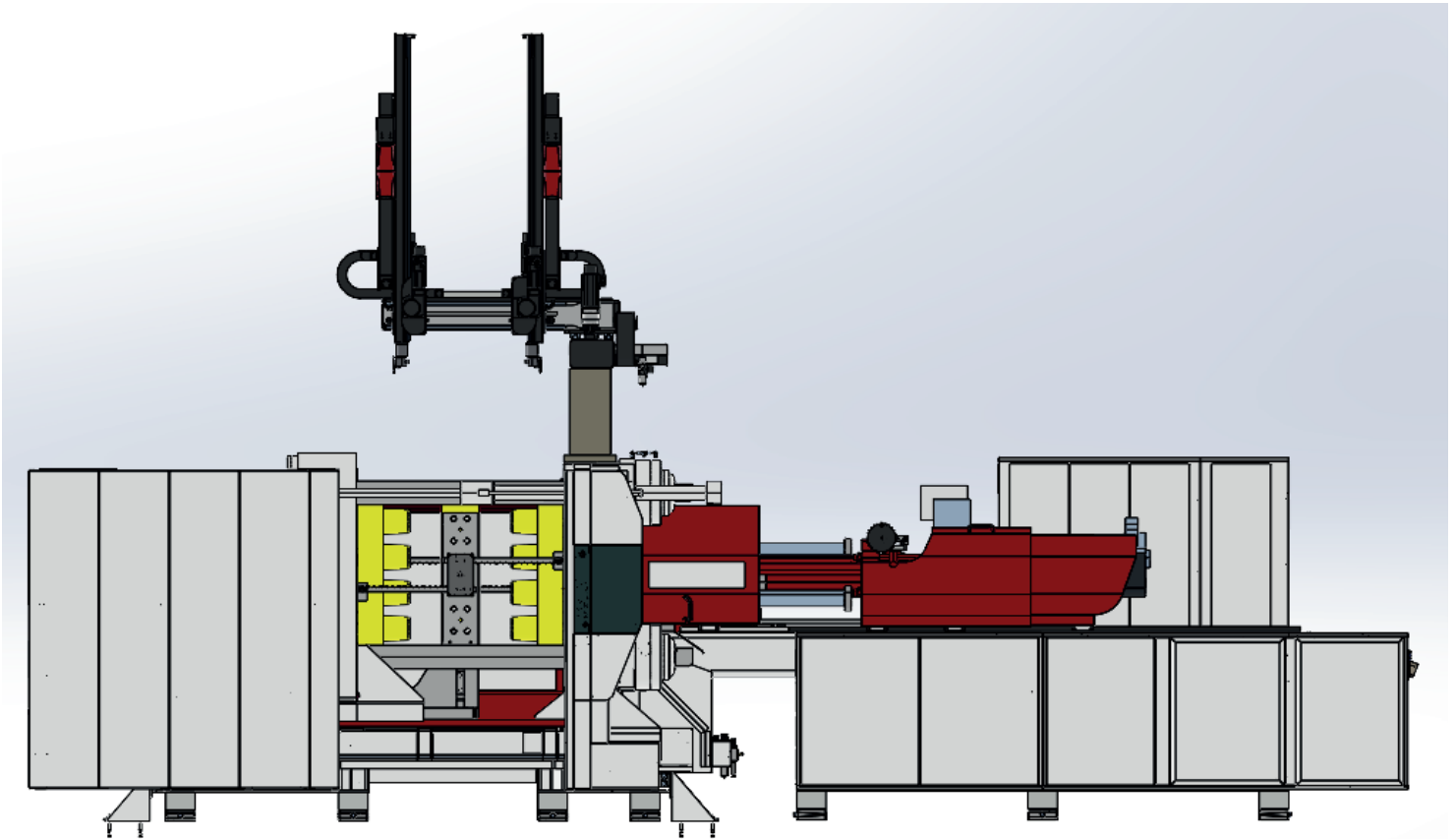


Choosing the Right Robot for Injection Stack Mold Demolding



Molding machine work cell with stack mold, 3x plate, 2x molding faces (A-D plates) and Dual Main Arm Robot

Stack, or family, molding, is a method to double production with a single injection molding press. Designing the optimal system, including the robots required to transfer parts from the process, requires careful consideration of many questions.



The most important factors for establishing an efficient and effective injection stack molding and part removal system include:

- Machine tonnage, which affects robot stroke and payload requirements.

- Molding cycle time target, dependent on wall thickness and mold cavitation, affect end-of-arm tool (EOAT) design.
- Part features, which affect the EOAT required to handle part removal (i.e., simple suction cups or sturdier grippers).

This WITTMANN USA whitepaper explores several common and less-common stack molding and part removal scenarios, and the ideal robots and EOAT configurations for each.

