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# Fabrication of Jigs in Toolbit Grinding for Shop Safety and Efficiency

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**Abstract:** This technology research aimed to fabricate jigs in toolbit grinding for shop safety and efficiency in the workshop. The toolbit is a high-speed steel, The sleeve is made from a round bar stock measuring Ø 50.80 mm X 75 mm long, and the barrel is made from a square bar stock measuring 50.8 X 50.8 X 75 mm long. The essential machining skills needed in fabricating jigs includes lathe and milling operation, drilling and tapping, grinding, sawing, deburring and CNC programming. The skills are taught in Machining NCII qualification offered in Don Bosco Technical Institute-Makati. The fabricated jig output was used in the machining process and was compared to the manual jig output. After the machining process, the fabricated jigs are safer compared to manual grinding output because it holds and supports the workpiece securely in place during the machining process and allows for more consistent and accurate machining operations. It also results in faster machining process and higher production rates compared to manual grinding and reduces the need for manual repositioning and realignment of the workpiece, which can save time and increase efficiency. The operator-researcher recommends future studies should explore on attaching the barrel and sleeve to the fabricated jig so that the operator will not hold the barrel while grinding.

**Keywords:** *Fabricate Jigs, , Machining NCII*

## 1. Introduction

Machining NCII is a technical vocational training program offered by TESDA (Technical Education and Skills Development Authority) in the Philippines. NCII stands for National Certificate Level II, which is a competency-based assessment that ensures that the graduates of the program have the knowledge, skills, and attitude required for the occupation. The Machining NCII program aims to provide students with the skills and knowledge necessary to perform basic machining operations such as drilling, turning, and milling. The program covers the use of machine tools, reading and interpreting technical drawings, performing basic measurements, and selecting and using appropriate cutting tools. The program consists of both theoretical and practical training, with emphasis on hands-on experience in a simulated workplace environment. Fabricating jigs is an essential skill that is taught in the Machining NCII program, as it plays a critical role in ensuring the accuracy and precision of the machining process.

Jigs are essential equipment for toolbit grinding because they offer a precise and dependable way to retain and guide the grinding tool during the production process. The design and construction of a jig for grinding carbide drill bits are described in the study of Chen and Yang [1], along with an assessment of the tool's precision and consistency of grinding. In comparison to freehand grinding methods, the authors find that using the jig improves grinding precision and consistency. The study conducted by Zhang and Zhu [2] presents the design and fabrication of a jig for manufacturing small-size ball-end mills, and evaluates its performance in terms of accuracy, efficiency, and

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cost-effectiveness. The authors conclude that the use of the jig results in improved accuracy and efficiency compared to traditional manufacturing methods, and that the cost of the jig is offset by the savings in production time and improved product quality.

The use of jigs in toolbit grinding has been shown in related studies to increase shop safety and efficiency by lowering the risk of operator injury, enhancing grinding precision and uniformity, speeding up production, and preventing the creation of faulty toolbits. By giving workers a safe and secure platform to grip and guide the grinding tool throughout the manufacturing process, jigs can enhance shop safety. Since jigs put a barrier between the tool and the machinist's hands, they help machine operators limit the risk of harm from slips and unintended contact with the grinding tool. Jigs can also lessen the possibility of mistakes and flaws in the completed toolbit, which can improve workplace safety. If defective toolbits malfunction or break while being used, there may be a risk of injury or equipment damage. The design and construction of a jig to increase the security and effectiveness of grinding operations are the main topics in the study conducted by Muratuglu and Efe [3]. By lowering the possibility of operator harm, cutting down on grinding time, and increasing grinding precision, the authors concluded that using the jig enhanced safety and efficiency. Using jigs can also aid in increasing output and decreasing manufacturing time from an efficiency standpoint. Jigs offer a repeatable and dependable way to hold and guide the grinding tool, which may assist to speed up toolbit manufacture and cut down on the amount of time needed for each one. This is particularly crucial in high-volume manufacturing settings since even modest efficiency gains may save a lot of time and money. This investigation on jig optimization for tool and cutter grinding aims to increase the precision, consistency, and effectiveness of grinding. The use of jigs increased grinding uniformity and precision, decreased production time, and increased overall shop efficiency [4]. The authors also point out that the use of jigs can increase shop safety by lowering the possibility of operator harm and avoiding the incidence of faulty toolbits. There are no specific studies comparing fabricated jig and manual grinding in the machining process. Thus, this study was conducted to fabricate the jigs in toolbit design for safety and efficiency in the fitter-machinist workshop of Don Bosco Technical Institute-Makati.

