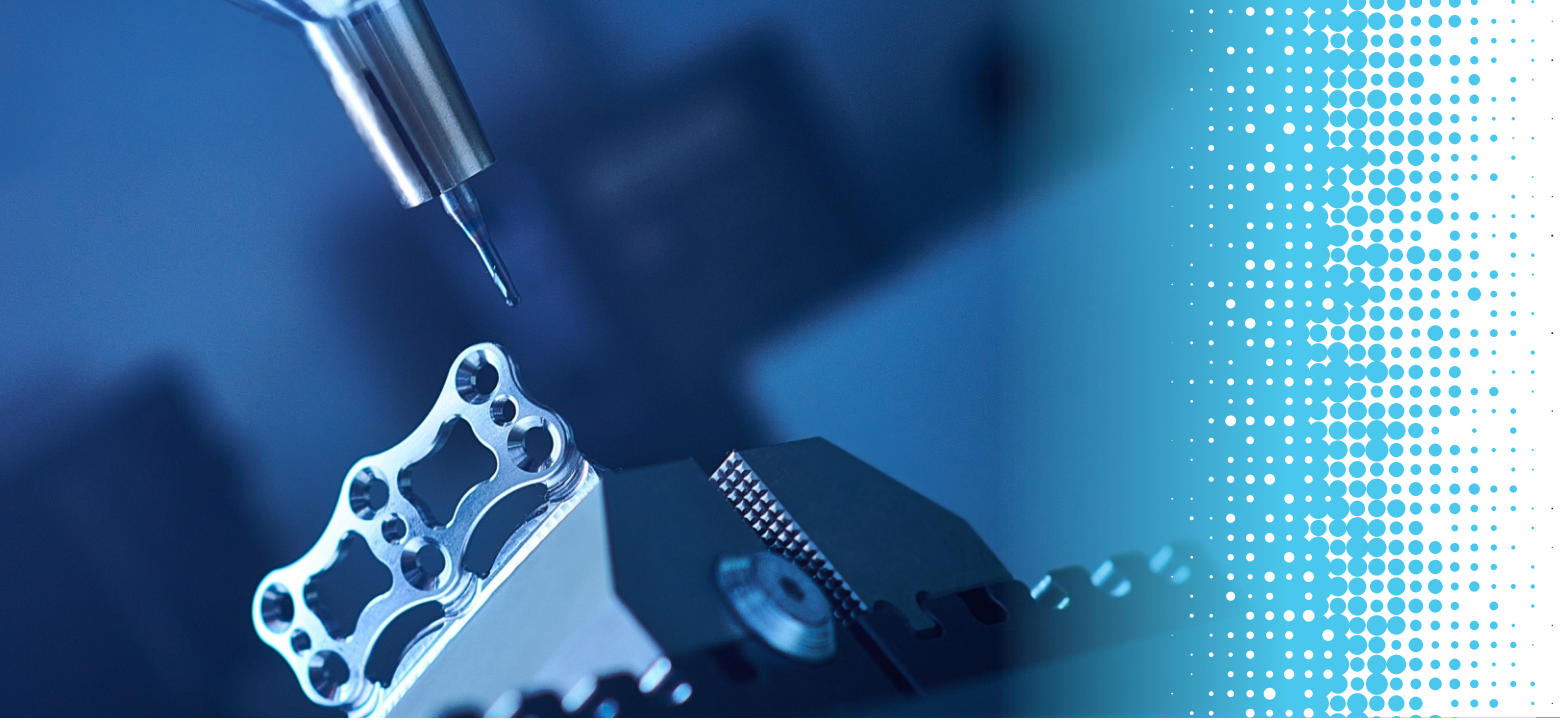

Dynamic-Production Machining Center ROI:
How to Determine a Machine's True Value

The Medical Market

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How to Determine a Machine's True Value

Justifying a capital equipment purchase by calculating its return on investment (ROI) can be challenging for many shops. Manufacturers often focus only on equipment price when making these calculations and fail to evaluate the total life cycle cost or anticipated performance of the equipment. In reality, the acquisition, operating, maintenance and decommission costs can all affect a machine's true ROI calculation.

