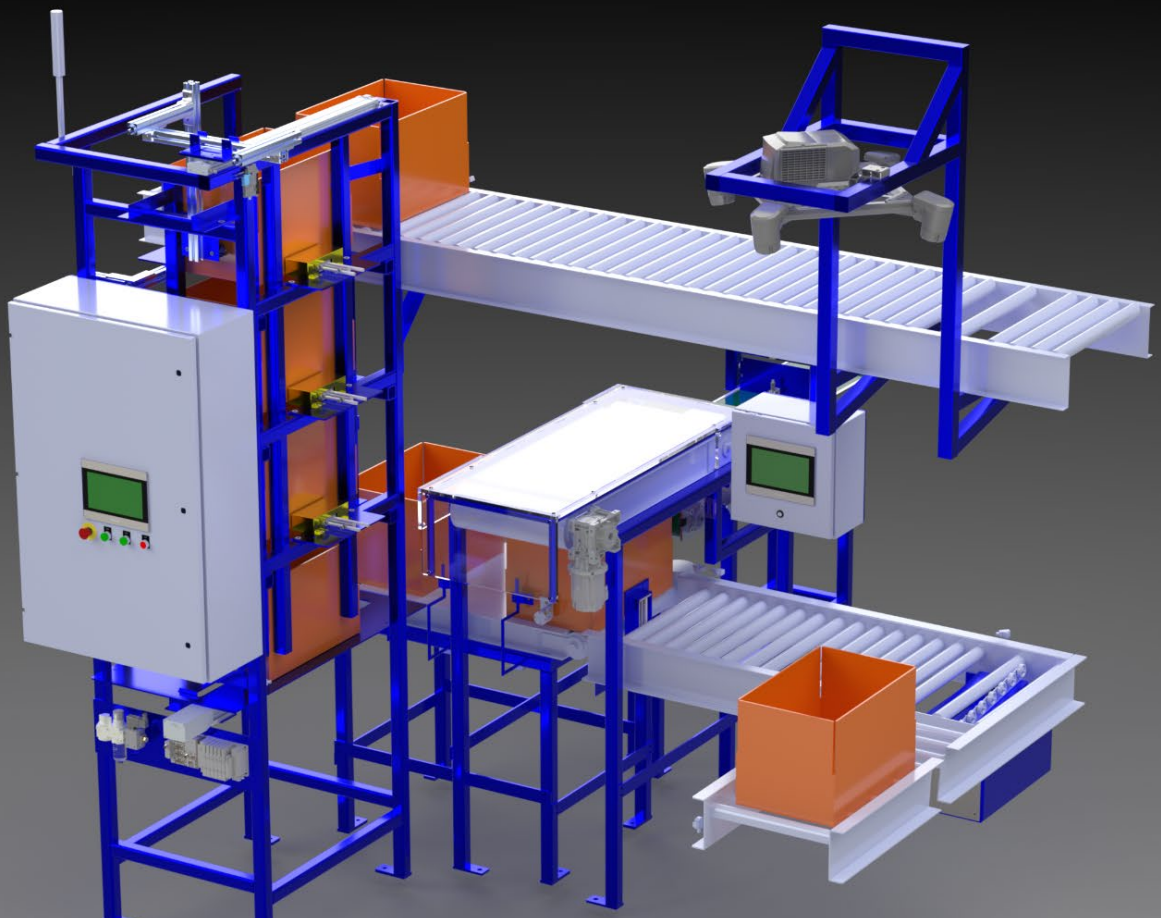
CELLORA ENGINEERING



TRUSS PLATE BOXING SYSTEM

Designed to reduce downtime and labor requirements for a high-volume press line

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Automated Box Handling System

The client was experiencing bottlenecks in their packaging line due to manual box handling, which led to inconsistent throughput, operator fatigue, increased labor costs, and operators injuring themselves on truss plates. They needed a reliable, automated solution to move, orient, and sort boxes of varying sizes without sacrificing floor space or flexibility.

To address these issues, we designed a fully integrated **Truss Plate Boxing System,** that includes:

- Box conveyor & chute system for indexing boxes vertically
- Gate mechanism to prevent crushing and regulate box flow
- Indexing station with sensor-triggered gate and clamp for precise box loading
- Magnetic transfer system using adjustable conveyors with both permanent and electromagnets to invert and drop steel plates into boxes
- Lift-and-transfer unit for smooth directional changes along the conveyor path
- Quality control station with third-party vision system to verify contents before dispatch

The results of this system are:

- Reduced manual labor and improved operator safety
- Minimized downtime due to reliable, continuous operation
- Adaptable system design for future packaging needs
- Lower operational costs through automation

KEY COMPONENTS & FEATURES

The box conveyor belt moves each box forward until it triggers a sensor. At that point, the conveyor stops, and the box is smoothly transferred into the chute. The chute guides the box to the main indexing plate, which then pushes it onto the loading conveyor. Another set of sensors triggers a gate, stopping the box again so it can be clamped in place for secure loading.

At the same time, the plate conveyor moves truss plates using adjustable permanent magnets. These plates are transferred to an inverted drop

conveyor, where electromagnets activate to release the plates into the box at the correct position.

After loading, the box continues along the conveyor. A lift-and-transfer unit redirects it around a corner, leading to a quality control station. There, a third-party vision system inspects each box to ensure proper loading, consistency, and accuracy.

Figure 1 shows the main components of the system, which are described in further detail in the following sections. Except for the plate conveyer, all other conveyers were produced by Rebstock Conveyors.

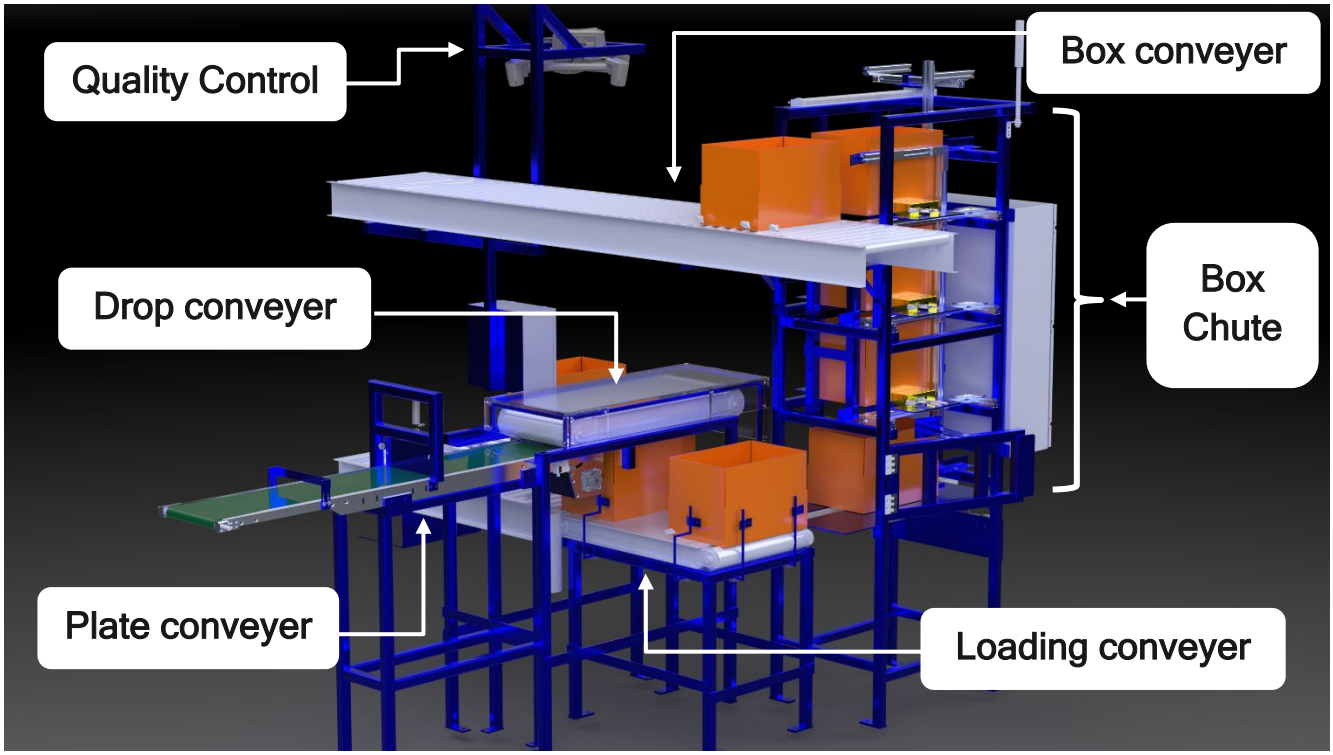

Figure 1. Main conveyer belts in the truss palate box system

Box conveyer

The box conveyor system uses three sensors to control and monitor the movement of each box. The first sensor detects when a box is present and moving. The second sensor confirms the box is in position to be transferred into the chute. When this sensor is triggered, the conveyor stops. At that moment, suction cups, powered by pneumatic control, securely grip the box. The box is then lifted and transferred into the box chute as seen in Figure 2 and 3. Once in place, the suction cups release it, and support holders keep the box suspended to prevent interference with the boxes below. Finally, the third

sensor verifies that the box has successfully entered the chute and clears the system for the next cycle.

