UNIVERSITY OF NOVI SAD
FACULTY OF TECHNICAL SCIENCES
ADEKO - ASSOCIATION FOR DESIGN, ELEMENTS AND CONSTRUCTIONS

MACHINE DESIGN

THE EDITOR OF THE MONOGRAPH:
PROF. PHD. SINIŠA KUZMANOVIĆ

ON THE OCCASION OF THE 48TH ANNIVERSARY
OF THE FACULTY OF TECHNICAL SCIENCES

1960 - 2008

NOVI SAD, 2008

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Dear Ladies and Gentlemen,

We are celebrating the 48th anniversary of our Faculty and I would like to greet You and to thank You on Your participation and scientific papers submitted.

We started in the year 1960 as the Faculty of Mechanical Engineering with seven professors, ten assistants and 170 students, who worked on 1000 m^2. After introducing new departments of electronics and civil engineering in 1974, the Faculty changed its name into the Faculty of Technical Sciences.

The founding of the Faculty of Mechanical Engineering in Novi Sad was undoubtedly recognized as a crucial moment for our profession after the opening of the Technikum – the first technical school in Vojvodina, after the First World War. The role of scientific and research work and education in the field of production and economy was underlined through the merging of all fields of engineering into the Faculty of Technical Sciences and the establishing of this educational institution. It was, as it is today, the reflection of the actual needs and spiritual and material potentials of this region.

Today the Faculty develops its activities in ten fundamental fields of engineering and evenly manages all three activities: education, scientific-research work and the transfer of the scientific results into practice.
Educational activity is performed through: under-graduate studies for B.Sc. degree in Engineering, post-graduate studies for M.Sc. degree, specialization studies and Doctor studies for acquiring a Ph.D. degree in 69 educational profiles.

Scientific-research work comprises 39 projects financed by the Republic Ministry of Science and Environmental Protection and 22 projects financed by the the Provincial Secretariat for Science and Technological Development and 29 international projects.

The Faculty consists of 13 departments, 39 chairs, 6 specialist services, 9 scientific and specialist centers and 9 small companies.

The reducing of the duration of the studies, one-semester subjects, European credits system, more optional subjects, three-level studies, diploma supplement, an increase in the quality of the teaching process and in number of graduated students - are the activities that marked last year. Owing to continual an perceptible changes, the interest in studies at the Faculty of Technical Sciences is growing, so the overall number of students for the last five years was doubled.
The Faculty with more than 10000 students, 700 employed personnel, located in 7 separate buildings of 30.000 m2, became one of the biggest and most developed faculty in the region.

Evaluation of teachers and the quality of the teaching process is carried out by the students at the end of every semester. This activity proved to be very usefull, because it revealed many problems that, after being solved, resulted in a better and more efficient teaching process at the Faculty.

The certification and recertification of system quality according to the international standard ISO 9000-2005 and various rewards attained prove high quality of all the processes at the Faculty and reflect our readiness to subsist and to develop more intensively in the future.

The goal of this Faculty is to retain a high place in top society, which means that all our future activities will be subjected to this already adopted mission.

Dean of the Faculty of Technical Sciences

In Novi Sad, 18th May 2008

Prof. Ph.D. Ilija Ćosić

Dear Reader,

In this year 2008, the Faculty of Technical Sciences in Novi Sad celebrates 48th birthday. In world proportion, maybe it is not some significant anniversary, but for our conditions it is a great period. On that occasion our Faculty wants to represent researching results of the leader researchers and scientists in the field of Machine design from these regions, in order to obtain insight in the present situation of this important scientific discipline. As a result of collective efforts, we have published the Monograph "Machine Design" with over 400 pages, that comprehends 78 papers from 12 countries:

- *Belarus, 1 paper*
- *Bosnia and Herzegovina, 1 paper*
- *Bulgaria, 10 papers*
- *Croatia, 2 papers*
- *Finland, 1 paper*
- *Hungary, 1 paper*
- *Poland, 3 papers*
- *Romania, 22 papers*
- *Russia, 2 papers*
- *Serbia, 26 papers*
- *Slovak Republic, 8 papers*
- *Slovenia, 1 paper*

Certainly, the Monograph could be larger and some papers maybe more quality, but the reviewers decided just like this. The papers are sorted according the similar researching topics. The papers that globally observe design processes are at the beginning of the Monograph. After them there are papers that deal with particular machine elements, and at the end there are papers that research manufacturing technologies.

I believe that all accepted papers treat analyzed topics explicitly and systematically on a high scientific and professional level, and thus they deserved to be published in this Monograph.

I hope You will often read this publication with a great pleasure, as like as I do it when creating its contents.

With deep respect and gratitude,

The editor of the Monograph,

In Novi Sad, 18th May 2008 — *Prof. Ph.D. Siniša Kuzmanović*

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AUTOMATISATION OF POWER TRANSMITTER'S DESIGN PROCESS WITHIN ZPS SYSTEM

Dragan MILČIĆ
Boban ANĐELKOVIĆ
Miroslav MIJAJLOVIĆ

Abstract: *Main goal of design process is to find optimal solutions for technical systems. Various decisions have to be made during design process in order to choose appropriate parameters, material and shape. Decisions made in design process connect other operations and activities in the structure of process and enable its continuum. Faculty of Mechanical Engineering in Niš is working on development of intelligent integrated system for design of power transmitters.*

Key words: *Power Transmitter Design, CAD, Intelligent Integrated Software System, Calculations, Design*

1. INTRODUCTION

Market gives all the time more complex requirements about productivity, quality and speed of new product's development. Intensive economical progress gives increase of project-constructional tasks with greater complicity. Conventional, "traditional" design, based on empiric and intuitional knowledge, does not allow successful follow up of development in other areas of human work. Company that wants to be concurrent on global market must use Computer Aided (CA) technologies during process of product design. Most used technologies for automaton of product design are Computer Aided Design/Computer Aided Manufacturing/Computer Aided Engineering (CAD/CAM/CAE) and they appear as mechanisms of backup for processes of modeling, engineering analysis and development of product's development documentation. Benefits reached by usage of CA technologies in area of gear design are multiple and can be illustrated as follows:

- Time of the design process has shortened for more than one to hundred times compared to the manual design (depending on object of design and level of automatism of design process),
- Price of the design process is lower for 10% to 90% comparing to the manual design. Application of the CA technologies does not require manufacture of expensive prototypes (in some cases this is necessary).
- Quality of design results is much higher concerning about the fact that application of Informational Technologies (IT) largely eliminates subjective sources of errors or mistakes.