It's important to carefully weigh ROI in order to make an informed decision about which equipment to purchase, as it can ultimately determine the payback period for the machine. This white paper discusses how to conduct a comprehensive ROI calculation by addressing these four areas:

- The factors of dynamic-production machines that impact ROI
- How automation can improve ROI
- How leasing versus buying affects ROI

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Factors that Impact ROI

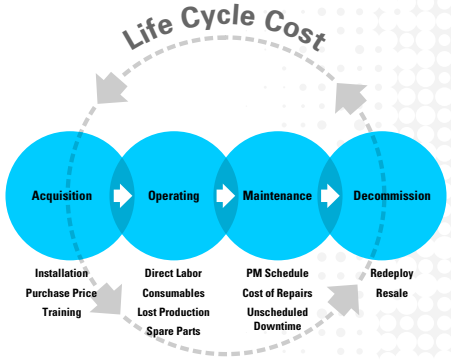
Manufacturers typically purchase new equipment to obtain higher capacity or improved methods and technologies for production. In determining ROI for these new machines, the manufacturer carefully examines the purchase price. However, the costs for operating, maintaining and decommissioning these new machines may dwarf the original purchase price.

Acquisition costs include the purchase price, installation and training. Post-sale service, supplier reputation, warranty and support services offered are other important factors to consider. A vendor's availability to conduct operations and maintenance training and improve employee competency is something that can prevent productivity drag. Maintenance and repair costs should also be factored in.

When it comes to operating costs, manufacturers must determine the impact this new equipment can have on productivity. The philosophy behind a machine's design and construction can greatly affect this. A high-performance machining center typically has a design and construction that improves key aspects of operation, including cycle time, tool life, part quality and reliability.

For example, a dynamic-production machining center has the acceleration and deceleration available to reduce non-cut time. It incorporates lightning fast rotary axes to support 5-Axis machining and multiple nested parts. Motion control is utilized which lends to the task of processing large programs for contoured organic shapes. The spindle must run smooth at any RPM as well as run cool to mitigate growth through long productions runs. The machine structure must support a wide variety of cutting operations and the ball screws should be core cooled and pretensioned for the longest service life even after years of production. The machine must also be automation ready to support any type of production from high volume to high mix.

- Putting these dynamic-production machine design attributes to work, a true evaluation of part cycle time can be completed. Multiple workpieces can be prepared in a single setup and the machine preprogrammed for each job. More parts per shift can be completed over commodity machines. Producing more parts and saving labor automatically lower the actual cost per part and easily overcome the original discounted purchase price.



3+2 Doesn't Always Equal 5

The move to 5-Axis processes already yields impressive results. Reductions of setups and part handling provide more streamlined operations. Tool lengths can be shortened with better part access. Also, the ability to finish more features in a single setups results in more accurate parts. This combination of benefits can yield huge gains for manufacturers.

These benefits can be achieved two ways. Adding a retrofittable rotary table to an existing platform or purchasing a dedicated 5-Axis platform.

Manufacturers using VMCs with an added rotary table know that 3+2 does not truly equal five. The capabilities of full 5-Axis machining vs a 3+2 setup can yield extremely different results.

VMCs which are specifically designed for 5-Axis machining offer unique kinematics advantageous for the medical parts manufacturing industry. Working with a true 5-Axis platform — rather than a 3+2 configuration—allows for high-speed finishing and unique fixturing opportunities to reduce overall cycle time.

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A true 5-Axis setup provides medical parts manufacturers the ability to produce small- and medium-sized parts using a highly productive spindle with a wide-range of applications and the ability to setup multiple parts per fixture. This capability can greatly reduce cycle time per part.

