



Sino-Russian Symposium on Materials Science and Processing Technology



EXPERIENCE IN CREATING AN EXPERT SYSTEM FOR AUTOMATED SYNTHESIS DEPARTMENTS OF WORKSHOPS OF MACHINE BUILDING ENTERPRISES

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1. Introduction

Mechanical engineering is a promising industry today, which should become the basis for the revival of the economy. The main task of machine-building enterprises is the production of parts, assembly units of machines and mechanisms, considering the requirements for quality and specified deadlines for the manufacture of machines with minimal costs of materials, energy, and labor.

Based on the description, a description of the experience in developing and presenting specialized software designed to automate the selection of the main technological equipment and the design of workshops or sections at modern machine-building enterprises.

The screenshot displays the PlantCAD software interface. The main window shows a 3D architectural rendering of a multi-story yellow building with a glass entrance. A sign above the entrance reads "BACO" and "ВОРОНЕЖСКОЕ АКЦИОНЕРНОЕ САМОЛЕТОСТРОИТЕЛЬНОЕ ОБЩЕСТВО". A person is walking in the foreground on a paved area. The software's menu bar includes "PROJECT", "REPORT", "ЯЗЫК", "UTILITIES", "SETUP", and "HELP". The sidebar on the right contains a list of menu items:

- © 2016-2021 Новошцов Сергей Леонидович
- Data input
- Parameters of the plant
- The formation of the task
- The group's task
- The choice of the task
- Production calendar
- Program release
- Parameters of the technological processes
- Analysis of technology
- Technological processes
- Equipment selection and means of mechanization
- Formative operation
- Расчет количества рабочих
- Calculation of cutting modes
- Work cycle
- Means of automation
- Energy economy
- Quality management
- Checking the accuracy standards Of the KGSHP
- Quality criteria
- Analysis of the causes of nonconformity
- Errors in the working documentation
- Report
- View report

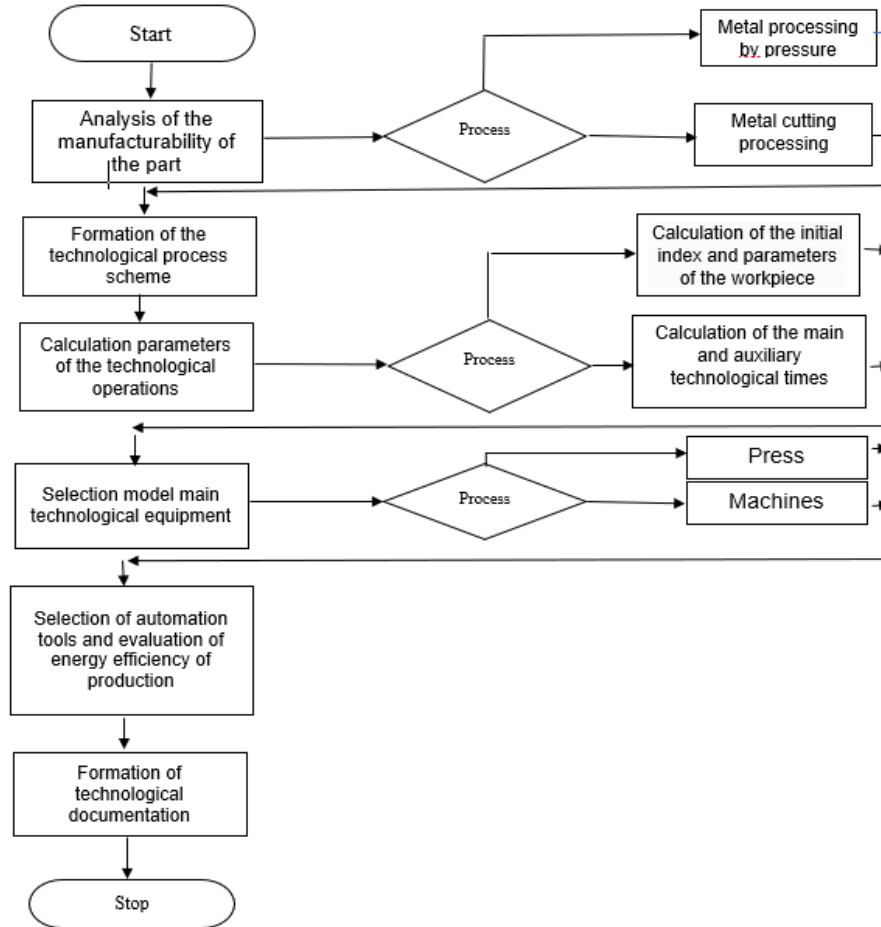
At the bottom of the window, there is a footer: "© 2016-2021 Новошцов Сергей Леонидович".