## 2. Material

The toolbit used is made of high-speed steel (HSS), a cutting tool used in metalworking, woodworking, and other material cutting applications. HSS is a type of alloy steel that contains high amounts of carbon, tungsten, chromium, and vanadium. These elements help to increase the hardness, strength, and wear resistance of the steel, making it ideal for cutting tools. The high carbon content in HSS provides the toolbit with excellent hardness, allowing it to cut through tough materials without wearing down quickly. The tungsten and chromium in HSS also contribute to its hardness and wear resistance, while the vanadium helps to increase its toughness and heat resistance. Toolbits made from HSS are commonly used in lathes, milling machines, and other machining tools. It can cut through a wide range of materials, including steel, cast iron, and non-ferrous metals. HSS toolbits are preferred over other materials due to their durability, longevity, and ability to maintain a sharp cutting edge even under high heat and pressure.

A sleeve made from a round bar stock measuring Ø 50.80 mm X 75 mm long is a cylindrical component that can be used in various industrial applications. The sleeve is made from different materials, including metals such as steel, aluminum, or brass, as well as plastics or composites. The specific material used will depend on the application requirements, such as strength, corrosion resistance, and temperature tolerance. To make the sleeve, a round bar stock with a diameter of 50.80 mm (or 2 inches) is typically used. The bar is then cut to a length of 75 mm (or 2.95 inches) and machined to the desired dimensions and finish. Sleeves made from round bar stock can be used in many applications where a cylindrical component is required. For example, they can be used as bushings, spacers, or bearings. They can also be used in hydraulic or pneumatic systems, as well as in machinery and equipment that require precise alignment.

A barrel made from a square bar stock measuring 50.8 x 50.8 x 75 mm long is a cylindrical component used in various industrial applications. The barrel can be made from different materials, including metals such as steel, aluminum, or brass, as well as plastics or composites. The specific material used will depend on the application requirements, such as strength, corrosion resistance, and temperature tolerance. To make the barrel, a square bar stock with a size of 50.8 x 50.8 mm (or 2 x 2 inches) is typically used. The bar is then cut to a length of 75 mm (or 2.95 inches) and machined to the desired dimensions and finish. The square shape of the bar allows for greater precision in the machining process, resulting in a more accurate barrel.

## 3. Method

A. Sleeve

1. Clamp the work piece to chuck of milling machine. Slotting is the first step in making the sleeve with dimension of 10 mm width, 30.4 mm depth and 60 mm long.
2. Insert a square bar measuring 10 mm X 30.4 mm X 60 mm long in the slot made in the sleeve by force fit.
3. Clamp the work piece again to milling machine, make 2 small slot in the sleeve parallel to the inserted square bar that will be used in making a hole for the pin.
4. Clamp the work piece to drill press, using Ø 4 mm drill bit, drill a thru hole in the small slot.

5. Insert the Ø 4 mm pin to the drilled hole.
6. After inserting the pin hole, put the blank sleeve in the lathe machine use surface gage to center the work piece.
7. Clamp the work piece in lathe machine use facing method/process to machine the end of the work piece to have smooth surface.
8. After facing, straight turning is performed to reduce the diameter of the stock round bar to Ø 30 mm X 60 mm long.
9. Remove burrs from the end corner of the work by performing chamfering process, then remove the work piece in the chuck.
10. Clamp the other side of the work piece (sleeve) in the chuck.
11. Using facing method/process, bring the length of the work piece (sleeve) to its exact length 72 mm long.
12. After facing, straight turning is performed again to reduce the diameter of the other side of the work piece to Ø 40 mm.
13. Remove burrs from every corner of the work piece.
14. Clamp the indexing head of vertical milling machine. Indexing method is done to make 360-degree graduation in the fabricated sleeve with least count of 5 degree.
15. After indexing, the sleeve is clamp again to drill press to drill 1 pc Ø 7 mm drill bit.
16. After drilling, screw thread is made in the drilled hole to put M8 X 1.25 set screw.

