

**INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH  
TECHNOLOGY****DESIGN, DEVELOPMENT AND TESTING OF 4 TOOL AUTOMATIC TOOL  
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**ABSTRACT**

An automatic tool changer or ATC is used in computerised numerical control (CNC) machine tool to improve the production and tool carrying capacity of the machine. ATC changes the tool very quickly, reducing the non-productive time. Generally, it is used to improve the capacity of the machine to work with a number of tools. It is one more step towards complete automation. Simple CNC machines work with a single tool. But if we require even more number of tools, then ATC is provided. But many ATC manufacturing companies makes ATC starting with minimum 12 number of tools. Because of that small scale industries are not able to upgrade their CNC machines with ATC because of high cost due to more number of tools and also no use of that much number of tools. Especially in CNC router machine which is mostly used by sculptures to carve on the different things. In which they need just basic tools that is minimum 4 to 6 tools.

**KEYWORDS:** automatic tool changer, Design,. tool magazine,**INTRODUCTION**

An Automatic tool changer or ATC is used in computerized numerical control (CNC) machine tools to improve the production and tool carrying capacity of the machine. ATC changes the tool very quickly, reducing the non-productive time. Generally, it is used to improve the capacity of the machine to work with a numbers of tools. It is also used to change worn out or broken tools. It is one more step towards complete automation. Simple CNC machines work with a single tool. Turrets can work with a large number of tools. But if we require even more number of tools, then ATC is provided. The tools are stored on a magazine. It allows the machine to work with a large number of tools without an operator. The main parts of an automatic tool changer are base, gripper arm, tool holder, support arm and tool magazines. However, the ATC increases the reliability, speed and accuracy, but it has also more challenges as compare to manual tool change like the tooling used must be easy to centre, be easy for changer to grab and there should be some mean for providing the tool self-disengagement easy. Tools used in ATC are secured in toolholders specially designed.

**LITERATURE SURVEY**

Beom-Sahng Ryuh, Sang Min Park and Gordon R. Pennock study on robotic die polishing station controlled by a PC and a robot controller. The station consists of a six-degree-of-freedom industrial robot manipulator, a pneumatic grinding tool, and grinding abrasives. The station also includes an automatic tool changer which is specifically designed to exchange the grinding tool such that the operation is completely unmanned. Since die and mold manufacturing is typically low volume production, it is not practical to use a robotic automation system and manually program the serial robot with a teach pendant. To improve the quality of the finish, the posture angle between the grinding tool and the surface of the part is computer-controlled. Also, to further enhance the performance of the system; i.e., to improve the grinding contact, an elastic material is inserted between the polishing pad and the holder. [1]

S. Balestra, A. Bertolin and C. Bozza study on the design and performance of a computer controlled emulsion Plate Changer for the automatic placement and removal of nuclear emulsion films for the European Scanning

System microscopes. The Plate Changer is used for mass scanning and measurement of the emulsions of the OPERA neutrino oscillation experiment at the Gran Sasso lab on the CNGS neutrino beam. Unlike other systems it works with both dry and oil objectives. The film changing takes less than 20 s and the accuracy on the positioning of the emulsion films is about  $10\ \mu\text{m}$ . The final accuracy in retrieving track coordinates after fiducial marks measurement is better than  $1\ \mu\text{m}$ . [2]

H Ambrosio and M Karamanoglu study on the length of time between the ideation stage and the making of physical objects is decreasing due to the use of CAD/CAM systems and additive manufacturing. Natural anisotropic materials, such as solid wood can also be transformed using CAD/CAM systems, but only with subtractive processes such as machining with CNC routers. Whilst some 3 axis CNC routing machines are affordable to buy and widely available, more flexible 5 axis routing machines still present themselves as a too big investment for small companies. Small refurbished articulated robots can be a cheaper alternative but they require a light end-effector. This paper presents a new lightweight tool changer that converts a small 3kg payload 6 DOF robot into a robot apprentice able to machine wood and similar soft materials. [3]

OBREA. C , PASCU. M and MIHAILA. L study on One of the main solutions for high speed and efficient manufacturing is based on the full automation of the entire manufacturing process. The automatic changing of the tools involved in the manufacturing process is carried out by the automatic tool changing mechanism, thus the auxiliary non-productive time consumed with the tool change is highly minimized. In this paper we present a novel automatic tool changer which is both simple and compact, and any milling machining center provided with chain or disc tool magazine can be equipped with. Also by adopting the use of this tool changing mechanism other subassemblies of the tool changing system, such as the tool transfer mechanism and the waiting position, are substituted by this changing mechanism. The auxiliary movements needed to bring the tool from the magazine into the waiting position are overlapped with the machining time, so that the total time for exchanging the tool in the spindle with the tool from the magazine is minimized. [4]

## AUTOMATIC TOOL CHANGER (ATC)

### 3.1 Types of ATC

There are mainly three kinds of tool changers available in market according to the tool magazine arrangements provided.

