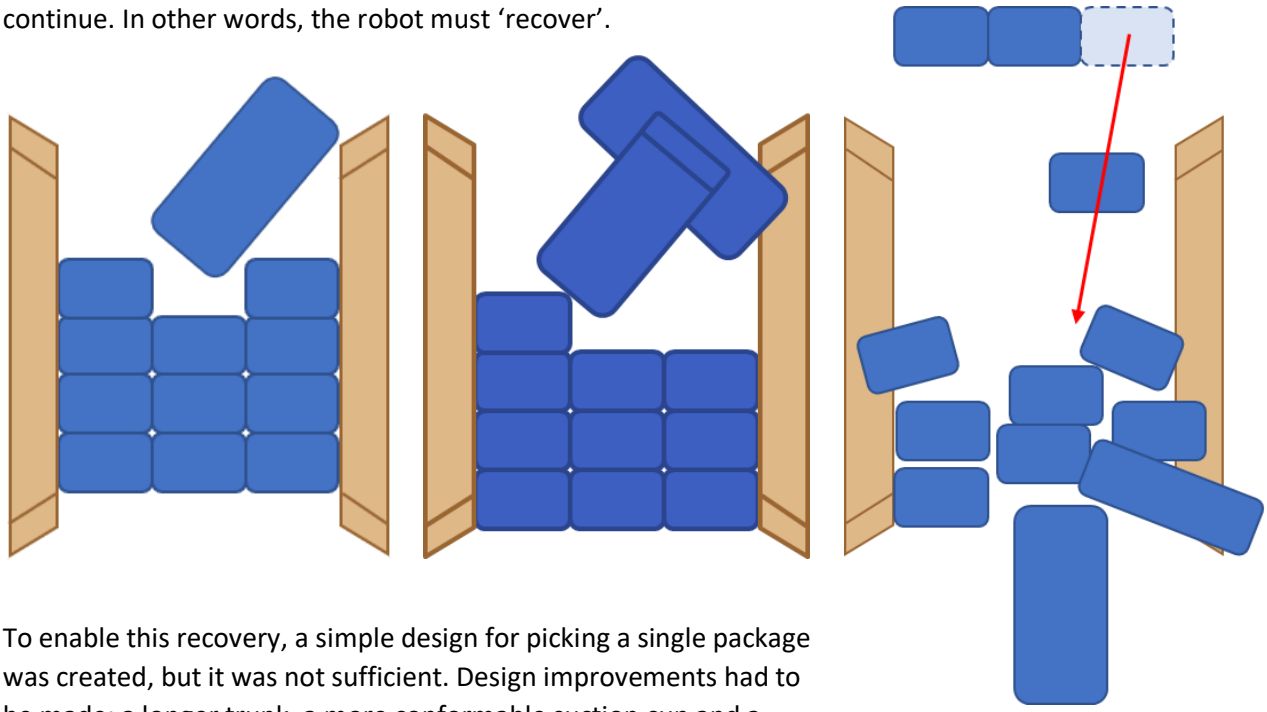
Automatic recovery in robotic pattern creation

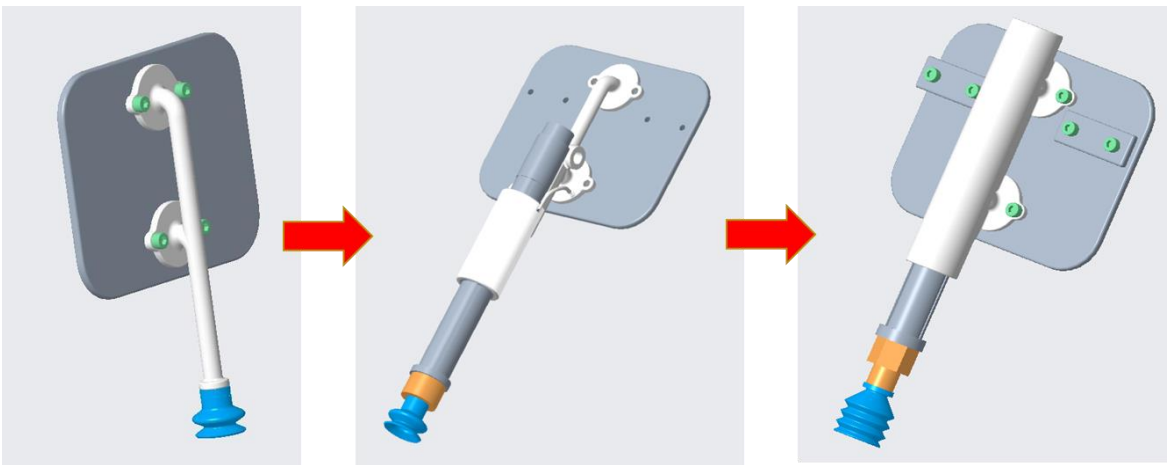
You are currently operating a production line, producing juice packages. Hundreds of packages swoosh by every minute, gets packed into crates and are sent along. The upside-down spider-looking packing robot with its four arms is moving at alarming speeds to keep up with the package flow and filling the crates. Suddenly something goes amiss in the packing cell and a red light is flashing. The line slows down to a halt. “Perfect”, you think, and go for a quick coffee, because you now have two minutes of break until the robot fixes the problem by itself.