B. BARREL

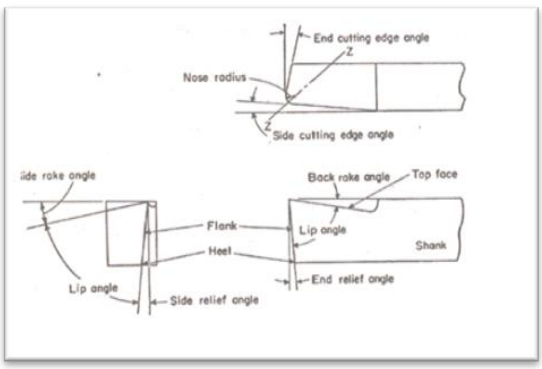
It is the part of the jig where the sleeve with inserted tool blank is placed and the degree of end cutting edge angle, side cutting edge angle and end relief angle is set.

Procedure:

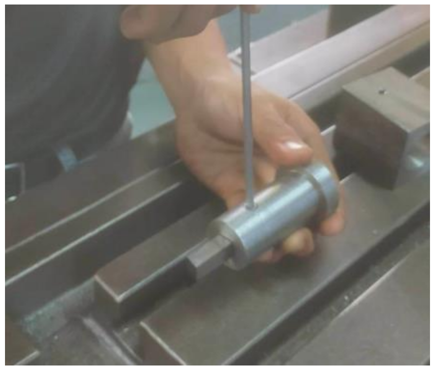
1. Clamp the work piece (barrel stock) in the Lathe Machine.
2. Facing process/method is performed to flatten the end of the work piece and to have smooth finish.
3. Remove the work from the lathe machine chuck.
4. Clamp again the other side of the work piece.
5. Facing process/method is performed to flatten the end of the work and finish the length of the barrel measuring 60 mm long.
6. Remove the barrel from the lathe machine chuck and lay-out one side of the barrel for drilling and boring operation on the lathe.
7. After lay-outing, clamp again the barrel to the Lathe machine chuck and center the barrel using the lay-out mark as the reference point.
8. Once the barrel is centered, perform center drilling.
9. Drill thru hole to the barrel using Ø 8 mm.
10. After drilling Ø 8 mm thru hole re-drill using Ø 16 mm.
11. After re-drilling using Ø 16 mm re-drill again to Ø 25.4 mm.
12. Once drilling is done, the thru hole is bore to Ø 30 mm.
13. Remove the barrel from Lathe machine chuck
14. Clamp it to the drill press chuck for drilling.
15. Drill Ø 7 mm hole on one side of the barrel for making set screw thread.
16. After drilling, screw thread is made using M8 X 1.25.
17. Last step is to put graduation mark setter on the barrel in the Milling machine.

## 4. Result

Using fabricated jigs in toolbit can help improve the quality, efficiency, accuracy, and safety of manufacturing or repair processes. To use the fabricate jigs:




1. Place the tool blank inside the sleeve.


2. Lock the set screw of the sleeve.

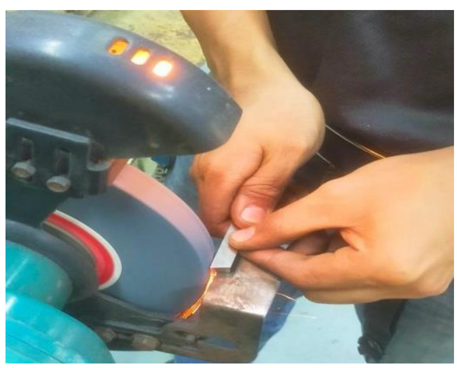

3. Put the sleeve inside the barrel


4. Lock the set screw of the barrel.


5. Grind the end relief angle using the tool bit jig.


6. Grind the end relief angle using bare hands.

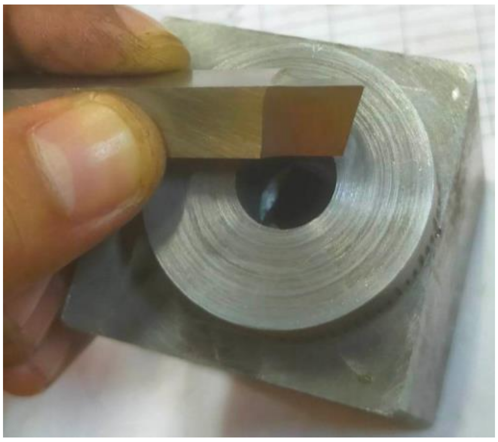

7. Grind the side rake using the tool bit jig.


8. Grind the side rake using bare hands.

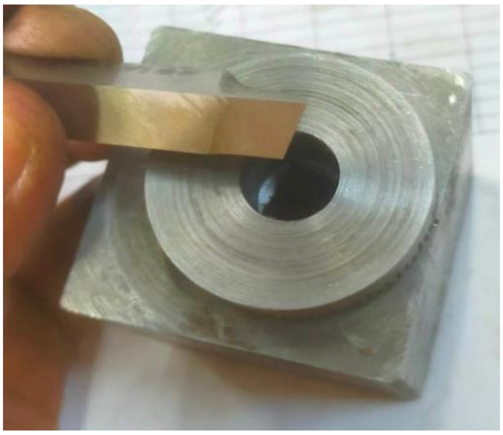
9. Grind the side relief using the tool bit jig.