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1. Introduction



Main algorithm PlantCAD



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2. Purpose of the work

Visual Studio interface showing the design of a Windows Form. The form contains a label with the text "Вариант № Label14". The Properties window on the right shows the properties for the selected element, including "FormBorderStyle" set to "Fixed3D" and "Text" set to "PlantCAD". The Solution Explorer shows a project structure with various files like "Form1.vb" through "Form20.vb".

```
Public Class Form22
    Inherits System.Windows.Forms.Form

    Friend Language As String
    Dim S1chislo, k99, k0, k1, k2, k3, k4, k5, k6, k7, k8, k9, k10, k11, k12, k13, k14, k15, k16, k17, k18, k19, k20, k21, k22, k23
    Dim Exc As Object
    Dim Flag As Boolean
    Dim Proc() As Process
    Dim Path, ModuleName, ProcName, rs11, rs10 As String
    Dim Number(20) As Integer
    Dim TypeOfUser As Integer
    Dim s1, L1, n1, i1, s2, L2, n2, i2, s3, L3, n3, i3, s4, L4, n4, i4, s5, L5, n5, i5, s6, L6, n6, i6, s7, L7, n7, i7, s8, L8, n8,

    Private Sub WinFormToolStripMenuItem_Click(sender As Object, e As EventArgs) Handles WinFormToolStripMenuItem.Click
        Dim process() As Process = System.Diagnostics.Process.GetProcessesByName("PlantCAD")

        Select Case Language
            Case "Eng" : Dim dr As DialogResult = MsgBox("Want to log out?",
                MsgBoxStyle.YesNo Or MsgBoxStyle.Question,
                "PlantCAD")

                Select Case dr
                    Case DialogResult.Yes
                        SplashScreen2.Close()
                        Exc = CreateObject("Excel.Application")
                        Exc.Application.DisplayAlerts = False
                        Exc.UserControl = True
                        Exc.Quit()
                        Exc = Nothing
                        Excel_close()

                For Each p As Process In process
                    p.Kill()
                Next
        End Select
    End Sub
End Class
```

Visual Studio interface showing the code for Form22. The code defines a Public Class Form22 that inherits from System.Windows.Forms.Form. It includes a Private Sub WinFormToolStripMenuItem_Click method that handles the click event of a ToolStripMenuItem, displaying a message box and performing actions based on the selected language.



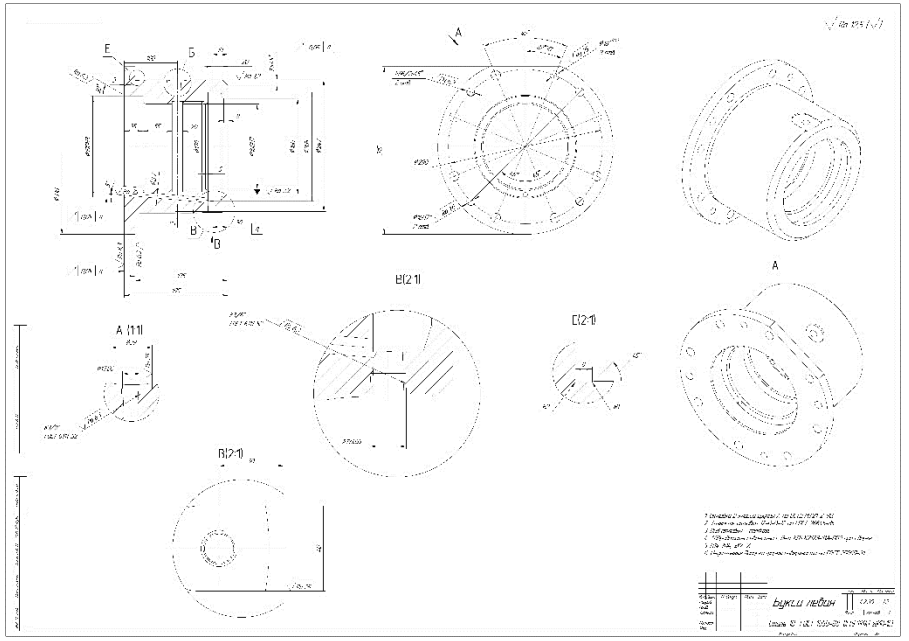
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3. Results of the study

At the beginning of the design, we have a minimum amount of initial data:

- 1) Detail drawing;
- 2) Part weight;
- 3) Material.



