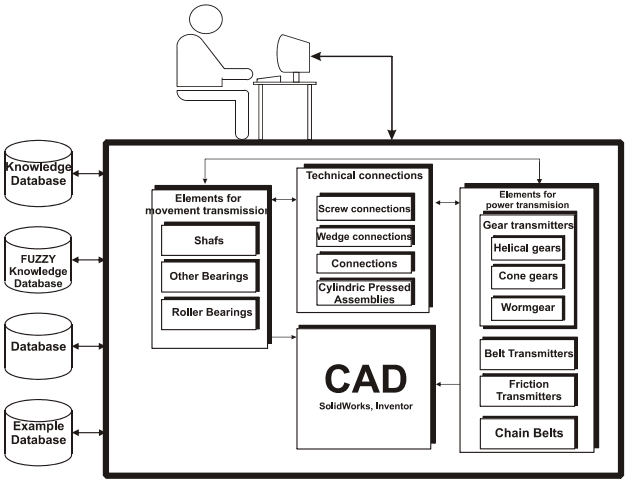

Fig. 2. Architecture of integrated system for power transmission's design PTD [1,3,4,8,9]

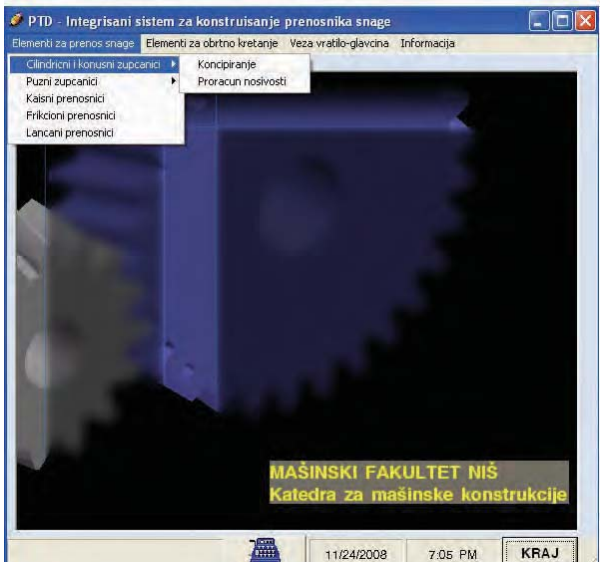

Fig. 3 User interface of the PTD software

Integral part of program module of Elements for power transmission, is software for calculation and design of power transmission belt. Software is capable to automate design process of power transmission belt. There is dynamical connection between this software and CAD (Solid Works).

2. PROGRAM MODULE FOR CALCULATION AND SHAPING OF BELT POWER TRANSMISSIONS

Program module for calculation and shaping of belt power transmissions is a redesign and a step forward in direction of automatisation. It has all the properties of the modern, professional calculation software.

Basic elements of every belt transmission are pulleys and belt. Belt is linking pulleys into one assembly. Basic types of belt transmissions are flat belt transmissions, wee belt transmissions and geared (timing) belt transmission.

This program module includes calculation of flat belt transmissions. The most often used materials for belts are: leader, plastics, polyvinyl, cloth or composite materials. This is one of necessary information for calculation. Other important and necessary information are nominal power of transmission, transmission ratio, input or output shaft number of rounds per minute, axle distance, working conditions, type of drive machine, working time rate, and construction of the transmission (Fig. 4)

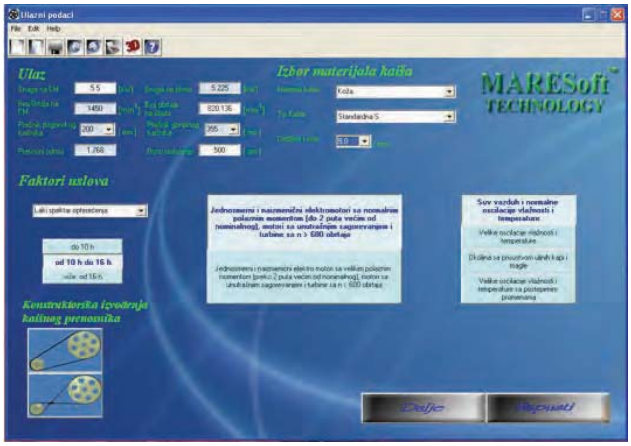

Fig. 4 Data input mask of the program module

As preliminary results, program module gives values of reaction forces in the belt, pre tightening forces in the belt, shaft loads, stress of the belt, frequency of belt's bending, length, width and height of the belt. Geometry of the drive and driven pulleys are given as well (Fig. 5 and Fig. 6)

