High Pressure vs Low Pressure Components

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Table of Contents

High Pressure vs Low Pressure Components

Introduction

A customer contacted Vektek desiring to convert their current manual clamping operation to a hydraulic clamping installation. The customer requested a concept for a palletized fixture that would perform all the processes, beyond the initial lathe operations, resulting in a finished part and presenting the largest possible number of parts to the machine for processing. The customer was willing to consider high pressure or low pressure component options where operations are performed using their current horizontal Twin Tower machining center with a 400 mm pallet.

Other design criteria required by the existing machining center included:

- Machine pallet size – 400 mm pallet
- Maximum weight on the pallet – 500 lbs. (227 kg)
- Maximum work piece swing diameter – 500 mm diameter
- Maximum Spindle travel: X = 24” (610 mm)
  Y = 20” (508 mm)
  Z = 22” (559 mm)
- Maximum height – 33.5” (851 mm)
- Minimum production rate two parts per machine cycle

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Case Study-Current Method

Examination of the current process indicated that a minimum of four separate machining processes were necessary to yield one finished part. Operators are currently batching using a manually clamped fixture that holds only one part.

The first operation, Op 10, is performed on a lathe. A batch of lathed product is moved to the machining center where the second setup occurs. In Op 20 one piece is loaded on a fixture, manually clamped, machined, ad staged for subsequent operation. This process is repeated for OP 30 and Op 40. Less than optimal productivity is being realized from the Machining Center and may directly affect the customer's market competitiveness comes into question.

Each setup in this system consumes approximately 2 hours plus the handling each part four times.

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Options Available

At the time of purchase of a new machining center the customer may decide to add an option of high or low-pressure on-line machine hydraulic system. This decision can make an incredible difference if the machine **must** be run, for whatever reason, solely on machine hydraulics. The selection of low pressure restricts the pressure available to actuate hydraulic components and may affect the productivity of the machine. Should a very large contract become available, the machine using Low Pressure clamping components may not be able to keep pace with the output or precision required by the terms of the contract.

Flexibility to add an auxiliary high-pressure on-line or off-line power source at initial purchase or post purchase of their machine hydraulics enables the manufacturer to accept and perform against larger more lucrative contracts even with smaller, less costly machines.

Automation using hydraulic clamping, regardless of pressure rating, will give the customer an advantage over the manual process. Either High Pressure or Low Pressure Clamping Components will produce more consistently located and held parts. This is particularly true when you consider operator variances in clamp tightening. Which components work best with the restrictions presented by the machining center itself will need further examination.

High Pressure components have a smaller footprint than the Low Pressure components. It is, therefore, logical to assume that fixtures can hold more parts and productivity can be significantly increased over the four single part fixtures presently in use. Part change and fixture setup time will be dramatically reduced over a single part fixture and consistent clamping is accomplished in a fraction of the time of the manual method. Machine cutting speeds may be dramatically increased because High Pressure components can deliver consistent clamping forces from 450 (2kN) to 11,700 lbs. (53kN) (depending on clamps selected). The High Pressure system runs at pressures up to 5,000 psi (350 Bar, 35 MPa) and requires a power source greater than most on-line machine hydraulic supplies, however, the comparatively modest price of the power source is easily justified by the increase in productivity.

Low Pressure components offer a substantial improvement in productivity over manual clamping. However, to reach the same level of force as their High Pressure counterparts their dimensions must be much larger, consequently, components with equal to or greater than 5,000 lbs (22kN) capacities are so large that they become impractical to use in standard machining operations. Most Low Pressure clamps operate at a maximum of 1,000 psi (70 bar, 7 Mpa). If this option is selected, similar timesavings at setup, part positioning and clamping consistency may be realized but machine-cutting speeds may not reach the same potential of the High Pressure clamps. Low Pressure components will run on typical machine hydraulics. An auxiliary high-pressure off-line system can be added to machines equipped from the factory with an on-line low-pressure supply.