One way to analyze and compare the difference between single- and multi-part setups is to calculate parasitic time included in producing each part.

While running one part on a 3+2 single-part setup, the machine must stop the spindle, move to tool change position, change the tool, restart the spindle, and move back to the part. The parasitic time is calculated per part for individual part machining; meaning that if it takes 120 seconds to complete nine tool changes, that's 120 seconds of parasitic time for each part.

On a true 5-Axis machining center, the parasitic time is still 120 seconds, as the steps to change the tool are the same as on the 3+2 machining center. However, having the ability to machine four parts on a multi-part setup is where manufacturers can see the amortization.

While machining a total of four parts individually on a 3+2 setup, the total number of tool changes is 36 (four parts x 9 tool changes for each part). This equates to 120 seconds parasitic time per part; generating a total parasitic time of 480 seconds to produce four parts.

An example of parasitic time amortization using a true 5-Axis is when the same four parts are machined in one run on one fixture. To machine these four parts, there are only nine tool changes total. This equals an aggregate parasitic time of 120 seconds. That's 30 seconds per part—a 90 second reduction in parasitic time from the 3+2 setup. Amortizing overall non-cutting time for four parts from 480 seconds on a single part setup to just 120 seconds on a multi-part setup is a huge time/savings cost benefit and can greatly improve ROI.

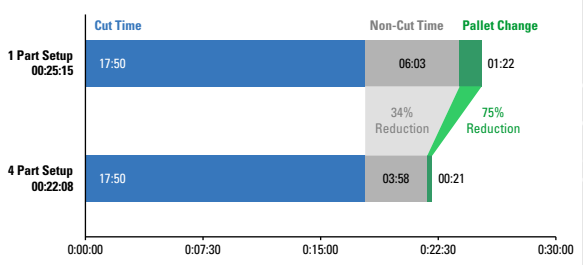
The ability to produce multiple parts on one run also improves continuity between parts, providing greater accuracy capabilities. This benefit should be incorporated into ROI as it can greatly reduce scrap costs and lessen post-processing time.

Traditionally, medical parts manufacturers have remained tethered to existing process part setups, while others have embraced multi-part machining in 5-axis environments. Historically, one fact holds true across the industry: process optimization is key to increasing ROI.

	Cycle Time	Parts per Year	Machine Time
Single Part Setup	25 min 15 sec	11,109	At capacity
Four Part Setup	22 min 08 sec	12,673	577 hours saved
Benefit	**12.3% reduction**	**1,565 additional parts annually**	**$86,550 in machine time saved**

As illustrated in the table above using a sampling of actual production data for cervical spine fusion plates, the time savings between single-part and multi-part setups provides additional production time per spindle. By optimizing the machining process—producing four cervical spine fusion plates on a multi-part setup, compared to producing only one plate on a single-setup—a 12.3% overall reduction in cycle time was achieved.

While process optimization can seem costly or time intensive on the front end, shaving even a few minutes off production per part can generate a massive boost to a manufacturer's ROI. This type of machine-enabled process optimization is only realized on a dedicated 5-Axis platform suitable to this type of fixturing.



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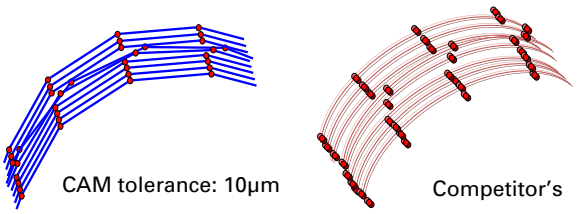
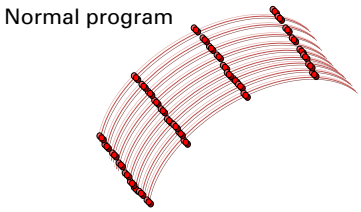
Advanced Motion Control Affects the Bottom Line

Lightweight, organic-shaped medical parts sometimes require delicate machining and excellent surface finishes. Medical manufacturers are also faced with the reality of post processes like polishing and deburring, which add cost per part and overall operation cost. In order to achieve a smooth shape, clean edges, and suitable surface finish, superior motion control is key.