During last decades various tolls and techniques of Artificial Intelligence (AI) have been developed. Application of the AI technologies gives new point to work of designer during design process. Decision making in design process can be qualitatively improved with application of AI; it is possible to automate design process and this means more qualitative results, more efficient problem solving, saves resources and time and Knowledge Engineering (KE) find its place in design process [1][2].

2. DESIGN PROCESS AND STRUCTURE OF DECISIONS IN DESIGN PROCESS OF TECHNICAL SYSTEMS

Design is mostly creative process, based on a science and experience ran thru step-by-step phases. It starts from an idea and at the end finishes as design and technological documentation for manufacture of technical system. This is a process which transforms idea into the project, which is, furthermore, basis for the manufacture. Goal of the design process is to find optimal solutions for the technical problems – more precise: optimal design. Optimal solutions consider adequate manufacture, exploitation and recycling of the concurrent technical system [3][8][9].
Design process follows precisely defined steps and phases (Figure 1).

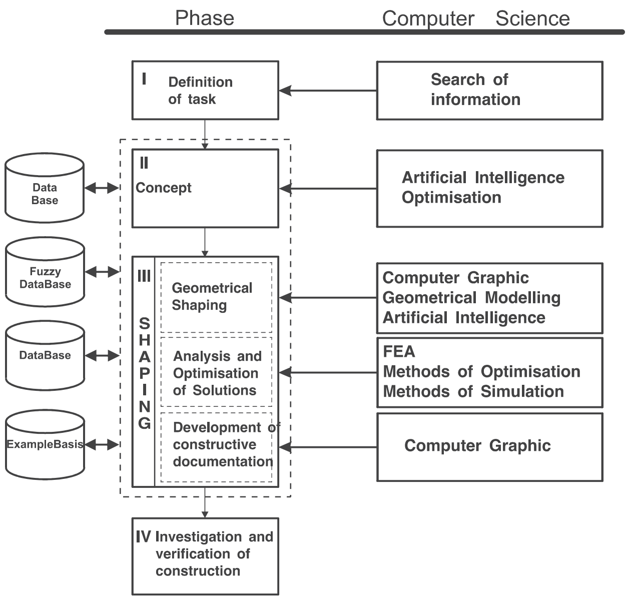


Fig. 1. Design Process and Applied Computer Methods

In order to find an optimal solution, it is important to define, at the very beginning of the design process, very precisely, design task. If it's possible, it should be completely analyzed. As a result of this phase comes check list of requests that technical system has to fulfill.

Second phase of the process is a concept of an idea-solution. Formulating the structure of functions, global function of the system is decomposed to partial and elementary functions. These functions are mostly concerning about energy transformation (forces, moments, movement), transportation of energy etc. Definition of elementary functions starts from the mathematical description of the transformation. Transformation can be achieved based on mechanical, hydro, pneumatic, electrical, magnetic, thermal, chemical or other principle. Most commonly used principle is mechanical, which is based on the basic physical laws. Combination of adequate principle solutions gives greater number of conceptual variants. Grading and comparison of variants gives optimal variant solutions.

As illustration, Figure 2 shows simplified structure of basic calculation operations and decisions making process in process of design of gear power transmitter. Complex connections and mutual conditionality of decisions and results of calculations, shown in this simplified figure shows complexity of this structure.

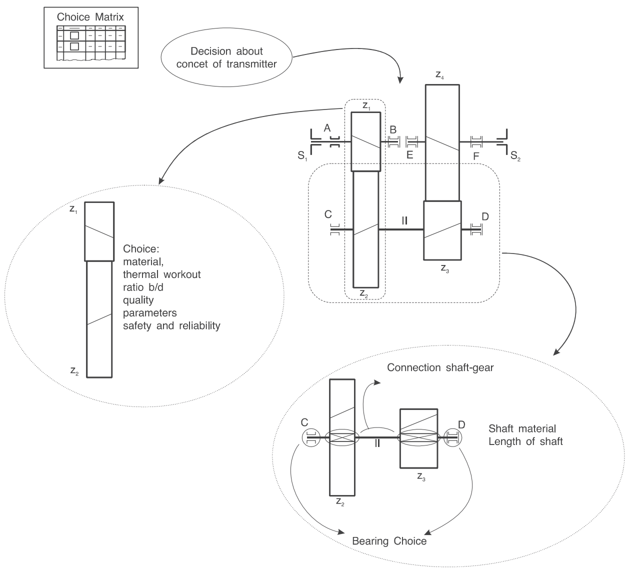


Fig. 2. Structure of Decisions in Design Process - Power Transmitter

Third phase is phase of shaping which defines executors of principal solutions. First part of this phase (development of the construction) includes preliminary calculations, which firstly defines global dimensions and later shape of the resumed part. Material and manufacturing process are determined and basic dimensions are chosen. This phase, beside creativity, requires several iteration steps, what gives higher level of defining designing solution. This is very complicated phase since requires combination of calculation and shaping and very often repetition of same steps thru adequate changes.

Second part of the shaping phase involves work out of drawings and development of technical, manufacturing documentation. This means, development of assembly drawings, based on drawings, and optimization of parts shapes, definition of quality of worked surfaces, requirements about precision etc.

Fourth phase includes development of documentation for parts of the system, finishes technical documentation and checks correctness of data on the drawings.