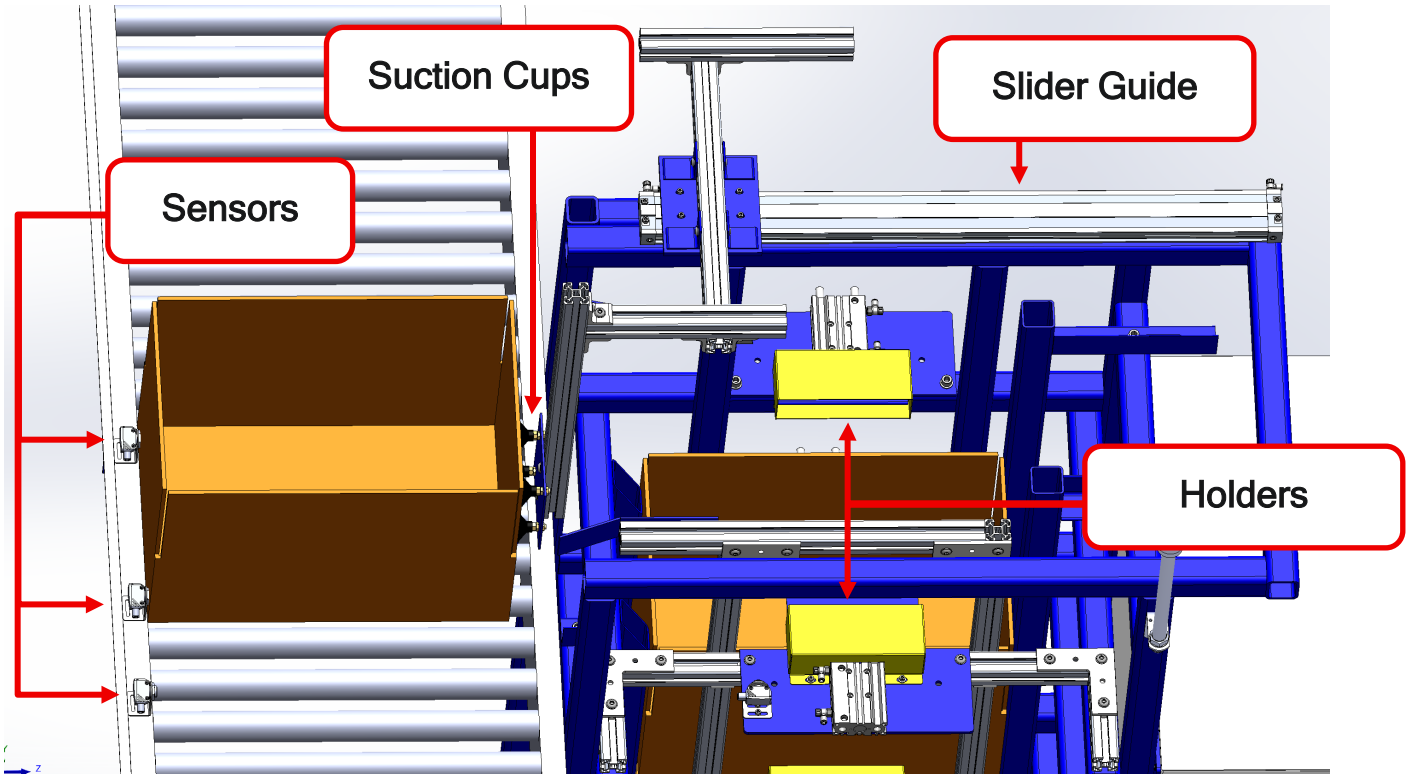

Figure 2. Box being grabbed by suction cups into the box chute

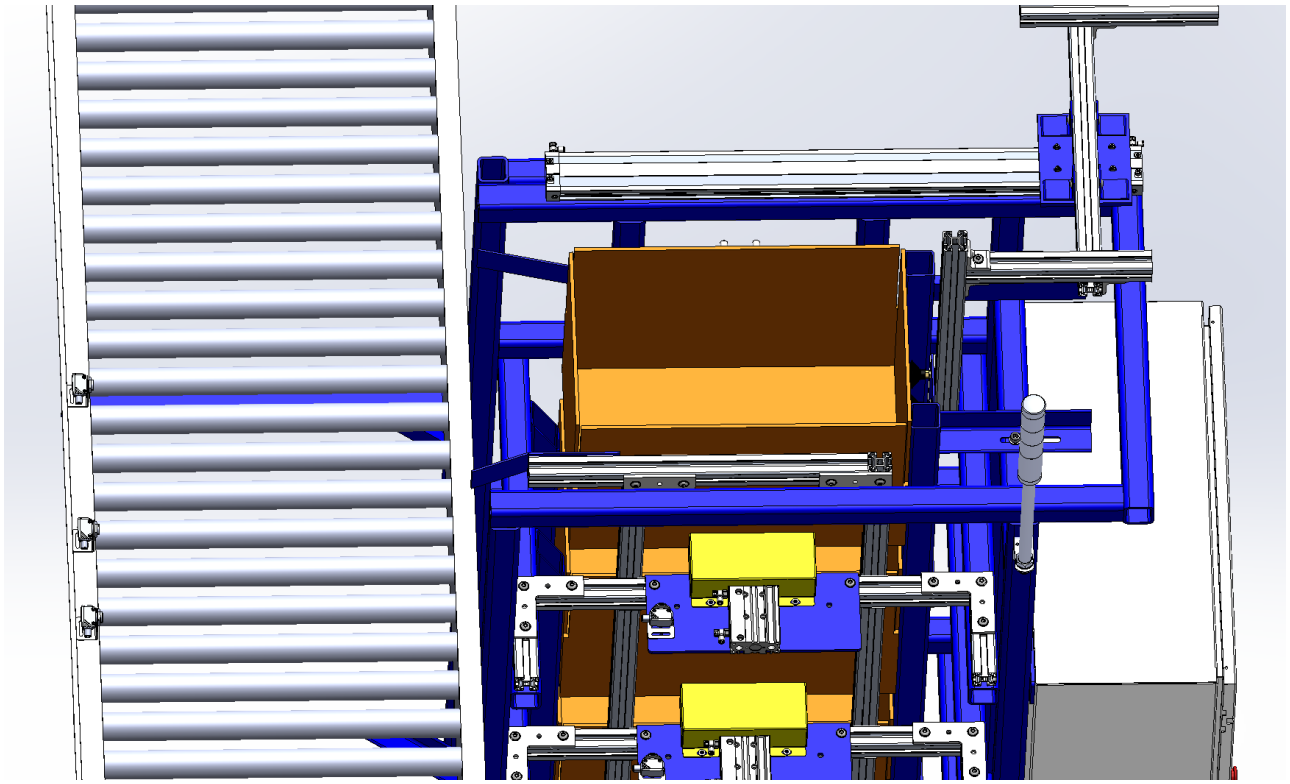

Figure 3. Box inside the box chute being held up by holders

Box Chute

The box chute was fully designed by our team, including the custom cover for the integrated electrical panel. Once a box is positioned in the chute, the suction cups release it, and mechanical holders on both sides support the box securely. When the bottom-most box reaches the main indexing plate, it is pushed onto the loading conveyor belt. The complete box chute assembly is shown in Figure 4, while Figure 5 offers a detailed view of the pusher mechanism. After each transfer, the boxes in the chute index downward by one position, staging the next box for loading.

