

# Automated pick and place mechanism for 3D-mould interconnected device and planar-PCB

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**ABSTRACT** – Demand on electronic manufacturing, specifically surface mount technology is continually increasing. The trend on surface mount technology was not limited on a planar surface of a printed circuit board (PCB) only but also on 3D moulded interconnected devices(MID) as well. The paper focus on the design and development process of small automated CNC pick and place machine for the small electronic manufacturing industry. Chip placement is one of the crucial steps in electronic manufacturing before reflow soldering is conducted. Manual pick and place of chip components for electronic prototyping in 3D-MID and planar PCB could be challenging due to its size and number of tiny components involved in the process. In this study, the prototype was successfully developed. The new small CNC pick and place machine able to transfer chip component up to chip size of 1 mm length and 0.5 mm width (0402-chip). This machine provides a better solution compared to manual chip dispensing and proven to have high repeatability in electronic manufacturing compared to the manual task. The Portable CNC dispensing machine with 3-axis capability equipped with controller board and open source G-code software. For further development, this machine could be extended to perform an additional task such as solder dispensing.

## 1. INTRODUCTION

In a conventional manufacturing process such as milling, drilling, lathe and clothes productions, machines with computer numerical control (CNC) technology were commonly used [1-3]. Liu et al. [4] highlighted the process management framework for the tool design and development of the CNC machine. The CNC framework required knowledge of the design and the process. The design and construction of the CNC dispensing machine may involve rapid prototyping technology in terms of its nozzle design and the CNC technology [5] especially its controller. Both technologies may share the same structural framework and build form. The merging of the technology with CNC machining principles may help in the construction of a CNC machine for dispensing purpose. Major electronics manufacturers already highly involved in the automated process. However, small companies still conducting manual dispensing task, especially for 3D-MID. The small industry should consider emulating towards the CNC approach to be more efficient and suitable for the solder dispensing process repeatability.

Moreover, the assembly process of electronic packaging becomes more complicated through time due to the decreasing size of the components and very high density of the chip component. Therefore, the primary purpose of this study is to present the development of an automated pick and place mechanism of the chip component using CNC technology.

## 2. METHODOLOGY

The process of designing the structure of the CNC dispensing machine was done by Catia V5R21. The main components in the portable CNC dispensing machine include the aluminium profile v-slot black anodized (code 2040 and 2020), Nema 17 stepper motors, Arduino-Compatible Mega 2560 R3, DRV8825 stepper motor drive, dispensing system, connecting wires, and mounting and joining hardware. Figure 1 illustrates the final design of the CNC dispensing system.

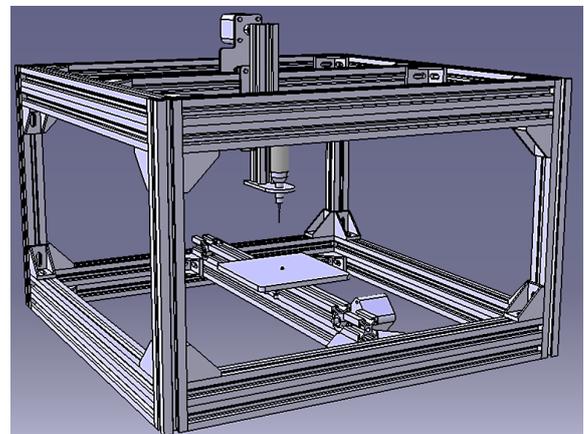


Figure 1 Design of the proposed CNC machine

The structure was constructed using several connecting frames with the help of mounting devices. The machine dimensions are 400 mm in length, 400 mm in height, and 400 mm in width to contribute to the machine portability. The base of the machine consists of a worktable which moves along the X-axis with the help of linear belt drive system and rack and pinion system. The top part of the machine which holds the dispensing system can be moved along the Z-axis and Y-axis. For the control on Y-axis movement, the belt is clamped at both ends. Then it will be tightly attached to the driver pulley and driven pulleys on the Y-axis beam to create

tension that will enable the Z-axis beam to move from left to right and vice versa. At the top frame of the machine, the dispensing system components attached to the Z-axis beam will follow the movement of the pulleys as the components are linked with each other. Figure 2 shows the close-up view of the top frame of the dispensing machine.

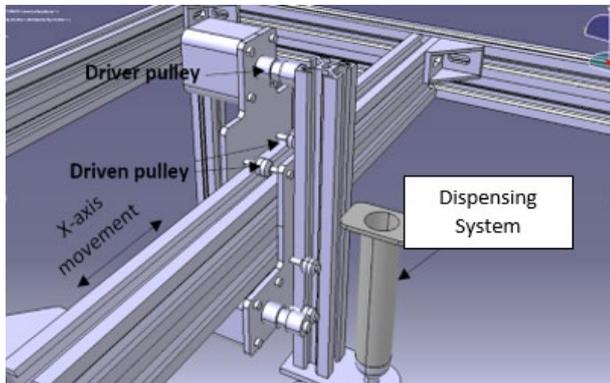


Figure 2 Detail view of the top frame, including the dispensing system.

### 3. RESULT

Figure 3 and Figure 4 show the result of the fabricated prototype of automatic dispensing system and manual chip dispensing, respectively.

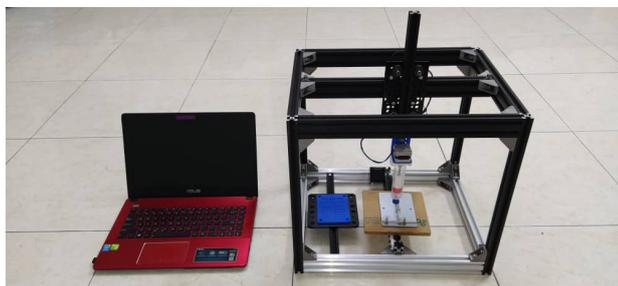


Figure 3 Fabricated prototype of automatic CNC dispensing system

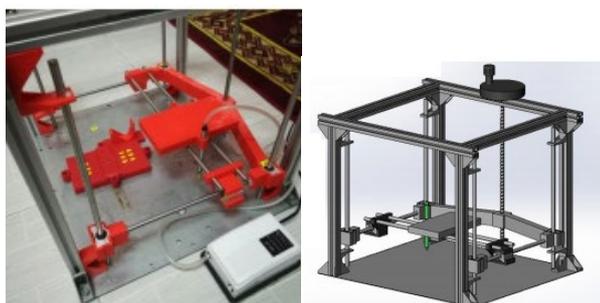


Figure 4 Previous model of the manual dispensing system

Table 1 lists the comparison of the fabricated automatic CNC dispensing prototype with the manual dispensing base on different aspects.

Table 1 Comparison between manual dispensing and CNC dispensing

Achieved features	CNC Dispensing	Manual Dispensing
Improved production Accuracy	YES	NO
Uniform and repeatable process	YES	NO
Reduce the number of defects	YES	NO
Small-and portable sized machine	YES	YES
Flexible manufacturing possibility	YES	YES

### 4. CONCLUSIONS

The final design was successfully fabricated. Incorporation of CNC technology into a dispensing system provides better solution compare to the manual task of the chip placement during electronic packaging, especially at the prototyping stage. However, a detailed analysis of fabricated prototype can be investigated further, and further improvement can be made by incorporating solder dispensing in the system before the chip placement process.

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