Every design phase is realized in complex structure of operations and activities. Phases are realized thru adequate operations like functional structures forming, choice of dimensions, shape modeling and stress analysis are.

Operations and activities which show parameter, data, and material in design process are called decisions. They connect other operations and activities in the structure and enable continuum of the design process. During thoughtful process, decisions are made unconscientiously, by inertia, experience, logics etc. In models of design process, decisions are result of cause-consequential mutuality and restrictions. This gives several approaches for this: algorithmic, principle of already known variants, optimization principle, non-algorithmic principles (expert systems, fuzzy expert systems), fuzzy principles, principle of neural networks etc.

3. INTELLIGENT INTEGRATED SYSTEM FOR POWER TRANSMITTERS DESIGN

Based on activities that have to be done during process of power transmitters design, Faculty of Mechanical Engineering in Nis, long time period is working on intelligent integrated system for design of gear and worm gear power transmitters – ZPS.

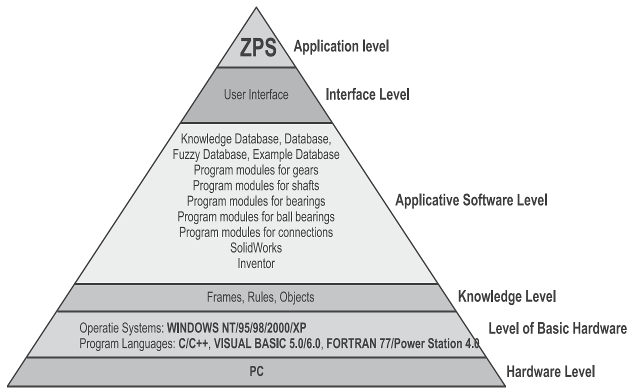


Fig. 3. Software Platform of Program System ZPS - for Design of Power Gear Transmitters [1]

ZPS is very complex and heterogenic, developed on a modular basis system. Primary aim of ZPS is to enable integrated application of various different program modules and systems developed by different authors or companies which are involved in automation of activities during gear power transmitter's design. That is the reason why software platform of developed system maximally uses all applicable standards in area of data exchange, communication and computer science.

Integrated program ZPS (Figure 4) consists of 3 parts:

1. Program modules for calculation of elements for power transmission,
2. Program modules for calculation of elements for rotation movement,
3. Program modules for calculation of mechanical connections.

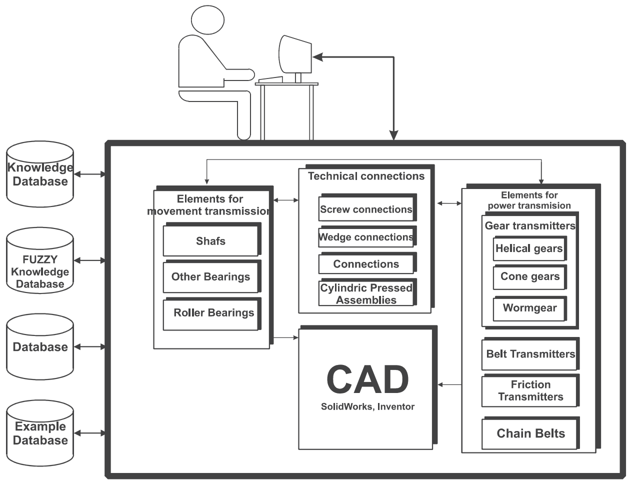


Fig. 4. Architecture of Intelligent Integrated System for Gear Power Transmitters Design

All program modules are developed in FORTRAN and Visual Basic and development of expert and fuzzy expert systems is used CLIPS or FuzzyCLIPS. Technical documentation is developed in SolidWorks and Autodesk Inventor [2].

Model of power transmitter is internal computer presentation of all characteristics necessary for its full defining. Model of transmitter can be realized as numerical model and as symbolic model.

Numerical model is shown with structure of data and mostly is realized in shape of matrix end vector mutually connected over pointers.

Symbolic model represents larger and more understandable model comparing to the numerical. This model is accepted and all characteristics, relevant for the description, are shown as appropriate descriptive symbols, similar or identical to the real characteristics. These symbols are grouped in assemblages, and they describe specific characteristics – represent one object.

4. PROGRAM SYSTEM ZPS AND POWER TRANSMITTER'S PARTS DESIGN

Product's design and shaping are very important phase in the design process. Shaping and design theory, with the subject of shape forming for machine parts, are one complete and very complex scientific discipline.

Geometrical modeling (in the following, the term used is – modeling) is final operation of the shaping process. To model machine part means "to define its shape into the 3D space" [7].

Modeling of mechanical system is done in several different levels, following the systems structure and complexity. If it is taken that basic unit is mechanical part, more functionally connected parts are making an assembly (or system), and more assemblies make a machine group or a system. This makes sensible definition of modeling of parts, assemblies and systems.

One of the output data from design process is virtual model which gives dimensions and shape of elements or assembly (geometrically completely determined in the 3D space).

For creation of those virtual models, engineer use various CAD (Computer Aided Design) systems, which, as output give 3D geometrical models (furthering the text, just - models) which can have realistic materiality. This completes design process and eases further product development process. Process of parametric machine parts modeling eases and shortness creation of the similar elements family and delivers higher quality of the design.

Program system ZPS, schematically shown in Figure 4 is intelligent integrated system for calculation, design and shaping of power transmitters, developed at Faculty of Mechanical Engineering in Nis. Two new modules have been implanted into the ZPS: module for calculation and design of the journal (radial) hydrodynamical bearings and module for calculation and design of belt power transmitters.

4.1. Program Module for Calculation and Design of Radial Journal Hydrodynamical Bearings

Program module for calculation and design of journal bearings has 3 following parts: user interface for data input, user interface for parameter calculation and interface for connection with the CAD software – Autodesk Inventor.

Calculation of the journal hydrodynamical bearings is iterative process, starting with geometrical parameters of the shaft (diameter), working conditions (loads, rounds per minute, working temperature) and tribological – technological characteristics (material of the bearing casing, medium for lubrication – oil etc.) [6]. User interface for data input is given in the Figure 5.