01 Stack Mold Benefits and Considerations

Stack molding can offer higher part production rates, for example, 48x parts every 10s cycle versus 24x parts with a common two plate mold design. The production benefit is obvious but also the stack molding workcell will save precious floor space with a single machine footprint. There may be no need to employ two machines to get the target production yields needed and so it's worth investigating this opportunity especially if it's likely to be a long-running application.

But achieving higher part throughput with a stack mold, along with high-quality robotic part handling, requires detailed process planning from the machine through mold design, followed by careful robot model selection and specification within the overall workcell. There are more technical considerations upfront compared to a two-plate mold, but a molder, toolmaker, and experienced robot supplier can successfully address them as a team.

Don't treat robot design and cost as an afterthought. In stack mold applications, the full workcell should be engineered together before steel is cut.

Key Stack Mold Requirements Include

- **Molding machine** must be specially configured with more mold open and stroke capability to accommodate the much wider stack molds heights (thickness) of the 3x plate assembly
- **Injection unit** must be able to handle the higher capacity plasticizing needs of the double shot size
- **Mold design** is more complex than a 2x plate mold and so a tool building specialist will be needed
- **Demolding robot** will need "two" arms to simultaneously demold each half of the mold i.e. A and D sides or B and C sides that the parts eject from, assuming a free fall of parts is not of the best interest of parts quality control needs.

While stack molding is initially a larger investment than a standard two-plate injection molding setup, the overall process may be less costly than using two duplicating certain equipment and stations within the workcell, while saving valuable shop floor space. In addition, this setup lends itself well to integrating value-added automation stations at the press within the workcell.

Doubling the throughput rate of parts produced from a stack mold is a clear advantage, but it also enables product "family" molding from the A and D plates or B and C plates. For example, related parts such as base components can be molded on the A plate while lid components are molded on the D plate.

This may be an ideal set-up for robot automation assembly or value-added automation stations that can be located beside the press, in-line with the robot placing parts to index and exit through a value-added station(s) within the workcell.

For example, robot and automation can be set-up to handle parts inspection, assembly, decorating, labeling, lasering, box-tote-gaylord pack-out. These value-added station benefits can easily be handled with stack molds and a proper robot and automation design.

Why is robot demolding needed? Some molders who explore stack mold demolding can't or prefer not to eject the parts and allow them to gravity "Free Fall" onto a conveyor below. Part quality control requirements often do not allow for that level of risk. After all, what is the benefit of doubling throughput without maintaining consistent part quality?

The solution is robotic demolding. This approach helps ensure parts remain clean, without the risk of oil or grease contact or impact damage associated with free-fall setups and allows the robot to place parts in a controlled orientation for potential value-added downstream operations.

In most cases, it is more efficient from both a quality control and part handling standpoint to demold parts in a controlled orientation and place them accordingly, rather than molding them in orientation, ejecting them into free fall where they become disoriented, and then relying on additional equipment to reorient them.

Control of the parts throughout the process reduces quality control risk, improves counting accuracy, and supports integration with value-added stations. The result

is stronger QC management and added opportunities for value-added processes while the robot is handling the parts.

With that in mind, specifying a robot and any supporting automation for stack molding requires consideration of several critical factors compared to demolding and part handling with a two-plate injection mold setup.

02 Critical Robot Selection Factors

Machine Tonnage, Robot Axis, Strokes and Payload

The molding machine tonnage required to run a stack mold largely determines the stroke requirements of the top-entry robot. In general, larger molding machines require larger robots with greater stroke capabilities.

To start, the stroke lengths of the linear three-axis top-entry servo robot, including the kick axis, demolding vertical axis, and traverse axis, must be carefully calculated by the supplier for stack mold applications. An additional integrated robot axis may also be included as needed to meet workcell requirements. A common example is a servo B axis integrated into the robot's wrist, providing end-of-arm tool orientation flexibility for downstream needs such as part fixturing or tray loading.

As far as size and scale, consider that machines at 700 tons or more may require a robot EOAT base plate as large as a shipping pallet (L x W). Even if the EOAT is a simple vacuum cup design, weight load calculations often reveal the need for a higher robot payload capacity than expected. For example, a robot with a 25–33 kg payload rating may be required to pick a shot of parts weighing less than one pound, per robot arm.

