Integrated project Engineering Technology

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Automation of stone strip cutting process for prefabricated housing construction

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Bridging programme for Master of Electromechanical Engineering Technology

Context

The company for which this integrated project is developed is **Kepler**, a **contractor and property developer** based in Genk. The company specializes in energy efficient **prefab houses**, all of which are made according to the same **standard model** without any deviations. Every Kepler home is finished down to the last detail. From high-quality materials and appliances to a fully landscaped garden.

Problem

The walls of the house are finished with **stone strips** delivered on pallets. These stone strips are used in two different colors and four different sizes: **a full strip, 25%, 50%, and 75% of a strip.** These sizes are achieved by having a worker **manually** cut the strips using a sawing machine. This leads to **loss of time** and **paying an additional employee**.

Objective

Our aim is to **automate** this cutting operation, which will **save time and manpower**, resulting in **cost savings**. Our solution is to design a technical device where the stone strips are supplied from a buffer via a conveyor belt, then cut into the right size via a cutting operation, visually checked for cracks and finally sorted by size. This is done via a **mobile technical installation** used indoors.

Requirements

Fixed requirements:

- Cutting stones to sizes of ¼ , ½ and ¾
- Sorting stones by size
- Manually replenishing the input buffer
- Construction must be movable
- Construction must pass through an 8-meter-wide gate
- Avoiding stone breakage
- Cost-saving
- Time-saving

Variable requirements:

- Cutting 3300 stones per day

Desire:

- Easy to maintain
- Dust extraction
- Limiting noise

Function block diagram

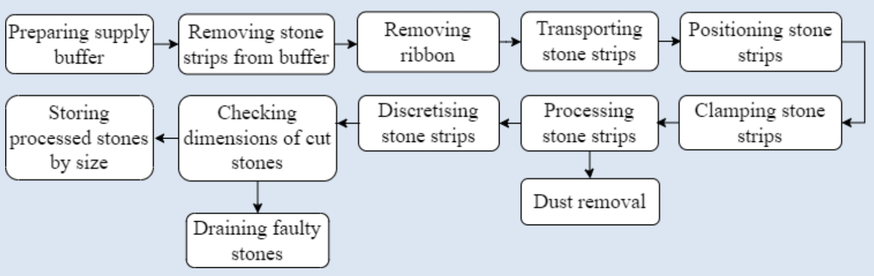
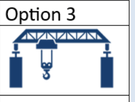
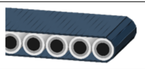
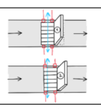
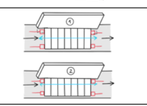
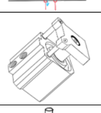
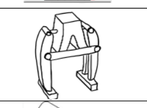
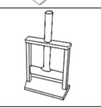
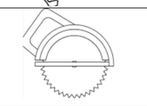
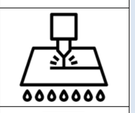
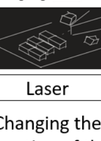
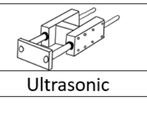
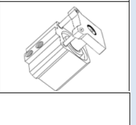
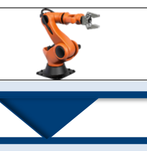


Figure 1: Function block diagram

Morphological overview

Tabel 1 shows the morphological overview, a tool to explore all possible solutions to a complex problem. At least one solution is given for each step according to the function block diagram.

Table 1: Morphological

Option 1	Option 2	Option 3
Placing pallets with transpallet	Sliding conveyor system	
		
		
		
		
		
		
	Dust screens	
		
Laser	Ultrasonic	Camera
Changing the direction of the conveyor belt	Trapdoor	
Adjustable collection box		