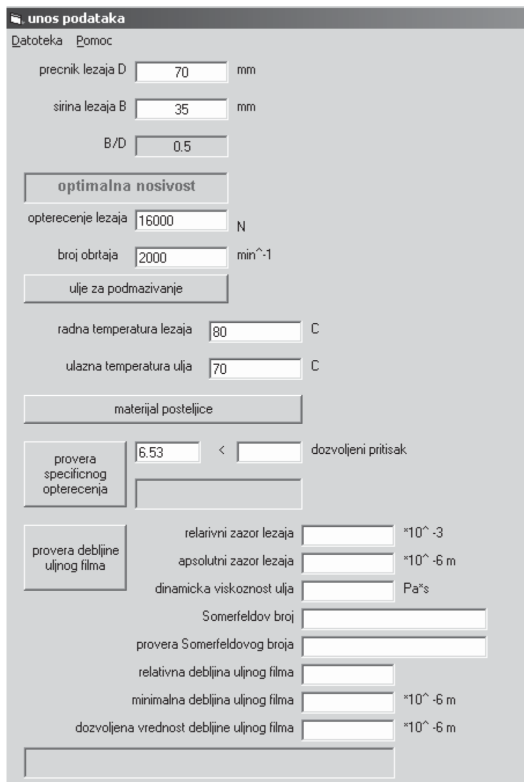


Fig. 5. Data Input Interface

Oil selection is according to the new widow, showed in Fig. 6. Oils recommended by the software are classified according to the ISO standard in 18 different categories (ISO VG 2, 3, 5, 7, 10, 15, 22, 32, 46, 68, 100, 150, 220, 320, 460, 680, 1000 and 1500) [3].

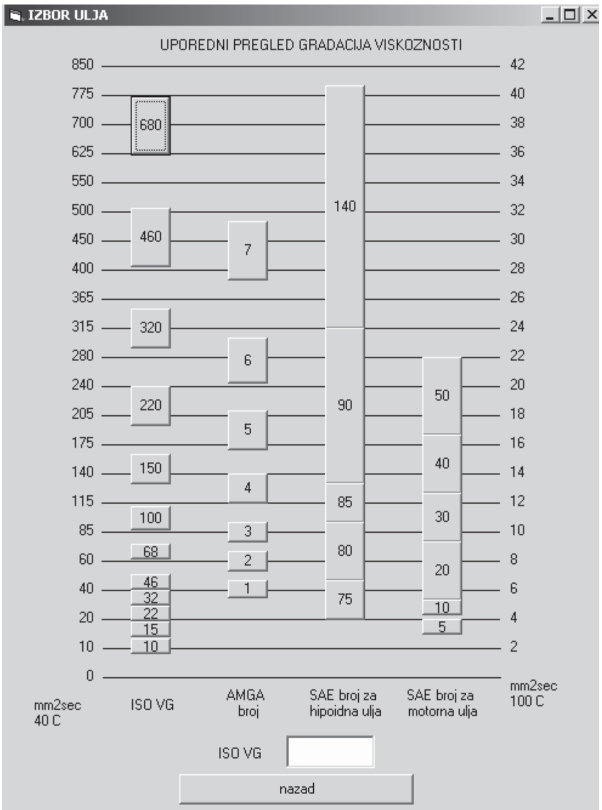


Fig. 6. Oil Choosing

Material of the bearing casing choosing is according to the standards. User is able to choose standard materials, but, if there is no material with characteristics that user expects, it is possible to add new data about materials to the database (Figure 7).

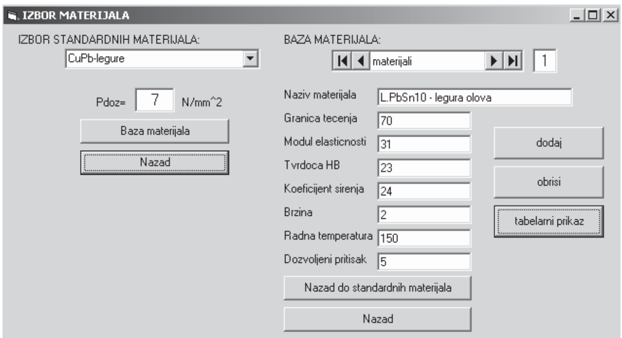


Fig. 7. Bearing Casing Material Choose

One of the main parts of calculations is dimensions fitting choosing. Fitting has to be standard and has to deliver adequate dimensional gap which enables creation of oil film, necessary for hydrodynamical floating. Hydrodynamical floating is creation of oil film which separates shaft and bearing casing. If there is no adequate absolute gap between shaft and casing, there is no possibility for hydrodynamical floating and damaging of the bearing is unavoidable. Fitting Choosing is shown in Figure 8.

When all of the required data is collected and given to the program, program controls then, rechecks criteria for calculations and informs user about results. If there are no correct results, program returns to the beginning of calculation – user has to change inputs to the program since there is no solution for the data user gave.

