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ANALYSIS OF THE TECHNOLOGICAL PROCESS OF MOUNTING THE SUBASSEMBLY OF THE HYDRAULIC POWER STEERING

Vladan OBUCINA[1)], Jelena ERIC OBUCINA[2)]

[1)] Army of Serbia, Kraljevo, SERBIA
[2)] College of Applied Engineering, Trstenik, SERBIA

obucina_vladan@yahoo.com, jecaeric79@yahoo.com

ABSTRACT

Engineering design is supported by EdgeCAM computer software package used in the analysis of the technological processes of power steering mounting structure. The power steering, which is analyzed in this paper, belongs to the hydraulic power steering with balls. Creating a treatment process is based on models where the product models can be imported from another software package or developing our own modules for the design process. This paper will demonstrate the application software package that allows the analysis of the components in terms of a hierarchical assembly of the complex structures.

Keywords: power steering, technological processing, modelling

1. INTRODUCTION

Despite the enormous progress in the field of the engineering design on the basis of the numerical control, the manual programming of CNC machines is often slow, inefficient and sometimes inaccurate. This is particularly true with the spatial processing of the complex parts and the surface treatment. The use of any supported computer systems design technology for programming the CNC machines, significantly reduces the time of the main processing, eliminating the risk of the program errors and improves the overall productivity.

Shortening the time of the target related to the birth of a new variant or product is necessary in order to achieve faster and better meet the great variety and the demand coming from the market.

The time required for the engineering activities within the product design and technology, the longest process of creating a variant or a completely new product can greatly be reduced by introducing advanced information systems and technologies. The most important element in the information technology is the modeling, which generates a structure that contains information on the product and the technology used in creating and exploiting the product. A very sharp line divides the product design, the manufacturing technology, the assembly and the controls that could disappear with the implementation of

CA tools, thus, providing a strong support for the engineers during the design. It can be argued that CA basically design engineering design tools.

In addition to the general definition of design, it can be set the definitions of different types of design in the engineering cycle. The design consists of four main aspects to each cycle stage: the specification of the functional requirements, the conceptual design, the preliminary phase and then the detailed design. Each of these steps is explained considering the detailed design of the adopted definitions.

The functional requirements are specified based on the customers'requirements. The engineer establishes a list of demands relating to the product or the system design.

The conceptual design appears as a second stage in the design process and sets the highest demands on the organizational designer. The conceptual design process is structured on logical considerations, for which matter the techniques of engineering, the architectural skills and the business experience for the work. These techniques allow for the application of scientific and mathematical principles that provide a practical construction and the operational results. The conceptual design results in a limited range of possible solutions from all the possibilities related to the function and the form of the final product. Thus, the conceptual design deals with the generation and the specification of the objectives and possible solutions that could eventually meet the desired intent. This designing phase requires an intensive evaluation of the generation that has limited the overall heuristic concepts.

The preliminary design phase is directed toward the use of the engineering techniques, the aesthetic abilities and the expert opinion are refined and the possible solutions obtained from the conceptual design phase are evaluated. During this phase of review and comment, the "best" of the design solutions that meets the given restrictive specifications t is used. It follows that the preliminary design phase is an intensive evaluation as compared to the previous generation of intent.

The fourth element of the design, the detail design, begins after the preliminary design and leads to the construction and the manufacturing of the product. All the details of the designed products are determined, as well as the instructions for its preparation and use. The analysis and the optimization techniques are often used to improve the design of those segments, which can be quantified.

The preliminary design phase is one of the first done by computer. The algorithmic numerically intensive programs for the analysis were developed to assist in this assessment. The need for linear programming and the optimization became apparent when trying to choose the optimal combination of many parameters in the design.

The conceptual phase recently attracted an increasing attention for automating the design process, primarily through the application of CA tools. This phase is focused on the qualitative and subjective aspects of design as compared to the more powerful (at least according to current knowledge) quantitative aspects of the design, using the artificial intelligence to computerize the subjective information. The first programs in design as those applied in the conceptual phase have been of help in developing the alternative solutions to the common situations or in the routine design. Now researchers are trying to enable the automation, to make available the architectural "creativity" or the ability to assist in unusual situations.

