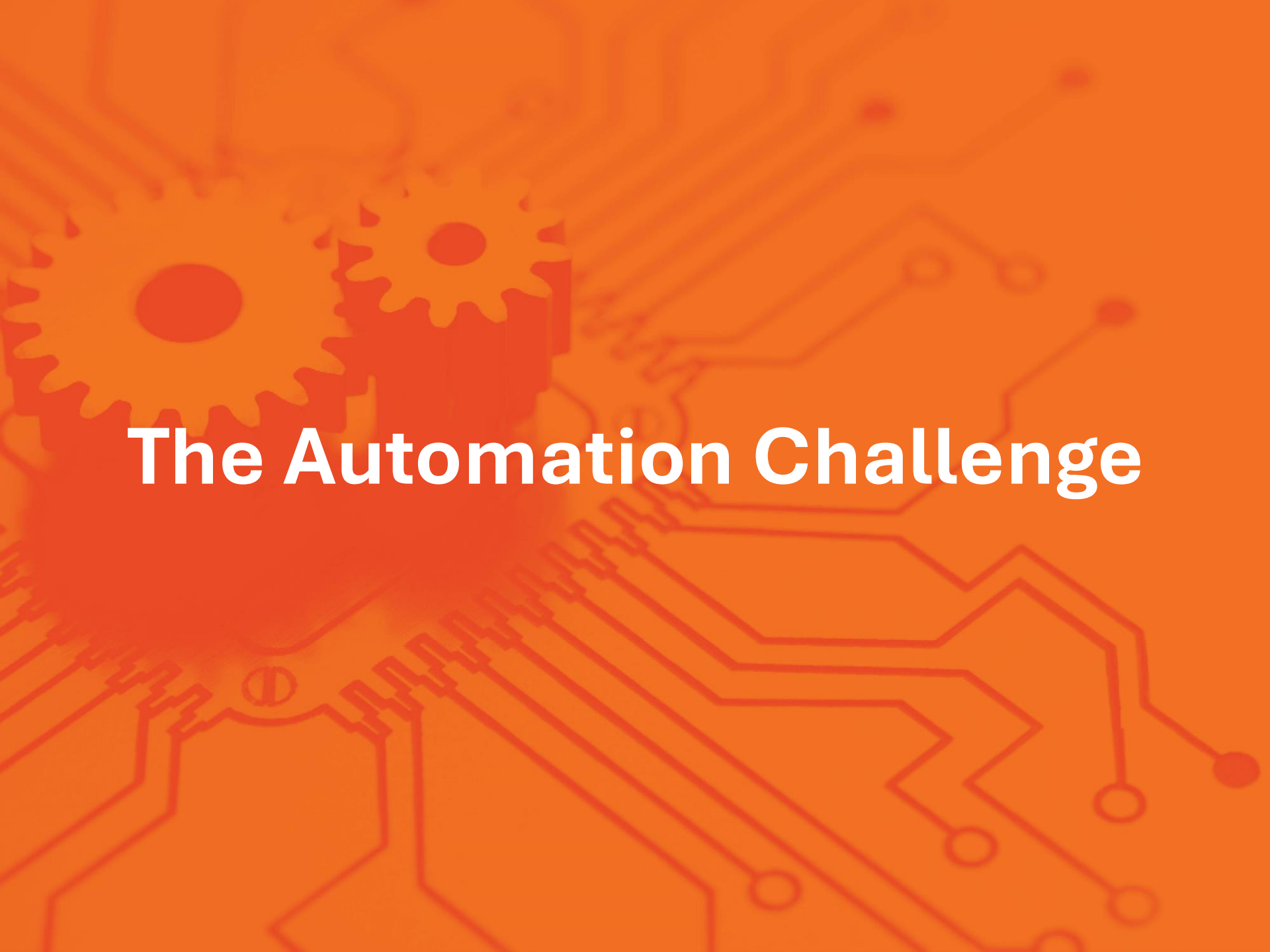




MARTEK
AUTOMATION

**The Automation Journey:
Short-Run, High-Mix
Microelectronics
Packaging**

The background is a solid orange color. Overlaid on this are faint, light-orange line art graphics. On the left side, there are two interlocking gears of different sizes. From the right side of the gears, a series of lines branch out, resembling a circuit board or a network diagram, with small circles at the end of some lines. The overall theme is mechanical and technological.

The Automation Challenge

Short-run, high-mix microelectronics manufacturing presents a unique automation challenge:

Manufacturers need the quality and repeatability benefits of automation, but frequent product changeovers can make conventional high-volume solutions impractical.

The Solution:

A successful high-mix automation strategy begins with a standardized material-handling platform. Properly designed transport carriers and magazines allow multiple package types to move reliably between process work cells while minimizing equipment changeover.

The Solution:

These systems can be integrated into a wide range of processes:

