Bachelor's Thesis Engineering Technology

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Automated rotation of printed circuit boards around the X-axis

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Electromechanical Engineering Technology

SITUATION

This bachelor thesis is in collaboration with IPTE (Integrated Production & Test Engineering), an automation company that designs and builds automated machines that are used for the production of printed circuit boards (PCB's). The company has a wide range of machines with different applications, such as removing electronic components from their packaging, the Y-FLIP-station (figure 1) for rotating PCB's around the Y-axis and robots that attach these components to the printed circuit board. IPTE also offers autonomous warehouse carts that transport loads from one machine or location to another. IPTE sells both stand-alone machines and complete production lines.

In this thesis the goal is to design an X-FLIP station that rotates printed circuit boards around their X-axis (figure 2). The X-FLIP station must also buffer incoming and outgoing printed circuit boards to ensure a smooth operation of the production line and be adjustable to accommodate a wide variety of sizes.

Figure 1: Y-FLIP

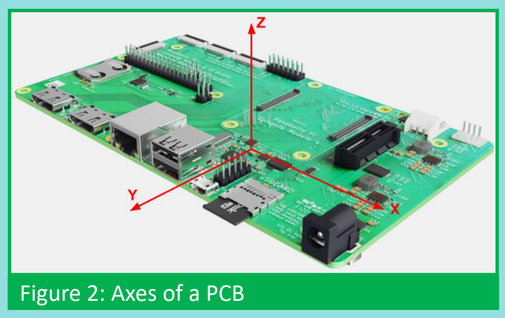

Figure 2: Axes of a PCB

OBJECTIVES

The aim of the bachelor's thesis is to develop an X-FLIP-station with buffers, that will supplement the product range of IPTE, as IPTE currently only offers Y-FLIP-stations.
Table 1 shows the development demands of the X-FLIP, the following text further explains some of these requirements. 1 cycle of the X-FLIP-line equals to the movement of the PCB from the start buffer to the end buffer, with a rotation around the X-axis in between. An important note on the machine dimensions is that the length has to be either 500 mm or 600 mm. Lastly the X-FLIP must have the ability to process PCB's with different dimensions.

Table 1: Development demands

QUESTIONS	DEMANDS
Maximum dimensions	L600 x H2000 x B1200 mm³
Maximum PCB dimensions	460 x 460 x 4 mm³
Minimale PCB dimensions	50 x 50 x 0,4 mm³
Maximum PCB weight	2,5 kg
Clearance above & below PCB	40 mm
Clearance left & right of PCB	2,5 mm
Connection point to other machines	915 - 1080 mm
Cyclus time	8s
PCB's/rotation	1

X-FLIP-Station

RESULTS

This project focused on the development of two machines in a production line, namely the X-FLIP and the buffer. After a thorough examination of the required functionality, the following structure were designed.

X-FLIP

Figure 5: X-FLIP

Figure 6 provides a comprehensive depiction of the structure and assembly of the X-FLIP. The X-FLIP comprises a frame that accommodates the turning mechanism, as illustrated in Figure 5.

The 2 spindles play a critical role in realigning the PCB'S with the production line after it completes a 180-degree rotation. The system includes 4 internal linear sliding rods to ensure a smooth and stable motion. A high-powered motor is attached at the base of the X-FLIP-frame to facilitate the rotation of the entire rotary mechanism by use of a timing belt.

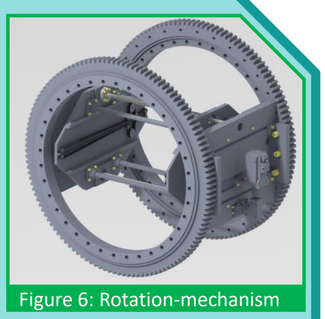

Figure 6: Rotation-mechanism

BUFFER

Figure 7: Buffer-mechanism

The buffer, shown in Figure 7, consists of two main sections: the magazine and the scissor elevator. The magazine makes use of a spindle so that it can store circuit boards of different sizes. For this sideways motion the racks are supported by 2 linear rail cars per rail on both side.

The scissor elevator, on the other hand, facilitates the vertical movement in the Y-direction of the entire magazine, allowing the PCB's to be accurately unloaded at the correct height. The elevator reaches this high precision by making use of a spindle that drives the elevator at the bottom. The PCB's then can get pushed out of the buffer by a pushing belt.

METHOD OF APPROACH

The process for arriving at the final design involves a comprehensive methodology which includes several phases. Starting with the development of the concept according to the imposed requirements to finally obtaining a detailed 3D design.

In the preliminary design phase, a function block diagram, depicted in figure 3, is created to gain an initial understanding of the key functions the machine must meet.

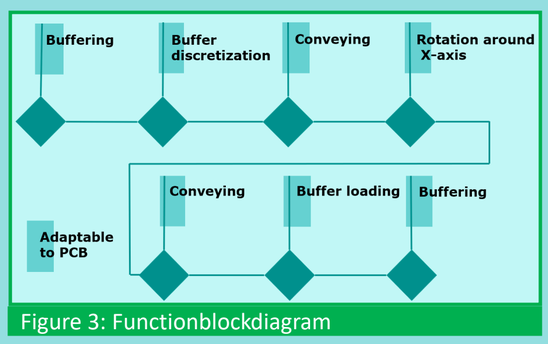

Figure 3: Functionblockdiagram

Numerous sketches were then developed and the problems identified were examined. Through extensive discussions and careful evaluations, the most feasible options were selected, as illustrated in the upper section of figure 4 for the X-FLIP and the middle section for the buffer. The next phase involved the meticulous refinement of the 3D design using Creo Parametrics, an advanced Computer-Aided Design (CAD) software.

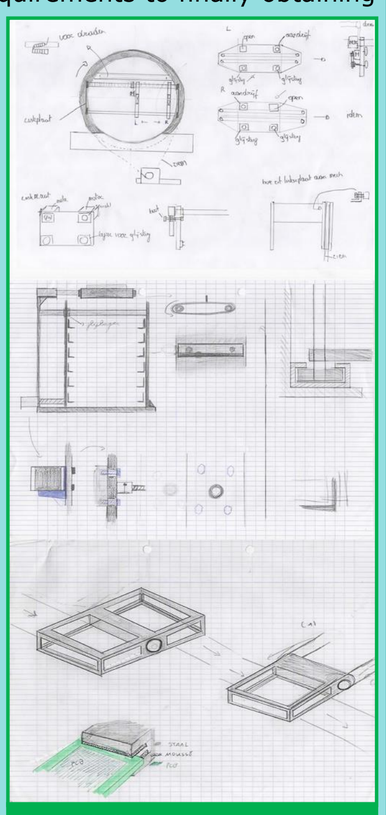

Figure 4: Concept drawings

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Referentielijst

[1] Vanderspikken, J. *IPTE - Integrated Production & Test Engineering, IPTE Factory Automation n.v.* IPTE. Available at: https://www.ipte.com/ (Accessed: November 10, 2022).