2. COMPUTER AIDED DESIGN TECHNOLOGY – CAM

As for the preliminary and detailed design phases, it is easier to explain the scientific disciplines that are used in these phases of the design process. Because of the interaction of other various phases of the design and the applied scientific disciplines, it is difficult to precisely define the conceptual design process. Here, the fundamental science is largely

Mechanical Testing and Diagnosis, ISSN 2247 – 9635, 2012 (II), Volume 4, 43-50

represented. The real way to find a solution, when it comes to the conceptual design, is based on the dominant presence of skills and scientific approach of the design.

The computer aided design system technology CAM generates a NC code based on the projected product model, which is a carrier of geometric information products. The product model can be found in the system, i.e., the module of its product design, or can be imported from a computer-supported systems for product design – CAD system. No matter which method is used, the CAM system provides two-dimensional or three-dimensional views of the product model in order to generate the NC code. The effectiveness of a CAM system is reflected in the ability to completely define the machining process for one or more components, including defining the steps, the cutting speed, the workpiece materials and the tools, as well as the ability to generate the NC code for any type of CNC control unit.

2.1. EdgeCAM Software Package

The EdgeCAM software package is used in doing this work, a computer aided design system technology running Windows operating system, intended for engineering and manufacturing environment.

The EdgeCAM is a computer-supported system software design technology for the CNC code generation from CAD models.

The EdgeCAM can accept CAD files from all the leading CAD programs, such as Solid Edge, Solid Works, Autodesk Inventor, KATIA, AutoCAD. It also has a module for the design of the products for which it is possible to generate 2D and 3D models and the modifications of the imported document. It has the ability to generate the NC code for any type of a CNC control unit. The EdgeCAM creates a treatment plan for optimizing the tool path, the shorter empty strokes, increases the tool life, reduces the programming time and increases the overall productivity.

2.2. EdgeCAM Regimes

EdgeCAM starts from a Design mode, assumes that you want to start creating a part. If you have already created the part or if you import an existing part, then you can begin the process of the technological processing. In order to use the EdgeCAM system, you should have some experience with CAD/CAM methods and the appropriate equipment and terminology. You should also have some experience with Microsoft Windows NT graphical user environment.

The design mode in the EdgeCAM software package has less instructions than the product design process for product design packages, such as Solid Edge, Solid Works, Autodesk Inventor, KATIA. However, the module for the product design in EdgeCAM-in is quite acceptable for the design of parts of a medium complexity.

EdgeCAM is a computer aided design system technology and is designed for the engineering production environment, built on twenty years of experience with over 15,000 users worldwide. Using the advanced features and the primitive palette of tools, this software package develops a treatment plan and optimizes the tool path, the shorter empty strokes, the increased tool life, it reduces the programming time and increases the overall productivity.

3. HIERARCHICAL STRUCTURE SUPPORT FOR COMPONENTS OF A POWER STEERING

The automation of the product design is based on a formalized and detailed knowledge of the standardized structured products. The engineering activities are carried out according to

the functional requirements in relation to the above restrictions. The limits are usually set with an integrated view of the product design and manufacturing. In fact, the research commitment is related to the formation of the general product model, from which it is possible to generate specific models to support the simultaneous design of the individual modules.

The development of the software packages, in the field of the simultaneous product design and technology at the beginning of the third millennium, has a lot of great consequences. This is reflected in a highlighted possibility of exchanging data between the models that make a simultaneous design approach. The platform on which the software packages are developed meets the first condition that is defined by the simultaneous modelling, namely transparency. In this way, the information from CAD models is directly transferred to the module for CAE, CAM and others.

3.1. Modelling Components of the Hydraulic Power Steering

For the purpose of experimental testing of pre-defined theoretical principles to achieve the flexibility of the assembly systems based on the flexibility of the basic elements of the assembly product structure, as previously stated, hereinafter referred to the modelled hydraulic power steering 5033.

The modelling of a hydraulic power steering is based on the modelling of the basic components.

Figure 1 gives the hierarchical structure of the hydraulic servo-steering gear, whose main subassemblies are: I - the housing subassemblies, II – the subassemblies clip and III - the shaft segment subassemblies and components: 3 - the cover, 5 - the sealing ring, 6 - the sealing ring, 7 - the cover housing, 8 - the cover housing, 9 - the shorter screw, 10 - the longer bolt, 11 - the lever, 12 - the nut, 13 - the rely washers, 14 - the cap.

