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TEAM 04

Neocon

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Universal Robotic End-of-Arm Tooling

Introduction

An innovative manufacturer, Neocon International requested robotic end-of-arm tooling for handling thermoformed plastic cargo liners and starter sheets. Used in conjunction with a mobile collaborative robot, the end-of-arm tooling would feed thermoforming machines with starter sheets, remove formed sheets, transfer product between different production stages, as well as package and palletize.

Design requirements included that it must not exceed the weight limit of the collaborative robot arm. Also, the end-of-arm tooling had to be universal to work with different products and adjust to size in under five minutes without any tools. Finally, the end-of-arm-tooling should successfully lift as many sample cargo liners as possible.

Team 04 has worked with Neocon and other stakeholders to deliver a prototype design to satisfy these requirements. This poster shows the engineering processes that resulted in the final design.
The details of the design as well as performance are also discussed.

Design Process

- The design process was supported by:
  - Robot specification (OMRON TM-12)
  - Workspace visualization (on-site tour)
  - Sample cargo liners
  - Vacuum circuit components and testing
- The design process centered on three themes:
  1. Identifying suitable vacuum suction cups.

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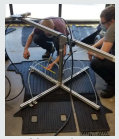
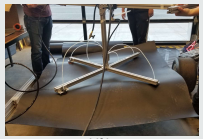
  2. Locating lifting points for all cargo liners.



Measuring



Lifting

  3. Designing an adjustable frame with internally routed vacuum circuit within the robot's net payload.

Details of Design

Vacuum cup selection

The corrugated and embossed designs of cargo liners resulted in the need for specialized vacuum cups in order to achieve suction. Through testing, rubber foam suction cups were identified as the only solution that could provide suction across the heavy textures of the cargo liners.

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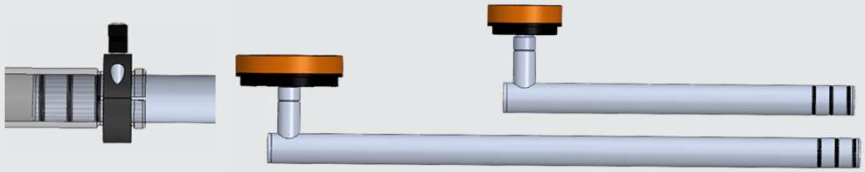
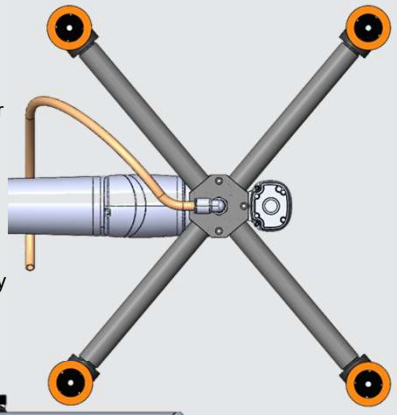
Manifold design

In order to support multiple styles and sizes of cargo liners, an adjustable system was required. This design used hollow tubes sliding within a central hub in order to freely change the position of the suction cups. The hub and adjustable arm tubes were designed to work as a manifold to directly supply suction to the vacuum cups without the need for pneumatic tubing and fittings. In order to provide sealing, rubber O-rings were added to the inner arm tubes. In order to secure the desired position and orientation of the inner arm tubes, a hand-tightened clamp was used.

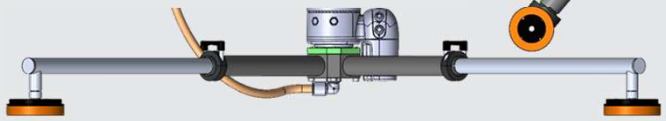


This design employs two different sets of inner arm tubes in order to accommodate the smallest cargo liners as well as the largest blank sheets using the same hub. The end effector size ranges from 0.5 x 0.43 m to 1.15 x 0.96 m.

The two sets of arm tubes use different sizes of suction cups. The long arm tubes use a larger diameter cup, which exerts a higher suction force for larger cargo liners. The short arm tubes required a smaller cup size because of a specific cargo liner geometry incompatible with the larger size cup.



The material for all the machined components is aluminum. Although light, the sliding of aluminum-on-aluminum causes wear during adjustment, ideally mitigated by surface treatment.



Conclusion and Recommendations

To aid Neocon International in their goal of automating production, Team 04 has designed and tested a one-of-a-kind solution to move and manipulate Neocon's products. The unique challenge was developing a lightweight end-of-arm tooling capable of grasping, holding, and releasing large, textured, pliable cargo liners.

Due to functional requirements and client preference, a vacuum-powered suction cup solution was selected. Specialized vacuum cups were necessary to maintain suction with the heavily embossed patterns and textures of the liners. A manifolded design was chosen over routing flexible tubing to reduce the chance of robot entanglement.

Following testing, vacuum leakage was identified around the mating surface of the inner and outer arm tube connections. Rework of the arms has been requested and it is recommended that testing be conducted following rework completion. It is also recommended that the aluminum parts be anodized and lubricated to prevent wear of the arm tubes.

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