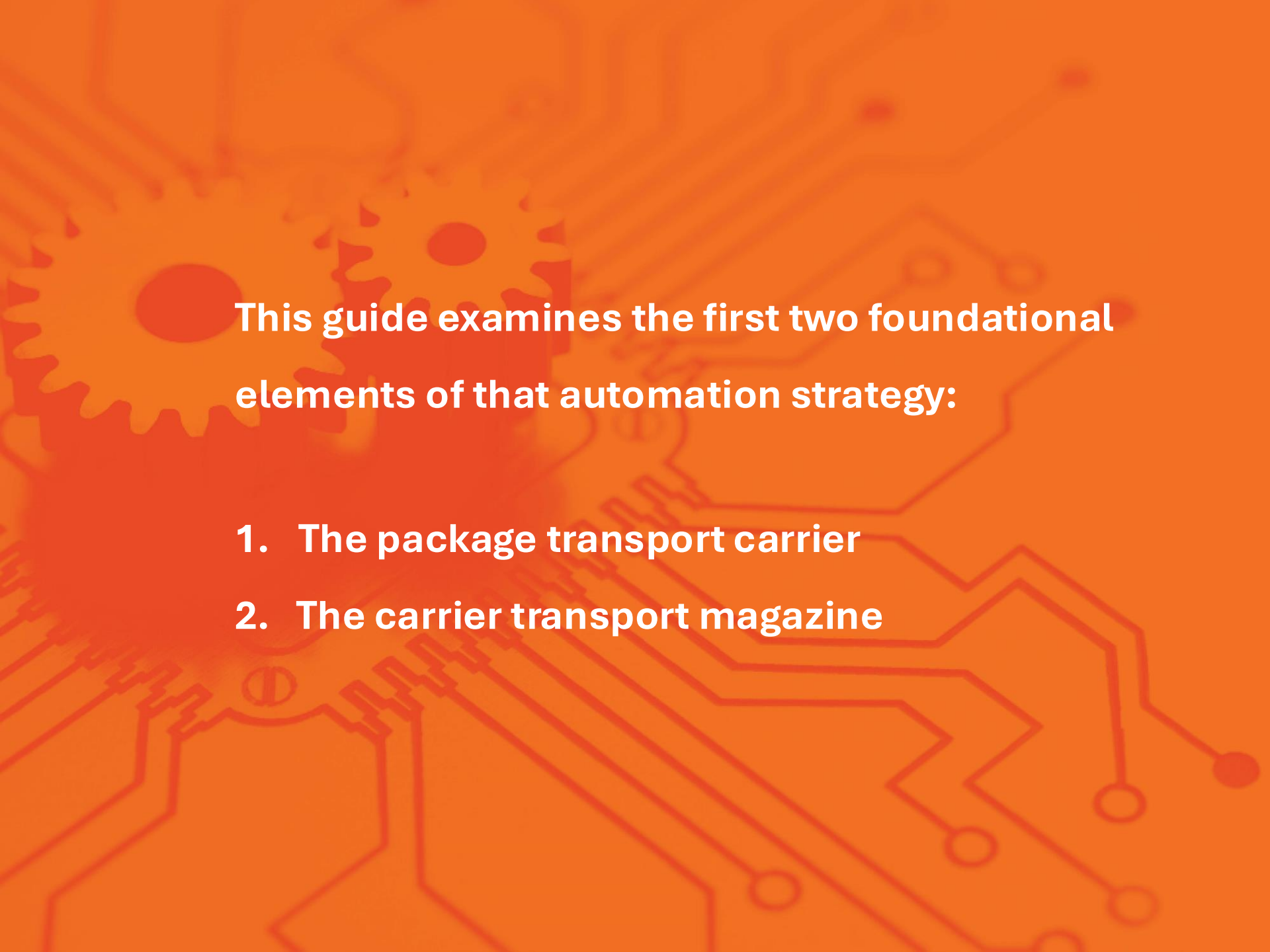
- Die Attach
- Wire Bonding
- Inspection
- Final packaging
- Laser Marking
- Functional Testing

The background is a solid orange color. Overlaid on this are faint, stylized white line drawings. On the left side, there are two interlocking gears of different sizes. From the right side of the gears, a series of lines branch out across the page, resembling a complex electronic circuit board or a network diagram. These lines include various geometric shapes like rectangles, circles, and dots, suggesting a technical or digital theme.

The Result

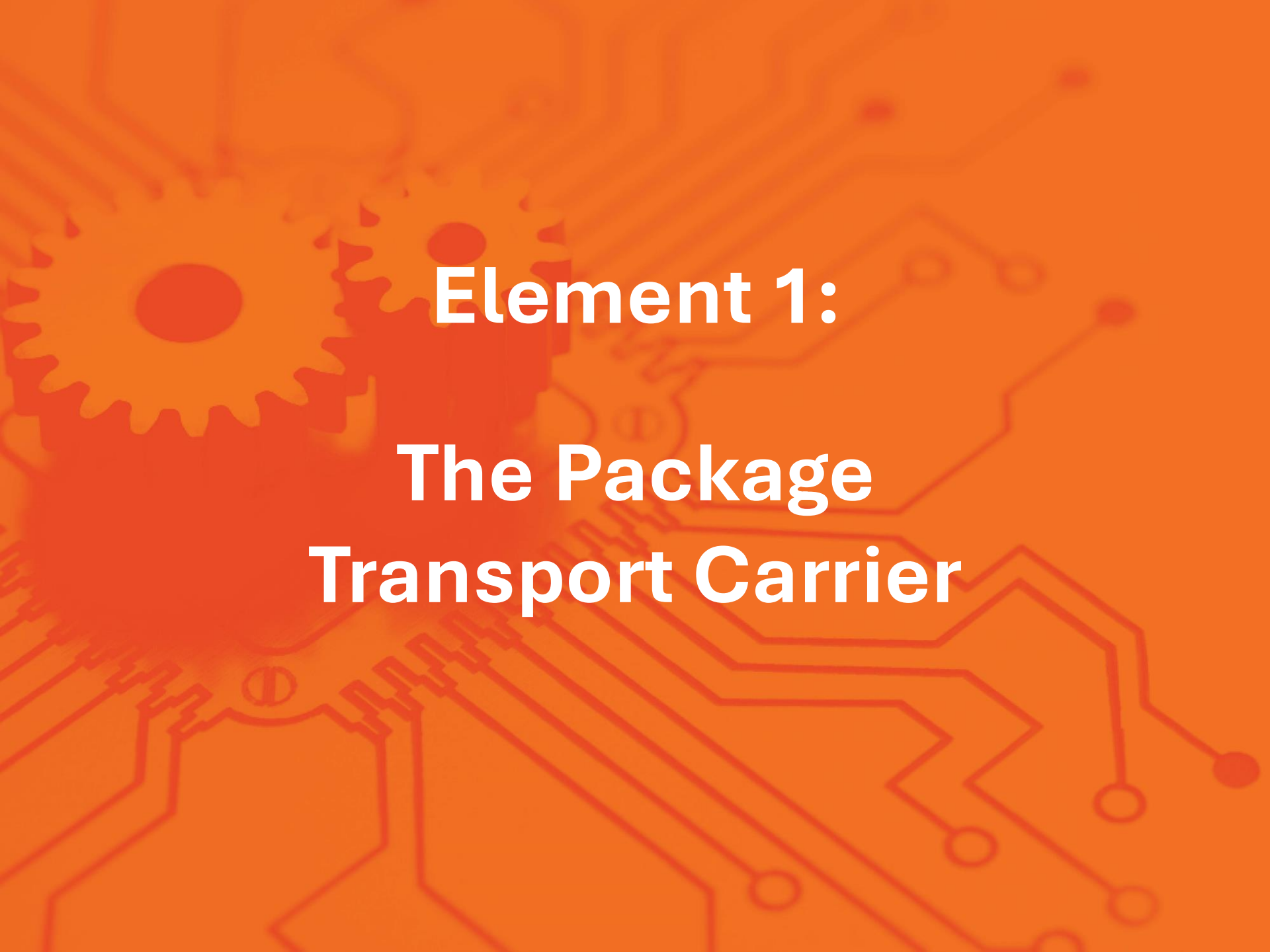
By standardizing the method used to transport products throughout the manufacturing process, manufacturers can reduce operator intervention, improve process consistency, enhance product traceability, and create a scalable platform for future automation.