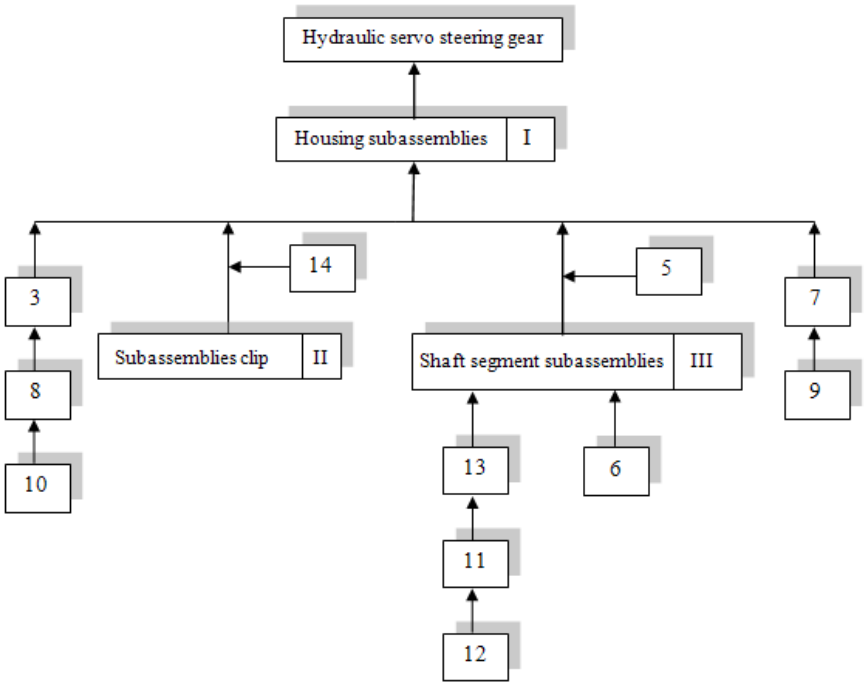

Fig. 1. The hierarchical structure of a hydraulic power steering

Mechanical Testing and Diagnosis, ISSN 2247 – 9635, 2012 (II), Volume 4, 43-50

In relation to the modelling component of the field, the problem is greatly complicated by the research approaches and the methods of modelling the structure assembly, the executive functions and the processes.

In analyzing the formation of the primitive assembly, the engineer starts with the function of this circuit. On the basis of the functional requirements, it is necessary to recognize the incumbents or the executive level at which the primitive is defined and then to form the skeleton subassembly or assembly.

Defining the prefabricated structure is based on the principles of design for DFA assembly as the main strategy of a simultaneous design. The aim of this strategy is to produce lighter and cheaper products and some researchers believe that DFA is the key for a successful design in a competitive environment.

Figure 2 shows the hydraulic power steering circuit type 5033, as a result of modelling with the help of the built environment-a Solid Edge.

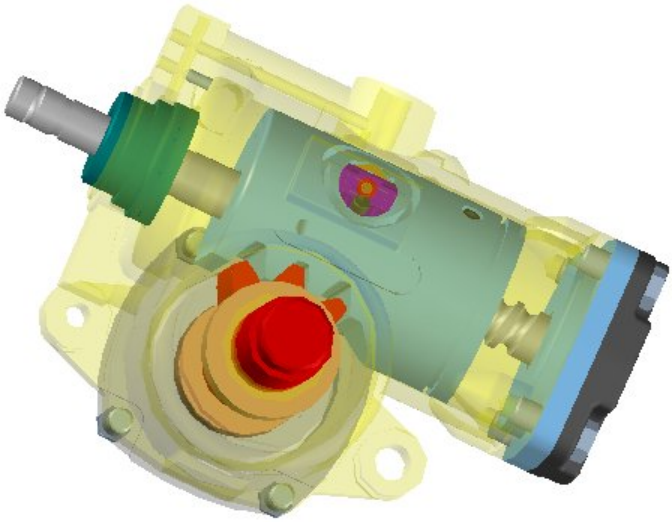

Fig. 2. Circuit hydraulic power steering

4. DESIGN PROCESS TECHNOLOGY FOR THE SELECTED VARIANT CARRIER UNIT

The functional analysis examines the complex structured objects in terms of realizing their functions in relation to the more complex parts of the system to which they belong. The different properties of the objects are synthesized via a set of functions in the integral whole. This allows for the representation of the objects as a whole and organizes the transition to study its structure and organization.

