MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL TECHNICAL UNIVERSITY OF UKRAINE
“IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE”
INSTITUTE OF MECHANICAL ENGINEERING

Department of Manufacturing Engineering

Readiness for qualification
Head of the department
_______ Oleksandr OHRIMENKO
«___»_____________2022

Diploma project

Level of higher education – first (bachelor)
Program subject area – 131 “Applied Mechanics”
Educational Program “Manufacturing Engineering”

topic: “Design and technological support for the manufacture of “Shaft Bearing Housing”

Student :
__________ ALI ADHAM ALI MOHAMED_______ _____________

Supervisor:
___________Assoc. Prof. Anatolii SUBIN_________ ______________

Reviewer:
___________Assoc.prof. Olha KHOLIAVIK________ ______________

I confirmed that in this diploma project there are no borrowings from the works of other authors without proper references.
Student _____________

Kyiv 2022

MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE NATIONAL TECHNICAL UNIVERSITY OF UKRAINE “IGOR SIKORSKY KYIV POLYTECHNIC INSTITUTE” INSTITUTE OF MECHANICAL ENGINEERING

Department of Manufacturing Engineering

«APPROVED»
Head of the department

_______Oleksandr OHRIMENKO

«___»____________2022

Assignment for the diploma project

for a bachelor's degree

Program subject area **131. Applied Mechanics**

Student from group MT-84 ALI ADHAM ALI MOHAMED _______

1. Topic of the project Design and technological support for the manufacture of “Shaft Bearing Housing”

Project supervisor Assoc. Prof. Anatolii SUBIN __________________ ,

approved by the University Order of «___»_________ 2022 №_____

2. Deadline for submission of the project «_16_» 06 2022

3. Task on general engineering issues Overview of the general issues happened with Shaft Bearing Housing manufacturing ____________________

«____» ___ 2022 _____ Head of the ME department Oleksandr OHRIMENKO

4. Tasks on the topic of the diploma project Design a technological process and define the technological equipment for the manufacture of parts “Shaft Bearing Housing”

5. The list of questions to be developed on the task named in **sect.3**
Review of general issues; explain the ways to solve

6. The list of questions to be developed on the task named in **sect.4**
perform standard tasks of designing the operational technological process of manufacturing parts "Shaft Bearing Housing"; to design constructions of machine tools for realization of technological process; to determine the cost calculations; to form a set of technological documentation

7. List of the graphic material (indicating mandatory drawings, posters, presentations, etc.) to present the major results of the general engineering issues investigations; design 3-D models and drawings of parts and blanks; to design schemes of performance of technological operations; modeling of G-code operation for its execution on the selected CNC machine; to design assembly drawings of machine tools for realization of technological process; the total number of sheets of the graphic part should be 8 sheets

8. Diploma section consultants

Section name	Task	Deadline	Supervisor
Economical	Perform the detail cost calculation	30.05.2022	

TIME SCHEDULE

№	The stage of the diploma project execution	Deadline	Notes
1	Technological section	1 week	
2	Technological section	2 week	
3	Design section	3 week	
4	Design section	4 week	
5	Other sections	5 week	
6	Formalizing of the project sections	6 week	

The assignment has been issued «_15_» 04 2022

Student ______________ ALI ADHAM ALI MOHAMED

Project supervisor ______________ Anatolii SUBIN

ANNOTATION

Design of work piece structure of shaft bearing housing deals economic calculation of new manufacturing part is already produce and the idea is to save money and increase production technological process implementation and to make manufacturing process better to reduce machining rejection, all mechanical work and design process standard operation to be done on it during the production process and all design activities covering this process.

Contents

1. Solving General Issues of Mechanical Engineering

The general issues of mechanical engineering regarding of “Shaft Bearing Housing” is as follows:

1.1. Overheating

The cages, balls, and rings transform from gold to blue as a result of overheating as well as the shaft on which the housing is fixed and placed.

Ball and ring materials may be annealed at temperatures over 400 ºF. As a result of this, hardness and bearing capacity are reduced. Early failure may occur if the issue is not handled.

In severe circumstances, the rings and balls might deform as well. The lubricant might be damaged or destroyed by the increase in temperature.

1.2. Common Overheating Causes

The most common overheating causes which effect the “Shaft Bearing Housing” are as follows:

- Inadequate heat transfer
- A lack of lubrication and cooling is to blame
- A lot of electrical power is needed

Bearing life and performance are negatively impacted by a lack of appropriate lubrication in high- speed and high-load situations.

1.3. True Brinelling

Brinelling happens when the ring's elastic limit is exceeded. Indentations in the raceways caused by brinelling might cause additional bearing vibration.

Extreme impact or static overload are common causes of brinelling. When it comes to brinelling procedures, it is advisable to avoid them. Among them are the following:

- Assembling and disassembling the equipment
- When pressing a bearing onto a shaft, do not apply undue stress to the outer ring
- Using a hammer to install or remove bearing

When the Brinell markings are severe and widespread, early fatigue failure is more likely to occur.

1.4. Reverse Loading

An axial load may only be accepted in one direction by angular contact bearings. This region of contact is cut off at its lower shoulder when the ring is loaded from behind, which causes the elliptical contact area to shorten when it's loaded from the front.

Look for signs of early failure and increasing vibration in addition to the rise in temperature and excessive stress. In this failure condition, the balls seem to have a grooved wear ring owing to the ball riding over the raceway's outside edge, and this suggests a tight fit.

1.5. Tight Fits

The bottom of the raceway is an obvious place to look for signs of a tight fit. The full circle of the outer and inner rings is the wear path. When the interference fits surpass the radial clearance at operating temperature, excessive loading of the ball results. As a result, increased torque and a rise in temperature are produced. With sustained use, rapid wear and early tiredness are inevitable.

1.6. Corrosion

Corrosion may be detected by looking for red or brown spots on the bands, raceways, balls, or cages of ball bearings as well as shaft housing. This problem may occur in bearings that are exposed to corrosive gases or liquids. A rise in vibration is followed by fatigue, wear, preload loss, and a higher radial clearance as a result of these processes. Corrosion at its most severe causes early fatigue breakdowns.

1.7. Misalignment

A ball wear path on the non-rotating ring raceway is a sign of misalignment in a bearing. This wear path is not perpendicular to the raceway's edges. "

When the misalignment exceeds 0.001 inches/inch, the temperature rises abnormally. The housing and the bearing are both impacted by this little misalignment. Common causes of misalignment include the presence of dirt or burrs on the shoulders and shaft of the housing. The threads on the shafts are not parallel to the soft seats.

1.8. Improper Mounting

The rotating ring should be press-fitted with the bearings in the vast majority of cases. One of the most common causes of premature bearing failure is damage caused by a variety of factors. This includes pushing on the inner ring of the bearing, putting pressure on the outer race of the bearing, loose shaft fits, loose housing fits, overly tight housings and a poor finish on the bearing seat. These are some of the most common causes of bearing failure.

1.9. Fatigue (Spalling)

Overloading, an excessive preload, tight inner-ring fittings, and utilizing the bearing beyond its projected fatigue life are all causes of spalling in bearings. Small, discrete particles of material may be found in the inner ring, outer ring, or rolling components after the running surfaces have been fractured. Spalling will continue to spread as long as the procedure continues. A considerable increase in vibration and noise is almost always present.

2. Technological Process

2.1. Analysis of the Service Purpose and Operating Conditions of the Detail in the Node

It is not necessary to mill the casings enclosing the spinning shaft in order to use mounted or housings with a rolling bearing to support it reliably.

For every given application, you want to be assured that the mounted bearing solution will provide the needed equipment performance while also being as cost-effective as feasible. As a result, it is essential that your equipment be able to withstand a wide range of circumstances, including those that may change over time.

If you want to find the best answer, we propose following this procedure. There are icons that depict each stage of the way.

2.2. Principles of Selecting Mounted Bearing on Housing

Ultimately, you want to be sure that you're getting the most value for your money when it comes to picking a mounted bearing solution for your application.

When creating a specification for a mounted bearing system, various factors must be taken into account. Our suggested bearing selection method may also be necessary to ensure that your solution contains the suitable bearing for your operating circumstances and performance needs.

You'll find the following in this area a brief description of the product, including the following details:

- information on the benefits of mounting your bearings
- the primary features of the various kinds of mounted bearing solutions
- an overview of the many options based on the size and type of shaft and housing

a product selection process, which is our step-by-step approach to analyzing your application and determining the optimum option for you. The design of a basic machine is possible to bolt on a mounted bearing solution to any machine structure that has a bearing housing, seals, and other components. It is possible to construct a machine structure using beams and frames, welded, riveted, or bolted together, without requiring a great degree of accuracy. If you don't want precision-machined bearing seats in your surrounding structure, don't use one.

2.3. Determining the Type of Production and the Impact on the Technological Preparation of Modern Machine-Building Production

The administration of industrial processes to ensure that they run smoothly and at the desired level is known as production management, which is also known as operations management. Both the service and manufacturing sectors make use of production management techniques. Marketing, human resources, and finance management all fall under the same umbrella of responsibilities. Production management encompasses all aspects of a manufacturing operation's activities, including product and process design, capacity and quality planning and control, and employee organization and supervision.