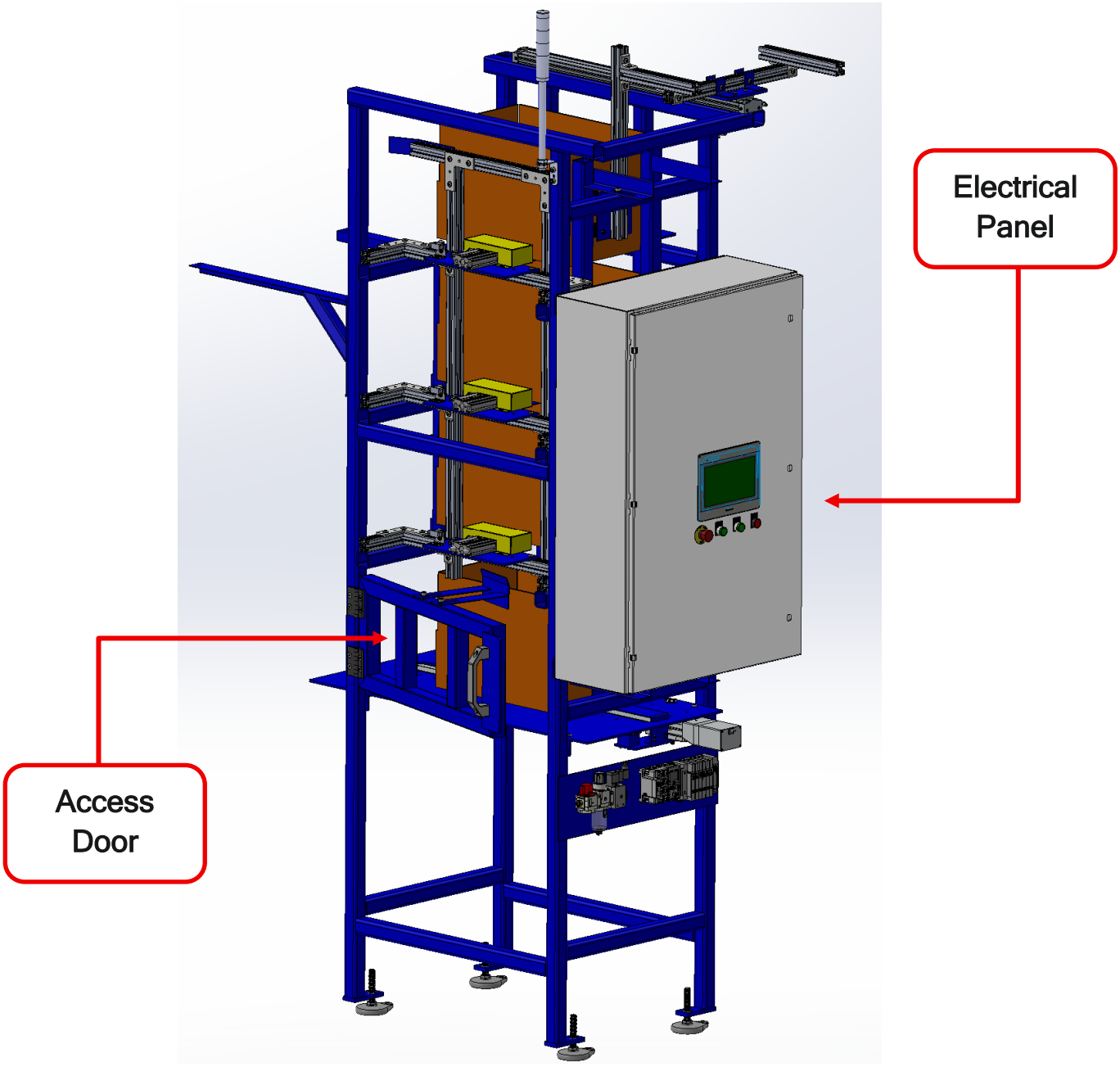

Figure 4. Box chute with boxes being indexed

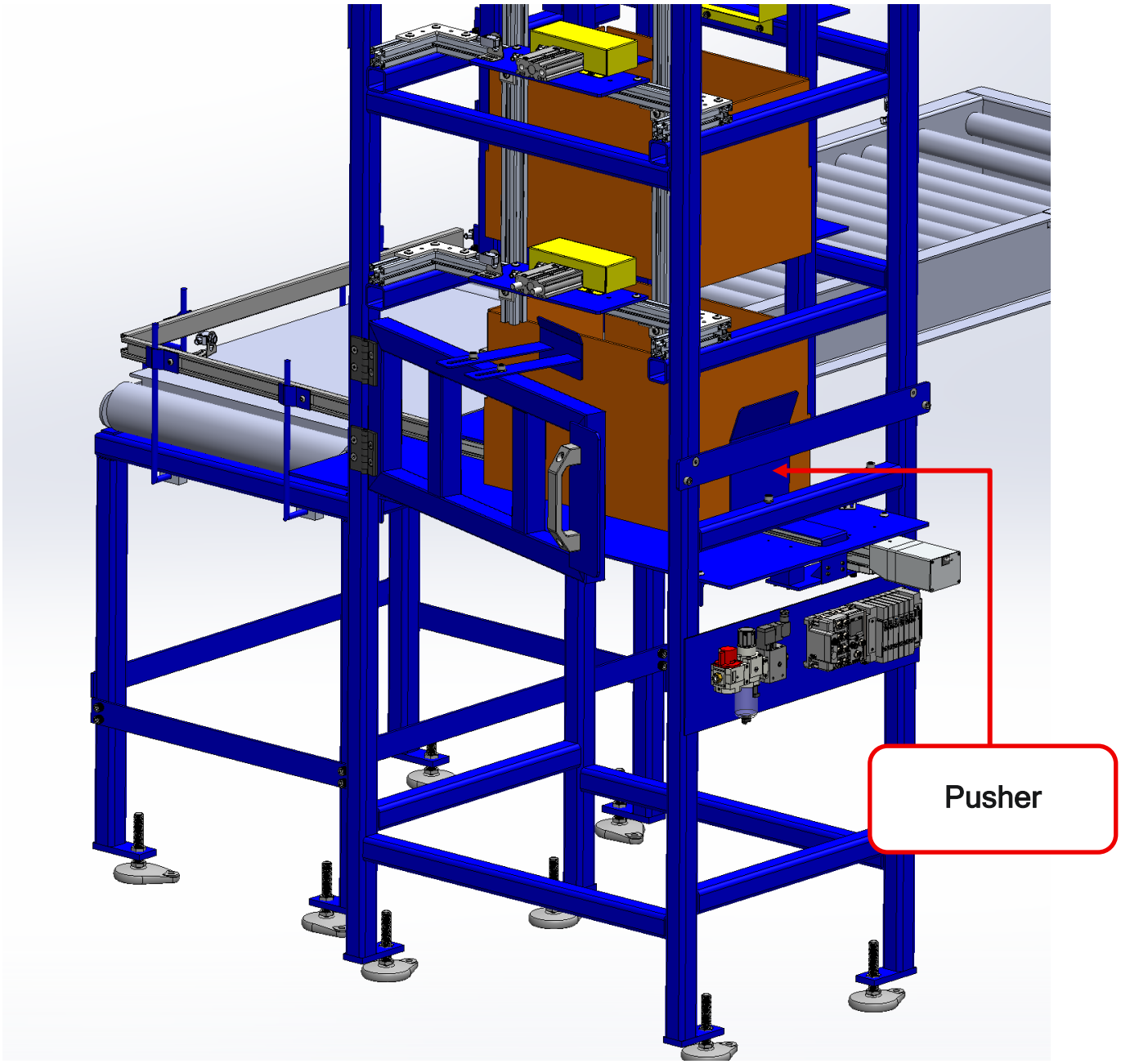

Figure 5. Box chute with clear view of the pusher

Loading Conveyer

For this section of the system, we designed all components except for the conveyor itself. Our team developed custom frames, box stop, and clamping mechanisms. As the box travels along the conveyor, it triggers a sensor that activates a gate to stop its motion. The conveyor halts, and the box is securely clamped in place to ensure safe and stable loading. The loading conveyor within the full assembly is shown in Figure 6, while Figures 7 and 8 highlight key components, with a particular focus on the motion of the box stop.