The functional analysis is of a basic importance for the function. The function of a part is determined by its geometric shape, the form and position tolerances and the dimensional tolerances. These data on the finished part allow to transform the technological process of its development, to date the most rational production conditions and is a qualitative transformation of the object from the balance sheet preform to the finished part.

The hydraulic power steering 5033 consists of many parts that make up the circuit. For the technological analysis in this paper, part 1 was taken, the worm shaft, and it is made with the technological process of processing time as the analysis and simulation using the EdgeCAM software package.

Mechanical Testing and Diagnosis, ISSN 2247 – 9635, 2012 (II), Volume 4, 43-50

To give a global idea of preparing the planning process, a machine-part analysis is suitable and it is necessary to define the different levels of the shape that will be adopted. The machine-specific analysis of the geometrical design is used to define a feasible process plan, based on the existing information about the production capabilities (machines, tools, ability to achieve the required accuracy, etc.). First, it is necessary to study the main characteristics of the section, with the most logical interpretation of the technical drawings.

All information from the technical drawings needs to give a description of mechanical parts, which includes:

- the geometric form,
- the dimensions and their tolerances,
- the shape and position tolerances,
- the quality of the surface finish (roughness),
- the material.

These general observations are the basis for the initial evaluation of the production methods for processing a given part.

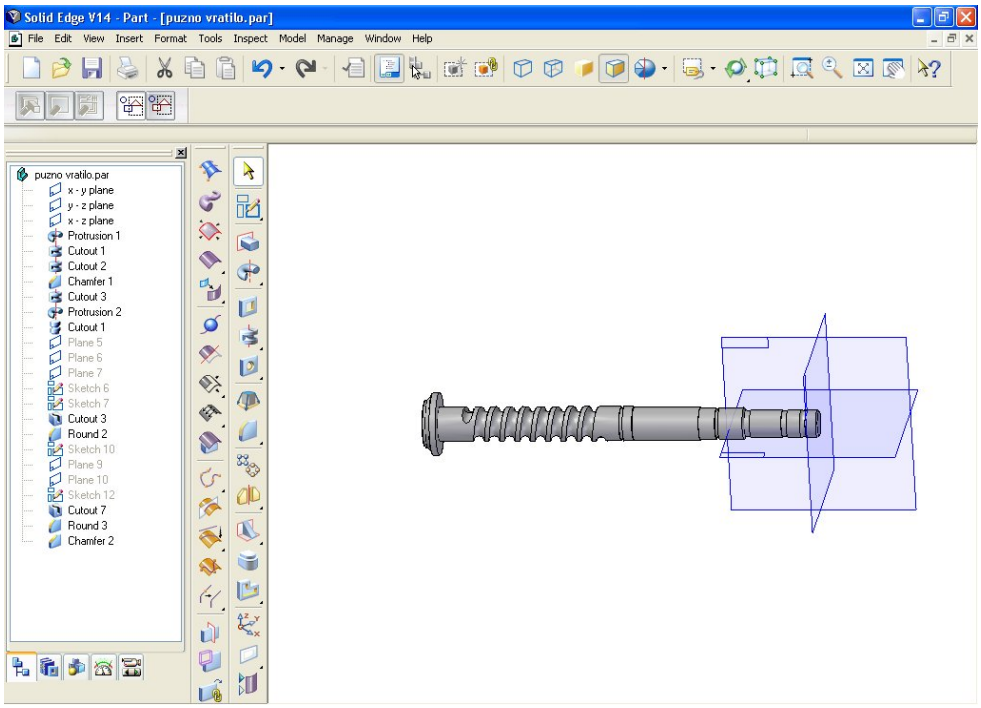

Fig. 3. A dialog box variant modelling

The product design process and the process conditions give the design variant of the technology for its development. Previously generated geometric and technological information about the product is used as a starting point in designing the technology.

The programming environment, in which will be performed the design process, provides the ability to use the geometric and technological information on the design technology of its production. The designing technological process is within the broad field that performs various activities, including the design and the selection of the builder. The process begins with the variant of tools in the dialog box, declaring the variables at the local level of the active part from the global one (Fig. 3). It is added some new geometric information on the tool that was not previously defined at the local level.