5 M’s People, machines, methods, materials and money are the "five M's" of production management. The operating system's human component is referred

to as the "Men" component. Being able to manage people is an essential skill for a production manager since so many workers are involved in the actual physical creation of items. Manufacturing equipment and processes must be planned and controlled by a production manager, who must first pick and then plan and control which equipment and technology will be employed in the process of creating a product or service. Manufacturing flexibility and the capacity of employees to adjust to changing equipment and schedules are critical challenges in this phase of production management.

2.4. Planning and Control of a Manufacturing Process

In production management, control is the most critical problem, and the five M’s convey the core of the primary jobs. If you're in charge of production, you need to make sure everything is running on time, on budget, and to your standards. First, process control ensures that activities are carried out in accordance with plan, and second, it monitors and evaluates the production plan to determine whether improvements can be made to better meet cost, quality, delivery or other goals. A product's production level may need to be modified to deal with variable demand or changes in a company's market share when demand is strong enough for continuous production. "Production- smoothing" is the name given to this issue. More extensive industrial engineering or operations research processes are needed when more than one product is involved in the issue. The management of inventories is a crucial aspect of the manufacturing process. A company's stockpiles comprise raw materials, components and parts, work-in-progress products, completed items, packaging and packaging materials, and miscellaneous supplies. It's widely accepted that manufacturing companies with large inventories (some accounting for more than 50 percent of total assets) typically hold production managers responsible for inventory management, despite the fact that effective use of financial resources is generally considered beyond the purview of production management. A company's competitive performance depends on its ability to effectively manage its inventory, which entails determining which things to keep in stock at different locations. Carrying every item at every location might take up a lot of money and lead to a buildup of outmoded, useless goods if you don't have a need for it right away. Industrial engineers and operations researchers construct mathematical models and computer tools that managers depend on to deal with inventory management issues.

In order to keep labor expenses under control, managers must first determine how much and what kind of work it takes to make a product, and then devise effective ways to complete the manufacturing activities that are needed. An essential part of management in this field is to use the principles of Taylor's work measurement, Gilbreth's time study and incentive systems to encourage and reward high levels of worker output Predicting human resource needs and translating them into recruitment and training programs is critical in the early stages of a company's operations, especially in the case of new operations. Other specialized groups are required to assist operations (such as those in charge of maintaining equipment or performing plant services and production scheduling and control tasks). Preventing costly capital equipment from sitting idle and wasting resources like as time, effort, and materials may be accomplished via proper people planning.

2.5. Importance of Models and Methods

Many quantitative approaches to production management have been created as a result of the vast complexity of ordinary production activities, as well as the almost limitless possibilities for modification and alternative approaches. Industrial engineering, operations research, and systems engineering have all contributed to the development of several of these methods. To deal with the immense amounts of data that come from today's big workforces, massive inventories, and tremendous amounts of work in progress, experts in various sectors are increasingly turning to computers and information processing. Industrial engineers and technical experts are critical to the success of many masses manufacturing processes.

Production-control summary				
	processes	**inventory**	**inspection**	**costs**
observation	measuring rate of output; recording idle time or downtime	recording stock levels	inspecting materials and parts	collecting cost data
analysis	comparing progress with the plan	analyzing demand for stocks in different uses and at different times	estimating process capabilities	computing costs in relation to estimates
corrective action	expediting	issuing production and procurement orders	initiating full inspection; adjusting processes	adjusting selling price of product
evaluation	estimating production capacity and maintenance schedules	drawing up replenishment policies and inventory systems	reassessing specifications; improving processes and procedures	evaluating production economics; improving data

Three sorts of choices are frequently made in the course of production and operations management:

2.6. Preparation for Production:

Operations managers are confronted with their initial set of challenges during the planning phase. During this phase, management determine where, when, and how manufacturing will take place. They choose the best places for the projects and gather the required materials.

2.7. Control of Production:

Controlling quality and expenses, scheduling, and day-to-day operations of operating a manufacturing or service facility are the emphasis of this stage of decision-making.

2.8. Increasing Output and Streamlining Processes:

Operational management's last phase focuses on improving the efficiency with which the firm's products and services are produced or provided. A choice may be made on any or all of the three at the same time.

Diversifying manufacturing and maintaining work efficiency were regarded as the most important priorities for innovative growth at the company

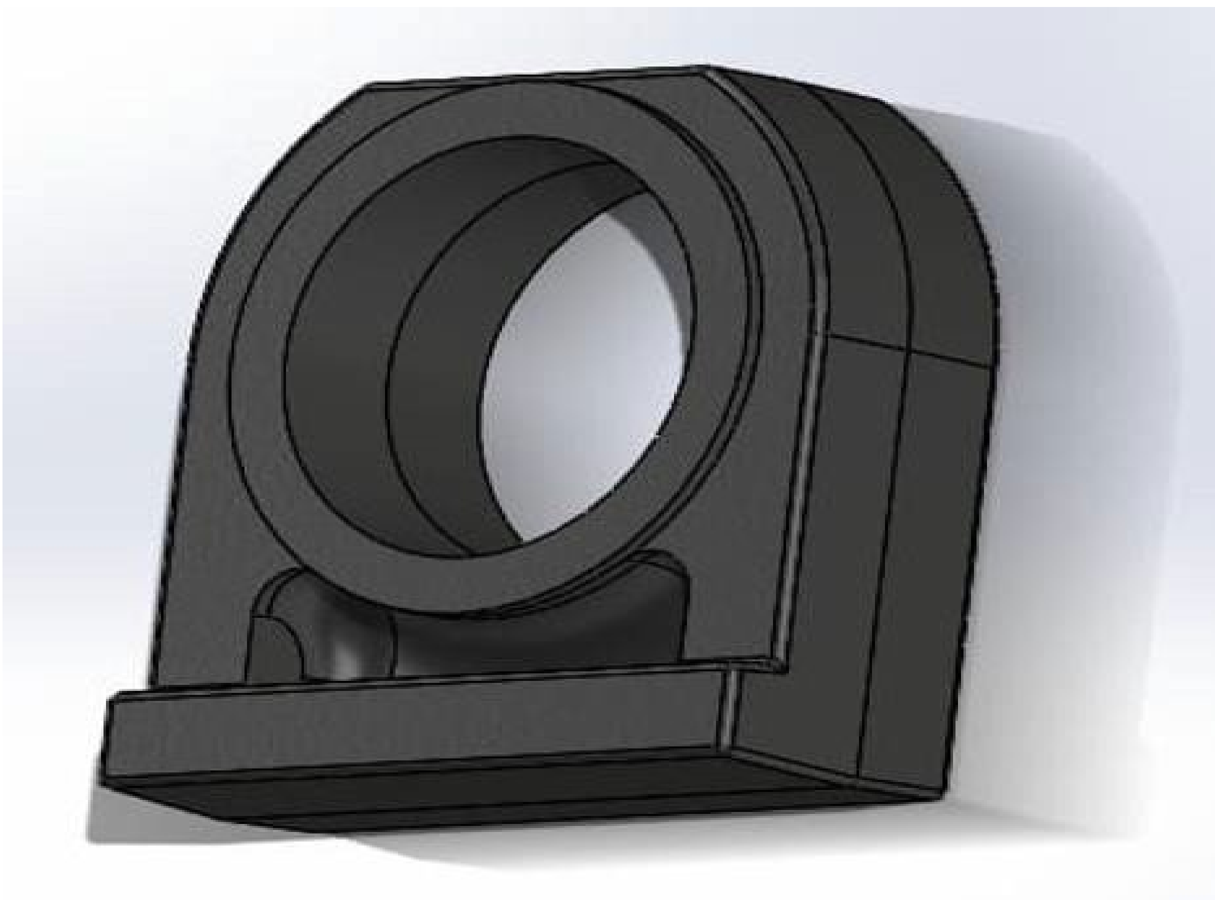
- Implementation of programs aimed at improving the environmental performance of production
- Implementation of Research and Advanced Development plans (development of new technologies in production)
- Implementation of measures to develop a quality control system
- Creation and implementation of information technology and modern data management methods; Implementation of measures to improve the innovation management system