Cavities, Circuits, Molding Cycle Time

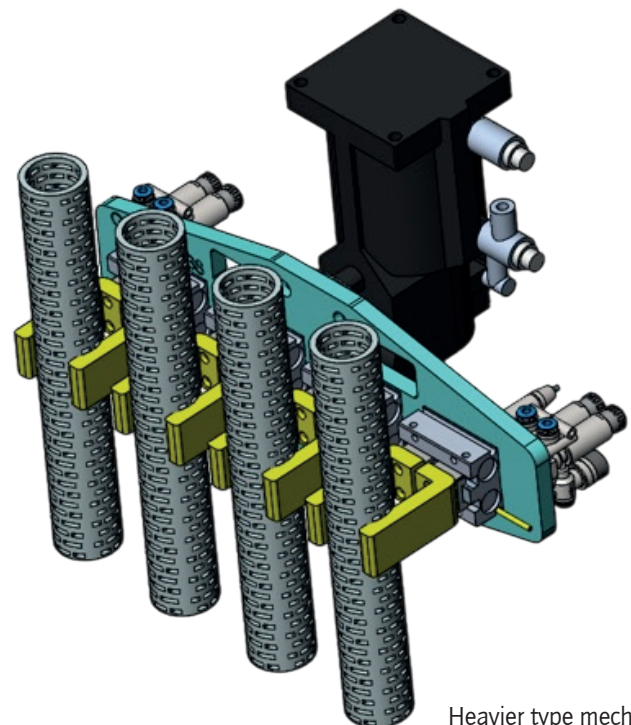
Other critical factors in stack mold demolding include the number of mold cavities, or parts produced per cycle. From large, low-cavity parts to high-cavitation packaging molds (16–128 cavities), these factors drive EOAT design, pneumatic and I/O requirements, payload capacity, and overall robot model choice.

In general, higher machine tonnage leads to larger EOATs and increased payload requirements. However, molding cycle time is also a key driver in robot selection. For example, very fast cycles of 4–6 seconds may require a high-speed side-entry robot. Cycles of 5–8 seconds may call for an ultra-high-speed top-entry robot, while cycles of 8–15+ seconds may be handled by a standard robot with upgraded specifications. Robot capabilities and configurations vary by supplier.

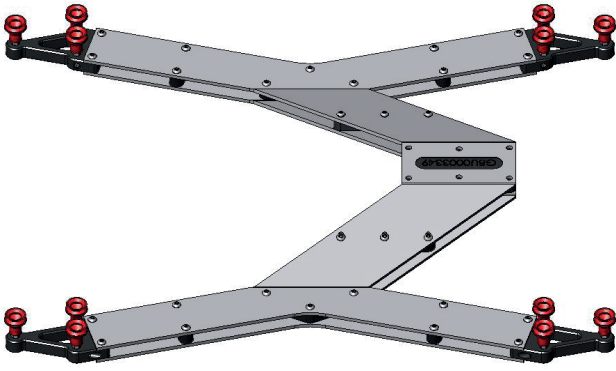
Caveat: Not all robot suppliers can provide the combination of high-speed cycling, servo wrists, and high payload capacity required for mid- to large-tonnage applications. Achieving both speed and payload performance can be counterintuitive, so it is important to evaluate supplier capabilities and understand any trade-offs in speed vs payload handling needs for the robot model of choice.

Part Geometry and EOAT Design vs Payload

Part geometry directly influences EOAT design and, in turn, robot payload requirements. If parts require mechanical grippers due to a lack of suitable vacuum surfaces, the EOAT will be significantly heavier than a vacuum-based design. This increases payload demands.



Heavier type mechanical gripper EOAT design example

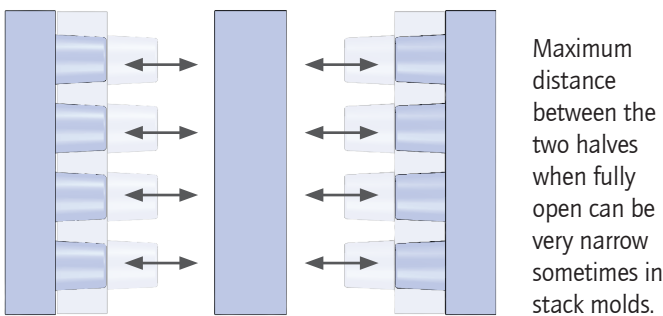


Light weight EOAT Vacuum-cup designs, parts demolding grip

For example, a 32-cavity vacuum EOAT on a 500-ton machine may weigh 15–20 pounds, while a comparable mechanical gripper EOAT may weigh 55 pounds per arm. In such cases, the robot supplier may need to select a higher-capacity model or configure the system for heavier loads. Grip type is therefore a critical factor in robot specification

Mold Open Daylight

Mold daylight in three-plate stack molds can be very narrow, sometimes eight inches or less. This may require mounting the EOAT directly to the robot wrist so only the EOAT enters the mold, rather than the full robot arm. For narrow daylights, EOAT designs are often thin in profile, resembling an inverted “paddle.” However, this in-



roduces additional requirements. The robot may need a taller mounting riser to ensure the EOAT clears the mold when closed, along with longer arm strokes to reach the mold centerline.

The robot wrist must also handle increased loads due to the EOAT being cantilevered from the wrist centerline, especially during rotation prior to part placement. In short, narrow mold daylights typically require longer strokes, stronger wrists, and specialized EOAT designs. Accurate daylight measurements early in the specification process are essential.