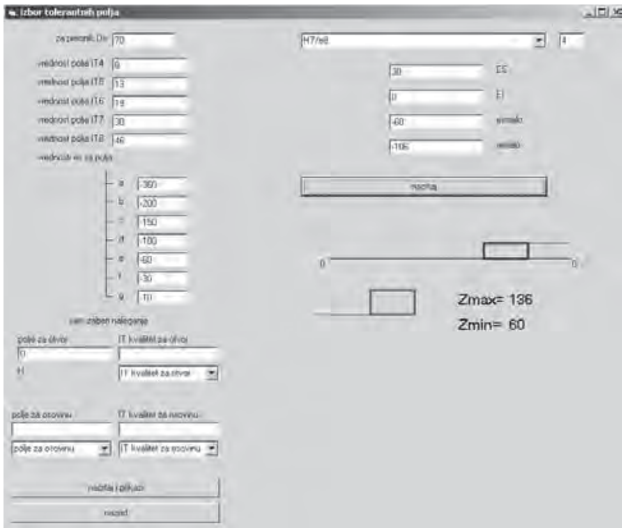


Fig. 8. Fitting Choosing

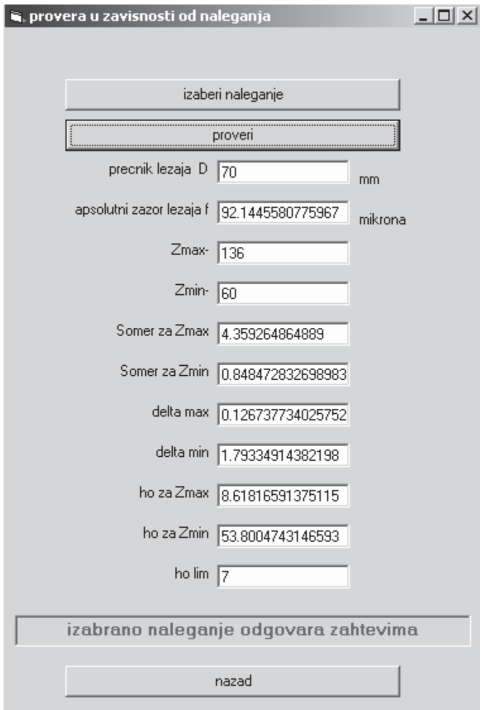


Fig. 9. Chosen Fitting Check

After calculation, if adequate solution has been found, program starts generation of the 3D model of bearing casing and 3D model of the journal bearing. Shapes of journal bearings and bearing casings are standard. Journal bearings can be designed as single-parted or double-parted Bearing casings are the most important part of journal bearings. All of them are shaped as hollow cylinders. They can be thin-walled or thick-walled. Bearing casings can be made out of single material. This material has to be tough enough and with adequate anti-friction abilities. Thin-walled bearing casings are standardized, defined by EN DIN 8221, and they are assembled to the bearings defined by EN DIN 502, EN DIN 503 and EN DIN 504. Standard shapes and dimensions of single-parted thick-walled bearing casings, made out of one material are standardized by EN DIN 1850 – shape G and shape U. Software includes shape of single-parted bearing casings according to the EN DIN

7473 and EN DIN 7474 with sprayed anti-friction film. Single-parted are variants for vertical fixation and with flange (EN DIN 502 and EN DIN 503). Dimension of double-parted journal bearings are defined according to the EN DIN 505. Software enables selection of bearing casing out of 4 different journal bearings (Figure 10).

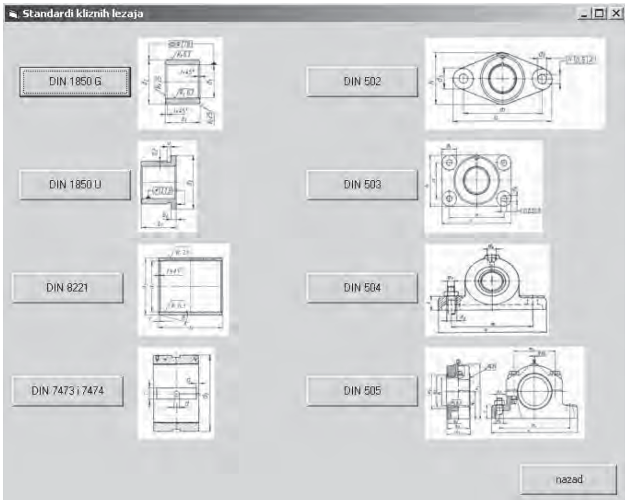
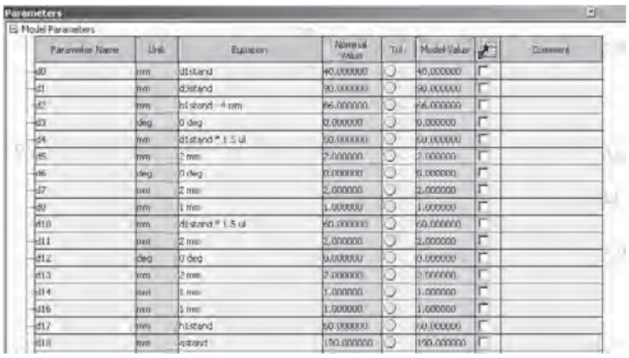


Fig. 10. Menu of Standard Journal Bearings and Bearing Casing

After the calculation program opens new window and based on selection (journal casing or journal bearing) recommends standard diameter of the bearing and based on it does reading data from database and shows all dimensions of the selected part of bearing. Since there are various variations of shapes (for the same diameter), software pays attention about them and requires from the user to make a selection. 3D shapes of bearings and casings are defined in CAD software Autodesk Inventor.
All model of standard journal bearings and bearing cases are parametrically modeled and some of dimensions are empirically calculated (Fig. 11).



Parameters

Model Parameters

Parameter Name	Unit	Equation	Nominal Value	Tol.	Model Value		Comment
d0	mm	d1stand	40,000000		40,000000		
d1	mm	d3stand	90,000000		90,000000		
d2	mm	b1stand - 4 mm	66,000000		66,000000		
d3	deg	0 deg	0,000000		0,000000		
d4	mm	d1stand * 1.5 ul	60,000000		60,000000		
d5	mm	2 mm	2,000000		2,000000		
d6	deg	0 deg	0,000000		0,000000		
d7	mm	2 mm	2,000000		2,000000		
d9	mm	1 mm	1,000000		1,000000		
d10	mm	d1stand * 1.5 ul	60,000000		60,000000		
d11	mm	2 mm	2,000000		2,000000		
d12	deg	0 deg	0,000000		0,000000		
d13	mm	2 mm	2,000000		2,000000		
d14	mm	1 mm	1,000000		1,000000		
d16	mm	1 mm	1,000000		1,000000		
d17	mm	h1stand	60,000000		60,000000		
d18	mm	astand	190,000000		190,000000		

Fig. 11. Table of parameters in Autodesk Inventor for one of the 3D shapes for journal casings

Dynamical connection between journal calculation software and CAD is achieved over Microsoft Excel Worksheet. Code Example 1 gives program lines which opens Worksheet and copies calculated data to the database (worksheet).