Manual components are often self-produced; yield generally high but uncontrolled clamping forces. In this case, one part, one load, one fixture would continue to be the case. One part would be produce for each 3rd load and setup (Ops 20, 30 and 40).

The question of which system is best suited for the customer will require evaluation of potential concepts against the constraints of the Machining Center.

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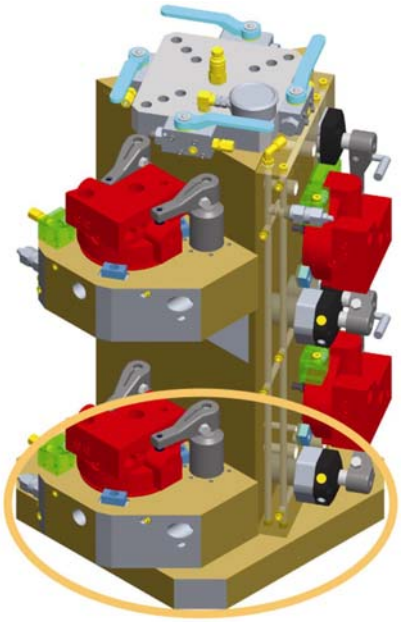
High Pressure vs Low Pressure Components

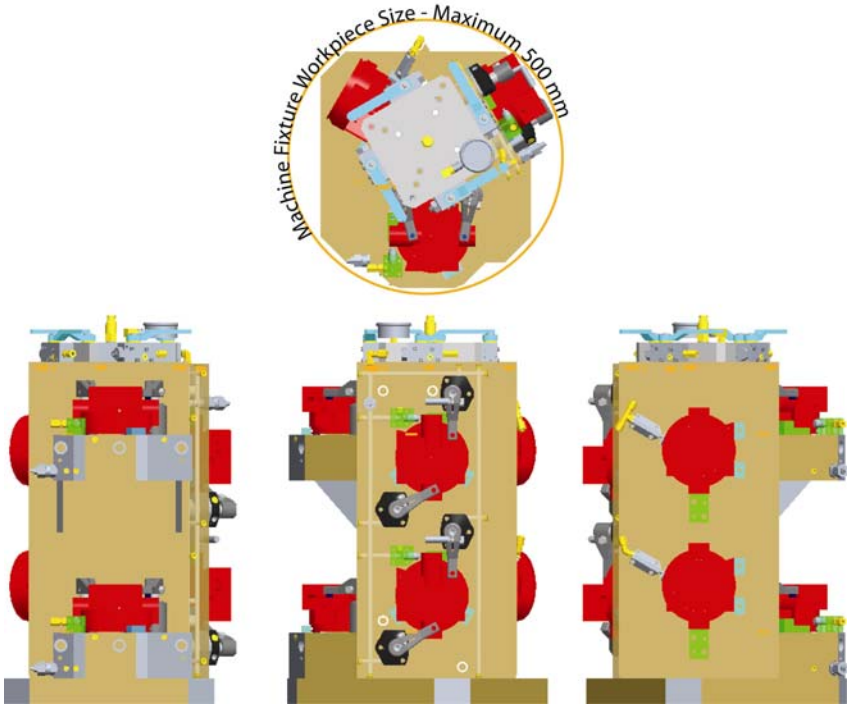
Solutions

All solutions are based on the implementation of a high strength aluminum alloy tooling column from Abbott Workholding Products, to achieve the weight restrictions of the machine A fixture of similar design based on steel or cast iron columns could weigh as much as 800 to 1,000 lbs.



Solution A offers a concept using High Pressure components. Each face of the pallet represents a previously defined operation, where the parts on face one are moved to face two, and face two parts moved to face three. All machining requirements are met with this fixture and two finished parts are delivered after a full machining cycle requiring only one setup.

A Twin Pallet fixture, in continuous operation, completes two parts per machining cycle on the fixture with a single setup. By building two identical fixtures, the machine will produce two parts on every machining cycle, four parts per full machine cycle.