Common Top-of-Mold interferences

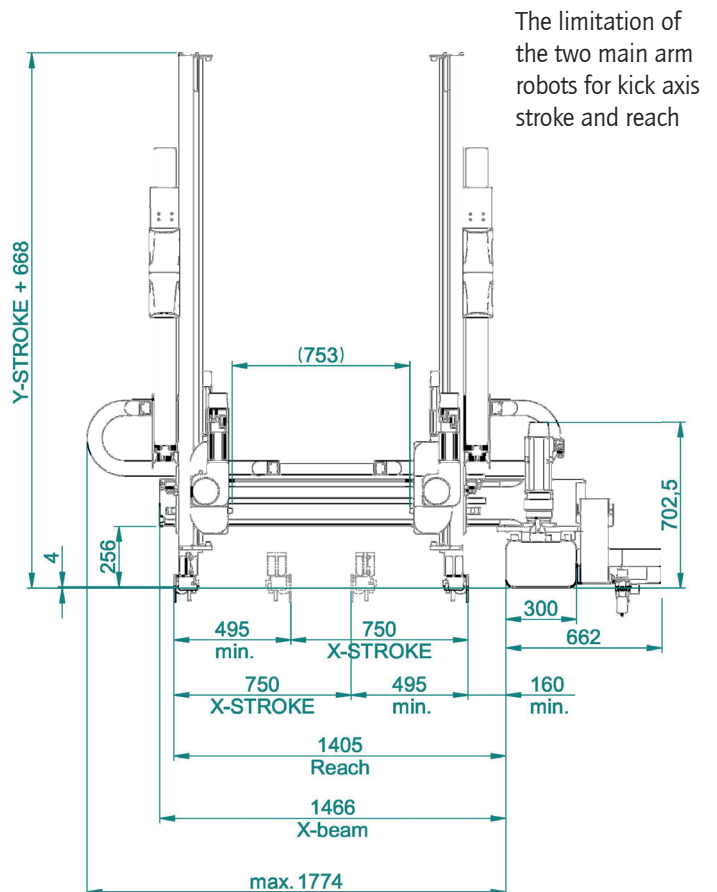
Obstructions above the mold, such as cable sets or hydraulic cylinders, can interfere with the robot’s operating path. These elements may extend into the robot’s “fly zone” and require additional arm stroke or height to clear.

Cable bundles on center plates are often overlooked in early mold drawings, yet they can significantly impact clearance requirements. Similarly, top-mounted cylinders may require the robot to operate from a higher position, increasing stroke and reach needs.

Any component extending above the platen surface must be factored into robot height, arm length, mounting structure, and part release positioning. For side-entry systems, additional obstructions such as racks or machine arms must also be considered. Providing this information early ensures accurate robot specification.

Robot Kick Stroke and Reach

A common question is whether a standard platen-mounted dual-arm robot can be used instead of dual floor-mounted robots. The answer depends on the distance between mold plates and from the stationary platen.



03 Choosing the Right Robot

The robot's kick stroke must reach the furthest plate, typically the D or C plate. If this distance is too great, a single robot with dual arms may not have sufficient stroke. In such cases, dual-opposing floor-mounted robots are required to achieve the necessary reach.

Dual-arm robots share a single Kick stroke beam, which limits stroke for each arm. This is why larger machines often require dual top-entry robots with independent reach capabilities.

Poor Stack Mold Design

Poor mold design can create challenges for robotic demolding. For example, if the cavity layout is wider than the spacing between leader pins, the robot cannot lift parts straight out due to obstruction.

