



# Production Fixture Design Considerations

When planning and designing a process for high volume production or automation, a basic manual fixture will not give the best results. Manufacturing engineers understand that following the 3-2-1 method for locating a part establishes three mutually perpendicular datum planes. Three points are needed to establish the primary plane, two points for the secondary plane, and one point for the tertiary plane. But when it comes to designing a robust process in a high volume or automated production environment, more is required beyond just implementing this basic fixture design concept. In this whitepaper we will discuss fixture design considerations that will prevent disruptions in the smooth flow of parts and will keep your operation trouble free with greater reliability.

When talking about high volume, we're referring to when production requirements start to reach 250,000 parts per year. With this high-volume parts production, there are specific factors that can make the difference between running an inefficient or efficient process. Manual operation of a fixture is not a viable option at these volumes; therefore, an automatic hydraulic actuated system will be needed to clamp and unclamp parts. Makino's solution for an automatic hydraulic system is the Fixture Hydraulic Unit.

### **Fixture Hydraulic Unit**

Makino developed the **Fixture Hydraulic Unit (FHU)** to handle the needs of medium to high volume production fixtures. This system is the core element that enables flexibility and productivity by reducing maintenance costs and improving part quality. This is accomplished by providing a continuous hydraulic supply to the fixtures through rotary unions that eliminates the need for manually connecting "jump-on hydraulics." Manually connecting the hydraulics repetitively allows air to enter the system causing erratic operation and the need for maintenance. The FHU system utilizes a manifold with internal porting in the fixtures which provides passages for hydraulics, coolant, and air. This makes it

possible to implement additional functions needed in a high production operation such as through-fixture coolant and air part seat detect which will be explained later.



The FHU includes clamp/unclamp valves and the ability to program the sequence. This capability—along with the continuous hydraulic supply—eliminates the need for accumulators, check valves, or sequencing valves on the fixture. The unique ability of this system makes it possible to change hydraulic pressure “on the fly” without bringing the fixture out of the work zone. One example of where this can make a difference is on a part that is shaped like a cereal bowl, which tends to deform under clamp pressure. With the FHU, the part can be clamped at full system pressure to locate on the primary locators. Then, pressure can be relieved in the work zone to allow the part to relax. Finally, full pressure can be reapplied to locate the part on the primary, secondary, and tertiary locators.

For a part that tends to deform under cutting forces and then springs into a distorted shape when unclamped, the FHU provides another benefit. With the FHU, the part can be clamped at full pressure, then programmed to be unclamped in the work zone to stress relieve the part between rough and finish cuts. It can then be clamped again at a programmed lower pressure for a finish cut to achieve flatness on a milled surface. In this scenario, no physical changes are required to the fixture during the process debug. Simply test different pressures and sequencing through programming, and when you find the optimum parameters, you are ready for production.

### Chip Shedding

In high volume production, chips can pile up. Therefore, it's important to design proper chip shedding on fixtures by eliminating flat shelves and creating sloped surfaces that provide a path for chips to flow inside the work zone. The goal is to keep all the chips in the work zone and let the machine's chip handling system remove them from the machine. Additionally, external hydraulic tubing on the fixture can get in the way, causing chips to get hung up. As you can see, Figure 1 is an example of a fixture with many opportunities for chips to get stuck.

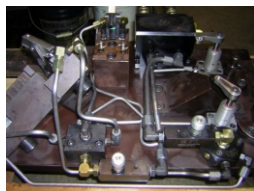


Figure 1

To prevent this, gun drill the fixtures and use a manifold to internally plumb the hydraulic lines needed for the fixture actuation. Gun drilling the fixtures has additional upfront costs; however, minimizing the need to stop production to clear away chips saves money in the long run. Keeping the face of the fixture as clean and free from obstructions as possible makes a huge difference in the reliability of the operation.

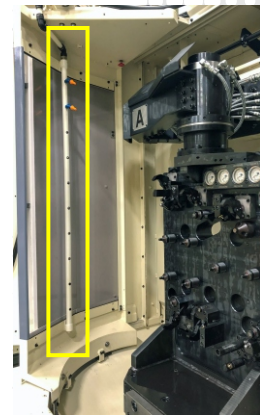
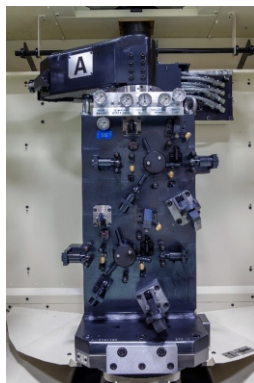