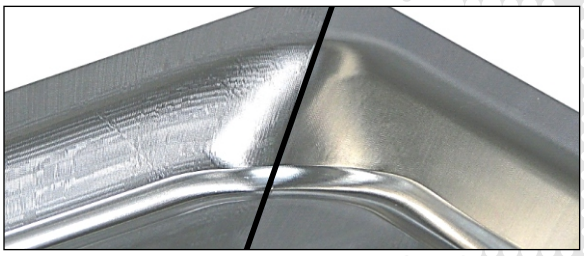




Less capable NC controller software simply executes the code as presented. Even with multiline read ahead, the result is a choppy surface that requires additional post process work in polishing or deburring to generate the desired finish. How much cost is wrapped up in unoptimized finishing and hand work, due in part to poor finishes from the milling operation?

Super Geometric Intelligence (SGI) is a Makino technology that is now on its fifth revision. SGI.5 affects the way the machine controller interprets the NC program. This remarkable software not only maximizes read ahead but interprets the entire shape of the tool path. Even if the cam system shows extraneous, rough points in the code, SGI.5 anticipates the surface flow, understands the overall surface and removes gouges and imperfections in the surface.

It's important for manufacturers to look beyond the milling operation in order to see what other processes can be improved downstream. Subtle parts of the machine, like motion control, can greatly expand future process upgrade capabilities. Makino 5-Axis technology equipped with SGI.5 delivers these downstream process improvements which can enrich the bottom line.



Normal **Pro6 Super GI.5**

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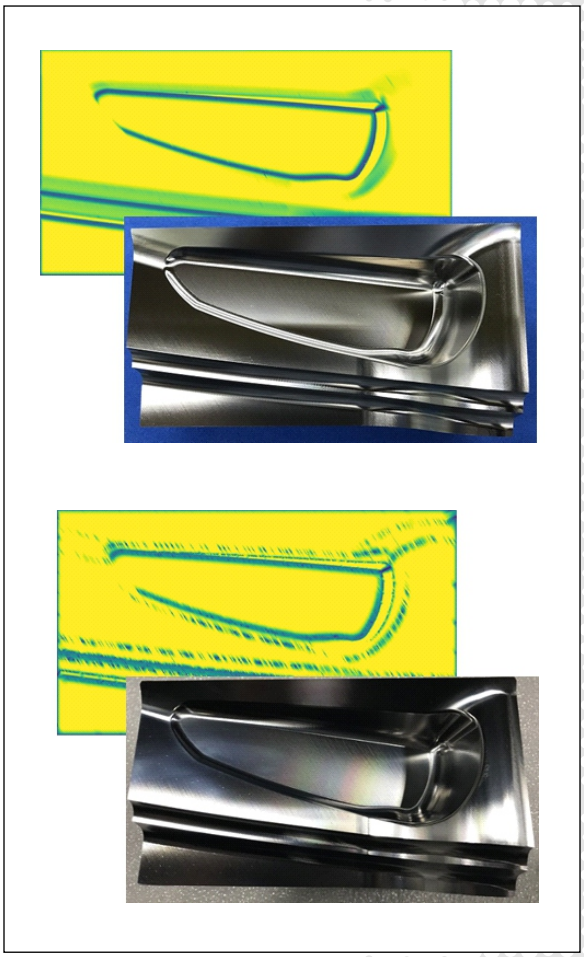
One of the ways SGI.5 achieves this superior finish is by maintaining a consistent velocity while cutting. Two machines, one Makino with SGI.5 and one competitor ran the same code on a complex surface. Sensors were used to measure velocity at each point during the program execution.

In the images to the right, the yellow represents programmed speed and the blue represents velocity of zero (tight corners or changes in direction). The green is indicative of the accelerations between full programmed speed and zero velocity.