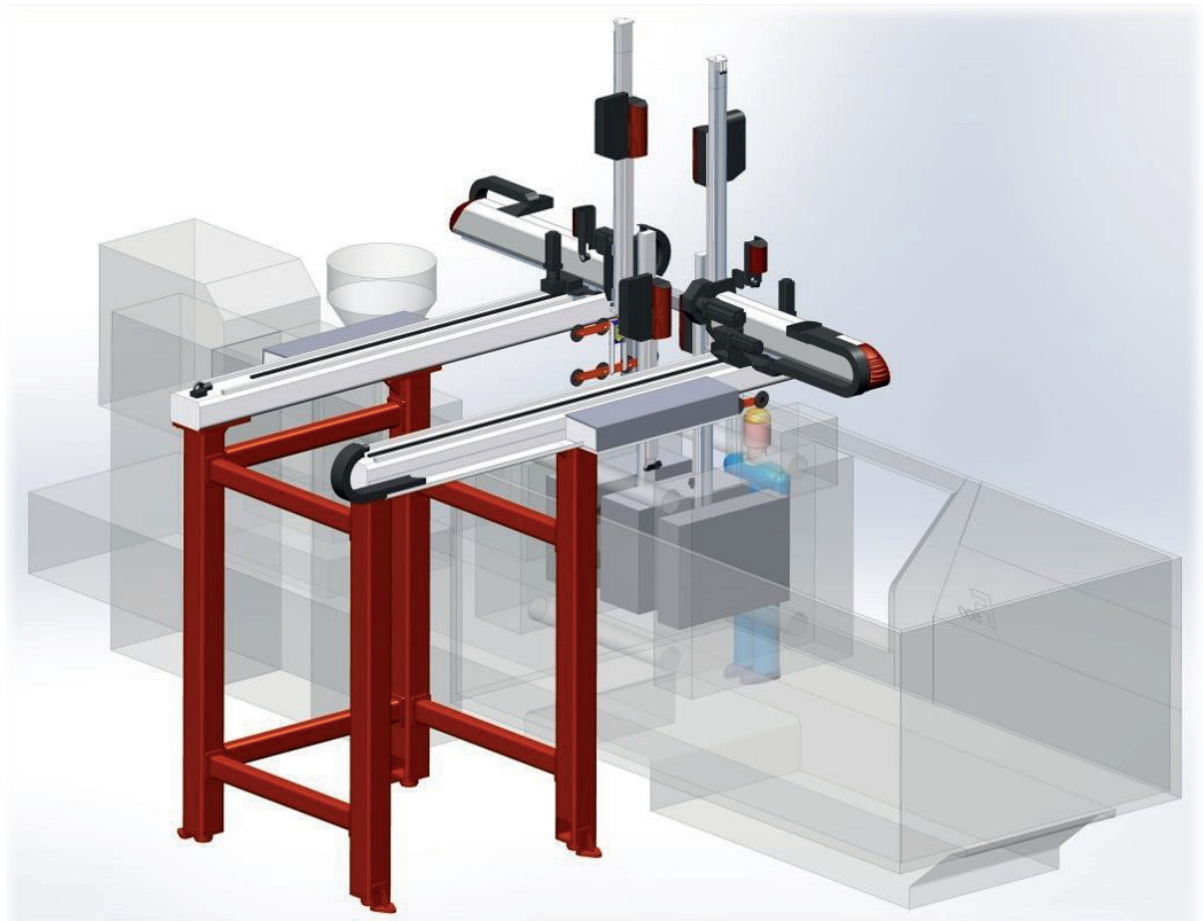
While specialized EOAT designs with collapsing mechanisms can address this, they add weight, complexity, and cycle time. This contradicts the goal of increased throughput. Molders should avoid such designs and involve robot suppliers early to optimize mold layout for automation.

Now that we reviewed some of the critical elements that affect and determine the robots specification, we can choose the correct robot model type / design for the application.

There are several types of robots that are available for parts handling / demolding in stack molding applications. In most cases, one of two primary styles will work, the dual top entry robot design or a single dual main arm robot. For more dedicated, long-term, super-fast cycle applications, a dual-side entry robot might be a good solution also. In any case, the supplier will determine which model is the best choice for the molder, then specify and quote accordingly.

Dual Top Entry Robots

This is the most flexible solution. Two opposing robots are mounted on a floor-supported weldment frame



Dual top entry rear
kick beam floor stand
mounted

over the machine, isolating them from machine vibration (common with fast cycles and older machines) and allowing extended kick axis reach, as often needed on machines over 500 tons.

Dual top-entry robots are designed with a rear-mounted kick axis beam, allowing the main arm assembly to be positioned forward on the axis so the two robots can face each other without interference from the beam. This configuration prevents any collision between the main arm assemblies and their EOATs.

Another **key advantage** of this design is the ability to utilize significantly longer main arms compared to dual-arm robots, while also supporting higher payload capacities. They are ideal for mid- to large-tonnage machines because the robots' vertical-arms can be made very long for demolding and can handle heavy mechanical gripper-type EOATs.

By comparison, a single robot with dual main arms may be limited by vertical axis stroke, restricting its ability to effectively service larger machines in the 800-, 1,000-, or 1,200-ton range. In contrast, a dual top-entry configuration minimizes these limitations. The robots are typically equipped with longer vertical axis strokes as standard, ranging from 2000 to 2600 mm, making them well-suited for larger press sizes. The extended reach also enables lower, more ergonomic part-release positions to conveyors or precision nest fixtures.

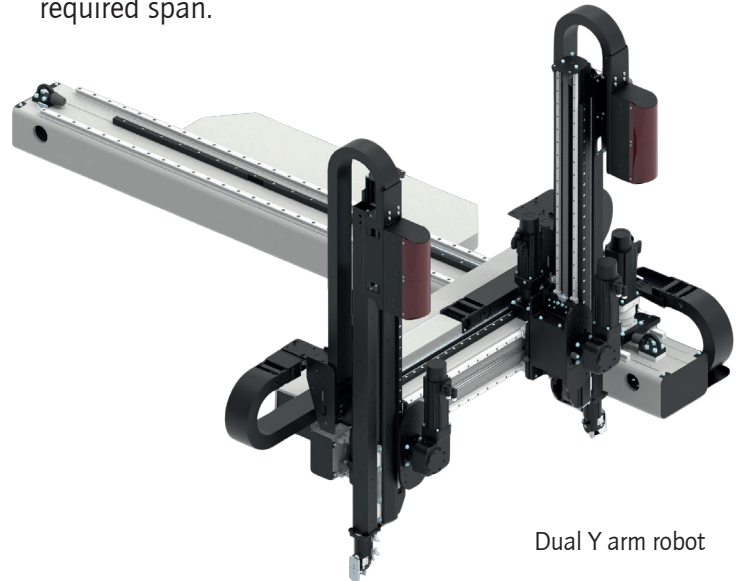
Overall, the dual top-entry robot configuration offers several performance and application advantages, including longer axis strokes, extended kick axis reach, and the ability to support higher-speed upgrade options at a relatively lower cost. It is well-suited for larger-tonnage applications and heavier EOAT payloads, while also maintaining separation from machine-induced vibrations during rapid mold open-and-close cycles, thereby enhancing operational stability and reliability.