Fig. 5 Results of the power belt transmission calculation

As a final result, this program module gives generated 3D models of pulleys – drive and driven (Fig. 6)

Fig 6. User interface for selection and generation of 3D model

3. BELT POWER TRANSMISSION SHAPING

Generally speaking, shaping of parts and assemblies is very important phase of the design process. Theory of shaping is scientific discipline whose object of research is procedure and methodology of parts, assemblies or machines shaping.

Modeling of the mechanical part is final phase of the shaping process. Geometrical modeling means: to create virtual 3D model in some Computer Aided Design Software.

The term **parametric modeling** denotes the use of parameters to control the dimensions and shape of CAD models. Think of a rubber CAD model that can be stretched and deformed through various controls, but cannot be ripped or torn. The manipulation of a CAD model of a single part could be through overall part dimensions or through the dimensions of features. Things get considerably more interesting if a parameterized assembly model is constructed. Changes in assembly dimensions or in part dimensions can cause changes in assembly and part shapes or in parts' assembled positions. Generally, it can be very useful to explore design spaces by manipulating parametric CAD models - creating multiple instantiations of a design and analyzing their properties.

There are two broad approaches parametric modeling:

- variational geometry
- parametric geometry

Sorry for the dual usage of **parametric**, but the terminology in this field resulted from an *ad hoc* process.

In general, the term parametric geometry refers to a 1-way evaluation of parametric relationships, much like a spreadsheet. On the other hand, the relationships in variational geometry models can be bi-directional. Variational geometry solvers are typically nonlinear, simultaneous equation solvers. The underlying mathematics suggests that variational geometry is more general and powerful, but in practice it is the command set in CAD systems that really controls modeling generality and power.

CAD system Solid Works has been used for development of 3D models.

Program module does not generate 3D model automatically. User has to decide either he needs model or not. For complete definition of pulleys (driven and drive) it is necessary to input data about shaft diameter, dimensions of the pulley hub (diameter, length, width), about body of the pulley (number of holes for mass reduction, diameter of pulleys etc. Software suggest initial values of pulleys (hub diameter d_G and hub width l_G), but, software user can change these values by himself (Fig. 7).

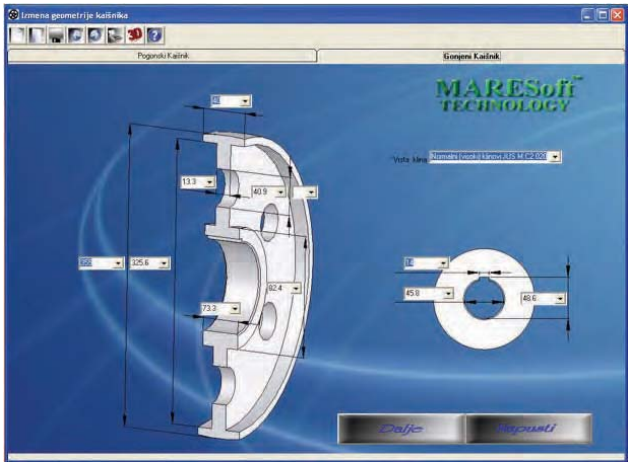

Fig. 7 User interface where diameters of pulley can be defined

Connection between program for calculation of belt power transmissions and Cad is possible to be achieved as:

- Connection over Microsoft Excel tables. Excel is used as database where parameters involved in calculations are inputted. Previously modeled pulley, called primary model, uses these parameters and after successful calculation updates itself according to the parameters from the Excel table. Values from Excel confine model and user gets model he calculated.[6], [8], [9] i [10]. Command Rebuild is activated automatically.
- Another approach uses primary model, as well, but directly copies data from system files of the CAD (Solid Works) called dll files (Fig. 8).