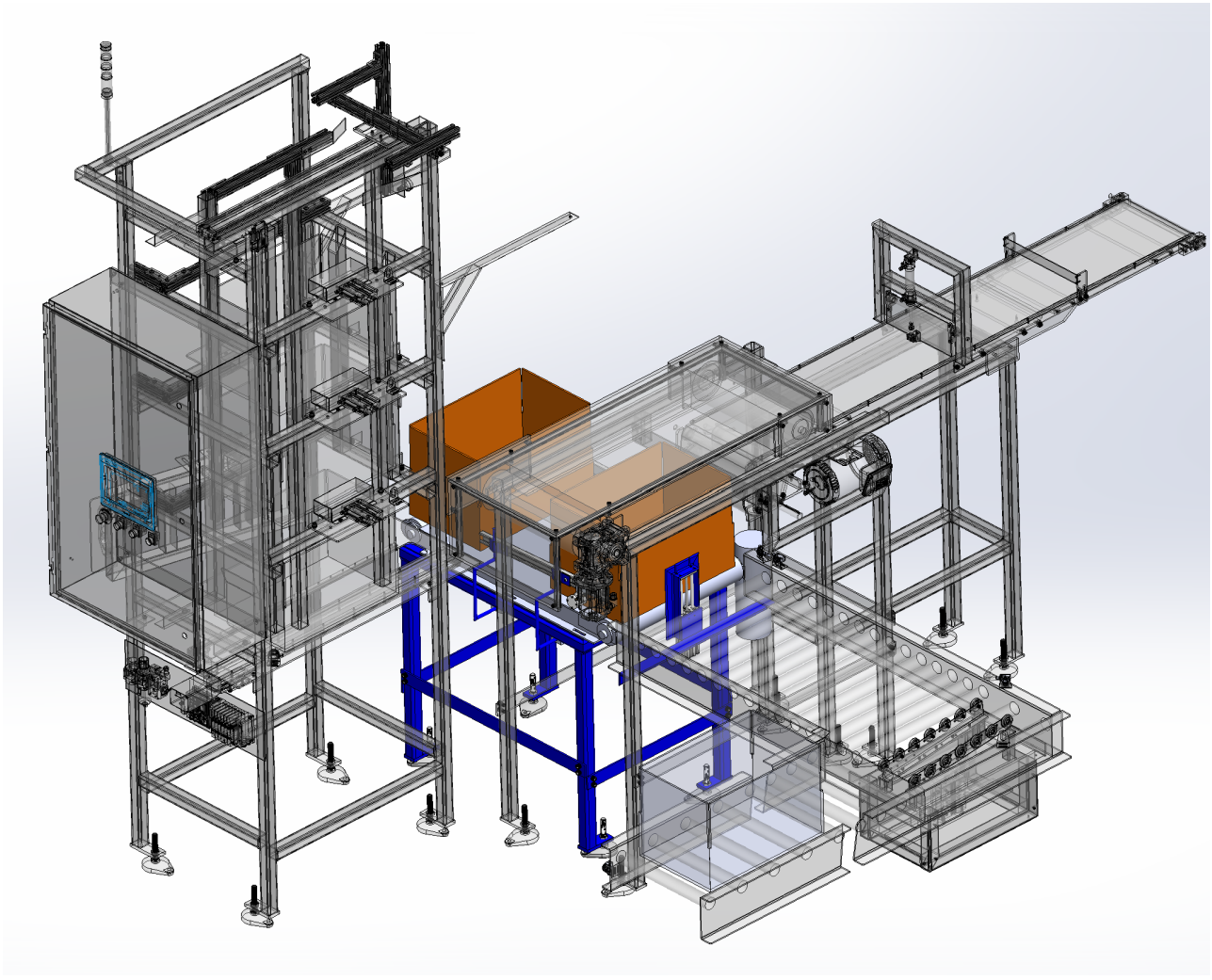

Figure 6. Highlight of the loading conveyer in the assembly

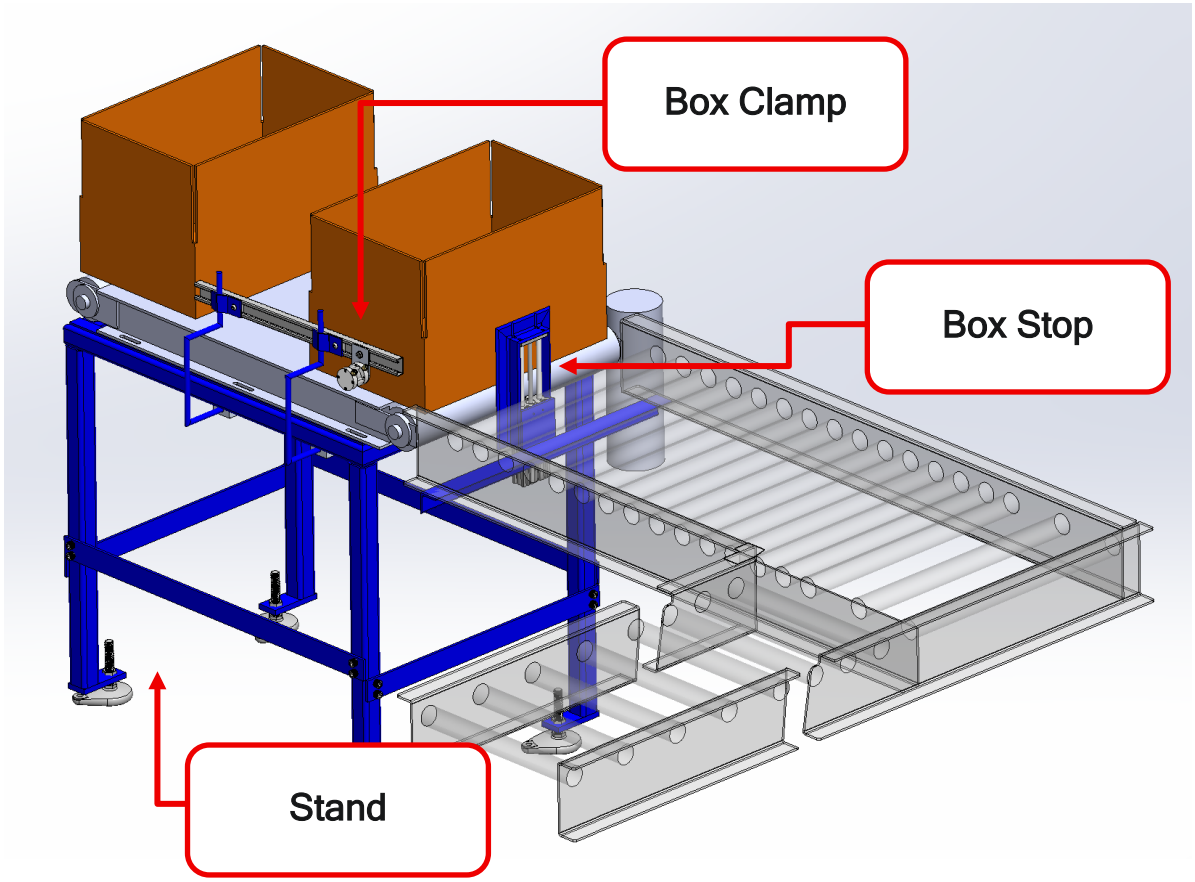

Figure 7. Loading conveyer belt with the box stop being up

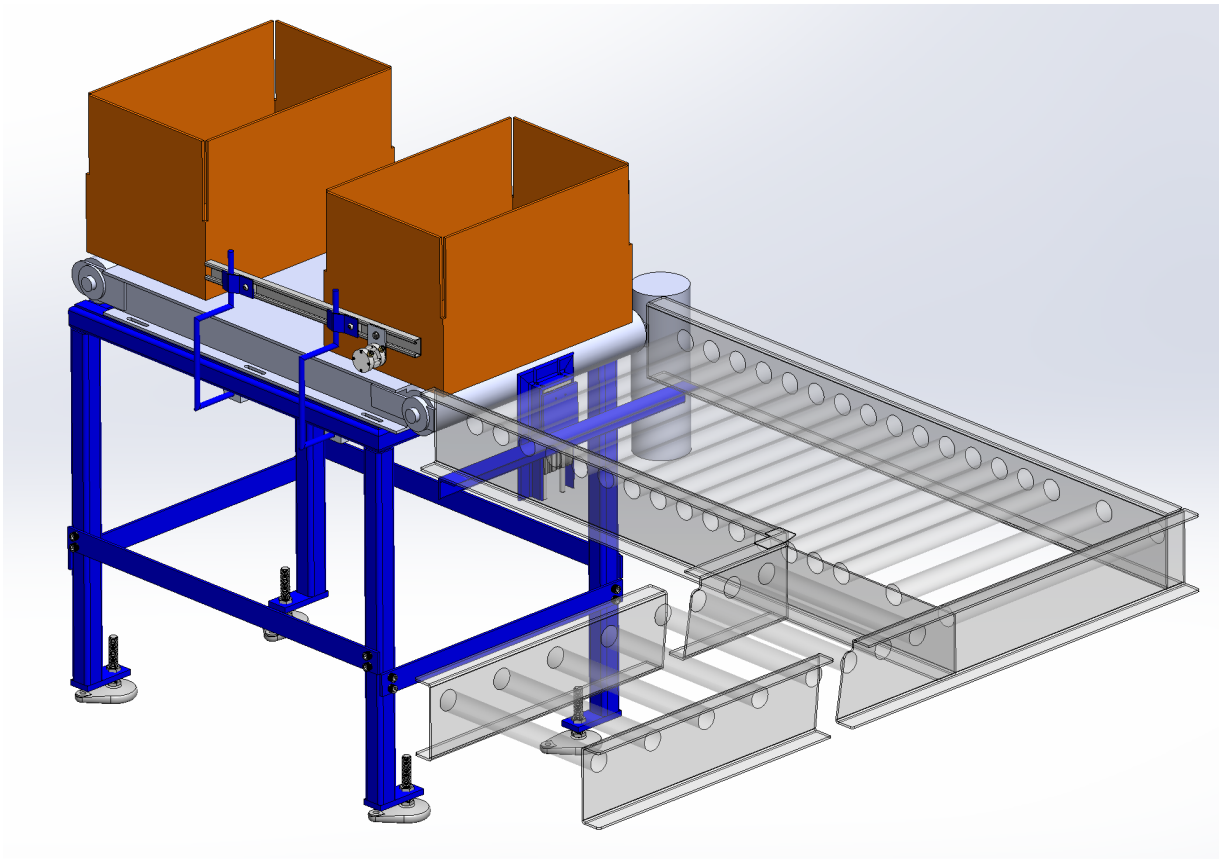

Figure 8. Loading conveyer belt with the box stop being down

Press Conveyer

This press was designed entirely from the ground up. The press conveyor receives truss plates from a third-party plate-making system and uses permanent magnets, some of which are adjustable, to provide greater flexibility in plate handling. Figure 9 illustrates the press conveyor within the overall assembly, while Figure 10 shows a standalone view of the conveyor itself. The magnets mounted beneath the conveyor are visible in Figure 11, and Figure 12 presents an exploded view of the conveyor belt for additional clarity.