Code Example 1: Starting Microsoft Excel Worksheet

```
Private Sub Command1_Click()
Dim x As Object
 Set x = CreateObject("Excel.Sheet")
 x.Application.Visible = True
 x.Application.Workbooks.Add
'otvaranje postojeceg fajla
 x.Application.Workbooks.Open  App.Path  &
"\din1850.xls", , True
'
 x.Application.Visible = True
 x.Application.Cells(1, 1).Value = "d1"
 x.Application.Cells(2, 1).Value = "d2"
 x.Application.Cells(3, 1).Value = "b1"
 x.Application.Cells(1, 2).Value = precnik
 x.Application.Cells(2, 2).Value = sirina
 x.Application.Cells(3, 2).Value = 34
...
End Sub
```

As output from the program, user receives 3D model, generated in Autodesk Inventor of the journal bearing and journal casing. Model can be remodeled, assembled or translated to the complete technical documentation (Figure 12, Figure 13 and Figure 14).

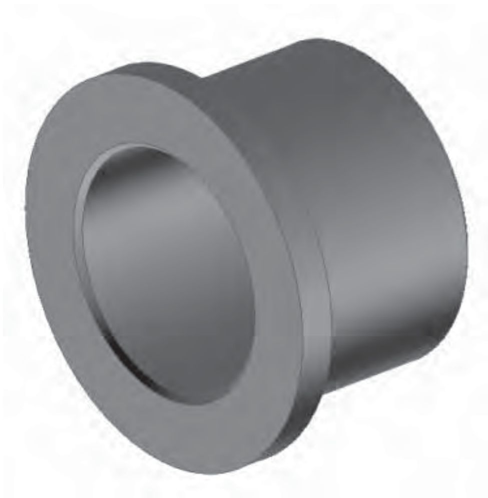


Fig. 12. 3D Model of Journal Bearing Casing Generated In Autodesk Inventor

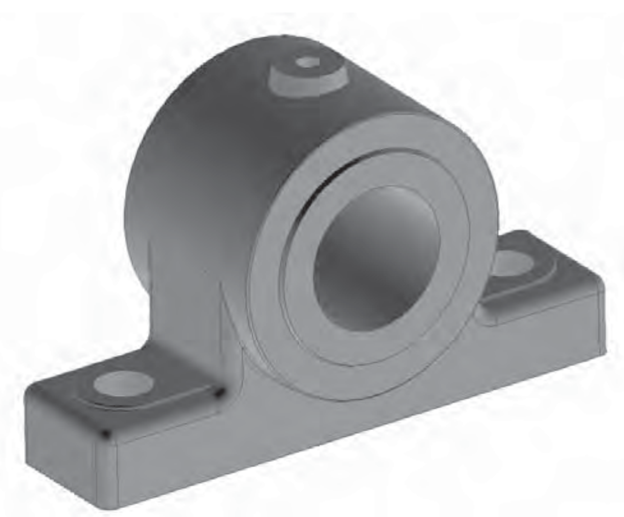


Fig. 13. 3D Model of Journal Bearing Generated In Autodesk Inventor

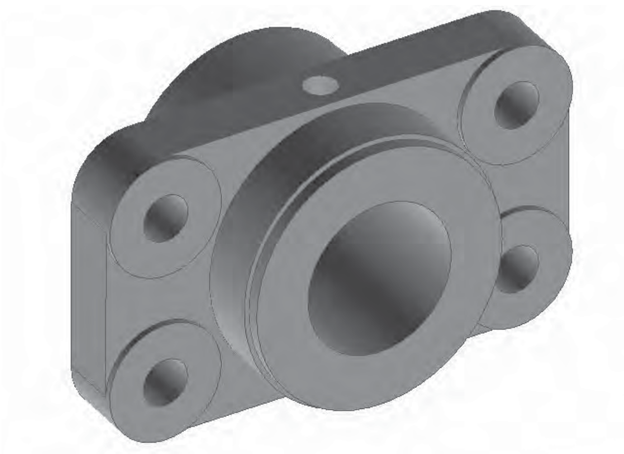


Fig. 14. 3D Model of Journal Bearing Generated In Autodesk Inventor

4.2. Program Module for Calculation and Design of Belt Power Transmitters

One of the consistent parts of ZPS integrated intelligent systems is program module for calculations and design of belt power transmitters. This program module has been redesigned (to the v2.0) and improved. Improvement that has been made is in automatisation of design process and process of belt wheel shaping.

Program requires form the user to input basic parameters of the transmitter: nominal power, transmission ratio, shaft revolution per minute, working conditions – working machine, gear machine and daily work in hours (Figure 15).

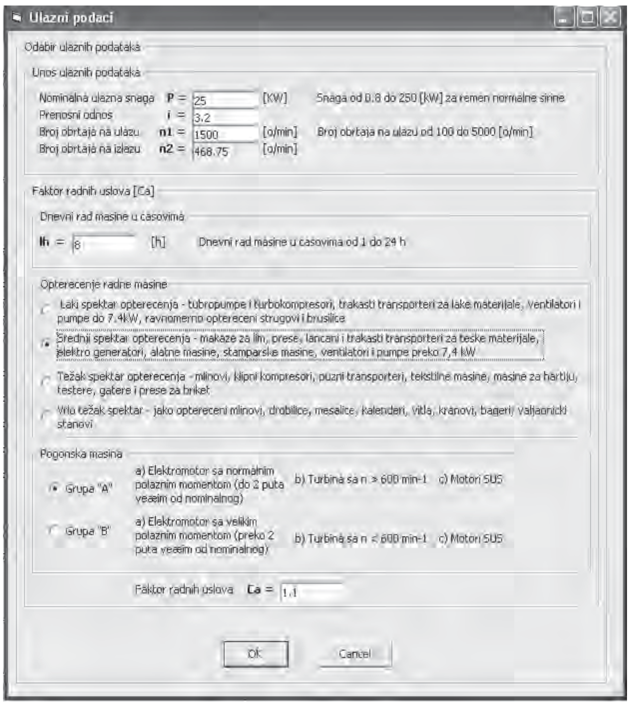


Fig. 15. Data Input Into the Software for Belt Transmitters Calculation

After correct input of data, program starts basic calculation of the belt transmitter. During this calculation, program chooses belt type, number of belts and recommends standard dimensions of wheels (Figure 16).