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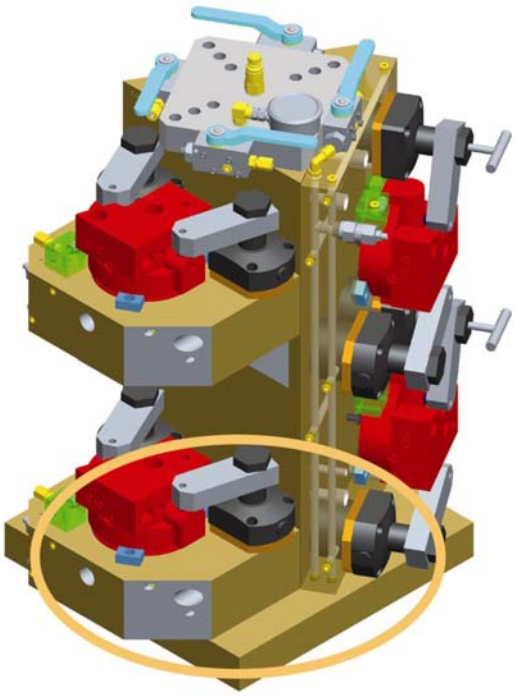
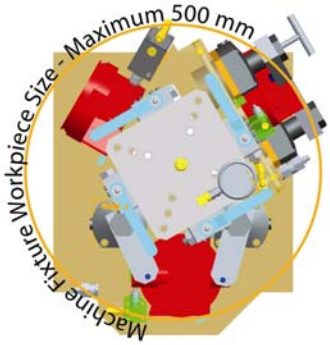
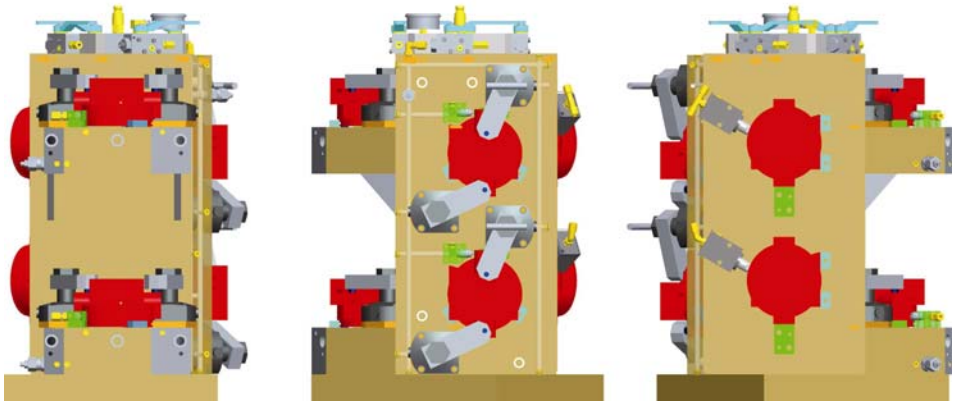
Solution B demonstrates a fixture that imitates Solution A part positioning, but uses Low Pressure hydraulic clamps to hold the part. The fixture envelope, due to increased device size, is larger than the machine restrictions and cannot be used. Beyond the envelope dimensions this fixture also exceeds the weight restriction of the machining center (added device weight and size), even with the aluminum tower. However this solution is useful to more closely examine the challenges to fixturing and productivity that Low Pressure components present.



Alternatively the customer may choose to order a machine with 500 mm pallet on which the fixture size and weight can be accommodated. The cost of a 500 mm pallet machine in this case was deemed prohibitive and other choices mandated.