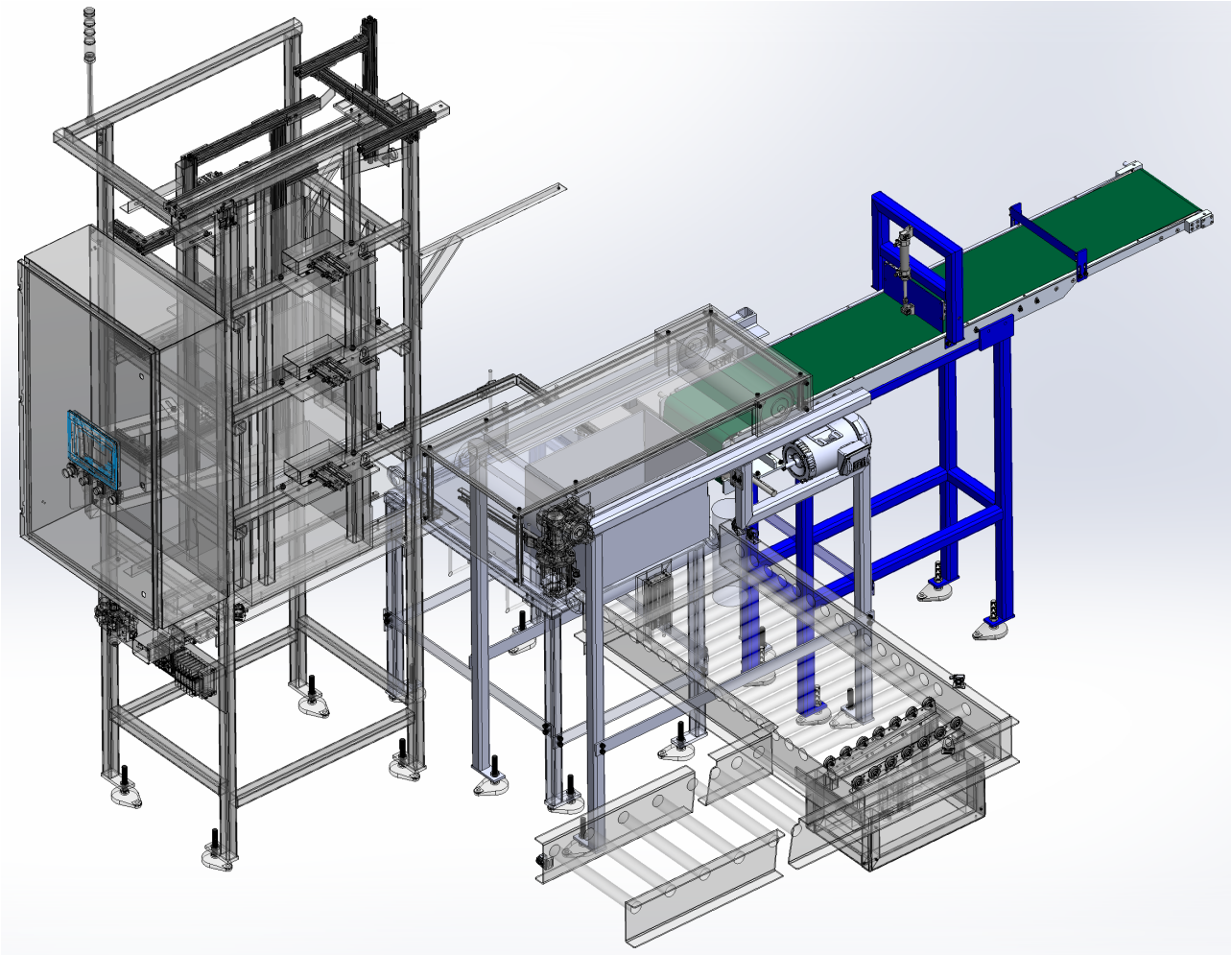

Figure 9. Highlight of the press conveyer in the assembly

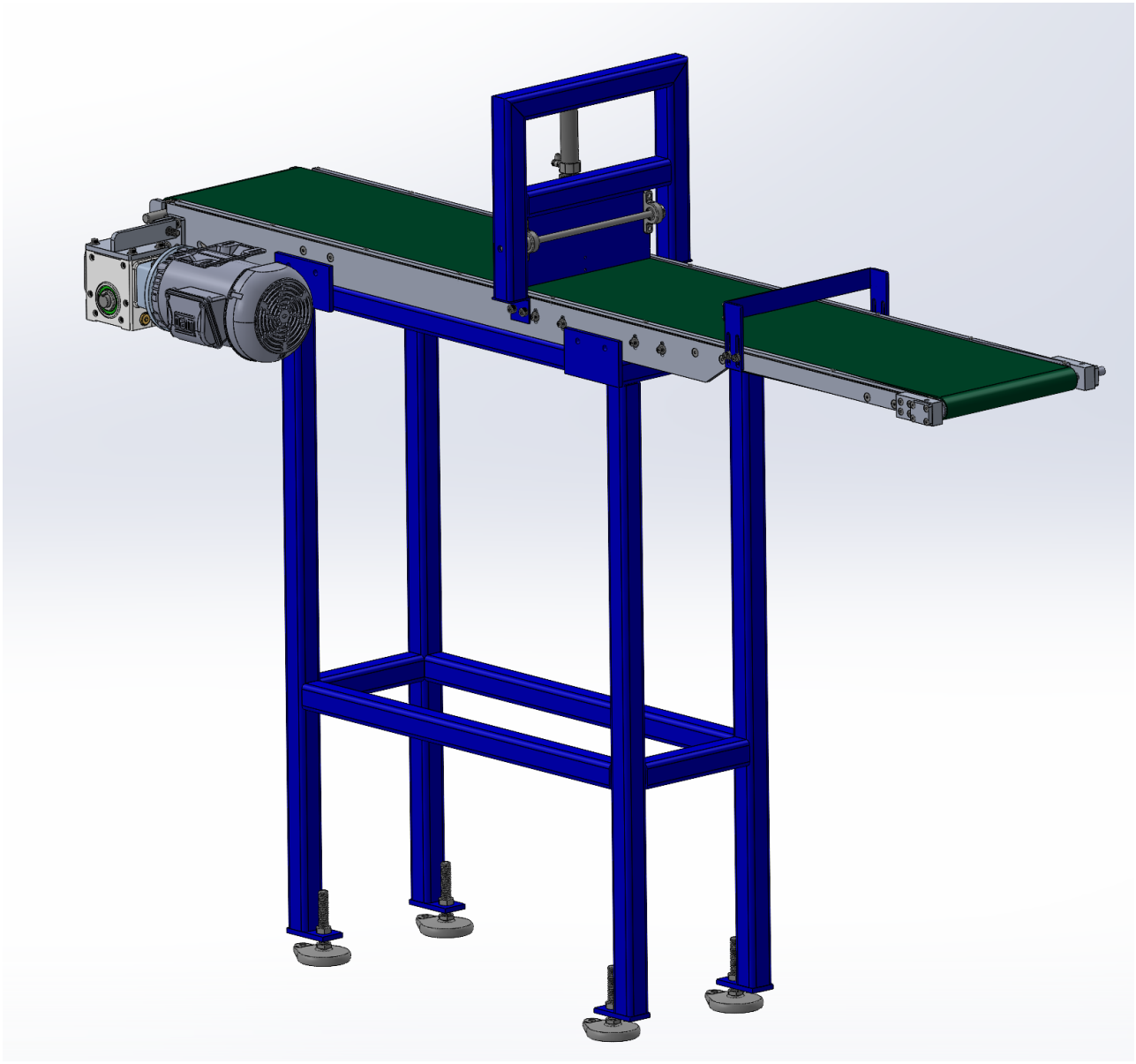

Figure 10. Press conveyor belt

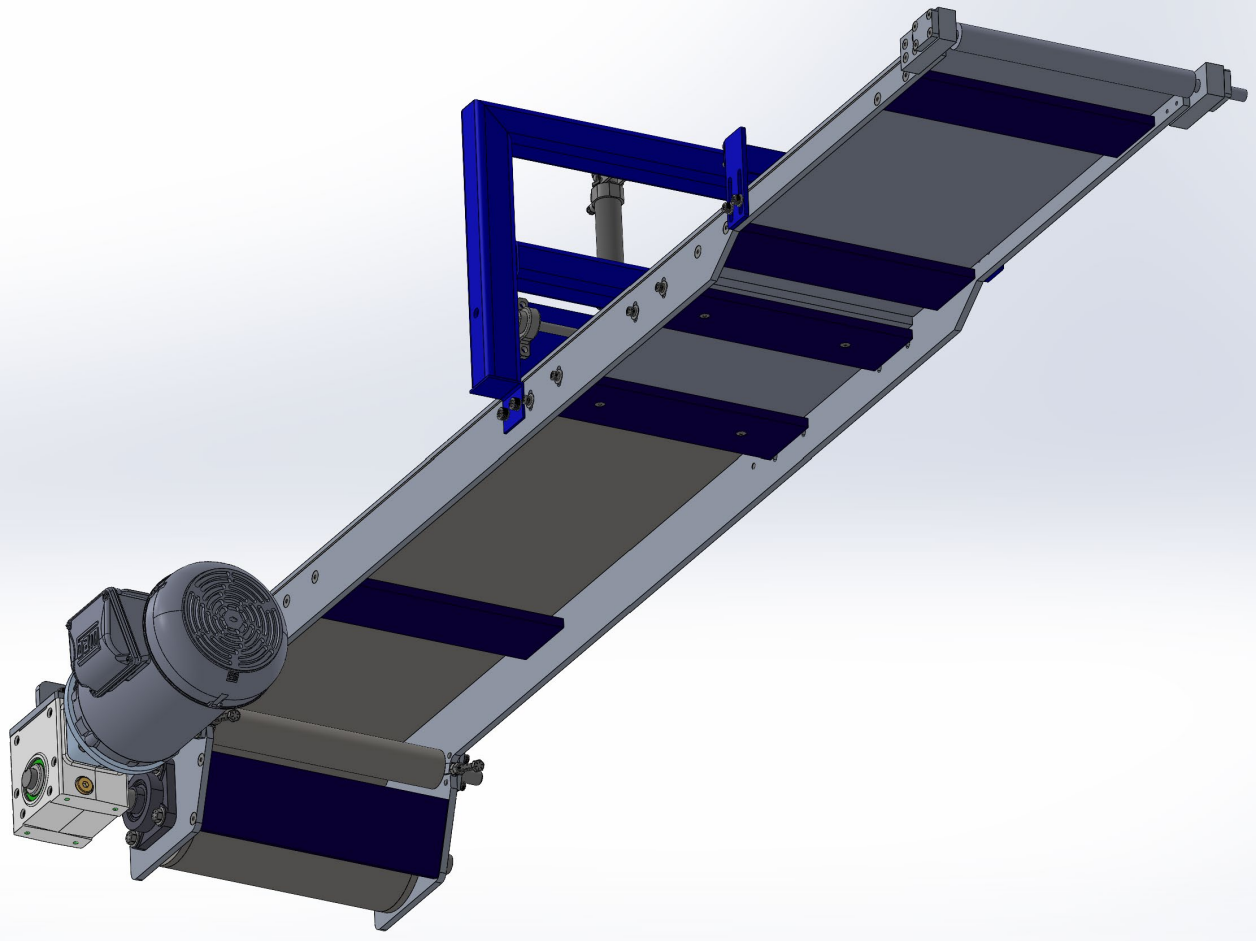

Figure 11. Press conveyor without belt to showcase the magnets

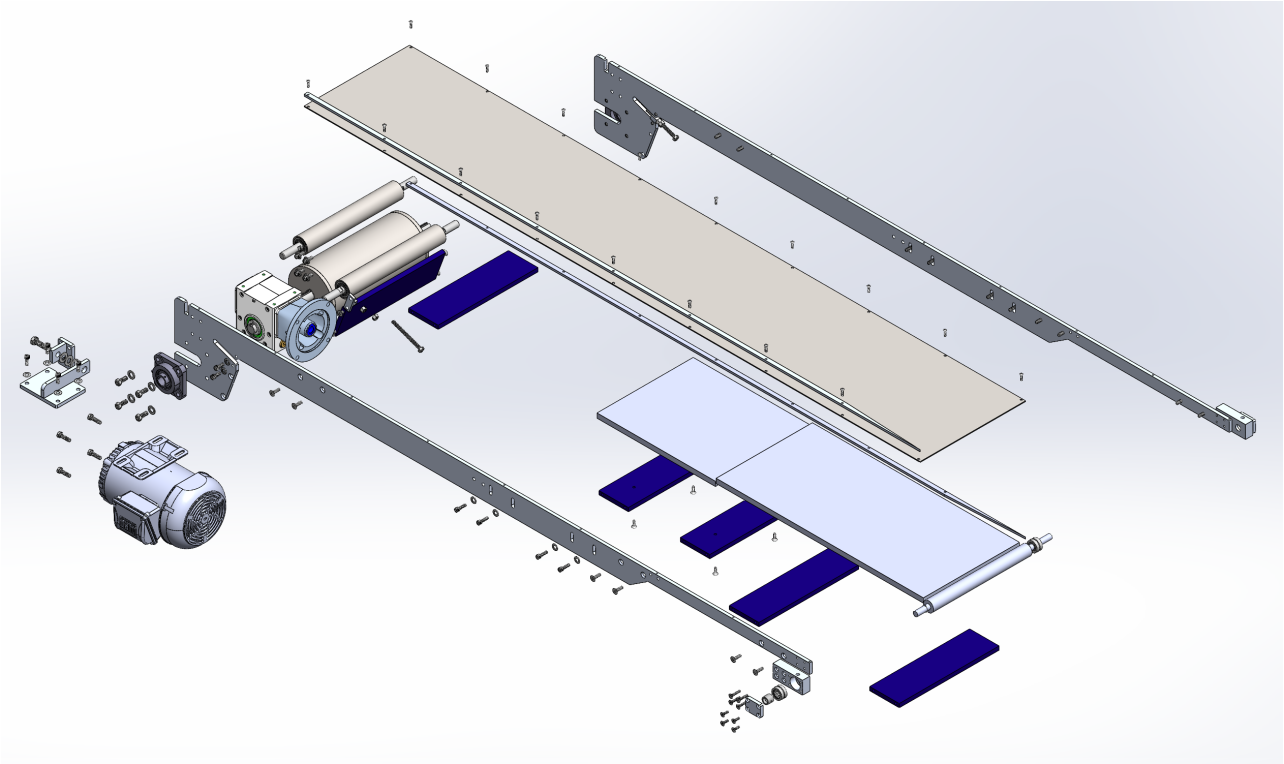

Figure 12. Exploded view of the press conveyor

Drop Magnet Conveyer

Similar to the loading conveyor, every component of the drop conveyor system was designed by our team, except for the conveyor belt itself, which was sourced from Rebstock Conveyors. This system utilizes a combination of permanent and electromagnetic magnets to transfer truss plates from the press conveyor into the boxes. The inverted configuration allows it to pick up plates with permanent magnets. Once the plates are correctly positioned, the conveyor halts, the electromagnets deactivate, and the plates are released into the box. This sequence repeats until the box is fully loaded. Figure 13 shows the drop conveyor within the full system, while Figure 14 presents it as a standalone component.