1. Tool change system with gripper arm
2. Tool change system with chain magazine
3. Tool change system with disc magazine

Tool change system with gripper arm

In this system, there are mainly two elements:

Disc with magazine

Gripper arm

In this system, a disc is provided with magazine, in which different types of tools are loaded. It can hold maximum 32 tools. In magazines, all the tools which are required are fixed in the magazines. The tool which is programmed in controller according to the program will be indexed in front of the gripper arm and then the gripper arm grips the tool and performs the operation. After completion of the operation by each tool, the gripper arm places the tool back in to the magazine.



*Figure 1: disc type ATC*

***Tool change system with chain magazine***

In this kind of system, a chain is provided with magazines for toolholding. This chain can hold numerous tools so it is used in heavymachineries. Starting from 32 it can hold more than 100 tools. In this kind of system there is no arrangement like gripper arm. Thechain itself is indexed and the machining is done while keeping the tool inthe chain only.

***Tool change system with chain magazine***

In this system, the tools are held in a big disc. This disc is not similar tothe disc provided in gripper arm mechanism. In this disc, there are toolgrippers provided separately for each magazine these grippers holds thetool and performs machining operation as well. This system disc can hold 32 to maximum of 64 tools. These type of toolchangers are used in medium capacity machineries.



*Figure 2: Tool change system with chain magazine*

**Components of ATC**

- Tool holder
- Gripper
- Main shaft
- Magazine plate
- Base plate
- Stepper motor
- Plummer block
- Electronic driver
- Bolt

### Functions of ATC

The use of automatic changers increases the productive time and reduces the unproductive time to a large extent. It provides the storage of the tools which are returned automatically to the machine tool after carrying out the required operations, increases the flexibility of the machine tool. makes it easier to change heavy and large tools, and permits the automatic renewal of cutting edges.

### Advantages of ATC

- To increase labor productivity

Automating a manufacturing operation usually increases production rate and labor productivity. This means greater output per hour of labor input.

- To reduce labor cost

Ever increasing labor cost has been and continuous to be the trend in the world's industrialized societies. Consequently, higher investment in automation has become economically justifiable to replace manual operations.

- To mitigate the effects of labor shortages

There is a general shortage of labor in many advanced nations, and this has stimulated the development of automated operations as a substitute for labor.

- To reduce or eliminate routine manual and clerical tasks

An argument can be put forth that there is social value in automating operations that are routine, boring, fatiguing, and possibly irksome.

- To improve worker safety

By automating a given operation, and transferring the worker from active participation in the process to a supervisory role, the work is made safer.

- To improve product quality

Automation not only results in higher production rates than manual operations; it also performs the manufacturing process with greater uniformity and conformity to quality specifications.

- To reduce manufacturing lead time

Automation helps to reduce the elapsed time between customer order and product delivery, providing a competitive advantage to the manufacturer for future orders.

## DESIGNING PROCESS

### Design of BT MAS-304 tool holder

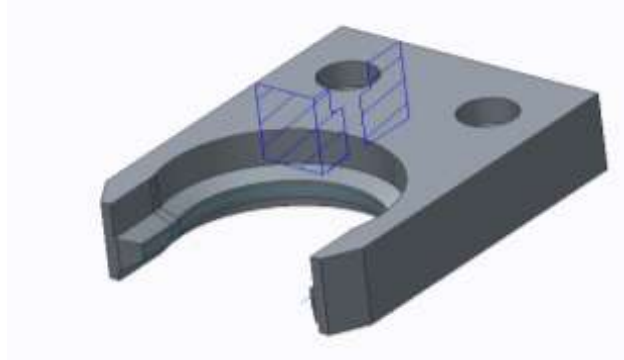
this is a ready made part available in market with standard dimensions which holds the require tool. The standard dimensions of the tool holder is as shown below the figure.



*Figure 3: design of tool holder*

### Design of gripper

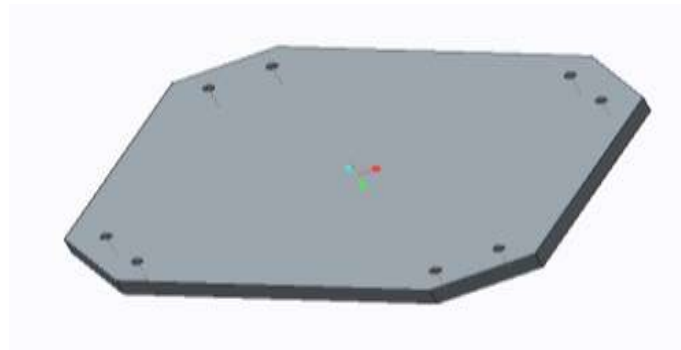
The following part called as tool gripper. In which BT MAS-304 tool holder is placed in the circular slot is provided, The dimensions of the gripper is as shown below the figure.