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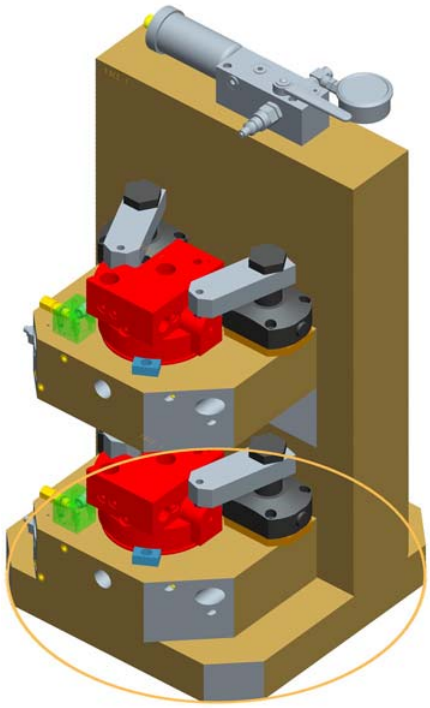
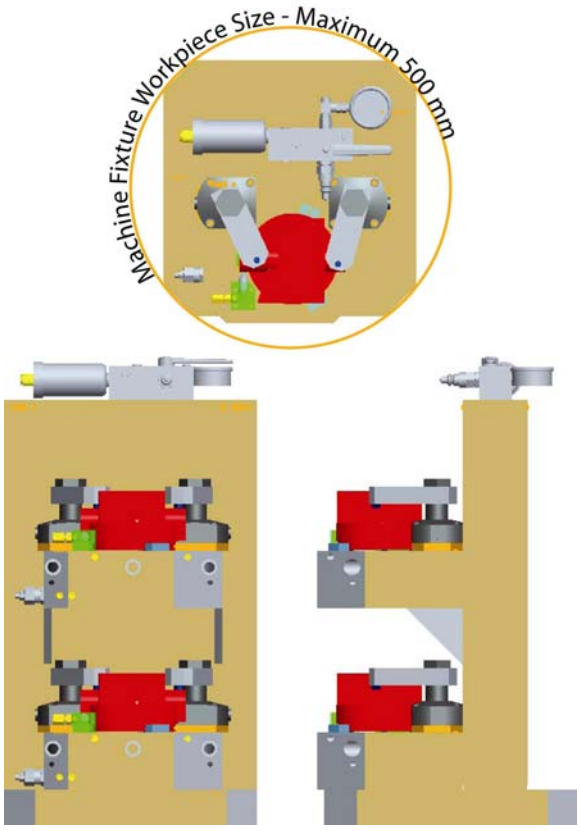
Solution C requires two parts A and B. Solution C Part A is a two-sided fixture using only one side of the tower and is used to perform OP 20 processing. A second setup is required for Solution C Part B, a two-sided fixture using both faces that conducts Op 30 and Op 40 processes. Solution C demonstrates a substantial improvement over the manual clamping method currently being used. However, This solution yields half the number of completed parts as solution A or B. (The manual system requires three setups to produce one complete part in the machining center.)



Solution C- Part A demonstrates a fixture that separates Op 20 from Ops 30 and 40 and uses Low Pressure hydraulic components to hold the part. The fixture envelope is reduced, however, two fixtures must be built to meet the machine restrictions. This fixture carries only two parts, feeding to the next fixture with Ops 30 and 40 completing the manufacturing process. It represents a successful way around the weight and dimensional restrictions of the machining center using Low Pressure hydraulic components.