Whether implemented within a standalone work cell or a fully integrated production line, transport carriers and magazines enable efficient product flow between manufacturing operations while supporting short-run, high-mix production requirements.



This guide examines the first two foundational elements of that automation strategy:

- 1. The package transport carrier**
- 2. The carrier transport magazine**

The background is a solid orange color. Overlaid on this are faint, stylized white line drawings. On the left side, there are two interlocking gears of different sizes. From the right side, a series of lines resembling a printed circuit board (PCB) trace pattern extends across the frame, featuring various right-angle turns, loops, and small circular pads.

Element 1:

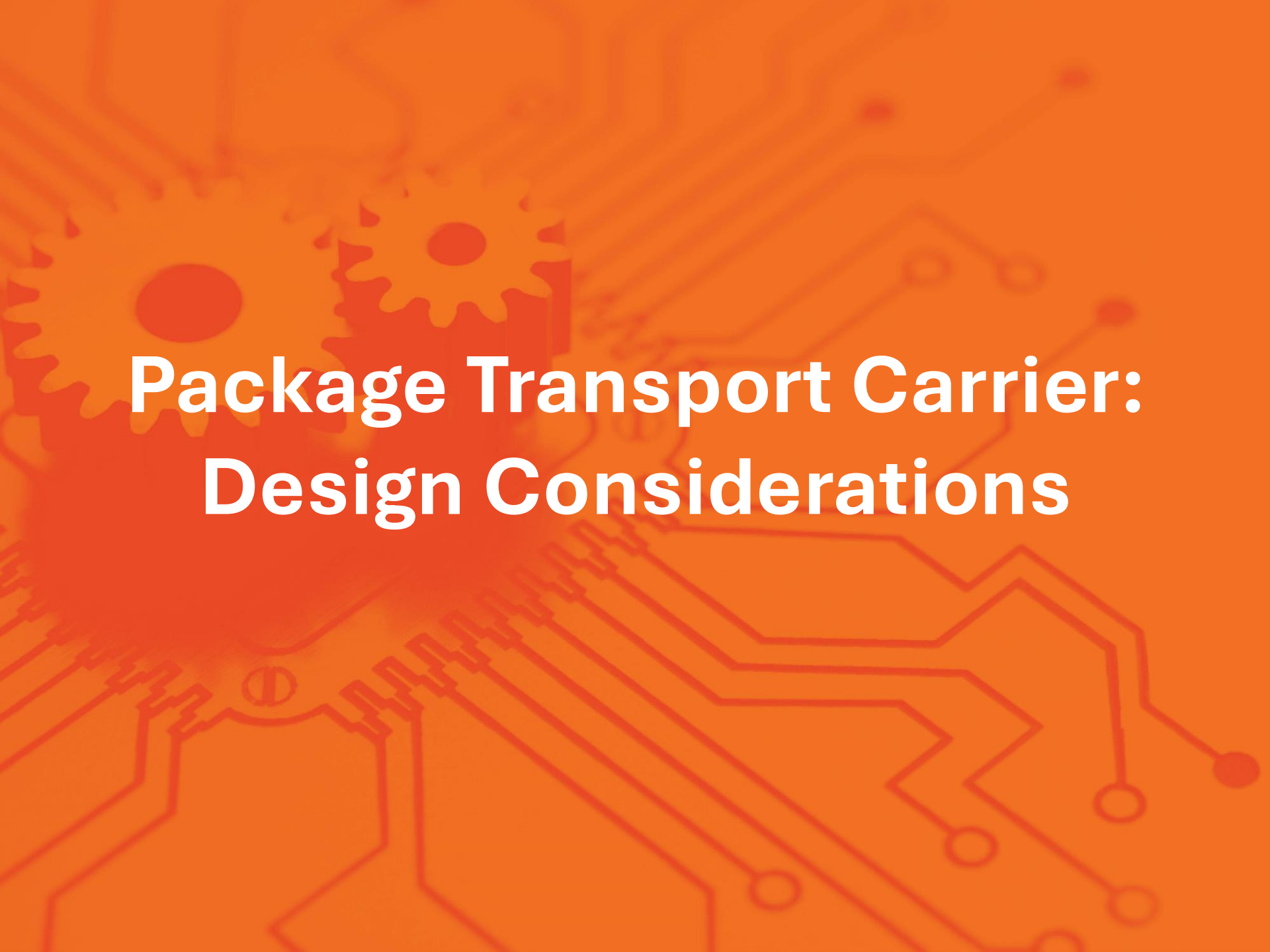
The Package

Transport Carrier

The package transport carrier is the first foundational element of any short-run, high-mix automated assembly process.