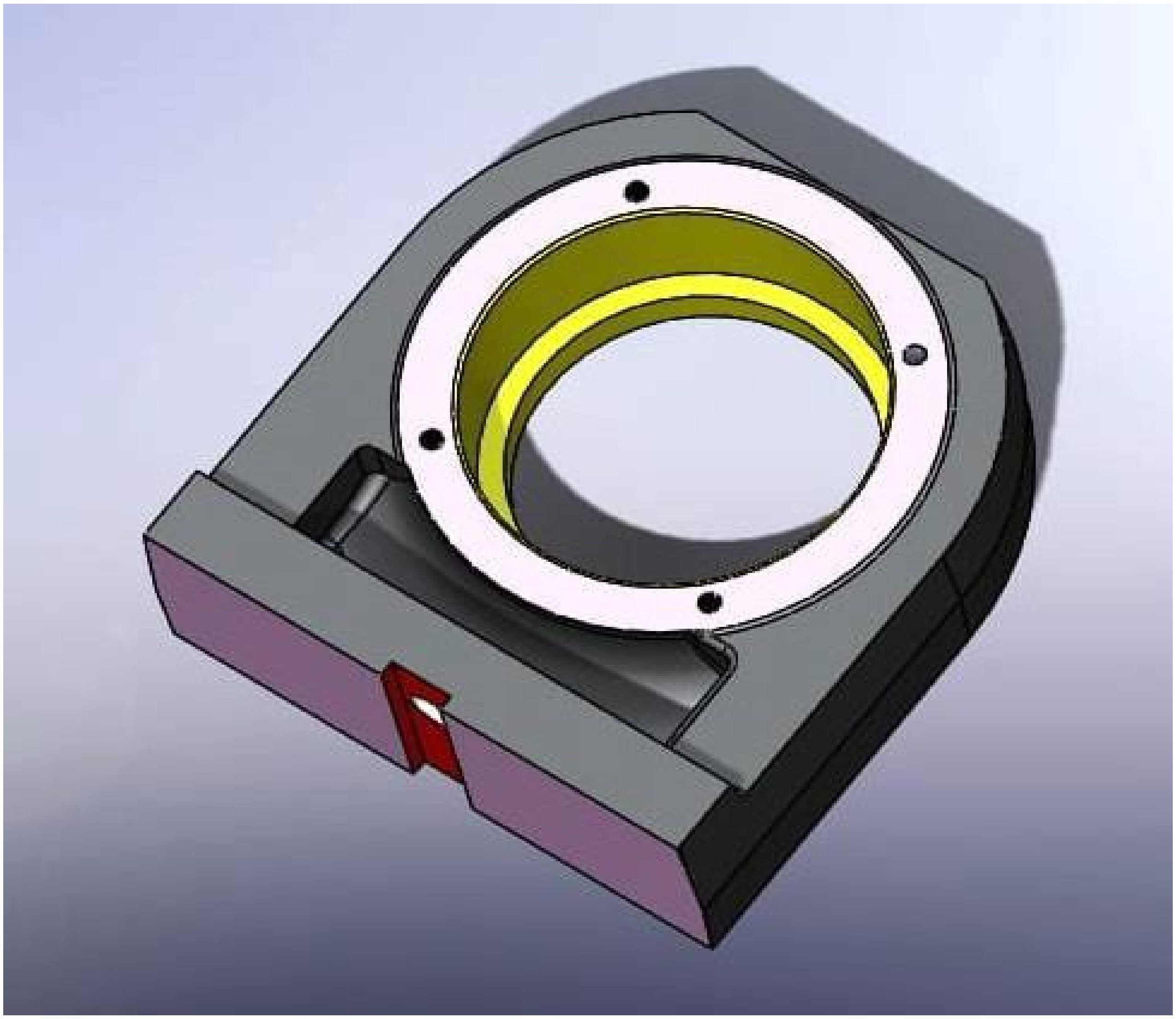
2.9. Part Design

In this beholder thesis the design process of shaft bearing housing is proposed and implemented. Thesis aim is to design and develop shaft bearing housing from scratch on Solidworks and AutoCAD. At this stage it helps entrepreneurs in the context of project development by explaining the formation process of the shaft bearing housing.

2.10. Analysis of design features of the part and its classifications

Shaft bearing housing is class of body part support bearing, protect them from contaminants while keeping in lubricant can also housing monitoring. Design of part is shown in figure it has two main cylindrical bore and four holes and one main hole on base of shaft bearing housing as shown in figure below





2.11. Design of part structure

- Technological process of casting in sand clay molds dimensional accuracy class of casting 11T-4-14-1= GOST 26645-15.
- A number of allowance for processing biblika - 8.
- Surface roughness of casting Ra 40 micrometer
- To specify unspecified incline 1. Unspecified radius perform 3.5 mm.
- The worked must be cleaned of burns, spills and scars removed level. Remains of spouts at highest of not more than 1 mm along, the parameter of socket bokan. Scars with height not more 1 mm and thickness is not allow more than 1 mm.

- Defects are allowed on treated surface except for cracks that do not exceed 2/3 of allowance for machining.
- On raw surfaces individual shells with the long dimensions in 3 mm depth up to 1 mm in the amount of not more than 5 pcs.
- Apply low temperature annealing.
- General tolerance ISO 8062 – CT10 – RMA 3 (F).
- Draft angle 3 degree and radius 2.5 mm.
- Final casting outcomes must be free of surface defects as per visual of drawing.

2.12. Calculation allowance for casting

Dimension of part	RMA	Min limit of size for external feature(or max or internal feature)	Casting Tolerance ,mm	Raw Casting basic dimension
157.00	3	160.00	3	161.5±1.5
20.00	3	23.00	3	24.5±1.5
48.50	6	54.50	4	56.5±2.0
95.00	7.5	87.50	4	85.5±2.0
83.00	3	80.00	2	79-0±1.0

2.13. Rationale for the choice of technological bases for the part "Bearing Shaft Housing"

Four types of surfaces that can be used to represent each detail are:

- Main design bases (OKB)
- Auxiliary design bases (DCB)
- Fastening surfaces (KP)
- Free surfaces (VP)

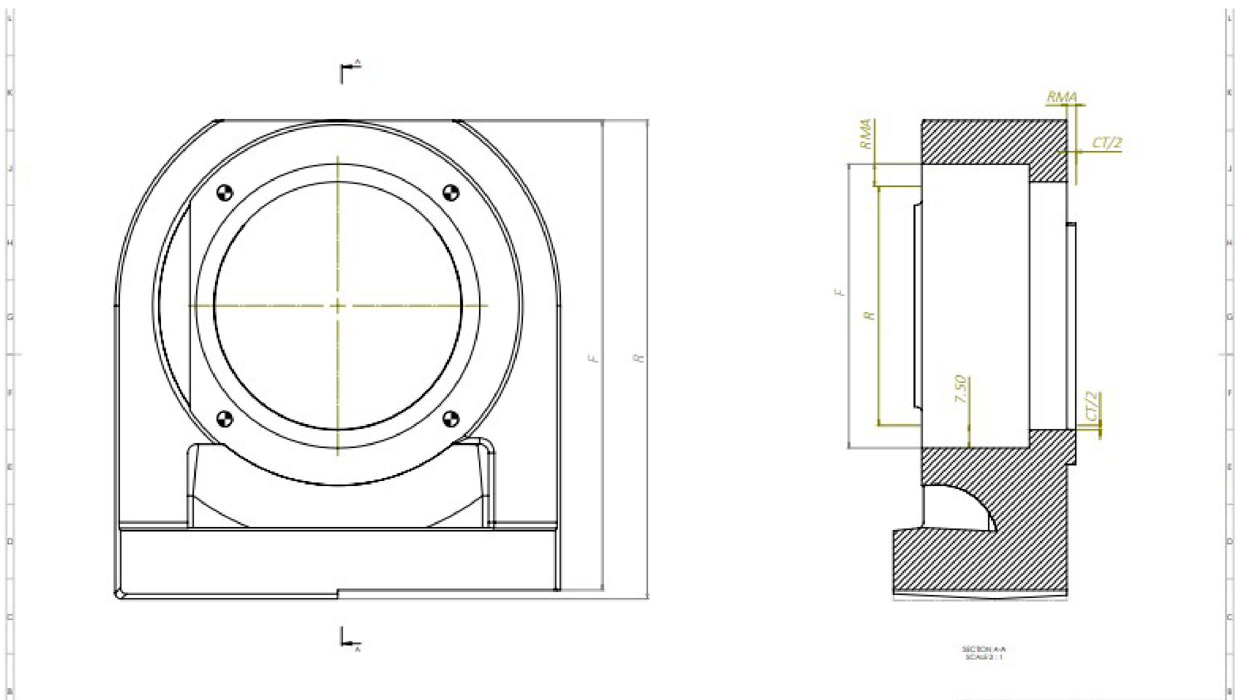
Fig. shows the general technological basis for constructing a project:

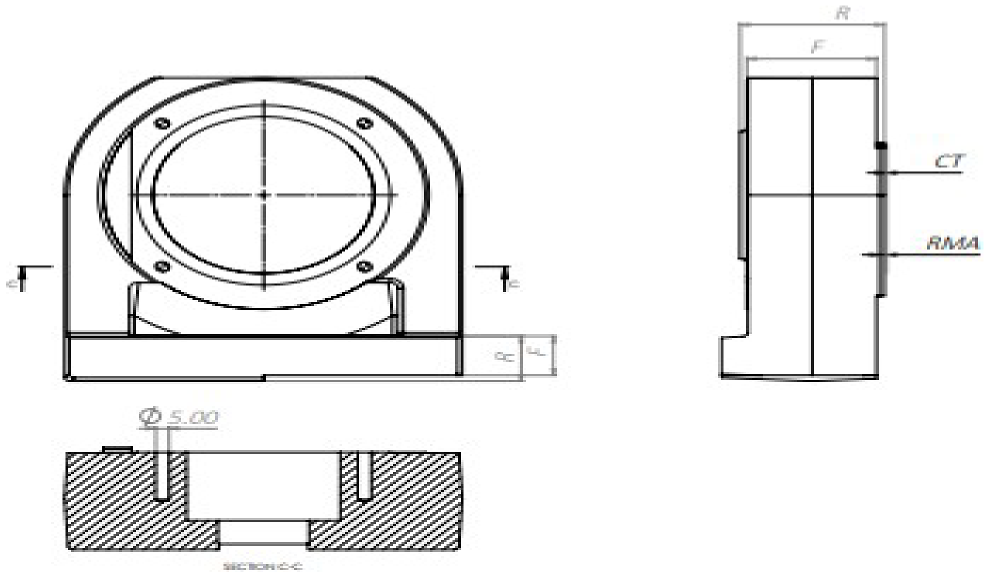
OKB may be employed in the same way as ZTB is in the implementation of a certain technical procedure.