It is important to note that a dual top-entry robot system typically represents a higher initial investment compared to a single dual-arm robot. However, in many cases, particularly for machines exceeding 700 tons, it may not only be the most effective solution, but the only viable one. Even in applications where both configurations are technically feasible, thoughtful robot selection can yield significant gains in performance, efficiency, and long-term flexibility.

An **often-overlooked benefit** of dual top-entry robots is their long-term adaptability. Should the original stack molding application no longer be required, the two robots can be decoupled and redeployed as independent units on separate molding machines. This ability to repurpose the equipment extends its value beyond the initial application, making it a highly flexible asset, particularly for contract molders who evaluate capital equipment over a 15–20 year lifecycle.

Dual Main Arm Robot Type (Single Robot)

This off-the-shelf option can be effective for smaller to mid-tonnage machines; however, it does present certain limitations in stroke, reach, and payload capacity. If the distance between the demolding surfaces of the B and C plates or the A and D plates is excessive, this type of robot may not be suitable, as it may lack sufficient kick-axis stroke or overall reach to accommodate the required span.



Dual Y arm robot

Additionally, this robot configuration typically offers a lower maximum payload capacity per vertical arm. As a result, when using gripper-type EOATs, it may not provide adequate payload handling for certain applications.

The main vertical-axis stroke can also be a limiting factor, particularly on larger-tonnage machines, where stroke requirements may reach or exceed 2,000 millimeters. Despite these constraints, single dual-arm robots remain a strong solution for many small- to mid-tonnage applications, where they can provide an efficient and cost-effective fit. As always, it is advisable to consult with your supplier to determine the most appropriate model and available options for your specific application.

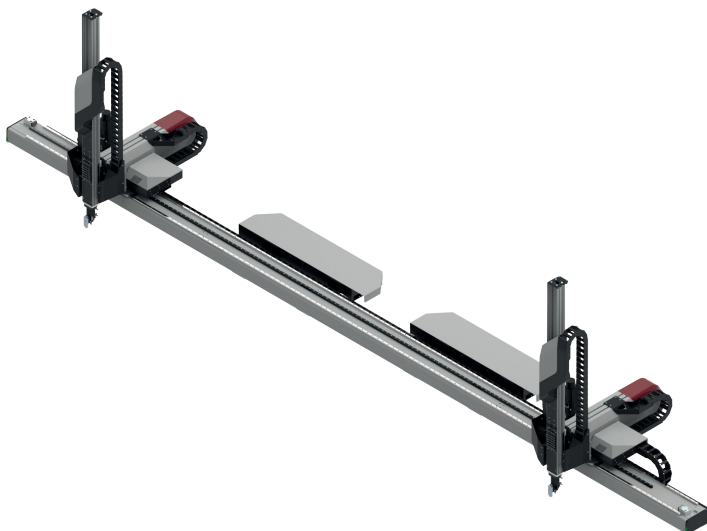
Tandem Longitudinal Robot Type

A two-arm, or tandem, robot in an L-type configuration, commonly referred to by some manufacturers as a Clamp Traverse (CT) configuration, demolds parts and transfers them to the clamp end of the machine.

This is a less-common configuration but has suitable applications in stack demolding. The robot features two robot arms on a single traverse beam which is oriented along the machine i.e. longitudinal for clamp-end part release.

In this design, the critical distance between the A and D plates is not a limiting factor, as the two robot arms operate independently along the beam. The kick-axis spread can be extended as needed, providing flexibility in stroke and reach.