*Figure 4: design of gripper*

#### **Design of disc magazine**

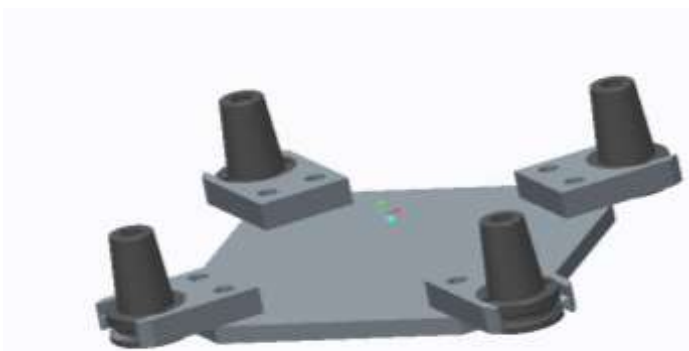
This is a disc on which tool gripper is attached on periphery of it with the help of bolts. The dimensions of the disc is as shown below the figure.



*Figure 5: design of disc magazine*

#### **Assembly of disc magazine and tool holder**

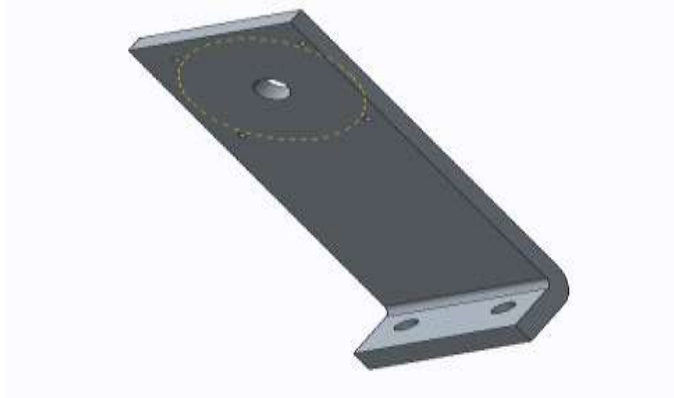
This is a whole assembly of an magazine with tool holders disc containing 4 tool. This assembly is fitted with the main shaft and it rotate as per requirement.



*Figure 6: Assembly of disc magazine and tool holder*

#### **Design of support plate**

The following part is called support plate. On which the motor is fixed on it. The dimensions of the support plate is as shown below the figure.



*Figure 7: Design of support plate*

#### **Design of plummer block**

This is a design of plummer block. With help of the plummer block the shaft not bend and work as a bearing . The dimensions of the plummer block are standard. We use two plummer block in ATC.



*Figure 7: Design of plummer block*

#### **Design of main shaft**

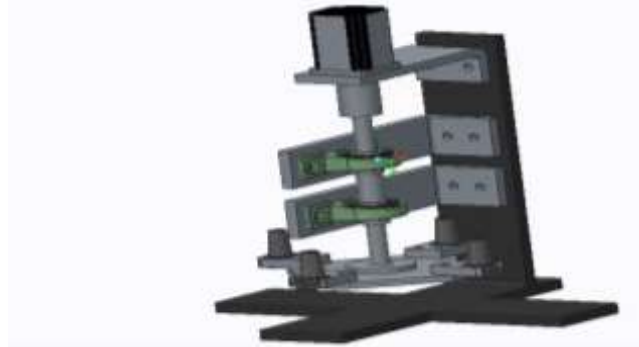
This is a design of main shaft. One end of the shaft is fitted with tool magazine assembly and the other end of the shaft is fitted with the gear box.



*Figure 8: Design of main Shaft*

#### **FINAL ASSEMBLY DESIGN**

##### **Assembly of ATC**



*Figure 9: Assembly of ATC*

## CONCLUSION

The disc magazine is the main component of an ATC in which the tools will be placed. The project relates to an automatic tool changing. The present project is to make 4-tool ATC to upgrade small scale industries. To provide them high efficiency, low cost, reliable performance, stable quality automatic tool changing. In order to improve productivity, reduce time of production for production with high accuracy and efficiency. First problem is that in CNC machine without ATC takes more time for tool changing manually. Second problem is that in Gujarat ATC manufacturing companies make ATC with minimum 12 number of tools so many industries can't afford that and may their use is less than 12 tools. To correct these problems following steps are taken: i. Attaching ATC to CNC machine ii. Making 4-tool ATC, which will ultimately increase production.

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