SBZTB U (3) + PO (2) + O (1) is the structural formula of the ZTB-based scheme.

The predetermined framework ensures a secure installation and a straightforward attaching method, while also allowing for the processing of a few essential surfaces.

A plane, a short cylindrical finger, and a short rhombic finger are used to construct this well- developed method. The additional requirements for manufacturing quality and wheelbase accuracy of the base holes O2 and O3 are a drawback of this base arrangement.





2.14. Design of Typical Sequences of Surface Treatment

The design steps or sequence for the for-surface treatment of the project is as follows:

1. Surfaces that have been sanded and polished prior to further phases of processing.
2. The qualitative features of the treated surfaces must be improved with each succeeding technological transition or operation. The treatment of the workpiece's surface must be revisited if this condition is not satisfied, for example while performing heat operations. This is because the subsequent steps of processing rely on it.
3. In the case of important, big, and high-value items, the roughing step must be kept separate from the succeeding processing stages, or aging techniques must be used.
4. Faults on surfaces where defects are not permitted must be treated in the early phases of TA so that they can be detected quickly and wasteful expenses may be minimized.
5. In the first stages, it is important to focus on the surfaces that have the greatest room for error and are the most critical. This design of TP allows for the longest possible age process, from roughing to final processing, to take place.

6. Six. The most critical surfaces should be treated at the most recent technical transitions to guarantee that all earlier mistakes can be corrected, that unintentional mechanical damage to surfaces may be eliminated, and that the natural aging process can continue for as long as possible.
7. Stepped shaft surfaces must be machined first to ensure that they do not affect the workpiece's rigidity, as well as to guarantee the shortest working strokes possible while machining the shaft. The most productive cutting modes are always used in this processing setup.
8. The stroke length of the tool with the smallest rack must be kept to a minimum throughout technological transitions and operations. Additional technical transitions like drilling an aperture or undercutting the end face may be required in these circumstances.
9. Surfaces having a defined spatial location should be addressed in one place.
10. It is necessary to separate processes for complicated surface processing, such as threading, plastic deformation, and surface honing (PVC). Please be aware that threading is not an issue with current CNC machines, thus threading can't be isolated from other processes.
11. The tool should not be changed until after final processing of the particular responsible surfaces. To be clear, as current CNC machines' positioning precision has improved, they've had to switch to rigid systems, which compensate for installation errors by deforming elastically when the tool is moved.
12. After the final treatment of the surface on which they are produced, the fastening surfaces must be treated in the third stage of TP.
13. The most efficient way to handle a large number of openings is to use a tool of the same size for each one, so that the most work can be done in the shortest time. When employing several axial tools at the same time, this criterion may not be taken into consideration (drill, countersink,

reamer).

14. There are several factors that need to be taken into consideration while developing machining processes on multi-purpose machines.
15. It is necessary to coordinate technical operations at the time of their execution in the highly structured machine-building production of CERs and CERs for the organization of workplace service.
16. There are two parts to any thermal processing procedure: pre-heat treatment, and post-heat treatment.
17. Surfaces need to be finished with chamfers before they may be chamfered. After PPD, chamfers, grooves that are cut onto the surface are carried out.
18. Prior to undertaking any especially risky actions, the TP should include control activities between the component modules. These operations should also be performed after processing.

2.15. Workout of design of a product on Manufacturability

Shaft bearing housing is object of operation and estimated by consumer for compliance with its clients. While starting machining operation product named as object of production having different criteria design requirements which are called manufacturability. For the production of shaft bearing housing part the design Engineer with confidence make drawing and check the production for high quality manufacturing.

Final production will start as the design work is done correctly testing, analysis prototype of the product. Production cost of reviewing is much low than again change later in manufacturing operations. It is not easy for designer to have to not only to improve. According to rules of technologists to make more or less serious change in the design uncovered to the objection of designer who refer to the facts to reconstruction the facts of shaft bearing housing lead to the already design and developed processing.

In process of production practical the requirements of technologist for the manufacturability of the parts at this position of control of design documentations was not accepted by designer every this mention in drawing after the product lunched. The task of the specialist who carry out the technology control help the designer in testing the part in manufacturability. There is now issue experienced a technologist, he cannot find technological solution easily.

Team management discussion is most important and is initial point of manufacturing and cooperative choice of optimal solution should me recommended in the development of technological process. In actually there are more difficulties and problems to control technologically design documentations.

Analysis of the available testing system for the manufacturing of shat bearing housing is show the checking the documentation of design and process of development is very week. At the stage of testing research work of the manufacturing it was observed that there was low quality of technological solution.

If there is any change in technological or design and manufacturing process it will be lead additional cost which is very native impact on cost and same with the term of product development. Without the fact that the development of new product of manufacturability is much important problem. The investigation of the above writing source permit us to presume that basically of the review issue that emerge during innovative readiness of creation utilizing computerized arrangement of mechanical planning of creation, is issue mechanized testing of item plan of manufacturability. There the undertaking of mechanizing the most common way of testing item plan for manufacturability is vital and requires the production of fitting devices for it arrangement.

As we are manufacturing part name shaft bearing housing, customer will provide design drawing of part with all requirements and specification like dimension etc. The development department check the design and will arrange meeting with quality department, procurement and foundry shop. The development department develop process of production standard operation (SOP)

That how the work will be done and tools selection machine arrangement operation wise standard operation testing process of part.

Consumers assess whether or not a product meets its intended function before deciding whether or not to purchase it. However, before it can be used, a product must first be manufactured, which has its own set of criteria known as manufacturability.

Because of this, the final design of the drawing must begin only after the designer is confident in the product's performance as well as its manufacturability, i.e. the ability of the product to be manufactured at a high quality in a certain production environment.

Final testing and analysis of prototypes of the product ensures that the product is manufacturable at the end of the design process. As a matter of fact, this is the final chance to make any significant design changes without jeopardizing the project. Reviewing the project now is far less expensive than making modifications later, while the product is being manufactured or operated.

The remarks of a techie often force a designer to not only enhance their design but also completely rebuild it. In most cases, designers oppose to design alterations by technologists, citing the fact that the reconstruction of individual elements results in processing of previously designed items. Many times, after a product has been released, the needs of the technologist for the manufacturability of a component must be included into the drawing. This occurs at the stage of technical control of design documentation. As a result, the design isn't final until it's reviewed by technologists and coordinated with them.

Technological control specialists are responsible for assisting product designers in conducting manufacturability tests on their designs. Even though a techie has years of expertise, he can't always come up with the best technical solution. For this reason, it is advised that while developing technical processes, the most critical and essential areas of production be discussed together and the best answer jointly selected. New products are put through rigorous testing to determine whether or not they can be manufactured by professionals from every step of the manufacturing process. In this way, all structural parts may be proven in terms of their function and dependability as well as cost and aesthetics more quickly.

Because no particular practical suggestions of the technologist for its execution have been made to yet, the technical control of design documentation is still quite challenging.

The analysis of design documentation, the order in which it is generated, is still systematically lacking in the enterprise's testing systems for manufacturability. The surface is being tested for its ability to be manufactured at this point in the research process. Developing and designing a single version of a technology within the short time allotted for technical preparation makes testing challenging. To put it another way, this means that technical solutions are of a poor quality, and all the difficulties in developing manufacturability is concentrated at this point, when the technological equipment has already been made.

There are extra expenses connected with the modification of the design and technical documentation at this stage, and in many instances the design of technological equipment anew and its fabrication in an emergency, which has a highly negative influence on prices and terms of product development.

According to literature, there has been no single spent system, a single methodological basis for testing products for manufacturability so far. Despite this, it must be acknowledged that the development of a new product for manufacturability is a very important problem and without it, the existence of any modern production in the field of instrumentation and mechanical engineering is simply impossible. There are almost 5000 publications listed under [1] that deal with the topic of manufacturability. The data presented in the majority of these papers supports what has been said so far.

To create new products for manufacturability, various techniques are used depending on the product and industry, which may validate the findings of literature study [2 13]. It is important to highlight that if the approach of working on manufacturability in sectors such as foundry and machining can be deemed adequately developed, then such fields as assembly (particularly robotic) and automation can't be stated to be as well-developed.

As a general rule, relatively little attention is given to the subject of testing new goods for assembly production and automation and robots. Only a few bits from [3 6, 8, 9] are likely to be included here.

Note that "manufacturability" is non-existent outside of the United States. The term "manufacturability" has been translated as "technical efficiency" in GOST 14.201-83 [14], "operational manufacturability" has been translated as "maintainability," and "repair manufacturability" has been translated as "repairability" in GOST R 51033-97 [15]. The phrases "manufacturability" and "design for assembly" are used instead of "manufacturability" and "design for manufacturing," respectively, in English technical literature, despite the precise translation. It's not uncommon to hear the term "DFMA" ("Design for manufacturing and assembly") bandied around.

One of the most critical steps of technical preparation for manufacturing is determining the manufacturability of product designs (TKV), knots, assembly units, and details. According to our findings, boosting the product's manufacturability by 8... 12 percent, and sometimes even 20 percent, may decrease the assembly complexity of the product 8... 12 percent, and even lower the manufacturing costs of the product 5... 10 percent. [4]. An automated method of technical preparation for production is the only one that can effectively handle all of the issues that emerge throughout the process.

Technology-assisted preparation of manufacturing is common in all developed nations. State programs to automate technical preparation for production and manufacturing of equipment and instruments were established in the United States in 1976 [16, 17].