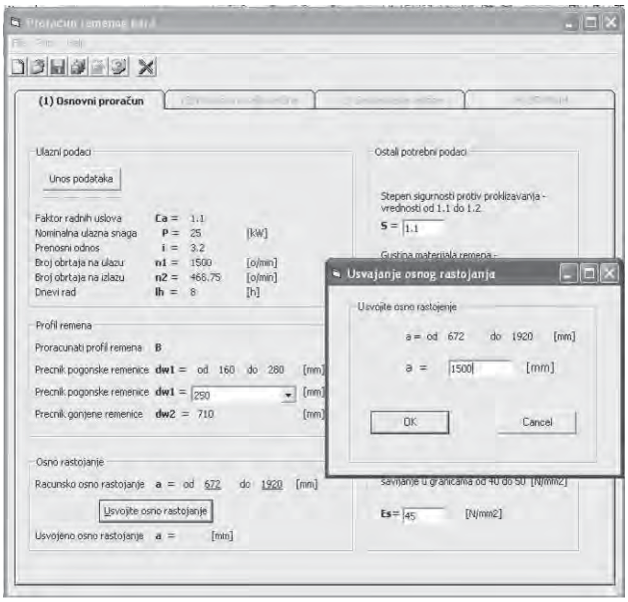


Fig. 16. Basic Calculation of Belt Transmitters

User has to adapt belt dimensions according to the standards. Program gives a possibility to choose standard diameter, center distance. Based on the calculated dimensions, program finds minimal and maximal value of center distance. User has to select and type standard value of the center distance as a value between minimal and maximal offered value.

Calculation of other values is automatic except in one case: if number of calculated and selected belt chains is greater then 12. In this case, user must select other belt type, stronger than previously chosen one, in order to decrease number of needed belts. This version of software (v2.0) uses only normal width belts.

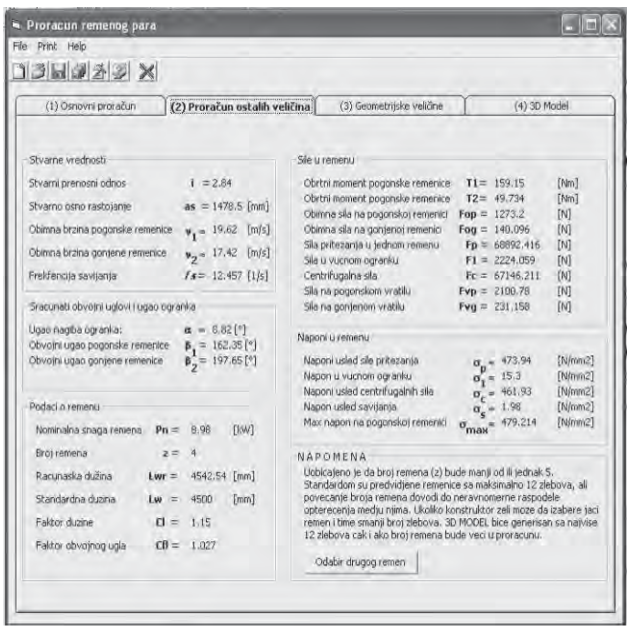


Fig. 17. Other Parameters Calculation

As a final result, this program gives generated 3D model of a belt wheel in CAD. Program gives necessary information about belt wheel's hub (diameter and length) and body of the wheel (width, shaft diameter, mass reduction holes, if necessary, for diameters larger then 300 mm).

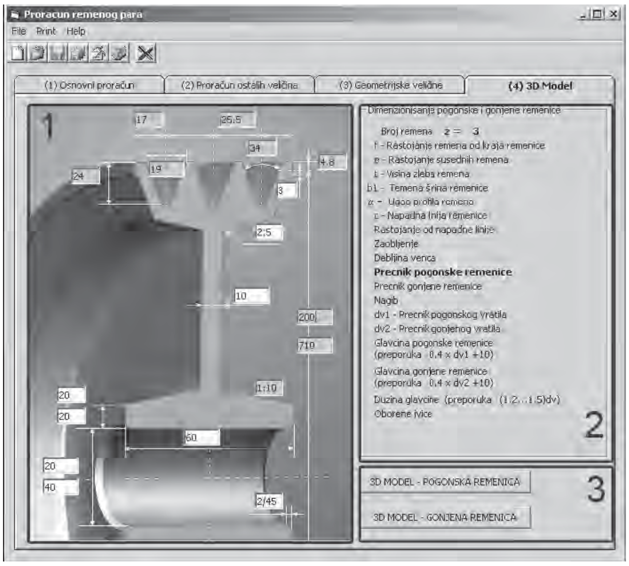


Fig. 18. 3D Model of Calculated Belt Wheel

Generation of the 3D model is not automatic. User has a choice to generate it or not. Dimensions required for modeling are copied from the calculations software to the Microsoft Excel Worksheet which plays the role of a local database. Software uses basic, previously prepared model of a belt wheel, which is connected to the Excel Worksheet. Model uses data from Worksheet to update its dimensions and rebuilds itself. Code Example 2 gives main program lines that start copy of the results to the Microsoft Excel Worksheet, start Solid Works and rebuild existing model.