Mechanical Testing and Diagnosis, ISSN 2247 – 9635, 2012 (II), Volume 4, 43-50

4.1. Generating NC Code for Simulating the Selected Processing EdgeCAM

```
**********************************
****
* Machine Tool   : Fanuc "T" Series
* Part Name      : struganje puznog
vratila
* Sequence       :
* Programmed By  : VLADAN
OBUCINA
* Date           : 06/10/10
* Time           : 14:57:02
*
* Total Machining Time (including
Toolchange) : 79.873     Minutes
* Idle Time           (including
Toolchange) : .000       Minutes
**********************************
%
:9999
 (STRUGANJE PUZNOG VRATILA)
N10 G21 G90 G40 G95
N20 G10 T00 X0.0 Z0.0 I0.8 K0.8
N30 G10 T00 X0.0 Z0.0 I0.0 K1.575
N40 G10 T00 X0.0 Z0.0 I0.8 K0.8
N50 G10 T00 X0.0 Z0.0 I0.4 K0.4
N60 G10 T00 X0.0 Z0.0 I0.0 K0.0
N70 G10 T00 X0.0 Z0.0 I0.25 K0.25
N80 G10 T00 X0.0 Z0.0 I0.25 K0.25
N90 G10 T00 X0.0 Z0.0 I0.25 K0.25
N100 G10 T00 X0.0 Z0.0 I0.25 K0.25
N110 G10 T00 X0.0 Z0.0 I0.25 K0.25
N120 G10 T00 X0.0 Z0.0 I0.25 K0.25
N130 G10 T00 X0.0 Z0.0 I3.0 K3.0
N140 G10 T00 X0.0 Z0.0 I0.4 K-0.4
N150 G10 T00 X0.0 Z0.0 I0.4 K-0.4
N160 G10 T00 X0.0 Z0.0 I0.4 K-0.4
N170 (STRAIGHT TURN
OPERATION)
N180 G54 (PCLNL-2525-M12 -
GC1015)
N190 T0000 M17
N200 M01
N210 G50 S420 M42
N220 G97 S225 M4 M9
N230 M3
N240 G0 X200.0 Z1.814
N250 X47.621 M7
N260 G1 Z0.882 F0.2
N270 X0.0
N280 Z1.764
N290 G0 X2.0 Z2.764
N300 X47.621
N310 G1 Z0.0 F0.2
N320 X0.0
N330 Z0.882
N340 G0 X2.0 Z1.882
N350 X47.621
N360 (HOLE OPERATION)
N370 M5
N380 G28 U0
N390 G28 W0
O400 G0 X200.0 Z50.0 M9
N410 G54 (USER DEFINED)
N420 T0000 M17
N430 M01
N440 G95
N450 G50 S3780 M44
N460 G97 S3780 M5 M9
N470 M3
N480 G0 X0.0 Z10.0
N490 G1 Z-3.0 F0.12 M7
N500 G0 Z10.0
N480 G0 X0.0 Z10.0
N490 G1 Z-3.0 F0.12 M7
N500 G0 Z10.0
N510 G28 W0
N520 G28 U0
N530 (TURNING OPERATION)
N540 M5
O550 G0 X200.0 Z50.0 M9
N560 G54 (PCLNL-2525-M12 -
GC1015)
N570 T0000 M17
N580 M01
N590 G95
N600 G50 S420 M42
N610 G97 S225 M5 M9
N620 M3
N630 G0 X200.0 Z3.0
N640 X41.95 M7
N650 G1 Z-250.0 F0.2
N660 X43.9
N670 G0 X45.9 Z-249.0
N680 Z3.0
N690 X40.0
N700 G1 Z-246.0 F0.2
```

5. CONCLUSIONS

Taking into account the concept of the design process, this CAD/CAA/CADD computer product shows a design of an assembling technology. Using the computer for modelling the production process makes the research be conducted on it instead of the physical model. Thus, the product model is the basic element of the integration of the computational modules supported by the production system. Taking into account the foregoing, this work underlines the possibility of shortening the integration process of forming the product model and its technological development. The introduction of the concept of integrating the process of product design and the technology, leads to improve the business operations that are reflected in a faster, higher quality and lower cost fulfillment of the demand coming from the market.

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