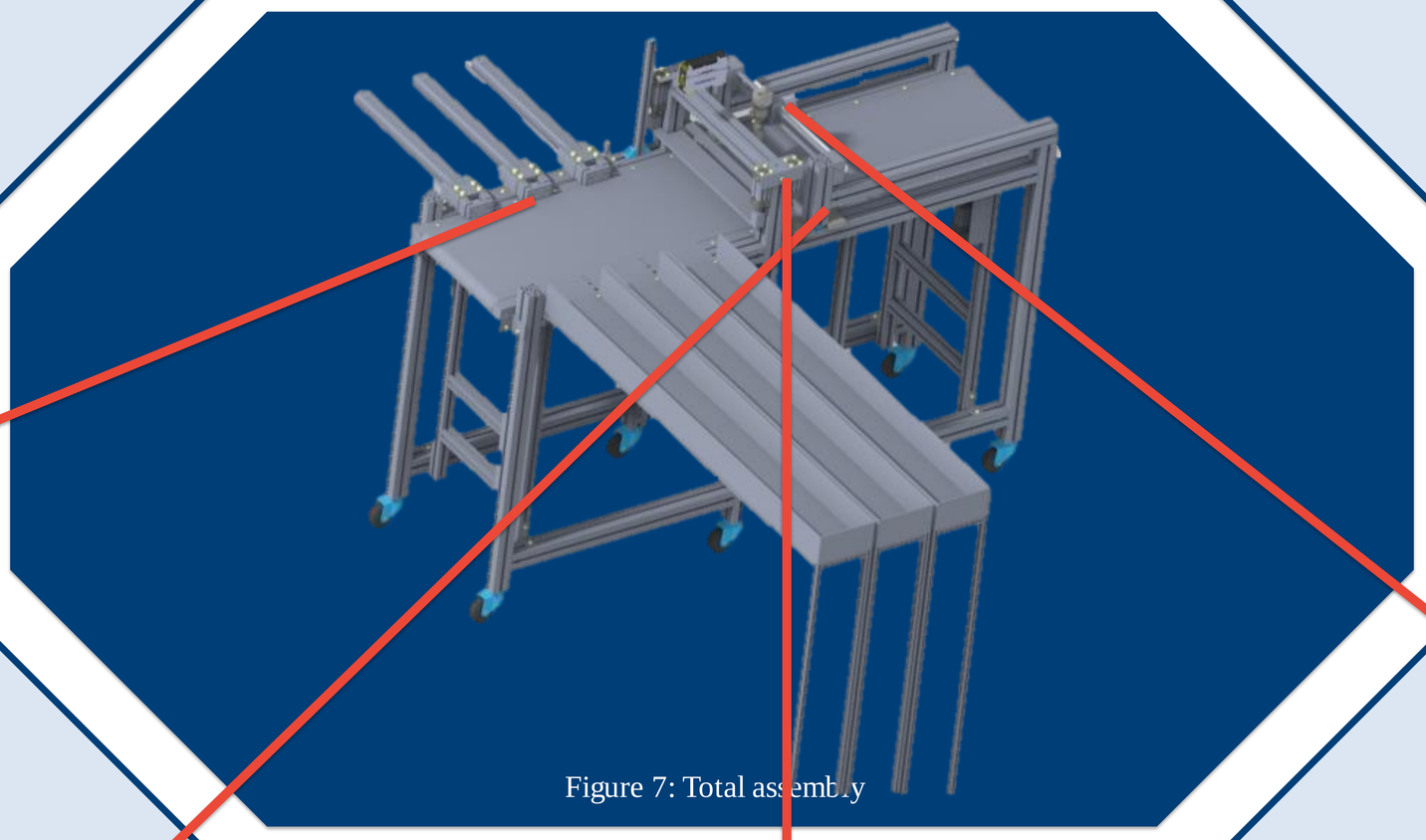


Figure 7: Total assembly

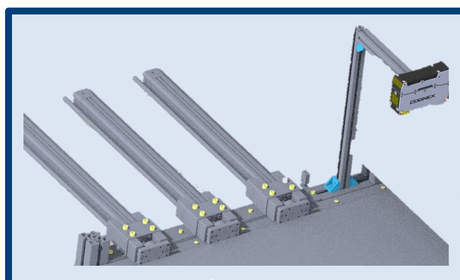


Figure 6: Verification and sorting

Verification:
Checking the stones for defects is done using a laser camera. The camera checks if the stones are damaged after the cutting process. If the stones are intact, they are detected by an optical sensor and then pneumatic cylinders will push the stones by size in the corresponding storage places.

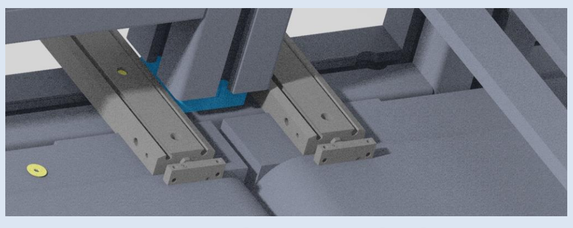


Figure 5: Clamping cylinders

Clamping:
Clamping of the stone strips is done by using 2 pneumatic cylinders on each side. This will keep the stones in place when they are cut.

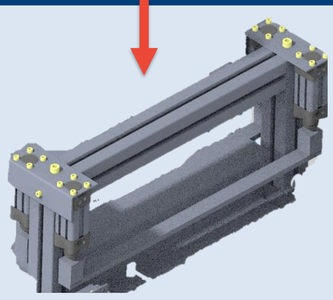


Figure 4: Positioning

Positioning:
The positioners, which are pneumatically controlled, ensure that the stone strips are positioned correctly in relation to the water jet cutter.

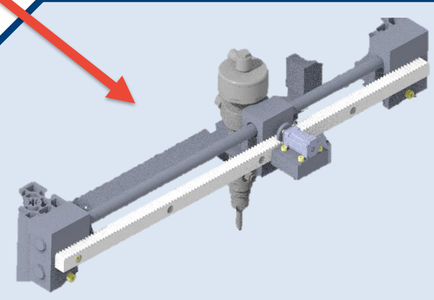


Figure 3: Waterjet

Cutting:
The stone strips are cut with a water jet cutter. This releases the least amount of dust and reduces the risk of defects.

Results

Conclusion

The objective of this integrated project was to assist **Kepler** in achieving its **operational goal of constructing one house per day**. The initiative focused on automating the process of **cutting stone strips**, which are integral components of Kepler's prefab housing units. By implementing automation in the stone strip cutting process, the project aimed to **reduce the reliance on manual labor**, thereby **decreasing production time and lowering costs**. This automation is anticipated to contribute significantly to the realization of Kepler's vision by enhancing efficiency and setting a foundation for the future automation of the entire assembly line. This strategic move not only aligns with industry trends towards increased automation but also positions Kepler to sustainably scale its production capabilities in a competitive market.

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Prof. Dr. Jeroen Lievens

De opleiding industrieel ingenieur is een gezamenlijke opleiding van UHasselt en KU Leuven