By leveraging edge-belt conveyors, it efficiently moves packages through various process work cells, ensuring seamless and reliable automation.

Selecting the right carrier is essential for maintaining precision, repeatability, and overall process efficiency. Factors such as size, material, and design should be carefully assessed to optimize workflow, enhance handling, and ensure long-term system performance.

The background is a solid orange color. Overlaid on this are faint, stylized white and light orange graphics. On the left side, there are several interlocking gears of different sizes. On the right side, there are circuit board traces, represented by thin white lines that form a complex, branching pattern. Some of these traces end in small circles, resembling vias or component footprints. The overall aesthetic is technical and modern.

Package Transport Carrier: Design Considerations

Design Considerations: Carrier Size

To ensure consistency and efficiency, all products to be conveyed should be assessed, and a standardized carrier size should be selected to accommodate the full range of products.

Standardizing the carrier width and length minimizes changeover time between different product types, improving overall process efficiency.

The size of the largest and smallest packages determines the required width of the carrier. Industry standard carrier length is 12 in. but shorter ones can be used if other circumstances require it.

Design Considerations: Carrier Size

Parts per Carrier

Maximizing the number of parts per carrier seems like an efficient approach, but it comes with trade-offs. Here are some key considerations:

- **Clamping Force Limitations**

Processes like heavy wire bonding require high clamping forces, which may be problematic if too many parts are loaded.

- **Work Order Size**

If the order size is small, a high-capacity carrier may result in partially filled loads. If the process relies on vacuum clamping, open or empty positions in the carrier can cause problems, potentially reducing stability and process reliability.

Design Considerations: Carrier Type



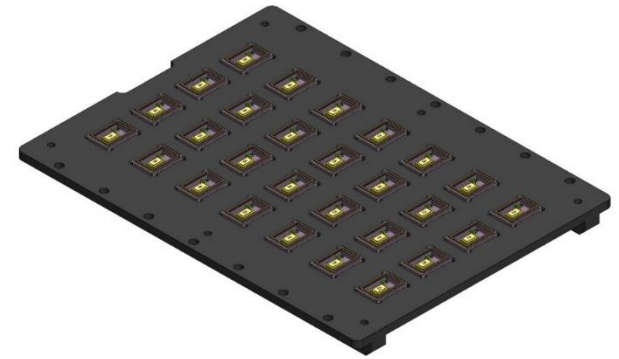
Carriers are typically manufactured in two types:

1. Sheet Metal Carriers

Progressive dies are utilized to fabricate carriers from stainless steel sheet metal in an automated die process.

- **Advantages:** *Ideal for high-volume production, offering the lowest cost per unit.*
- **Disadvantages:** *High non-recurring engineering (NRE) and tooling development costs make it less viable for low-quantity applications.*
- **Thermal Considerations:** *When exposed to thermal cycling, they may warp over time, leading to feeding jams and requiring rework or replacement.*
- **Accuracy:** *These carriers use tabs for package positioning, which may not provide the precision required for certain assembly processes.*

Design Considerations: Carrier Type



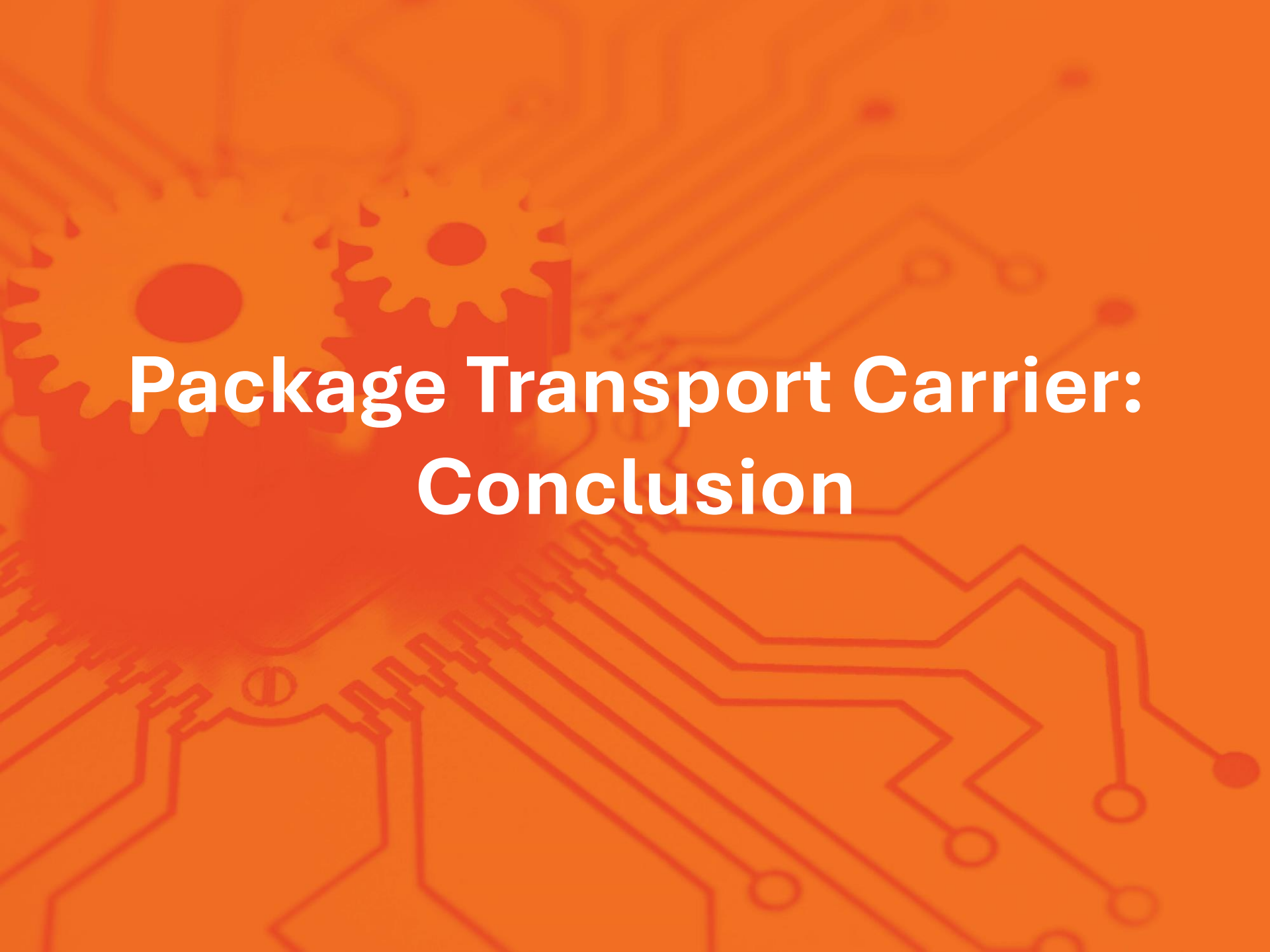
Carriers are typically manufactured in two types:

2. Machined Metal Carriers

CNC milling equipment is utilized to manufacture carriers from various materials.

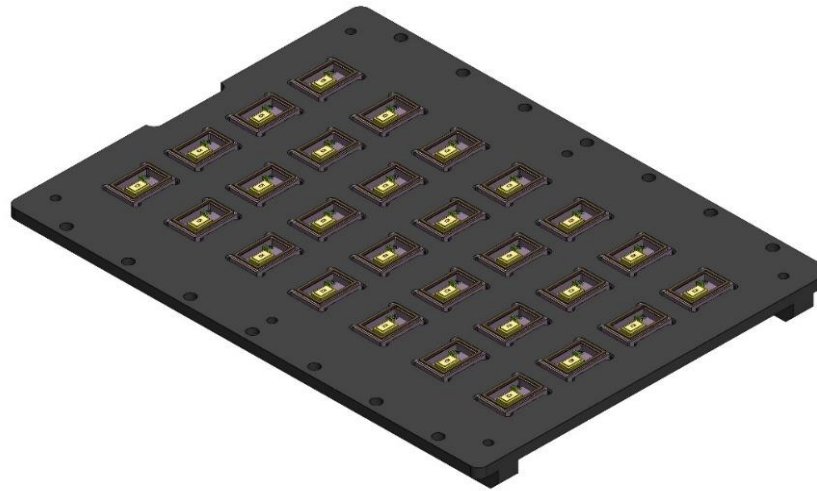
For ESD safety, conductive materials and coatings should be used in most cases.

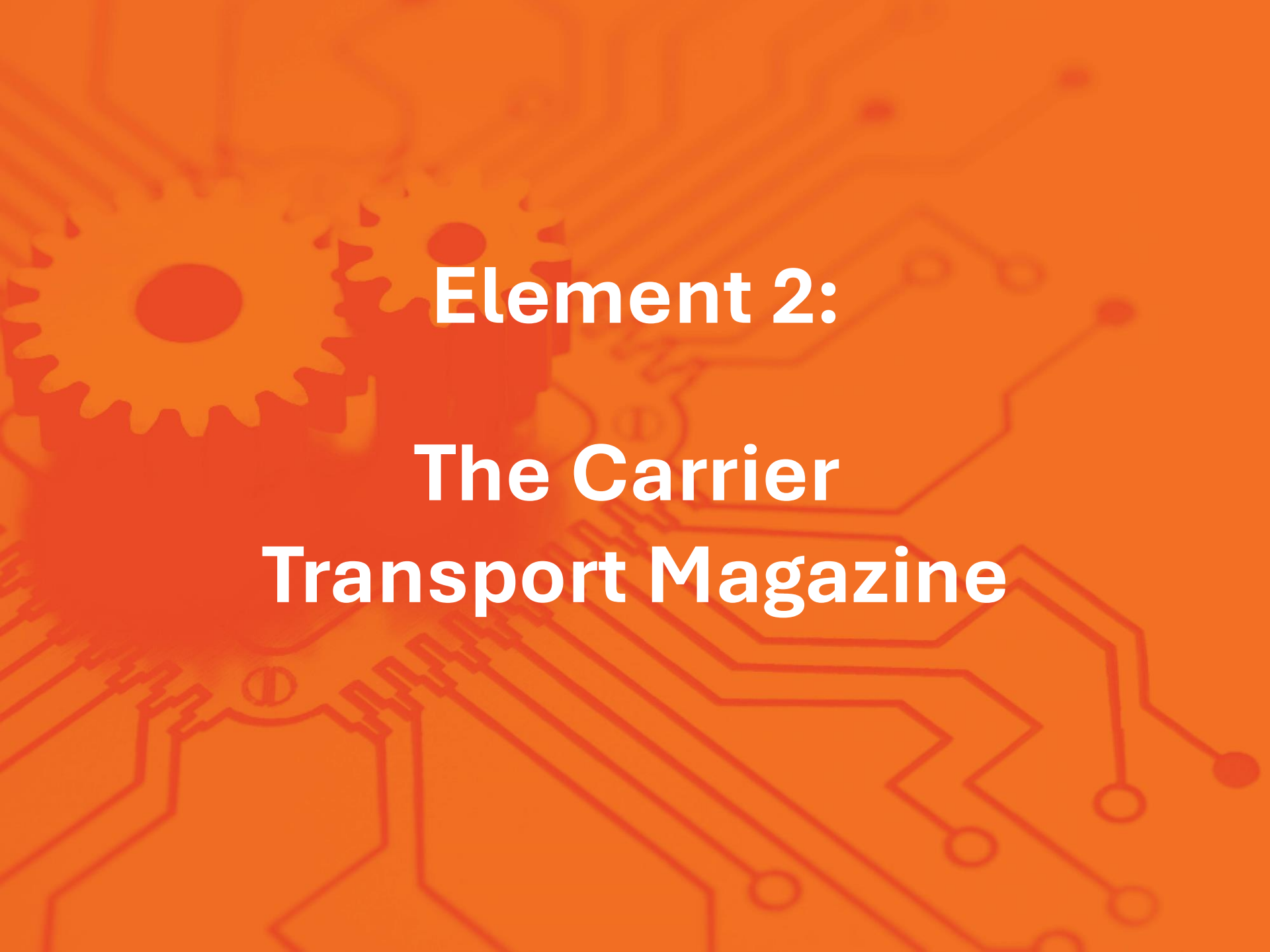
- **Advantages:** *Ideal for low-volume production, with lower NRE and tooling costs compared to sheet metal stamping.*
- **Disadvantages:** *Higher per-unit cost due to increased manufacturing cost.*
- **Thermal Considerations:** *Machined carriers resist warping even when subjected to thermal cycling. Typically, they will remain flat and precise for many years of use.*
- **Accuracy:** *These carriers can be machined to tight tolerances, allowing for precise package positioning. They also enable the integration of locating and clamping features for enhanced stability.*