And after the final development of its design, the technologist or designer has a question: on the machine of which model is it most rational to perform its processing?

1) On this ?



3) Or on this ?



2) Or on this ?





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3. Results of the study

The traditional approach to technological preparation of production is based on the use of a huge number of specialized programs. The use of these systems is associated with great labor intensity and waiting for the result will take considerable time.





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3. Results of the study

The proposed system will allow you to estimate the costs associated with the selection of equipment and its placement in the production center.

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Data input
Parameters of the plant
The formation of the task
The group's task
The choice of the task

Production calendar
Program release

Parameters of the technological processes
Analysis of technology
Technological processes
Equipment selection and means of mechanization
Formative organization
Расчет количества рабочих
Calculation of cutting modes
Work cycle
Means of automation
Energy economy

Quality management
Checking the accuracy standards Of the KGSHP
Quality criteria
Analysis of the causes of nonconformity
Errors in the working documentation

Отчет
Просмотреть отчет

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Mechanical presses

Manufacturer company	Appointment	General view
HKM3 Kurimoto Smeral	Пресс предназначен для горячей штамповки поковок из черных и цветных металлов из штучных нагретых заготовок и может применяться как в составе автоматизированных комплексов, так и в качестве самостоятельной	
Press models <input checked="" type="checkbox"/> According to the calculation data	Technical characteristics	
K48538 КД8040Б КД8040 КБ8042 КГ8042А КБ8544А КБ8544Б КМ8044 КД8044 КД8040 КГ8048 КА8549	Nominal force: 40 (4000 т) Slider stroke: 400 Number of automatic slider moves: 50 The number of single moves of the slider: 14	

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Metalworking machines

Machining center or machine	Appointment	General view
фрезерный сверильный шлифовальный карусельный расточной зубонарезной	The machine is designed for cutting (turning) workpieces made of metals and alloys in the form of bodies of rotation.	
Machine models <input checked="" type="checkbox"/> According to the calculation data	Technical characteristics	Machine model TURNING CENTER M-
QUICK TURN 250MB GLS-1500L Mega Turn 400 HAAS TL-1 QTU-350 HP QUICK TURN 350M MULTIPLX 6300-II MULTIPLX W-300 HEADMAN HCL 400 TAKISAWA LA-1500L MEGA TURN 500MS INTEGREX J-200 INTEGREX J-300 INTEGREX J-400 INTEGREX-100 Integrex J-200	Maximum processed diameter: 580 Power, kW: 22 Length, mm: 5520 Width, mm: 2420 Height, mm: 2780	

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4. Solving problems for related training profiles. Materials Science

$$L = L_0 + L_1 + L_2 \quad K_{KP} = \frac{N_J \times i \times t_F}{F_e \times 60}$$

$$T_0 = \frac{L}{S \cdot n} \cdot i$$

$$R_{TO} = \frac{n_f}{K_{MO}} \cdot m \cdot (1 + K_S)$$

$$K_Z = \frac{O_{SR}}{G_m}$$

$$M = \frac{O_g \cdot K_H}{P_e \cdot C_P \cdot (365 - D_{NP})}$$

$$P_e = P_T \cdot K_Z \cdot K_V$$

$$K_V = \frac{T_P}{T_N}$$

The relative simplicity of the applied methods and formulas allows us to obtain a fairly accurate forecast.



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5. Program operation experience

The purpose of the system development is to accelerate the technological preparation of production by automating most processes, including the selection of the main technological equipment.

The work is based on the calculation of the main technological time in the case of the analysis of metal cutting processes and the determination of the press force by the forging mass. At the same time, modern database technologies are used, which is based on the selection and analysis of the target function.