In our nation, automated methods of technical preparation for manufacturing were first developed in the 1960s. With regard to the creation of theoretical foundations and the attainment of practical results, scientists play a significant role in the building of automated systems for technical production preparation. Many others, including SP Mitrofanov (18–20), VI Averchenko (21–24), GK Goransky (22–24), MM Kapustin (25–31), D.D. Kulikov (19, 20, 32), VV Pavlov (27, 28),

B.S. Paduna (19, 20, 32), V.D. Tsvetkova (33, 34), LS Yampolsky (35, 36), and AP Gavrish (

According to this literature review, automated product design testing for manufacturability is by far the least researched problem that arises during the technical preparation of production employing automated methods of technological preparation of production.

Consequently, the challenge of automating product design manufacturability testing is critical, and the construction of relevant tools is required to solve it successfully.

3. Casting Process and Material Analysis

Material we have used for shaft bearing housing is **Gray Cast Iron (ISO 185 – CLASS 150)** this material has good thermal conductivity and high strength this material is most common used for majority of applications.

3.1. Chemical compositions of Gray Cast Iron is given below table

C	S	P	Si	Mn	Cr	Ni	Mo
3.04	0.11	0.0068	2.58	0.42	0.07	0.02	0.005

Iron extracted from core iron and melt in electric furnace, where its separates into pig iron and slags. Furnace heated at temperature of 1800 degree Celsius in an oxygen atmosphere at this stage slag formed to the top which will be removed that causes of defects that names slag.

Below molten pig iron contain 3 wt. % - 5 wt. % carbon. This is combination of iron steel coke and limestone.

When the impurities once removed than carbon content is less. And this point silicon is added to convert carbon content into graphite.

3.2. Mechanical Properties Gray Cast Iron Material

Tensile strength σ_B	Hardness HB	density ρ
152 MPa	**205 HB**	**0.01g/mm^3**

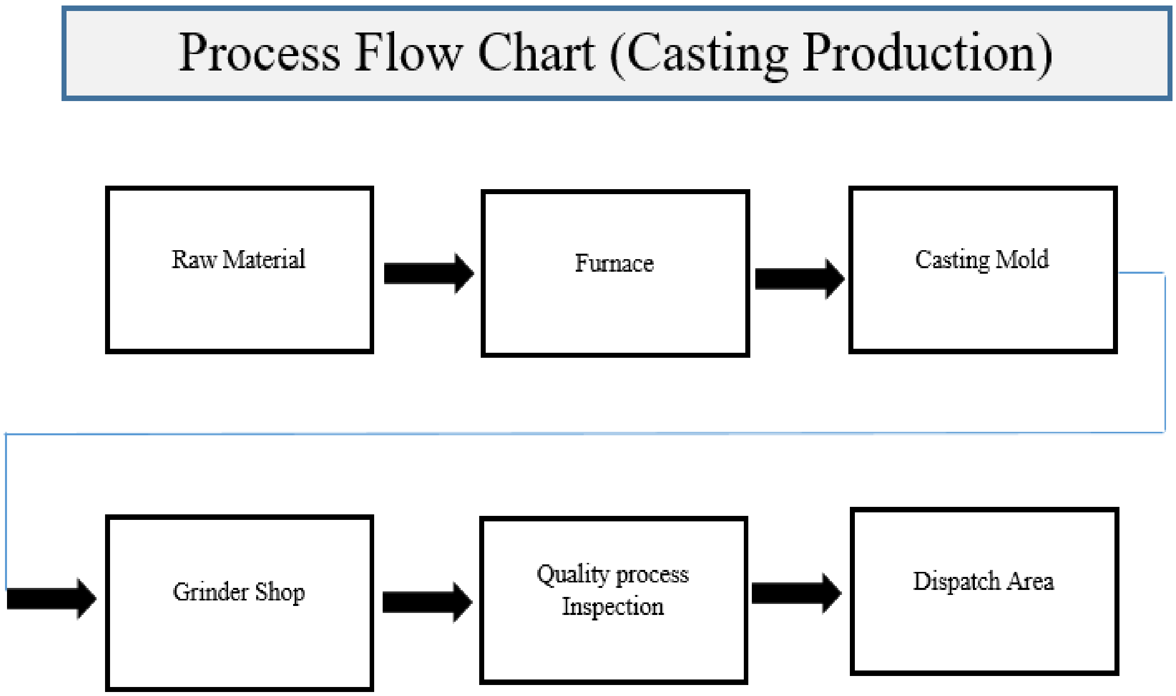
Weight of Material is 5.12 kg.

Selection of the base process and design of blank

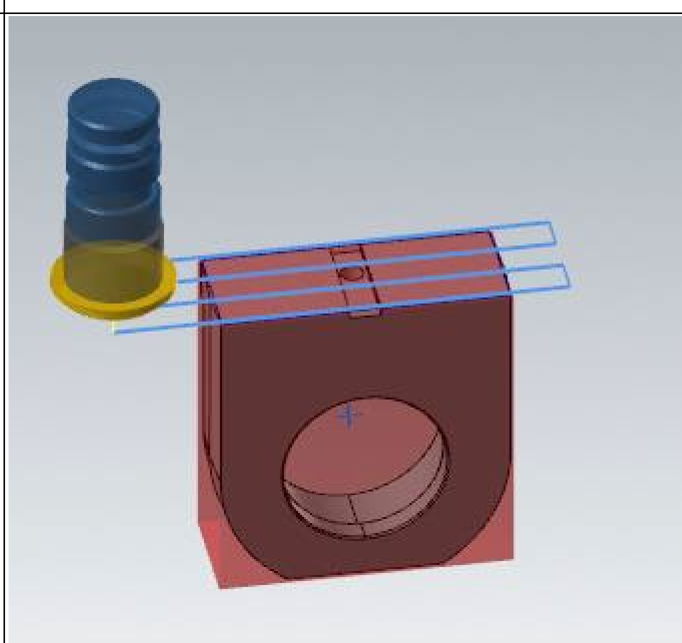
- Initial data for process
- Drawing of shaft bearing housing
- Material (Gray Cast Iron)

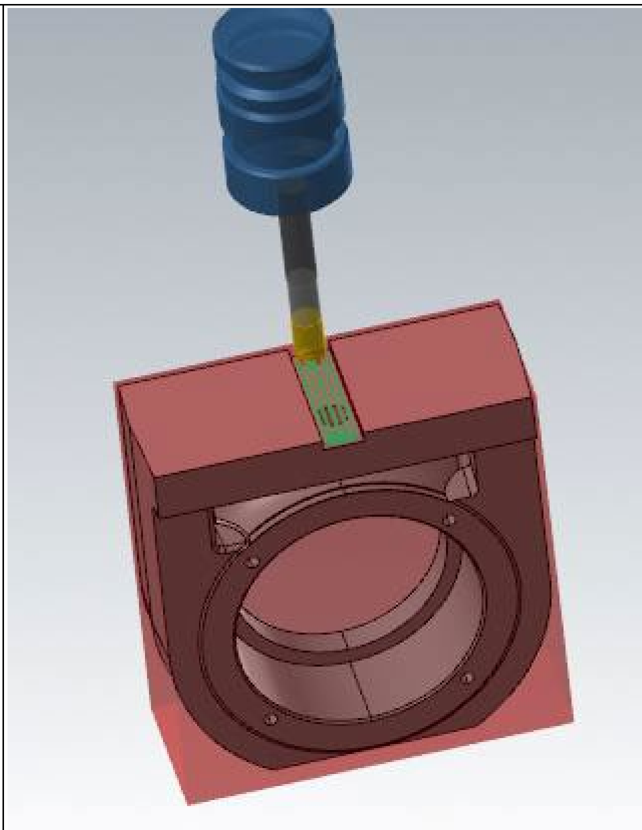
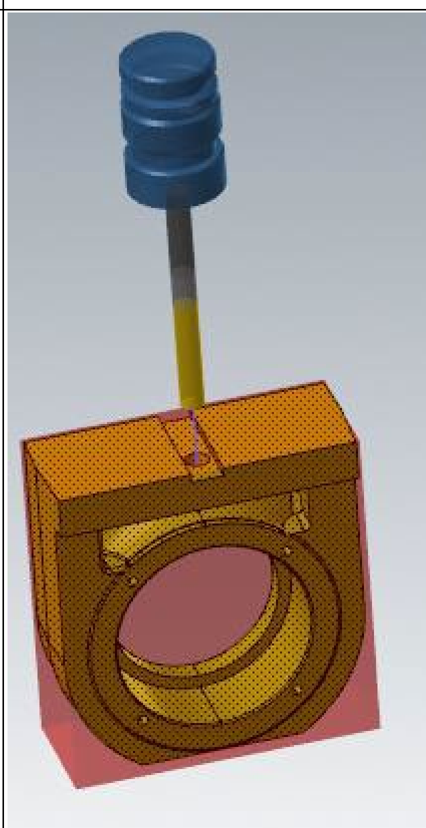
For production process of shaft bearing housing logo is design below that how we will start production and process first of all we have raw material we will convert in liquid form and then fill in casting pattern and after this we will send this part to grinder shop to remove extra material from casting part, short blister used to fill the cavity of part. Quality department in foundry shop will check material chemical and mechanical properties and part size according to drawing if it will pass than dispatch to machining shop for manufacturing.