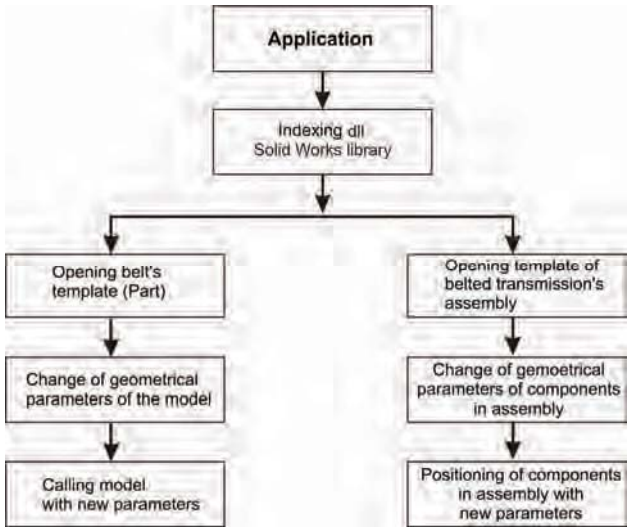

Fig. 8 Dynamical connection between program for belt's calculation – PTD module and Solid Works (CAD)

Software gives CAD 3D models of drive pulley, driven pulley and assembly of pulleys with belt (Fig. 9).

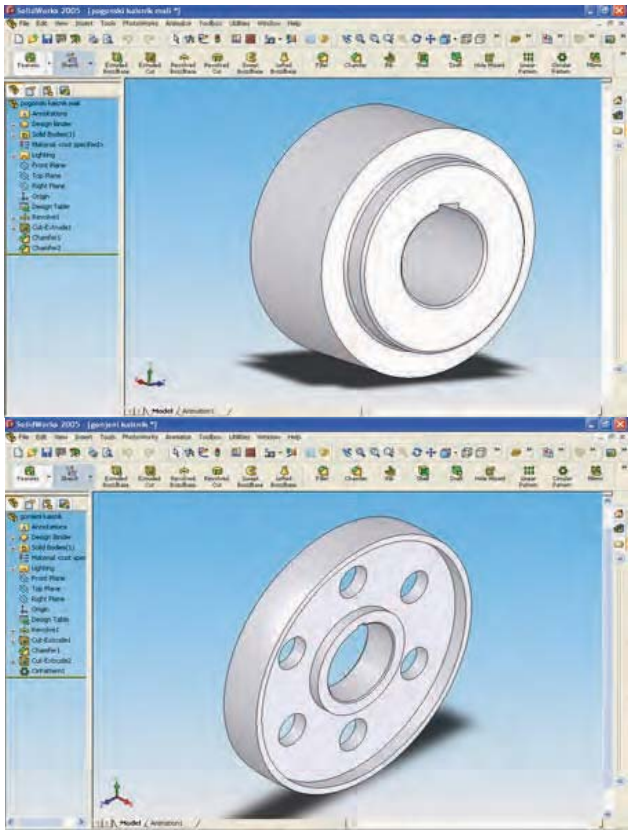

Fig. 10 3D model of driven pulley generated in Solid Works

4. CONCLUSIONS

Based of the previously mentioned it can be concluded:

1. Product development is a process that includes all activities from an initial idea for a product through to the market launch of a product.
2. Computer hardware, high-speed communications and software all play a major role in current product development processes.
3. Their recent use to support product development can be linked to benefits including reducing time-to-market and cost, improving quality and supporting globally distributed development processes.
4. Computer aided product development is more than geometric modeling alone, although it plays a fundamental role, and more than a single tool.
5. Integrated approaches to CAx tools and their use are needed to support product development, the unique requirements of the various stages and the total system including industrial design, technical design and manufacturing.
6. Integrated program module called PTD is developed on Faculty of Mechanical Engineering in Nis. It can be used for various design problems,
7. Some program modules of PTD are dynamically connected with the CAD systems such Solid Works and Autodesk Inventor are. This connection automates design process and shortens the design time.

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