It's clear the Makino with SGI.5 maintains more consistent velocity (more yellow area) and also more smoothly and precisely works to and through tight corners with no over shoot or gouging. This is especially clear in the resulting surfaces in both cases. The competitive motion control is inconsistent in these same areas. The results are gouging from overshoot.



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Equipment ROI

Does your ROI calculation consider all costs of ownership?

Does your ROI calculation consider all costs of ownership?
Initial investment cost is only the tip of the iceberg, hiding a multitude of hidden costs that manufacturers must consider to understand true ROI.

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Finally, there are those operational factors usually ignored in a typical ROI approach. When examining these hidden costs of ownership, a manufacturer should consider the following aspects:

- What is the expected performance of the machine—will there be less scrap, less waste and higher quality parts being made?
- Does the equipment and its processes give the company an advantage over the competition?
- How often will the company use this equipment?
- Can the business eliminate floor space because it's using fewer machines?
- The financial impact of inventories and work in process (WIP).
- Are there any advantages surrounding utilities and energy efficiency?

There are many often uncalculated costs associated with maintenance. It is important to remember that once production starts, unscheduled downtime can quickly erode any saving on purchase price. Because maintenance budgets are typically incorporated into operating costs, they normally are probably not directly accounted for in a capital equipment ROI calculation. The costs associated with repair, a preventive maintenance schedule and any cost for unscheduled downtime should be considered. With a high-performance machine, these costs are not the same as they would be if a company kept an inefficient, less reliable machine running.

When purchasing equipment, manufacturers also need to consider decommission costs. The residual value of the ma- chine should be accounted for in the actual ROI. Typically, after the contract or payments are up, manufacturers must decide what to do with the machine. They can dispose of the machine or keep it running for another four to 10 years.

Maintenance Example:

With a hypothetical ballscrew, the replacement of the part can be $3,700 to $4,900. Installation and labor are an additional $1,500 to $2,000. There is also the cost of scrapped parts, unplanned downtime and overtime to catch up on lost production. Production goes to zero until the part is fixed. It's also important to remember that the ballscrew failure didn't happen instantly. The machine was likely declining in performance before anyone realized what went wrong, affecting part quality. There are often many uncalculated costs associated with maintenance. Also, one should not confuse a warranty as an insurance policy against downtime. If the machine is down, the cost of this unplanned event is far greater than the repair costs. A company's profitability is dependent on efficient operations.

Because the low-cost machine is fully depreciated after three years, it looks inexpensive on the accounting books. This type of thinking leads many manufacturers to keep the machine running in the shop long after it should have been removed. Typically, with a lower-cost machine, in years four through 12, maintenance costs skyrocket, part quality suffers and scrap increases, all while perishable tooling costs escalate. At the end of three years, the machine has minimal value. In contrast, a high-performance quality machine can extend component life and reliability, reduce maintenance costs and retain 50 percent of its value at the end of three years. These benefits should be factored into actual ROI.

How Automation Can Improve ROI

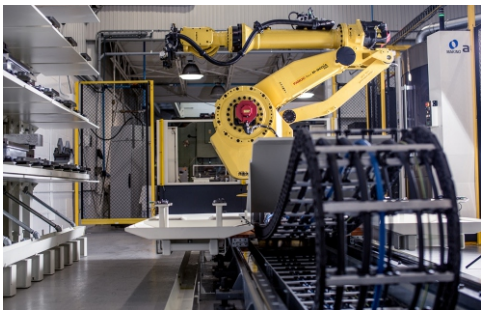
Many manufacturers don't take into consideration the fact that automation can increase machine utilization by as much as 95 percent, because machines are kept in cycle. The minute one part is completed, the next part goes into production, sometimes running 24/7.

Faster part turnaround results from eliminating direct setups on the machine. More throughput helps the business become more profitable. By factoring in better machine utilization through a high-performance machining center, machine count can also be reduced. Businesses can purchase fewer machines to achieve desired production volumes.