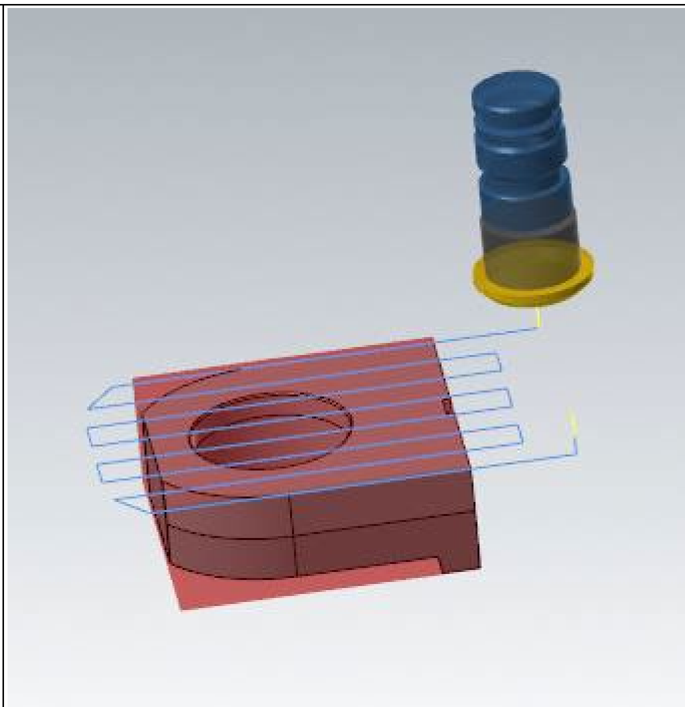
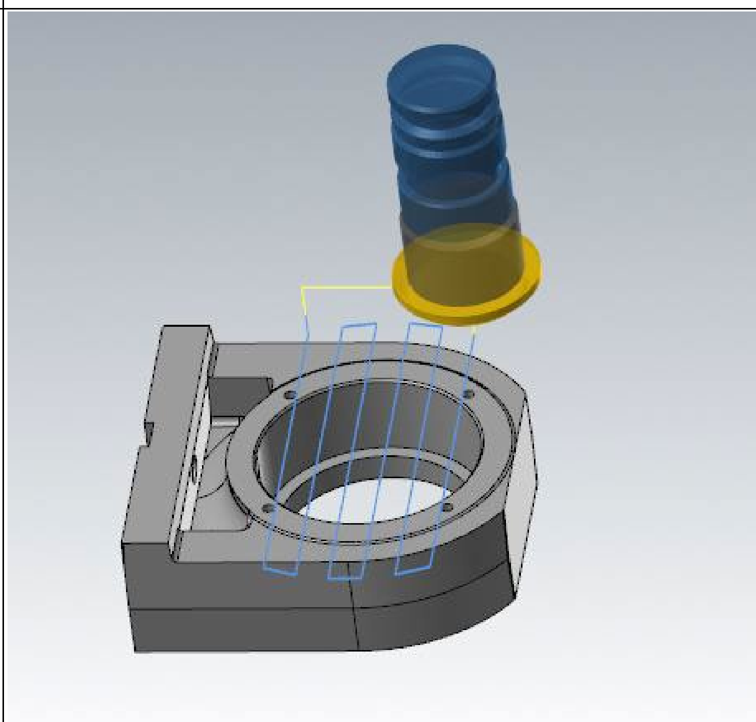
3.3. Process Flow Chart for casting production of Blank Shaft Bearing House.

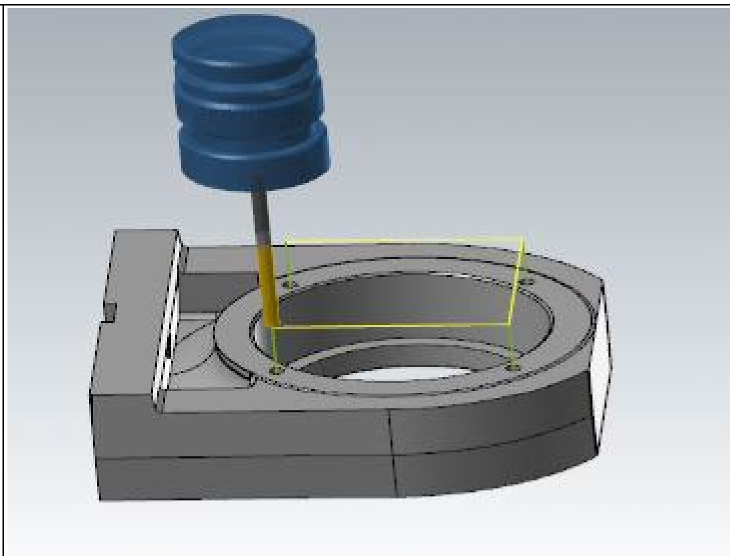
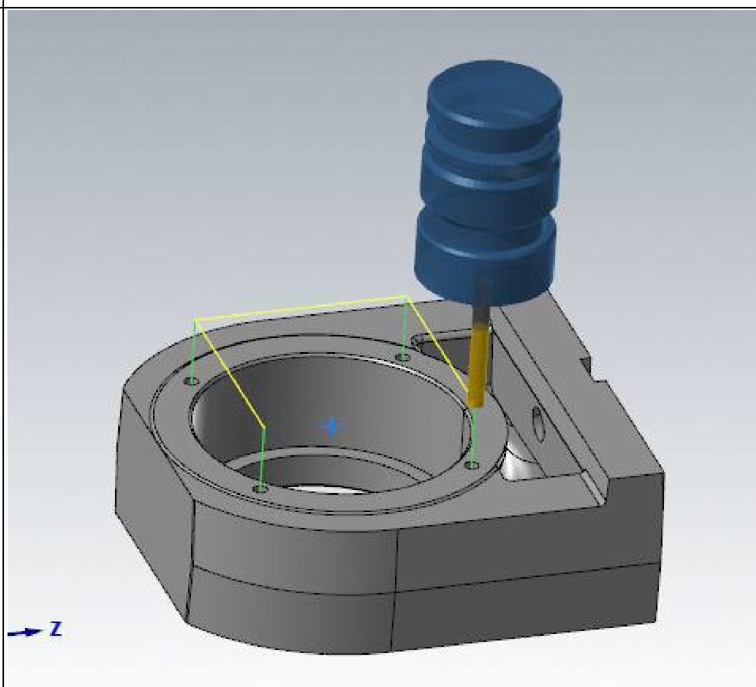


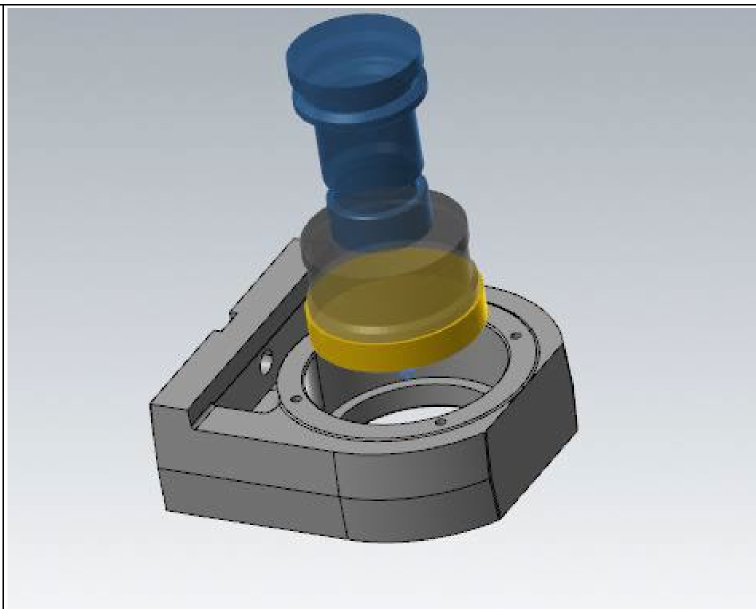
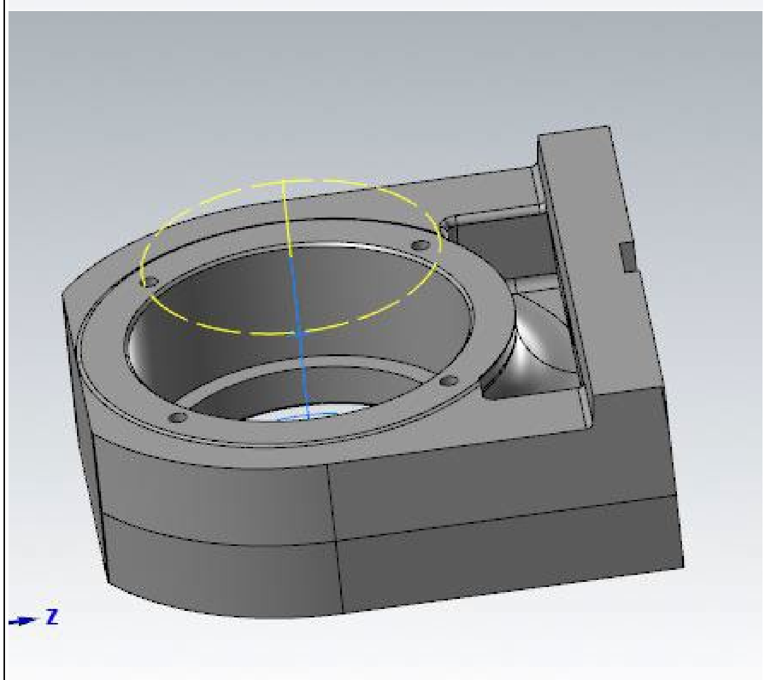
3.4. The list of operations