The background is a solid orange color. Overlaid on this are faint, stylized white and light orange graphics. On the left side, there are several interlocking gears of different sizes. On the right and bottom sides, there are intricate circuit board patterns consisting of thin lines, right-angle turns, and small circles representing vias or pads.

Package Transport Carrier: Conclusion

For most short-run, high-product-mix applications, machined carriers are preferred due to their lower upfront costs, extended lifespan and design options compared to sheet metal carriers.



The background is a solid orange color. Overlaid on this are faint, stylized white line drawings. On the left side, there are two interlocking gears of different sizes. The larger gear in the foreground has a central circle. To the right and extending towards the bottom right corner are several parallel, slightly wavy lines that resemble a circuit board or a network diagram. There are also small circles and dots scattered throughout the background, some of which are part of the circuit-like lines.

Element 2:

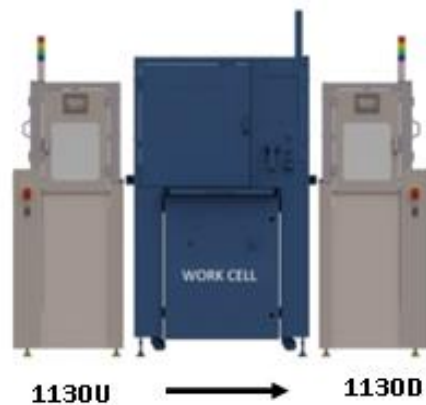
The Carrier

Transport Magazine

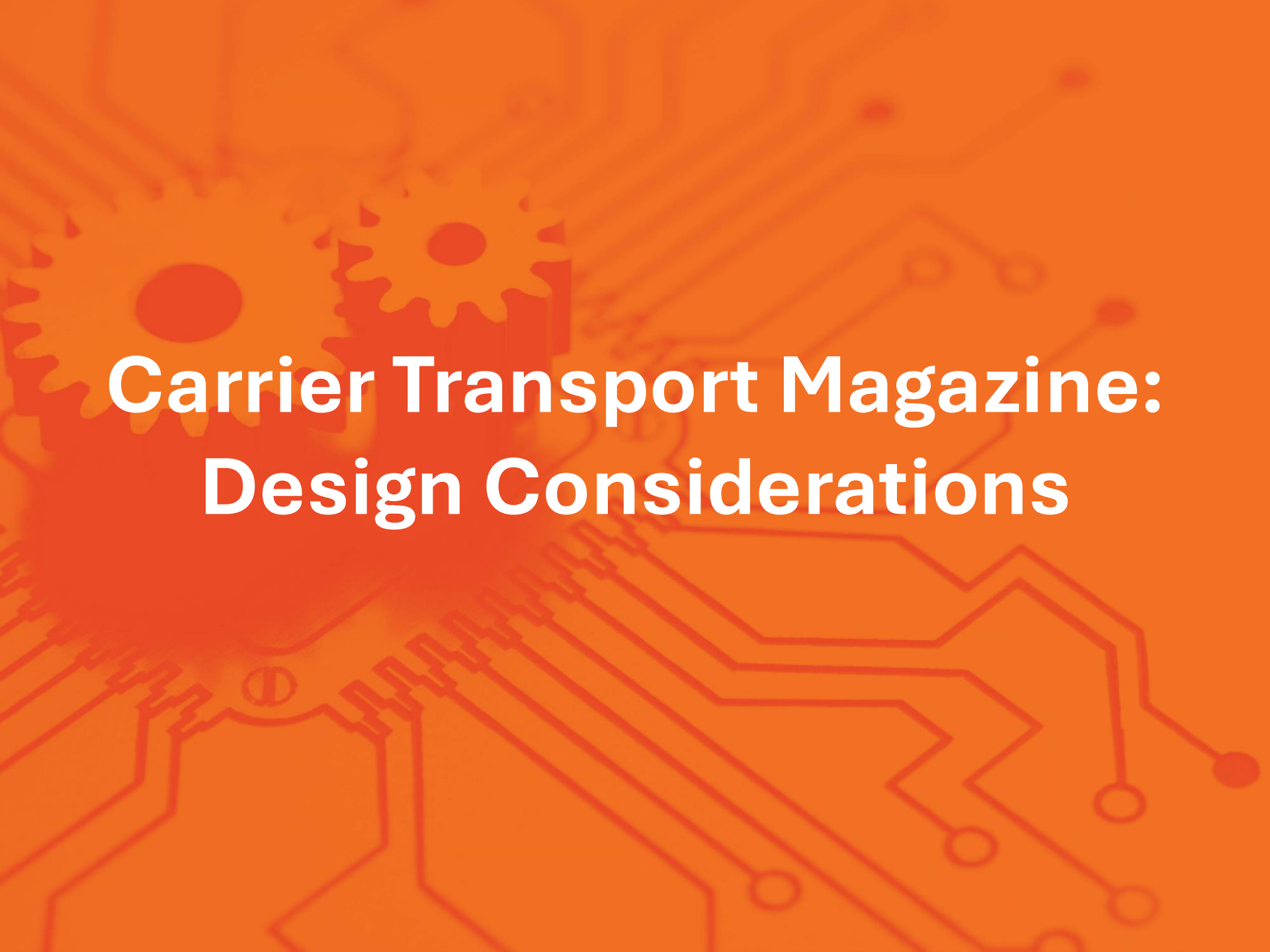
The carrier transport magazine holds multiple carriers in slots, facilitating the automated loading and unloading of products into and out of assembly cells or an integrated line.