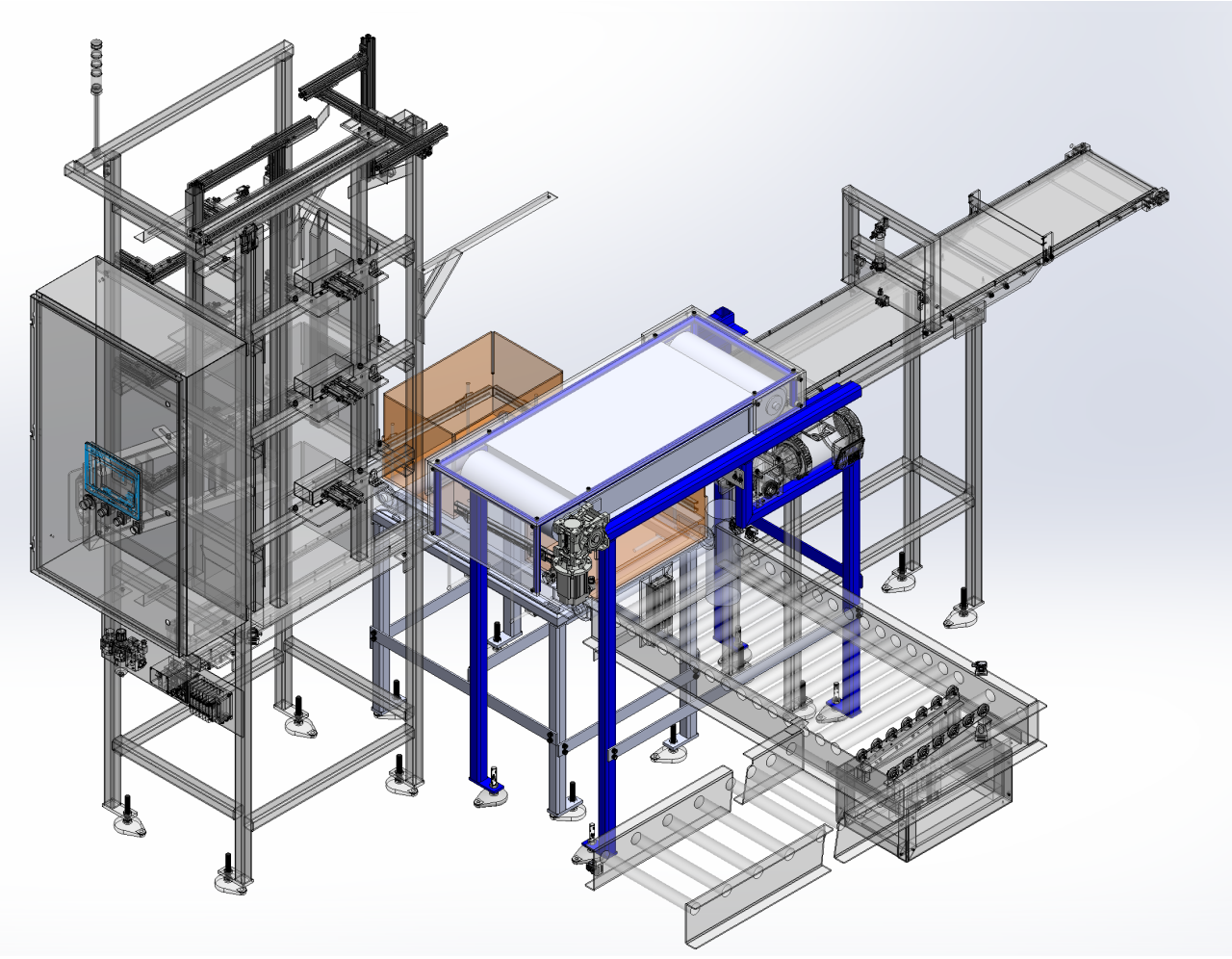

Figure 13. Highlight of the drop conveyer in the assembly

Figure 14. Drop conveyer

Exit Conveyer

Once the loading process is complete, the gate lowers, the conveyor restarts, and the clamps release the box. A custom-designed lift-and-transfer unit then redirects the box around a corner, guiding it to the final quality control station. As shown in Figure 15, the exit conveyor belt is positioned within the larger system, while Figure 16 provides a close-up view of the lift-and-transfer mechanism.

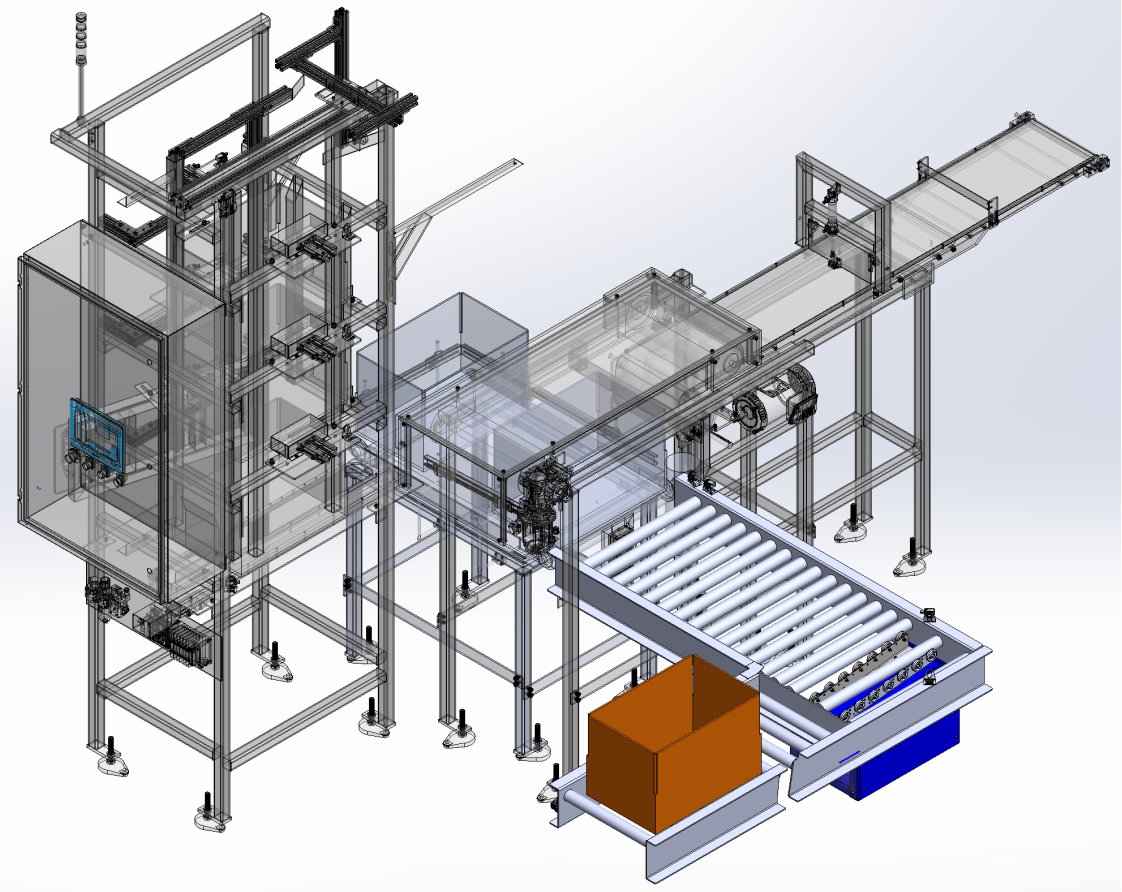

Figure 15. Close up of lift and transfer mechanism

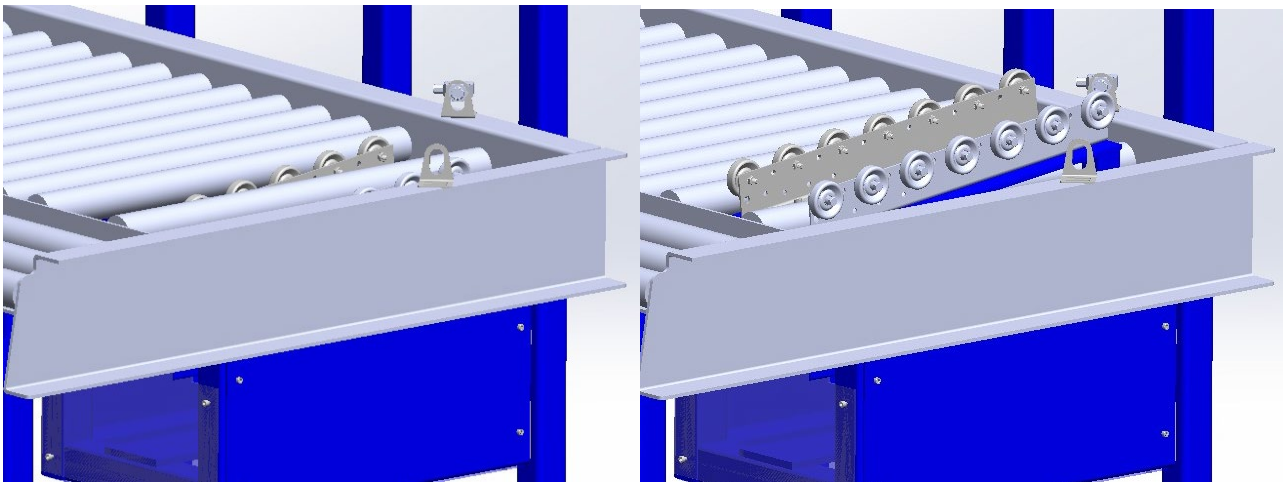

Figure 16. Close up of lift and transfer mechanism

Quality Control System

Once the box is filled with truss plates, it passes through a Keyence vision system that verifies the correct quantity and placement of plates before wrapping and shipment. The mounting frame for the vision system, as well as the external panel housing the system's interface, were both designed by our team to ensure optimal positioning, durability, and accessibility. If the box meets all quality standards, the system displays a pass confirmation on the control panel. Figure 17 highlights the quality control system within the overall assembly, while Figure 18 provides a detailed view of the inspection unit.