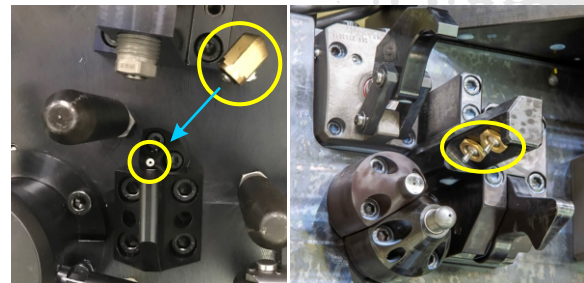
Figure 2

### Fixture Wash

If all chips are not able to be removed in the work zone, adding a fixture wash in the pallet stoker area will help remove them before unloading parts. This can be accomplished by adding a manifold in the pallet stoker area with spray nozzles directed to the fixture (highlighted in Figure 2). Additionally, a fixture wash can improve automated loading by washing the fixture down between the robot unload and load cycle.

### Locator Wash

The primary, secondary, and tertiary locators need to be free of chips for accurate loading of parts. To accomplish this, supply machine-filtered coolant through the fixture to spray nozzles that are mounted close to the locators. This prevents chips from becoming lodged between the part and the locator; causing a defect, especially in an automated load scenario.



### Air Seat Detect

It's not always possible to keep every chip from landing on a locator and causing a part load issue and defect. A machine feature called an "air seat detect" can check to determine if a part is seated against a locator. It works by measuring air pressure differential at the locator. This is accomplished with a 1mm hole in the locator connected to a steady air supply. Air flows freely before the part is loaded. Once the part is loaded and seated on the locator, the airflow is constricted.



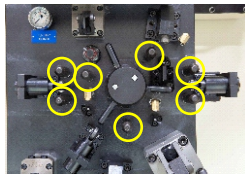
A digital pressure sensor measures the pressure differential and indicates if there is a problem. If the air detect check fails after the clamp sequence, it automatically unclamps, re-clamps, and then rechecks again. If it fails once more, a machine alarm is triggered with an indication of which switch failed. The operator then needs to take action to determine the cause and to clear the chips if necessary. This method can measure as small as a .0015-inch gap to catch even the tiniest chip that's preventing the part from properly seating against the locator. The digital pressure sensors are tuned in for each application to get the optimum setup. Aluminum die castings provide smooth surfaces that can be dialed in closer, while rougher surfaces, such as cast iron, need a larger range to prevent false alarms.



Another use of the air seat detect option is for detecting broken locators on the fixture. This is accomplished by machining a blind hole in the round or diamond locator with an internal air passage connected to it. If the locator breaks, there will be air flow and the digital pressure sensor will detect it and signal with an alarm.

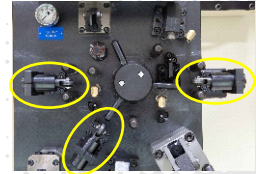
### Part Guides

When an operator is loading parts in a fixture, it's possible they will not always load the part in the correct orientation—especially if the part is generally symmetric. Designing part guides on the fixture helps the operator load the part and prevents parts from being loaded in the incorrect orientation by utilizing poke-yoke concepts. Part guides also offer ergonomic benefits as the operator can more easily locate the part. In addition, they can protect the fixture from damage caused by slamming the part into areas not intended to touch the part.



### Part Retention

On horizontal machining centers, gravity can cause a part to fall away from the locators on the fixture prior to clamping. Part retention devices can help to keep the part over the locators before hydraulic clamps are engaged. Less movement of the part during clamping ensures a solid and accurate part location on the fixture.



In an automated load scenario, some integrators will use the robot to hold the part in place until the clamp initiates. With part retention on the fixture, the part will stay in position ready for the clamp sequence to begin and free up the robot to move on to its next task.

Part retention also makes it possible to use the capability of the FHU described above for unclamping and re-clamping "on the fly" in the work zone. In the scenario where stress relieving a part between rough and finish cuts is needed, the part retention details keep the part in place between the unclamp and clamp sequence.

There are various standard catalogue items available for use on a fixture for part retention. Because they are often used in a dirty contaminated environment, it is typical to see these components fail frequently. For this reason, Makino developed its own design and has been using it successfully for many years.

Makino has the expertise and experience to make sure your production is trouble free. This is true because of the in-house knowledge that has accumulated over decades of executing turnkey and automated systems. To learn more about how Makino's Promise of Performance can help you meet your production demands, visit [www.makino.com/support/engineering-services](http://www.makino.com/support/engineering-services).