Unprocessed product on carriers are loaded into the magazine slots and placed into an upstream **Magazine Unloader** system that automates the feeding process. Once processed, carriers are transferred into a downstream magazine via an automated **Magazine Loader**.

By integrating magazines with automated unloaders and loaders, manufacturers can streamline the feeding of carriers into individual work cells or along an automated production line, enhancing efficiency and reducing manual handling.



Custom magazine with slots for air flow and pins for containment when transporting

The background is a solid orange color. Overlaid on this are faint, stylized white line drawings. On the left side, there are several interlocking gears of different sizes. On the right and bottom sides, there are complex circuit board traces, including straight lines, right-angle turns, and small circular pads. The overall aesthetic is technical and industrial.

Carrier Transport Magazine: Design Considerations

Design Considerations: Magazine Size

The magazine size is determined by the carrier dimensions. Standardizing carrier sizes allows Magazine Unloaders and Loaders to maintain a consistent configuration, eliminating the need for changeovers. The magazine's slot capacity depends on the height of the parts and the total weight of a fully loaded magazine. This should be carefully managed to prevent ergonomic issues of operators moving the magazines.

Design Considerations: Thermal Cycling

Some users incorporate batch ovens for curing processes which must be considered when designing and manufacturing magazines. If using a convection type oven, then slots or holes to increase airflow is a crucial component.

Design Considerations: Magazine Types

1. Sheet Metal Magazine

This type is manufactured using sheet metal fabrication methods, where parts are cut, formed, and assembled using welding or rivets.

- **Advantages:** *Ideal for high-volume production, offering the lowest cost per unit. Lightweight and allows for easy integration of airflow features for thermal cycling.*
- **Disadvantages:** *Less rigid, leading to a shorter lifecycle and potential for jamming.*
- **Thermal Considerations:** *Deforms over time when exposed to thermal cycling, reducing lifespan.*

Design Considerations: Magazine Types

2. Extruded Magazine

Constructed from extruded aluminum, these magazines are available in fixed sizes: **3.1 x 12, 4.3 x 12, and 5.4 x 12.**

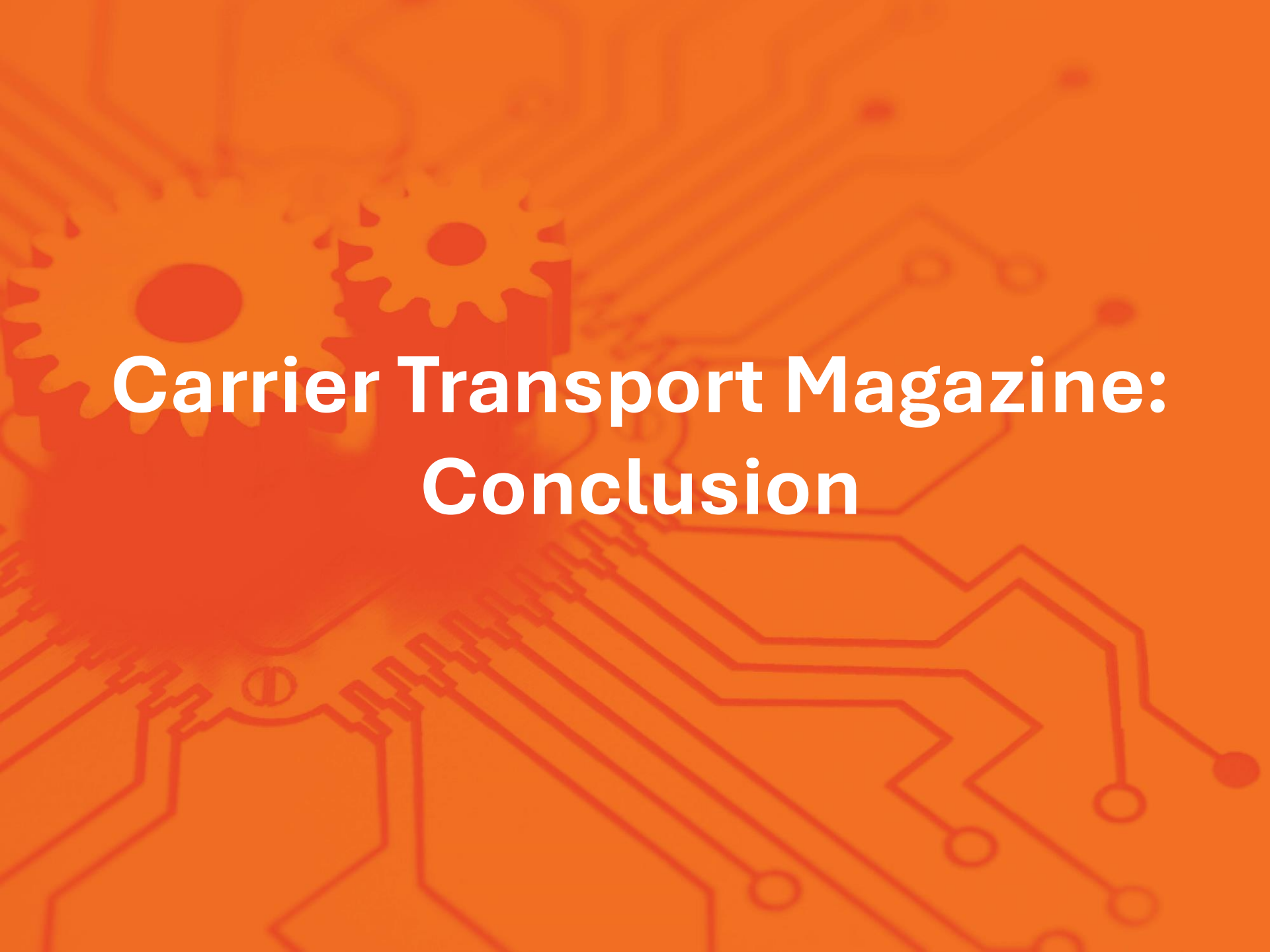
- **Advantages:** *Cost-effective if the standard sizes meet requirements.*
- **Disadvantages:** *Requires secondary operations for airflow slots or additional features. Includes stacking features but lacks interlocking, leading to movement when feeding carriers.*
- **Thermal Considerations:** *Withstands thermal cycling, but adding airflow features significantly increases cost.*