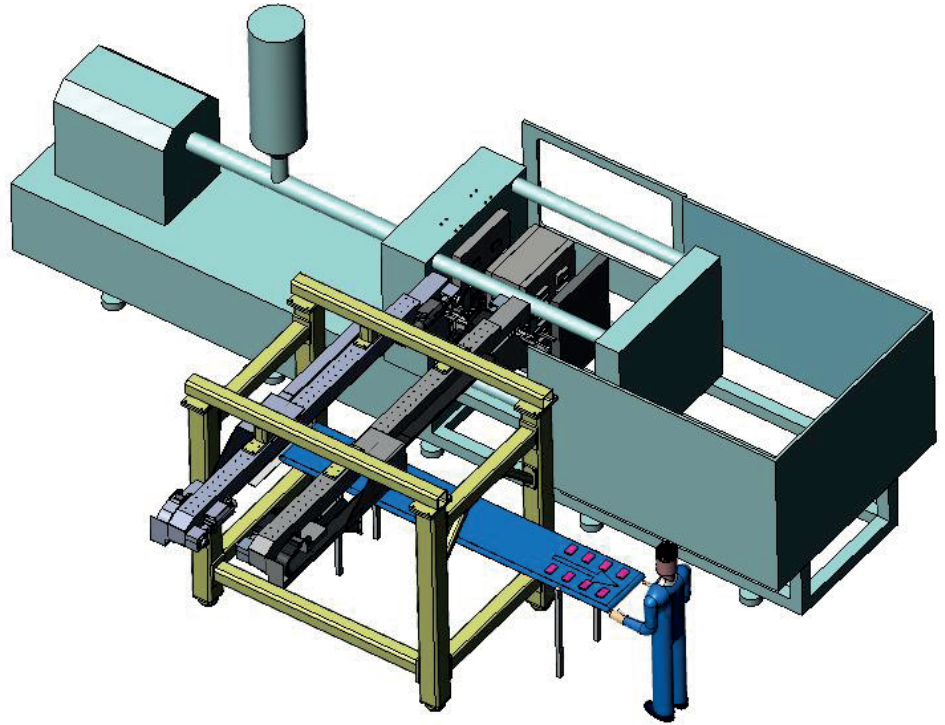
From a performance standpoint, this configuration is generally not suited for cycle times under 10 seconds. However, it offers a high-torque solution for applications requiring heavy EOATs, making it well-suited for large stack molds and large-part handling.



Tandem L type robot

Dual Side Entry Robot Type

Side-entry robots are two floor-mounted units on guided linear rails that remove parts horizontally from the mold's rear, with the rear gate removed. Ensure no harmonic arms or racks interfere with their approach.



Dual side entry robot for stack molds

Two EOATs Each on Dual Side-entry Robots

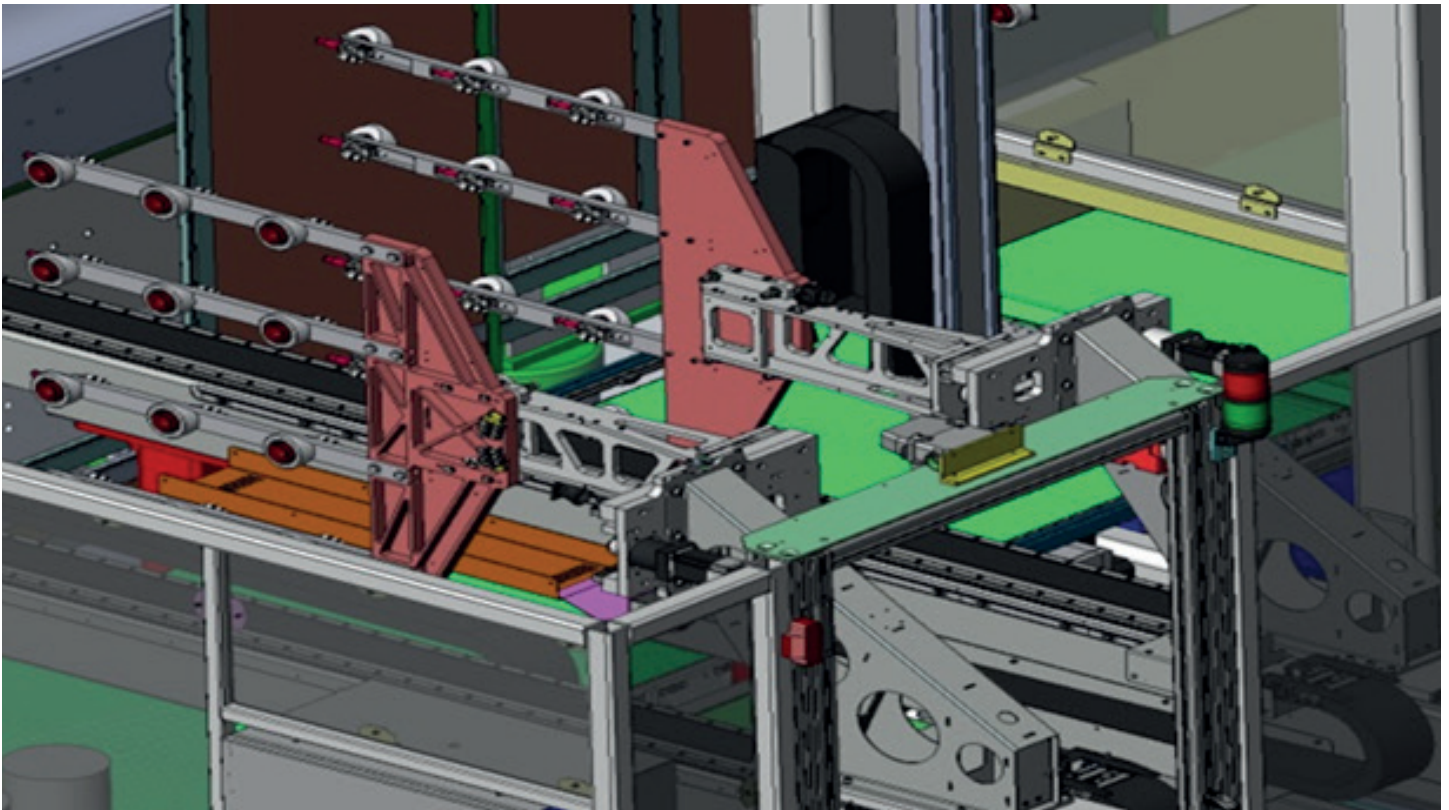
The dual side-entry design is particularly well-suited for very fast cycle times and narrow daylight conditions. It can support a wide range of mold configurations, handling anywhere from two to 128 cavities per mold side or plate.