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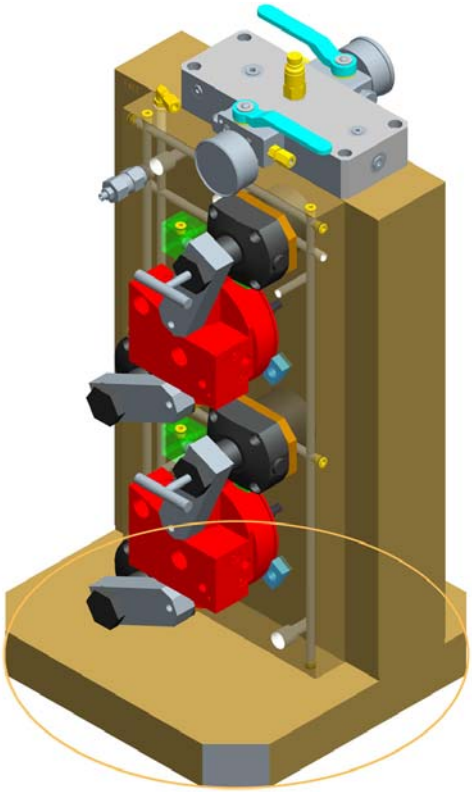
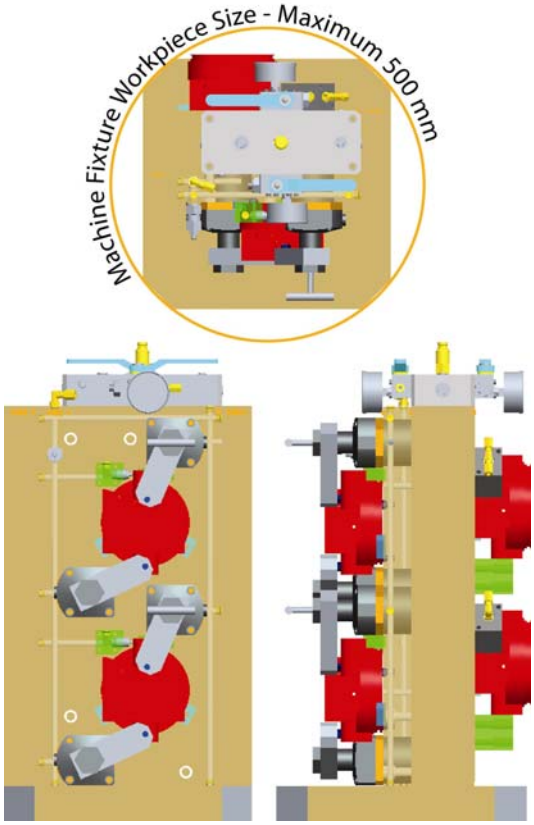
Solution C – Part B demonstrates a fixture for Ops 30 and 40 and uses Low Pressure hydraulics to hold the part. This is the second of the two fixtures that must be built to complete the process. It should be noted, however, that 2 fixtures must be built to meet the machine restrictions. This fixture carries 4 parts, feeding from the previous fixture to complete the manufacturing process. It represents a successful way around the weight restriction of the machining center using Low Pressure hydraulic components. It must be considered that only six parts may be on the Twin Pallet machine and the six parts consume the entire machine function until operations are completed. Twelve parts may not be loaded; no second job may be worked on at the same time. It is a successful way to use low pressure in this application. Maintaining the use of a 400 mm pallet and building 2 fixtures rather than trading up to a 500 mm pallet machine offsets the added cost of building 2 fixtures.





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Benefits

- Machining Center Setup time is dramatically reduced relative to the existing manual process
    - From three to one in the High Pressure Solution
    - From three to two in the Low Pressure Solution
- Continuous Production (2 parts produced per cycle of fixture high pressure, 2 parts per cycle of fixture pair low pressure)
- Maximize machine capability (12 parts per Twin Pallet High Pressure) (6 parts per Twin Pallet Low Pressure)
- High Volume production capabilities
- Improved part loading and handling function
- Tool change time cut 50% (cuts two parts before tool change)
- More consistent and reliable clamping may allow cutting speed increase
- Vibration dampening effect results from hydraulic clamping
- Improved quality and consistency of parts
- Inexpensive additional Power Source may be added for High Pressure Operation
- Live hydraulics open up the potential for more sophisticated safety controls and automation
- Reduction in repetitive motion injuries

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High Pressure vs Low Pressure Components

Summary

It is up to this customer to choose an option for implementation.

- One high pressure pallet on a 400 mm Twin Tower machine within specifications as listed
- Two high pressure pallets on a 400 mm Twin Tower machine as listed (12 parts, double production)
- One low pressure pallet on a 500 mm machine within specifications of the larger machine (increased machine cost)
- Two low pressure pallets on a 500 mm machine within specifications of the larger machine (12 parts, double production, increased machine cost)
- Two Low Pressure pallets on a 400 mm machine within specifications as listed

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