Design Considerations: Magazine Types

3. Machined Magazine

Machined from solid material, offering maximum customization for size and features such as airflow slots and stacking capabilities.

- **Advantages:** *Best option for custom sizes and features.*
Cost-effective for smaller production quantities.
- **Disadvantages:** *Highest cost per unit.*
- **Thermal Considerations:** *Excellent resistance to thermal cycling.*

The background is a solid orange color. Overlaid on this are faint, stylized white line drawings. On the left side, there are several interlocking gears of different sizes. On the right side, there are circuit board traces, including straight lines, right-angle turns, and small circles representing vias or pads. The text is centered in the upper half of the image.

Carrier Transport Magazine: Conclusion

For most short-run, high-product-mix applications extruded magazines are the best option if a standard size fits and thermal cycling is not required.

For custom sizes and thermal cycling needs, machined magazines are the preferred choice.

After finalizing your Transport Carrier and Magazine configurations, automated material handling is essential for efficiently moving products through the assembly process.

At the upstream and downstream points of your assembly cell or integrated line, Magazine Unloaders (upstream) and Magazine Loaders (downstream) play a crucial role in automation.

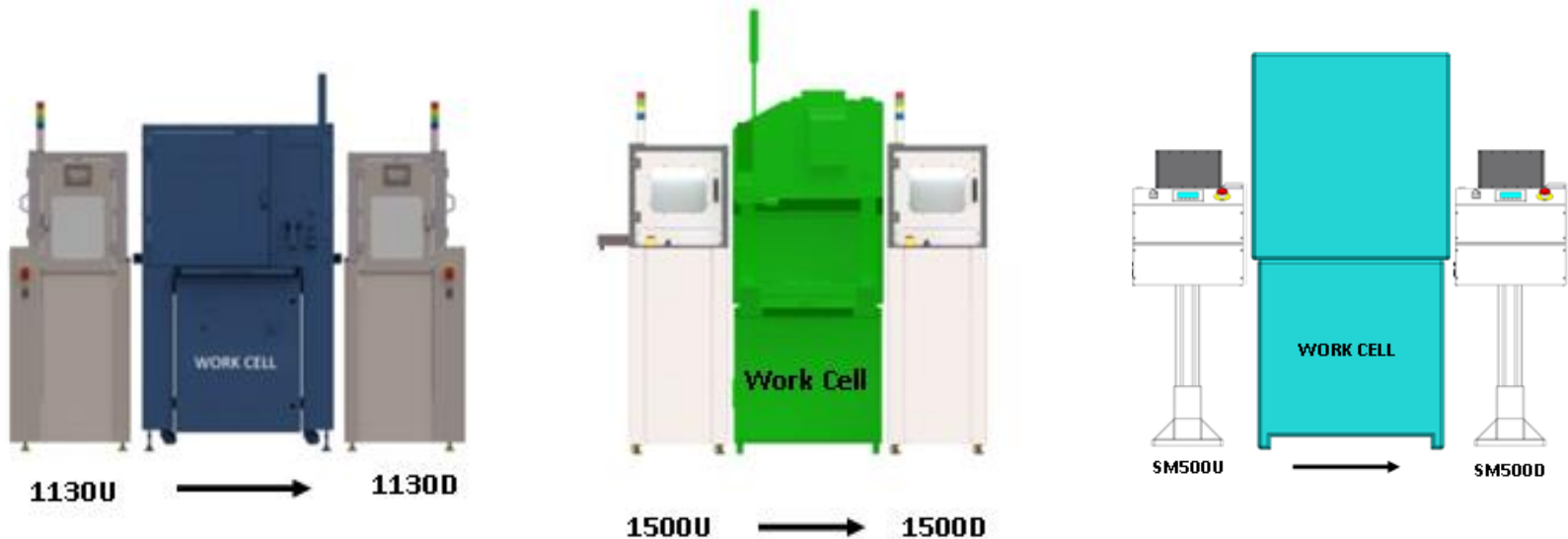
By incorporating the appropriate magazine handling system, you can streamline your process, improve efficiency, and reduce manual labor.

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Martek Automation's Magazine Handlers

Martek Automation offers multiple models to fit varying capacity needs:

- **High Capacity - 1130U (upstream) & 1130D (downstream):** *Handles multiple magazines.*
- **Medium Capacity - 1500U & 1500D:** *Supports two magazines.*
- **Single Capacity - SM500:** *Designed for a single magazine.*



Next Steps

There are many next steps in your automation journey which we will cover in additional blogs:

- Work cell or integrated line
- Quick change tooling strategy
- OEM assembly cell selection
- Ancillary systems:

Magazine unloaders/loaders and tracking systems (SCADA stations, bar code readers, and inspection stations including 2D optical inspection, 3D scans, and functional testing)

Contact Us

Reach out to Martek Automation for your
short-run, high-mix automation product needs:

sales@martekautomation.com

www.martekautomation.com

Thank you

Have specific questions or inquiries? Let's talk



MARTEK
AUTOMATION

sales@martekautomation.com

41728 Eastman Dr., Murrieta, CA

951-305-0541 x101

www.martekautomation.com

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