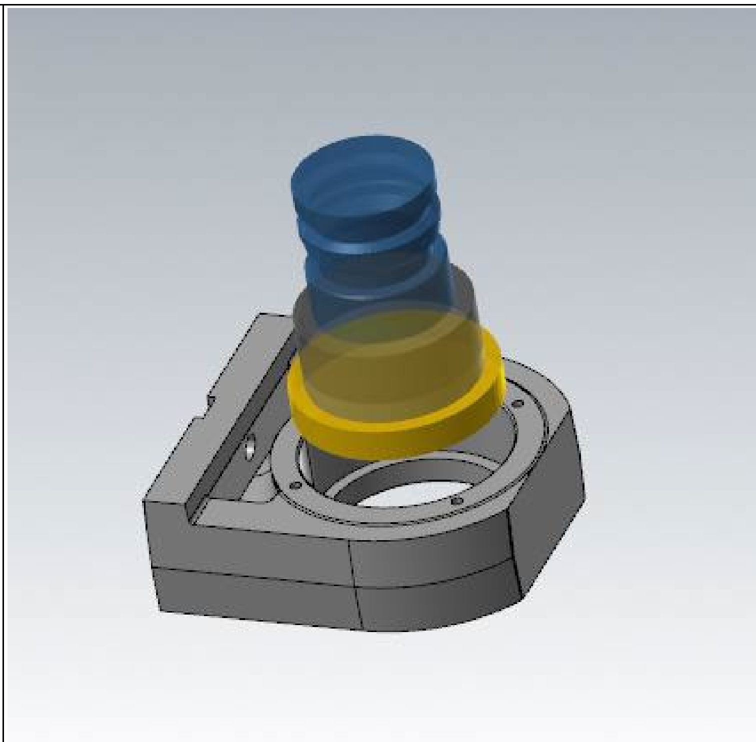
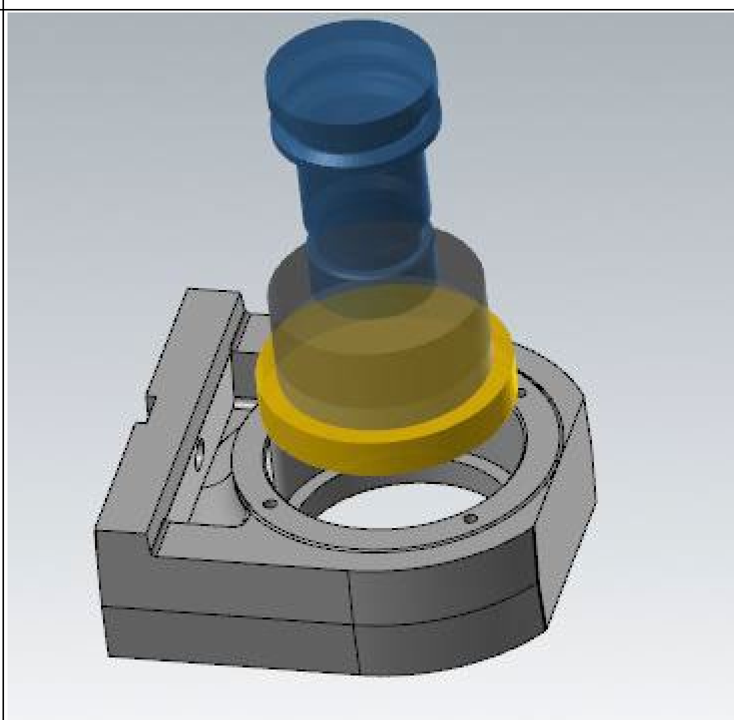
Name	Schema	Description
005		Face Milling operation

010		Drilling operation
015		Drilling operation

020		Back facing
025		Front facing

030		House drilling
035		Housing tap

040	 	Machining operation

045		Rough step boring operation
050		Boring operation

4. Fixture design and clamping force calculations

4.1. Fixture 1 design and clamping force calculations

Machining process here when we will fasten shaft bearing housing part in fixture than there are many forces cutting tool forces, self-workpiece force so, while designing fixture we have need to calculate its forces and clamping forces,

According to the conditions of forces in X- axis and Y- axis, calculate the clamoring force reliable work piece.

For the calculation we accept the following simplifying assumption.

- Part weight is not taken in account.
- Support and clamping mechanism should be rigid.
- Setting figure do not perceive the cutting force.

On the base of equilibrium condition we will find allowable force Q.
X=0 KP = 2P. (f_1+f_2), P = 2kP/ (2. (f_1 + f_2))}

Where P= $\sqrt{p_y^2 + p_z^2}$ = 1.00 P_Z

Pz – tangential components of cutting during milling and its value is 6075 N.

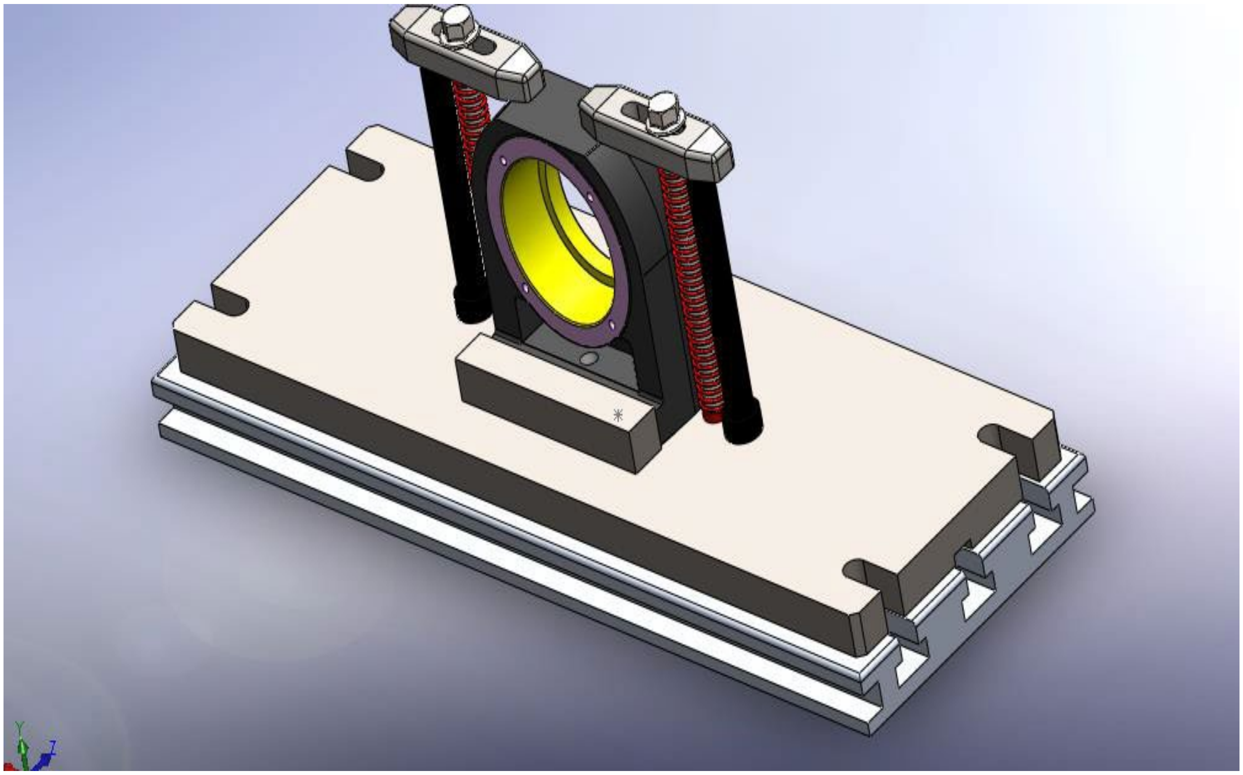
F1 is the coefficient of friction of the clamping mechanism with part for unthread f1= 0.2 F2 is the coefficient of friction of clamping mechanism with part for thread f2 = 0.16