Code Example 2: Start of the Microsoft Excel Worksheet application, input of the calculated data, and dimensions of the driven belt wheel. Start of the Solid Works software.

```
Sub ModelGonjeni()
    Set objExcel = New excel.Application
    Set objWorkBook =
objExcel.Workbooks.Open(App.Path &
"\3d\remenica gonjena.xls")
    Set objWorkSheet =
objWorkBook.Worksheets("Sheet1")
    Set objWorkSheet = objExcel.ActiveSheet
    Dim sTxt As String
    f = Val(Form1.txtF.Text)
    E = Val(Form1.txtE.Text)
    Alfa = Val(Form1.txtAlfa.Text)
    C = Val(Form1.txtC.Text)
    t = Val(Form1.txtT.Text)
    B1 = Val(Form1.txtB1.Text)
    r = Val(Form1.txtR.Text)
    Debljina = Val(Form1.txtDebljina.Text)
    D1 = Val(Form1.txtD2.Text) / 2
    DGlav = Val(Form1.txtDGlavcina.Text)
    Lg = Val(Form1.txtLg2.Text)
    Obaranje = Val(Form1.txtObaranje.Text)
    Z = Val(Form1.lblZR1.Caption)
    v = Val(Form1.txtVratilo.Text) / 2
    Ivica = Val(Form1.txtIvica.Text)

    objWorkSheet.Range("B3").Value = 2 * f
+ (Z - 1) * E
    objWorkSheet.Range("C3").Value =
Debljina
    objWorkSheet.Range("D3").Value = v
    objWorkSheet.Range("E3").Value =
Obaranje
    objWorkSheet.Range("F3").Value = r
    objWorkSheet.Range("G3").Value = Alfa
    objWorkSheet.Range("H3").Value = C +
Ivica
    objWorkSheet.Range("I3").Value = DGlav
    objWorkSheet.Range("J3").Value = Lg
    objWorkSheet.Range("K3").Value = D1 + C
    objWorkSheet.Range("L3").Value = t
    objWorkSheet.Range("M3").Value = B1
    objWorkSheet.Range("N3").Value = f
    objWorkSheet.Range("O3").Value = E

    'objExcel.Visible = True  ' The created
excel workbook would be visible.
    objWorkBook.Save
    objWorkBook.Close '(True) 'This will
fire the SaveAs dialog box
    'ShellEx "App.Path & \proba\box.SLDPRT"
    sTxt = Chr(34) & "C:\Program
Files\SolidWorks\SLDWORKS.EXE" & Chr(34) &
" " & Chr(34) & App.Path & "\3d\remenica
gonjena.SLDPRT" & Chr(34)
    Shell sTxt 'Chr(34) & "C:\Program
Files\SolidWorks\SLDWORKS.EXE" & Chr(34) &
" " & Chr(34) & App.Path &
"\proba\box.SLDPRT" & Chr(34),
vbNormalFocus
End Sub
```

After successful startup of application, Solid Works opens basic belt wheel model, activates link to the Microsoft Excel Worksheet, copies data from worksheet to the references of the model. Model is automatically being rebuilt and dimensioned as calculation software determined (Figure 19).

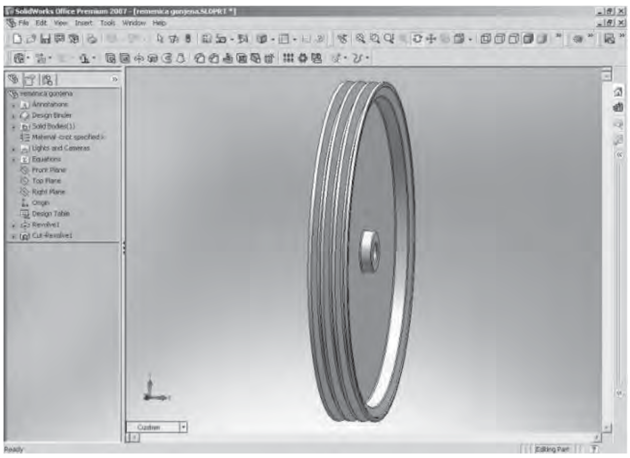


Fig. 19. 3D Model of Belt Wheel Generated In Solid Works Software

5. CONCLUSIONS

Presented material concludes following:

- Systems for design of power transmitters ZPS possesses modularity, integration, interactivity, intelligence, openness, it is concurrent and effective
- ZPS system shortness time for design,
- Application of the expert systems and fuzzy expert systems and neural network delivers optimal

constructions, since time for concept is maximally literature based and uses recommendations of famous manufacturers,

- Main parts of intelligent integrated program systems for power transmitter's design are program modules for calculations of power transmitters, rotating elements and for mechanical parts connections.
- Further directions of ZPS's development are in automatisation of design process of power transmitters.
- Program module for journal hydrodynamical bearings design consists of 2 parts: one for calculations of journal bearings and one for design and modeling of journal bearings and its parts.
- Modeling of journal bearings is made by CAD software Autodesk Inventor.
- Program for calculations and design of belt transmitters has similar concept as journal bearings calculation software but, CAD program used for modeling is Solid Works. In this case, both belt wheels are generated – pinion and driven.
- In both earlier mentioned cases connection between software and CAD is established over Microsoft Excel Worksheet.

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FACULTY OF TECHNICAL SCIENCES WAS ESTABLISHED AS FACULTY OF MECHANICAL ENGINEERING IN NOVI SAD, WITHIN THE UNIVERSITY OF BELGRADE ON MAY, 18, 1960. AFTER THE UNIVERSITY OF NOVI SAD HAD BEEN FOUNDED ON JUNE 28, 1960, THE FACULTY BECAME AN INTEGRAL PART OF THE UNIVERSITY OF NOVI SAD TOGETHER WITH SIX OTHERS FROM VOJVODINA. WHEN THE ELECTRICAL AND CIVIL ENGINEERING DEPARTMENTS WERE ESTABLISHED, THE FACULTY CHANGED ITS NAME INTO THE FACULTY OF TECHNICAL SCIENCES ON APRIL 22, 1974.

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