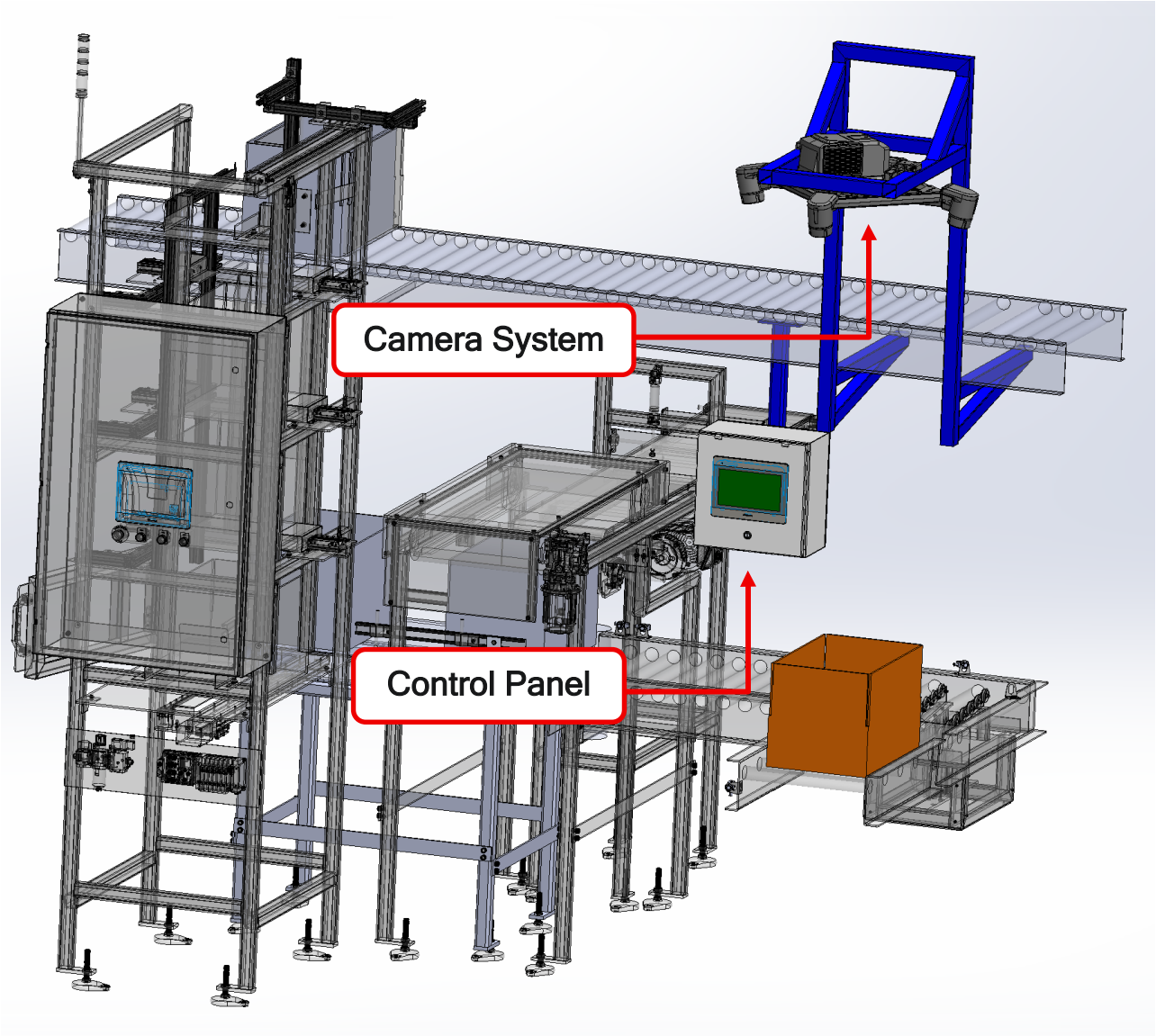

Figure 17. Highlight of the quality control system in the assembly

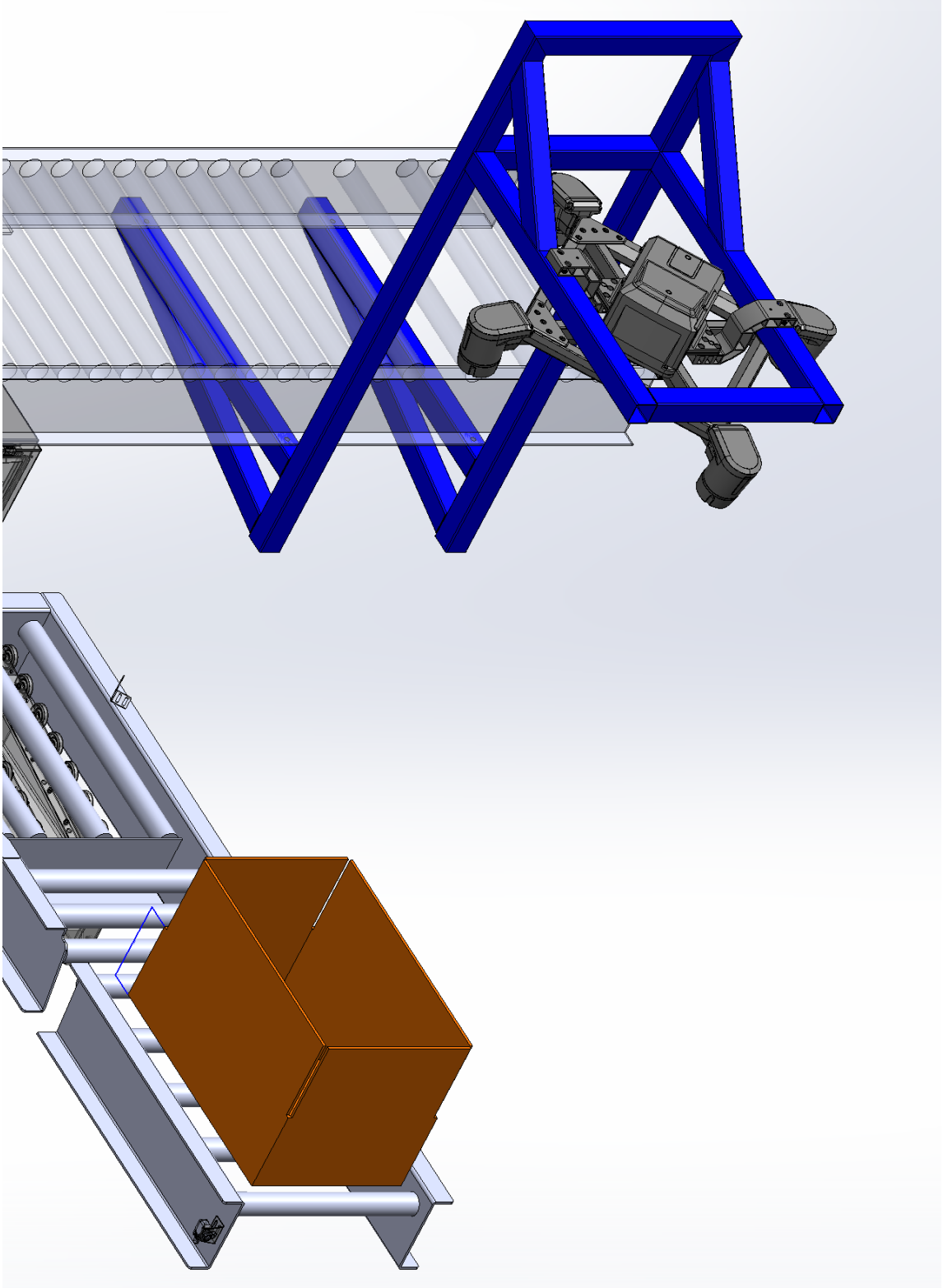

Figure 18. Close up of the quality control system

DESIGN PROCESS

Our approach to this project was highly collaborative and detail oriented. From the outset, we worked closely with the customer to understand their previous systems and identify opportunities for improvement. Through consistent communication, we tailored the solution to meet their exact needs, adding new features and streamlining existing processes. We used SolidWorks extensively for modeling and simulation, consulted with conveyor and camera system suppliers for third-party components, and incorporated on-site feedback throughout the build. One key lesson learned was the importance of proactive cable management; in future iterations, we plan to implement a more structured and efficient system based on the customer's input.

FINAL RESULTS & SYSTEM IMPACT

This system successfully addressed several key operational challenges:

- Automated the box handling and truss plate loading process
- Improved consistency in plate placement and box filling
- Reduced manual labor and operator oversight
- Streamlined flow between stations with precise indexing and timing

As a result, the customer saw improved throughput, reduced dependency on operators, and more reliable quality control through integrated vision inspection. The system was also designed to feed directly into a downstream palletizing system developed by our team, enabling a seamless and fully automated packaging line from start to finish.