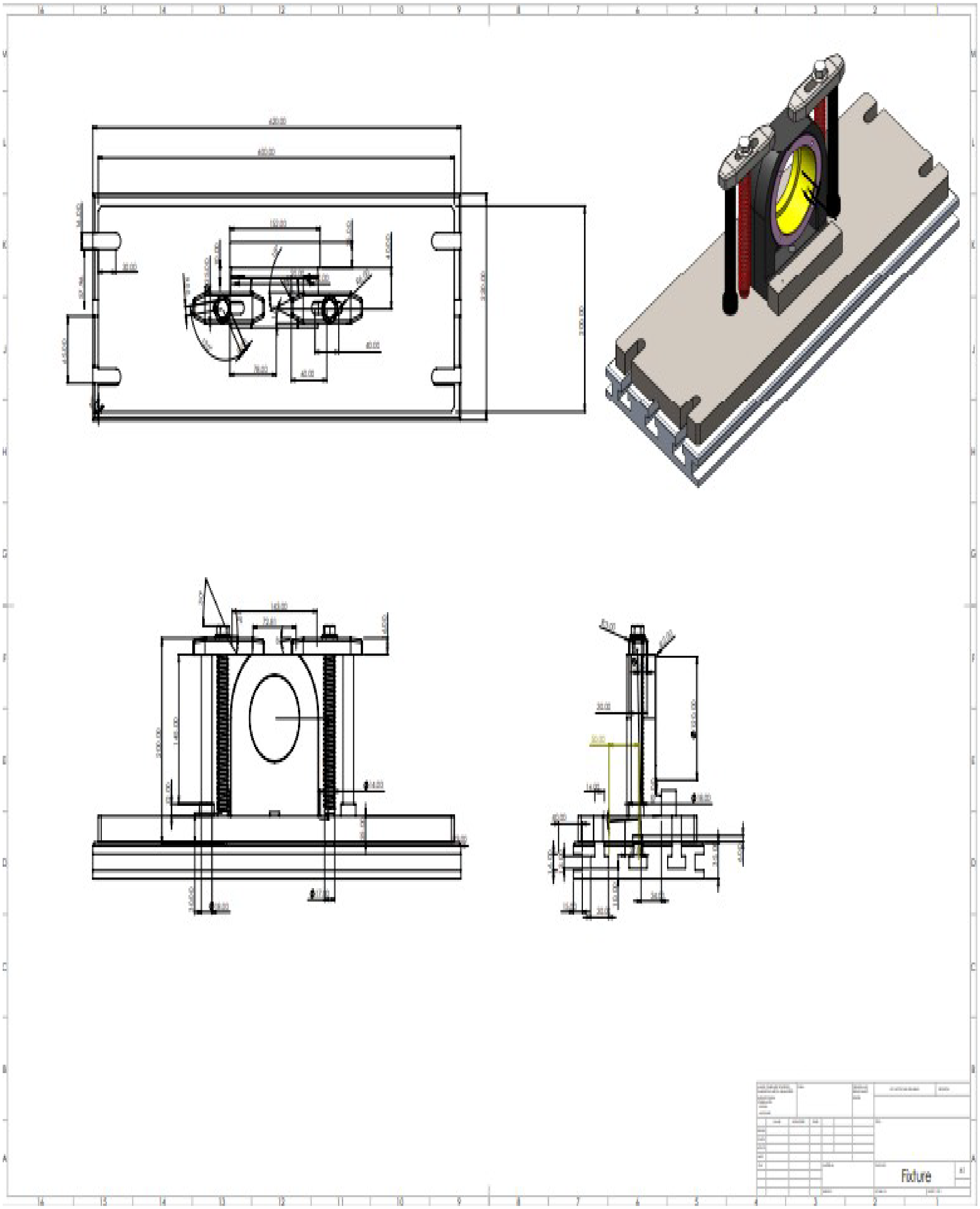
So, According to

GOST K= 2

Therefore Q= (1.07 .k .P_Z)/ (2. (f_1 + f_2)) = **12433.4 N**

We accept fixture force is **12433.4 N**




Fixture

5. Cost estimation

We will calculate total cost for production of shaft bearing housing from casting to machining process discuss labor cost, electricity cost and material cost.

Total cost is calculated on the base of process selection that how production will done in foundry shop and machining shop. Our production plan for shaft bearing housing is 10000 quantity.

Cost of production of shaft bearing housing is calculated with the help of casting production Manager and Development deputy director of Manufacturing Company, I have calculated cast of

- Material cost
- Electricity cost
- Machining tool and coolant
- Labor cost

Cost Estimation			
Project	Shaft Bearing Housing		
Cost For Casting Process			
Data	**Amount($)**		
Material Cost		Total	$ 52,203.00
Electricity Cost	Year	Total	$ 6,757.00
Labor Cost	Year	Total	$ 3,730.00
Total Cost			$ 62,690.00
Workshop Manufacturing Cost			
Labor Cost	Year	Total	$ 1,881.00
Electricity Cost	Year	Total	$ 2,475.00
Coolant Liquid	Year	Total	$ 742.00
Machining Tools	Year	Total	$ 1,485.00
Total Cost			$ 6,583.00

Total Production per year	10000
Total casting & Machining cost	$ 69,273.00
Per part Cost	$ 6.93

6. Occupational health and safety

6.1. Personal Safety

- When working in a factory, always wear eye protection. You may use this regardless of whether or not you use a computer. Your own safety might be threatened by the actions of others.
- There is no one-on-one student employment in any retail establishment. You should be accompanied by at least one other person. A friend or family member may call for assistance if you are injured.
- See a doctor right away if you've been hurt. Any and all injuries, no matter how small, should be reported to a parent or an instructor as soon as they occur. As a result, we'll be able to lower future dangers.
- Using unlicensed equipment is a crime. Both you and your equipment will be shielded from harm by this method.
- In order to utilize the workshop, students must be on the accredited list.
- Pets are not permitted in the workshop at any time. In addition to being an eyesore, pets may be hazardous when left alone on the shop floor.

6.2. Dress

- Open-toed or high-heeled shoes are not permitted. Choose shoes with soft soles and solid soles to safeguard your feet. Your feet will be better protected if you wear the correct footwear.
- Loose clothes are strictly prohibited. In addition to tires, scarves and loose-sleeved shirts, this category covers but is not limited to. There is a preference for sleeve lengths that fall below the elbow. Arc-flash and metal sparks are better protected by wearing long sleeves when exposed to high temperatures like those seen in a fire.
- In the Bilious hardware shop and Mudd Instrument store, employees are not permitted to wear shorts, shorts, or skirts. Freshly cut metal, like sheet stock, has sharp edges because of the heat. Protect yourself and your loved ones by wearing long pants. In addition, heated chips may burn or slash exposed skin, which might scare workers.

- If you have anything on your person that could become entangled in the machine, take it off. Loose bracelets and rings are included in this category. Necklaces and other jewelry should be removed if they aren't properly secured.
- Prevent any and all hair, including the beard, from being entangled in any equipment that is in motion.
- While operating a moving equipment, gloves are not allowed. Gloves are prohibited because they may get tangled in moving parts and pose a safety hazard. the following are the exceptions to the rule:
- When using a bench or portable grinder or piercing wheel, always wear gloves.
- In order to protect yourself from chemicals or pollutants, use membranous gloves (like latex or nitrile).

6.3. Machine Maintenance Safety

- Don't mess about with machinery while it's running. When you are working on a moving equipment, you are exposed to additional threats.
- All security measures should be in place and operating properly. You should notify your Monitor if the Monitor is broken or malfunctioning.
- Never leave a computer running unattended. When the machine is running, some people may not be able to notice it and may be hurt by moving components.
- It's not a good idea to try to manipulate the machine in any way. Seizures might occur if you try to stop the machine with your body. It's best to let the machine do its thing.
- All moving machinery must be kept away of all body parts at all times, including hands, hair, feet, etc. All moving components, notably cutting tools and chucks, should be treated with extreme care.
- Remove chuck keys, wrenches, and other tools from the machine after making modifications. When the machine opens, any chuck keys that are still in the chuck become deadly flying objects.
- It's best to switch the machine off if you hear anything strange. The machine isn't working properly if it makes weird noises to you. Problems should be reported to the shop clerk.

- Compressed air should never be used to clean equipment. As a result, the life expectancy of the equipment will be drastically shortened. To clean the equipment, use the chip brushes and detergents supplied.
- When cleaning your clothing or your body, never use compressed air. Concentration of particles in the skin and eyes may occur. Air may enter the bloodstream in extreme circumstances.

6.4. Work Practice

- Before turning on the machine, make sure all of the tools and equipment are securely attached and backed up.
- When working with large or delicate items, it is common to need additional support structures to ensure their safe operation. If you're not sure whether or not your project requires more assistance, seek advice.
- When delivering products that are either inaccurate or too heavy, enlist the assistance of others. This will keep you and your loved ones safe from harm.
- Remove the sharp edges of newly cut stock by deburring. Included in this package is a piece of material that returns to stock. In order to prevent human harm and to match mechanical sections of the machine, pierced edges should be removed.
- When working alone, the machine should be used.
- It is morally wrong to depend only on machines. Grab a chair if you need to take a break.
- Do not use the machine while talking. Do not use the machine while talking to anybody else. Don't be a bother to anybody else. It just takes a few seconds for an accident to occur if you're not paying attention. Shut off the machine if you must talk.
- Before beginning any job, check that you have enough light to see properly. Workplaces that are well-lit promote worker safety and well-being.
- Maintain a tempo that is comfortable for you. The risk of equipment damage is increased when chasing prevents safe operating procedures from being followed.
- A harmful activity should never be attempted by someone who does not know how to perform it. Have faith in your own senses. If you're unsure about what you're doing, check with the monitor.

- The use of excessively loud music is prohibited. You must be able to hear the machines in action and speak with them. Earbuds and headphones are not permitted.

6.5. Workshop Cleanliness rules

- The floor should be kept clean and clear of any liquids such as sawdust, oil or grease. You should clean up fluids as soon as possible since they are slippery.
- Things should be kept in such a manner that they don't get in the way of your progress. Return anything you don't need right now to its correct place.
- When not in use, put tools away. This keeps tools from being misplaced and ensures that others may use them.
- Put all of the leftovers in the trash.
- Ten minutes before you need to leave the shop, stop working. During this period, they'll be able to clean and replace their household equipment.
- We're all responsible for keeping the shop tidy. Having a busy or messy office is not an excuse. You're working too quickly if your workplace is crowded. Take it easy. Keep in mind that cleaning up after someone will not annoy them. This also applies to you, I'm sure.

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