10. Grind the side relief using bare hands.

The operator used the fabricated jig and manual grinding in the machining process.



11. Fabricated jig output



12. Manual jig output

## 5. Discussion

The metals and engineering sector is an important industry in the Philippines. It contributes significantly to the country's economy through its production of various metal products and engineering services. According to the Department of Trade and Industry (DTI) [5] of the Philippines, the metals and engineering industry accounts for 24% of the country's total manufacturing output and employs around 750,000 workers as of 2019. According to the data from the Philippine Statistics Authority (PSA) Labor Force Survey (LFS) conducted in October 2021, the employment rate in the manufacturing sector, which includes the metals and engineering industry, was 8.8%. This is slightly lower compared to the employment rate of 9.2% in the same period in 2020. Moreover, the DTI recognizes the sector's importance in providing inputs to other key industries, such as construction, transportation, and energy. The sector also plays a crucial role in promoting innovation and technological advancement in the country. Individuals who will take Machining NCII will get a job in the metals and engineering industry, particularly in the areas of manufacturing, machining, and metal fabrication. The Machining NC II course is a 337-hour program that focuses on the use of computer numerical control (CNC) machines. The course covers topics such as programming and operation of CNC machines, tool selection, and quality control. Trainees who complete the course are expected to be able to operate and program CNC machines and produce precision parts. fabricating jigs is one of the competencies included in the Machining NC II course offered by TESDA. The competency unit is of bench work under the learning outcome off-hand grinding and is included in the list of core competencies required for the course. In this competency unit, trainees are taught how to fabricate jigs and fixtures that are used in machining operations. The unit covers the identification and selection of materials, preparation of materials, interpretation of technical drawings, fabrication techniques, and quality control procedures. The competency unit aims to develop the trainee's knowledge and skills in designing, fabricating, and using jigs and fixtures to improve the accuracy, speed, and quality of machining operations. By the end of the course, the trainee is expected to be able to fabricate jigs and fixtures that meet the required specifications and standards.

Fabricated jigs are safer compared to manual grinding output because it holds and supports the workpiece securely in place during the machining process. This reduces the risk of accidents and injuries that can occur during manual grinding in the DBTI-Makati workshop, where the workpiece may slip or move unexpectedly, causing the operator to lose control of the grinding tool. Fabricated jigs also help to ensure the accuracy and precision of the machining process, which can be difficult to achieve manually. They are designed to position the workpiece in the correct orientation and location, allowing the operator to perform machining operations with greater consistency and repeatability. In addition, fabricated jigs improve the quality of the output by reducing errors and defects that can result from manual grinding. It helps to eliminate variations in the machining process that can occur due to operator's fatigue or inconsistencies in manual grinding techniques. It is important to emphasize that any machining operation, including the use of fabricated jigs, should be performed with appropriate safety measures and training to avoid accidents and injuries.

A fabricated jig output is more efficient compared to manual grinding output. Fabricated jigs are designed to hold the workpiece securely in place during the machining process, which allows for more consistent and accurate machining operations. This can result in faster machining times and higher production rates compared to manual grinding. In addition, using fabricated jigs can reduce the need for manual repositioning and realignment of the workpiece, which can save time and increase efficiency. Jigs and fixtures can also help to reduce the risk of errors and rework, which can further improve the overall efficiency of the machining process. However, it's important to note that the efficiency of the machining process depends on various factors, such as the complexity of the workpiece, the type of machining operation, and the skill level of the operator. While fabricated jigs can improve the efficiency of the machining process, proper training and experience are still required to operate the equipment effectively.

For future studies, the researcher recommends a fabricated jig with an attached barrel and sleeve. The jig allows the students to achieve a precise angle and shape for the toolbit, which is essential for achieving the desired cutting performance. The barrel and sleeve provide a guide for the grinding process, ensuring that the toolbit is ground to the correct shape and angle.

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