X

Mechanical presses

Manufacturer company	Appointment	General view							
<div style="border: 1px solid gray; padding: 2px;"> <div style="background-color: #007bff; color: white; padding: 2px;">HKM3</div> <div style="padding: 2px;">Kurimoto</div> <div style="padding: 2px;">Smeral</div> </div>	<div style="border: 1px solid gray; padding: 2px;"> <p>The press is designed for hot stamping forgings from ferrous and non-ferrous metals from piece heated blanks and can be used both as part of automated complexes and as an independent</p> </div>								
<div style="border: 1px solid gray; padding: 2px;"> <p>Press models <input checked="" type="checkbox"/> According to the calculation data</p> <div style="border: 1px solid gray; padding: 2px; min-height: 100px;"> <div style="background-color: #007bff; color: white; padding: 2px;">KA8538</div> <div style="padding: 2px;">КД8040Б</div> <div style="padding: 2px;">КД8040</div> <div style="padding: 2px;">КБ8042</div> <div style="padding: 2px;">КГ8042А</div> <div style="padding: 2px;">КБ8544А</div> <div style="padding: 2px;">КБ8544Б</div> <div style="padding: 2px;">КИ8044</div> <div style="padding: 2px;">КД8044</div> <div style="background-color: #007bff; color: white; padding: 2px;">КБ8046</div> <div style="padding: 2px;">КГ8048</div> <div style="padding: 2px;">КА8549</div> </div> </div>	<p>Technical characteristics</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">Nominal force</td> <td style="text-align: right;">40 (4000 тс)</td> </tr> <tr> <td>Slider stroke</td> <td style="text-align: right;">400</td> </tr> <tr> <td>Number of automatic slider moves</td> <td style="text-align: right;">50</td> </tr> <tr> <td>The number of single moves of the slider</td> <td style="text-align: right;">14</td> </tr> </table>		Nominal force	40 (4000 тс)	Slider stroke	400	Number of automatic slider moves	50	The number of single moves of the slider
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5. Program operation experience

The purpose of the system development is to accelerate the technological preparation of production by automating most processes, including the selection of the main technological equipment.

Upon completion of calculations in this program, we will receive the following data:

- 1) the most efficient technological equipment;
- 2) expected equipment commissioning costs;
- 3) the number of workers;
- 4) cycloramas of automated complexes, etc.

Metalworking machines ✕

Machining center or machine	Appointment	General view												
<ul style="list-style-type: none"> <li style="background-color: #007bff; color: white; padding: 2px;">Токарный фрезерный сверлильный шлифовальный карусельный расточной зубонарезной 	<p>The machine is designed for cutting (turning) workpieces made of metals and alloys in the form of bodies of rotation.</p>													
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<p>Technical characteristics</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 70%;">Machine model</th> <th style="width: 30%;">TURNING CENTER M-5</th> </tr> </thead> <tbody> <tr> <td>Maximum processed diameter</td> <td style="text-align: right;">580</td> </tr> <tr> <td>Power, kW</td> <td style="text-align: right;">22</td> </tr> <tr> <td>Length, mm</td> <td style="text-align: right;">5520</td> </tr> <tr> <td>Width, mm</td> <td style="text-align: right;">2420</td> </tr> <tr> <td>Height, mm</td> <td style="text-align: right;">2780</td> </tr> </tbody> </table>			Machine model	TURNING CENTER M-5	Maximum processed diameter	580	Power, kW	22	Length, mm	5520	Width, mm	2420	Height, mm	2780
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5. Program operation experience

The technology of mechanical engineering for the rational manufacture of parts of mechanisms and machines uses the knowledge and experience of related areas and professional training. When designing, knowledge about the physical and chemical properties of metals and alloys is important, which, under certain conditions, will significantly increase the service life of mechanisms and machines and significantly reduce material consumption [8, 9]. This section is also present in the PlantCAD software package and so far allows solving the following tasks:

- 1) calculation of the induction crucible furnace;
- 2) calculation of the furnace performance;
- 3) calculation of the furnace for heat treatment of parts;
- 4) calculation of centrifugal machines and etc.

Induction Crucible Furnace

Components of the furnace

Brand of the casting material

Steel Сталь 08X18Г8Н2Т

Сталь 08X18Н10

Сталь 08X18Н10Т

Сталь 08X18Т1

The volume of production of castings т/год.

The volume of production of castings

Equipment load factor (0.7-0.8)

Number of working days (265)

Calculate

The required capacity of the melting furnace

When working around the clock $\eta = 0,03$

For single-shift work $\eta = 0,05$

For two-shift work $\eta = 0,09$

taking into account the yield of suitable casting

When working around the clock $\eta = 0,058$

For single-shift work $\eta = 0,087$

For two-shift work $\eta = 0,175$

Preliminary selection of the furnace model

Furnace model ИСТ-0.4

Productivity, t / h 0,44

Capacity of the crucible for steel, t 400

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Dialog of the module "Induction crucible furnace"



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6. Conclusions

The main result of this work was the creation of a new class of software that allows you to make the right decision when designing a technological process or upgrading an existing one.

The applied modular approach in the structure of the developed software package will allow us to improve its functionality flexibly and quickly in the future.



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Thank you!

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