This article is about the automatic self-recovery of packing delta robots by the use of a smart pneumatic gripper tool, and an even smarter gripper attachment! The master thesis that this article is based on has resulted in two patent applications by the company.

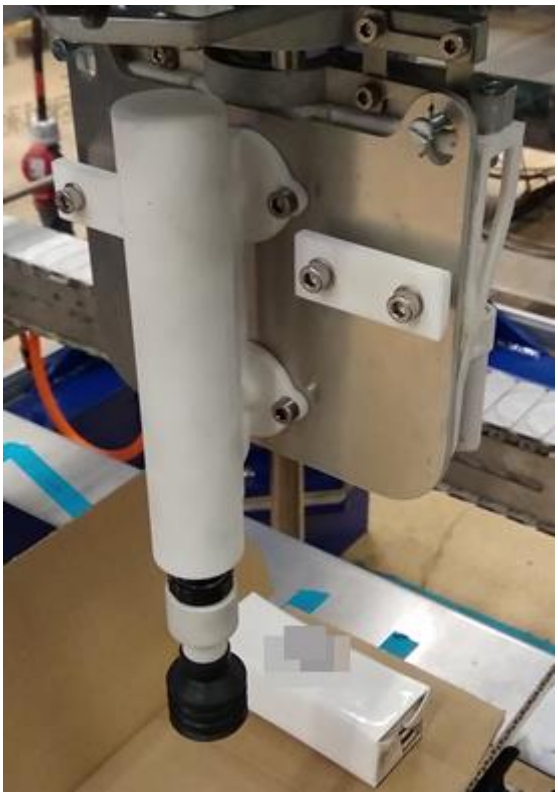
Packages are placed into cardboard trays in a rectangular pattern. This is called the ‘pattern creation’, but the process is not perfect. Errors can occur, such as fallen packages or a destroyed pattern as shown in the figures below. These packages must be removed in order for packing to continue. In other words, the robot must ‘recover’.



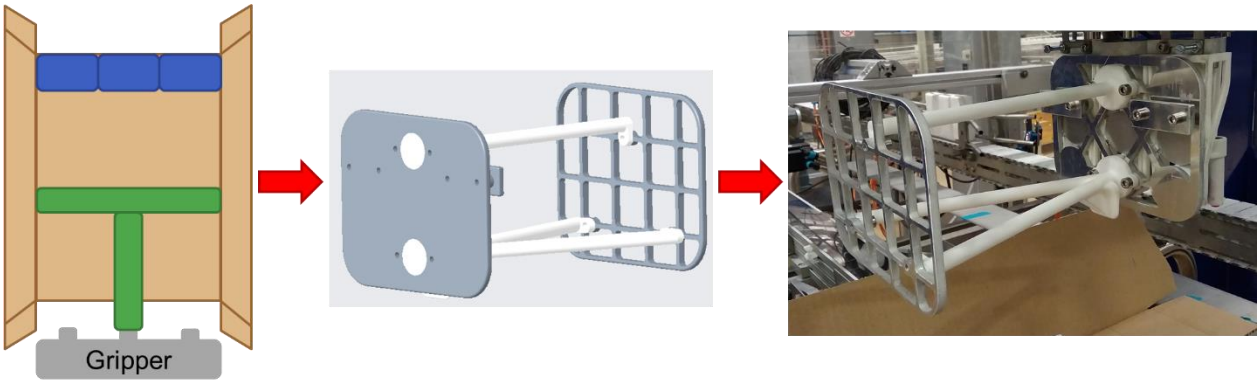
To enable this recovery, a simple design for picking a single package was created, but it was not sufficient. Design improvements had to be made; a longer trunk, a more conformable suction cup and a spring-loaded trunk to not crush packages. Air connections were simplified and hoses designed away, and a hanging mechanism was added to the attachment so that it would not fall of the gripper head if vacuum was not running.



The final picking attachment can be seen in the figure to the right. The design was tested for speed and robustness and showed good results in both aspects. Picking angles of up to 55 degrees were tested and the attachment showed no difficulties in handling these. Picking speeds of down to 1 second per package was measured, but was highly dependent of the package orientation and the travel distance of the package from the pick-up point to the drop point.



A second attachment for pushing the packages off the blank, much like a bulldozer, was also designed. This attachment is intended to be used when a problem is considered “non-recoverable”, e.g. when a package is crushed and there is no surface for the suction cup to connect with, or when the problem is or of reach for the ordinary picking attachment. The push attachment and its schematic design process is shown in the figures below:



Conclusively, it can be said that this concept is a very viable solution for automatic recovery. It handles many of the identified pattern problems with acceptable speeds and robustness. Some aspects that can be improved on and were not included in the master thesis were:

- A safer method of presenting the attachment to the gripper and eliminating risks with picking it up and putting it back.
- A return feed for the non-damaged picked packages that returns them to the main package flow, ready for packing once again.
- A concept for handling the ejection of cardboard trays that are damaged.