Each robot can be specified with high-torque capabilities, allowing for substantial payload handling. Depending on the design, particularly in European systems, payload capacities can range from approximately 5 kilograms to 20 kilograms or more.

Beyond high-speed part removal, dual side-entry robots can also support integrated downstream operations, including part reorientation, stacking, counting, labeling, vision inspection, and other value-added processes such as tote, box, or Gaylord pack-out.

In general, dual side-entry robotic workcells represent a higher capital investment (often exceeding \$300,000) and typically involve longer lead times. However, they offer the advantage of operating in facilities with lower ceiling heights while delivering very high-speed performance. These systems are most commonly used in dedicated, long-term production environments and are less frequently selected for short-term or highly flexible contract molding applications.

Two EOATs each on dual side entry robots for stack molding



Top-entry Robot with "Horseshoe" EOAT

This is a relatively uncommon solution for stack demolding, but it can be effective in specific applications. This cost-efficient design utilizes a single robot equipped with a specialized strut arm framework, often resembling a "horseshoe" or tuning fork, to support two EOATs on a single heavy-duty vertical-axis arm. Due to the added structural weight, the robot typically requires a more robust vertical-axis drivetrain.

In operation, the robot employs a single main arm with two EOATs, each mounted to its own wrist assembly. When the mold opens, the robot indexes down to the mold centerline. From this position, it first extends forward (kick axis) to demold from the D plate, then

retracts along the kick-axis to position the second EOAT for demolding from the A plate.

Once both sets of parts have been removed, the robot returns to the center of the daylight and lifts out of the mold area. This configuration effectively enables one robot arm to perform dual demolding functions using two wrists mounted on the vertical-axis struts.

While this approach offers a relatively low-cost solution for stack mold demolding, it is not well-suited for high-speed applications or molds with wide center sections, where reach and cycle time constraints become more critical.

04 Check-list of Critical Factors for the Robot Type and Specification Design for Stack Mold Demolding Applications:

- Overall molding cycle time
- Injection molding machine tonnage
- Number of parts / cavities to demold
- Any runners to also demold?
- Part design vs EOAT part gripping method / design
- Robot payload handling needs
- Robot arm and stroke length needs
- Mold leader pin dimensions vs shot width
- Obstructions to the robot and EOAT path: Sprue bar, side of mold, top of mold, and overhead
- Distance from the stationary platen face to the D plate of the mold stack when fully opened, kick axis needs and reach
- Downstream needs: height of parts placement, orientation, device ready timing, flip stations

05 Quick Reference Chart for Stack Molding Applications

Stack Mold Robot Types

	Dual Main Arm	Stand Mounted Dual Robot	L-Type Tandem, Clamp-end Parts Release	Single Main Arm with Horseshoe EOAT	Dual Side Entry	Notes
Tonnage Machine	200 - 700	400 - 2000	200 - 2000	200 - 2000	400 - 1200	
Cycle Time, Speed	8 - 10s+	6s+	10 - 12s+	15s+	6s+	
Ranked	2	1	2	3	1	dual top entry robots offer the highest speeds/fastest cycle times
Total Number of Cavities						
Vacuum	2 - 64	Not Limited	Not Limited	Not Limited	Not Limited	
Mech-Gripper	Limited due to the weight of mech-grippers	Not Limited	Not Limited	Not Limited	Not Limited	for high cavity count and mechanical gripper EOATs the payload handling will be limited for Dual Arm Robots
Payload Handling	Limited to ~10 kg	Not Limited	Not Limited	Not Limited	Not Limited for some Brands	for high cavity count and mechanical gripper EOATs the payload handling will be limited for Dual Arm Robots
Parts Release Height	Arm Stroke Limited	Not Limited	Not Stroke Limited	Not Stroke Limited	Not Limited	on large machines the parts release height can be limiting factor for Dual Arm Robots
Price-Cost	Mid	Mid - High	Mid	Low-Mid	High	compare performance to price

■ Pros ■ Cons

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