Automation also allows for flexible production quantities. Small batch runs, multiple part types, and quick changes between jobs can all be improved with automation by incorporating a transport mechanism that moves fixtures between machines or between a fixture plate between tombstones. Part mix and part volumes can be changed quickly and reliably in order to address the customer's evolving needs. Lead-times are reduced. Automation also allows for multiple part types moving across the same machining center. cycle times, eliminates repetitive movements, improves tool life and reduces labor, all while resulting in more parts per shift.

The outcome brings higher quality parts with less scrap and lower part costs. The manufacturer is able to gain a competitive position in the marketplace due to reduced labor and part expenditures. Higher quality parts can also propagate a stellar reputation, increasing orders and generating new customers. All of these factors reinforce the fact that automation should be included in any ROI calculations.

When considering automation investments, its important to consider the machine design. As you evaluate and compare different machines, look at what automation considerations have been designed in. Does the machine have good chip shedding for unattended operation? Does the table have provisions to support quick change chuck systems? Has the manufacture developed robust option like auto doors and robot interface to support automation? Answering all of these considerations will result in the most robust automation solution required for dynamic production scenarios.



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The Impact of Leasing vs. Buying

After evaluating the cost per part from acquisition, operating, maintenance and automation, a manufacturer should next determine the best way to pay for the equipment.

There are two ways to pay for equipment: with cash or through financing. Paying cash enables a business to own the equipment as soon as the transaction is's completed. The company can amortize the cost over the lifetime of the equipment. However, buying can also reduce the company's availability of cash for other investments, such as plant expansion or improvement, marketing or purchasing future equipment. This liquidity risk should be carefully factored into the equation.

Financing enables a company to better match monthly cash flow being generated from the equipment to the obligation of the monthly payment due under the financing vehicle.

There are two ways to finance a purchase: through a traditional loan or by leasing the equipment. With a traditional loan, the borrower pays a certain amount monthly and then owns the equipment at the end of a term. Leasing equipment can be an alternative acquisition strategy that can lower the operating cost of high-performance equipment. Of all of the financing options, leasing offers the most flexibility to meet a company's unique business needs.

When buying an asset, it is critical to consider the long- term costs of ownership, such as maintenance and downtime that can mount when a company holds onto an asset over time. Through leasing, a company can further improve its cash flow while obtaining better equipment and better ROI. Leasing gives flexibility in capacity and financing. The company is able to add another machine if the customer asks for increased production. It can return equipment at the end of the contract, if desired, or purchase it at the end of the lease.

If a company's production run lasts only three years, it makes more sense to lease because the company pays just for the machine's depreciation; yet the company is still receiving the full benefits of a high-quality dynamic-production machine. Alternatively, if a lower quality machine is purchased with the intention to discard it at the end of three years, the overall costs end up being the same as if the company had leased a high-performance machine, except that the company is not enjoying the benefits of a dynamic-production machine.

Leasing can save cash flow on a monthly basis that mak ing loan payments or paying cash for equipment cannot. This is because the company is paying for the value of the machine being used over the lease term only. There are two types of leases: Capital and Operating,

A **Capital Lease** is very similar to a term loan. The asset and lease liability is recorded on the company's accounting books, which show the monthly depreciation and interest expense. At the end of the lease, the company can purchase the equipment for a nominal amount. In a capital lease, the company is paying for the entire cost of the machine over the lease term and owns it at the end, just like a traditional loan.

An **Operating Lease** is very much like renting the machine over an agreed-upon time period. The monthly payment obligation is expensed in operations. An operating lease gives a company the lowest monthly payment obligation, as the company is paying only for the value of the equipment being used during the term of the lease. The value of the equipment at the end of the term is the most important cost driver for determining the monthly payment obligation. At the end of the lease, the company determines if it wants to extend the lease, purchase the equipment or return the equipment

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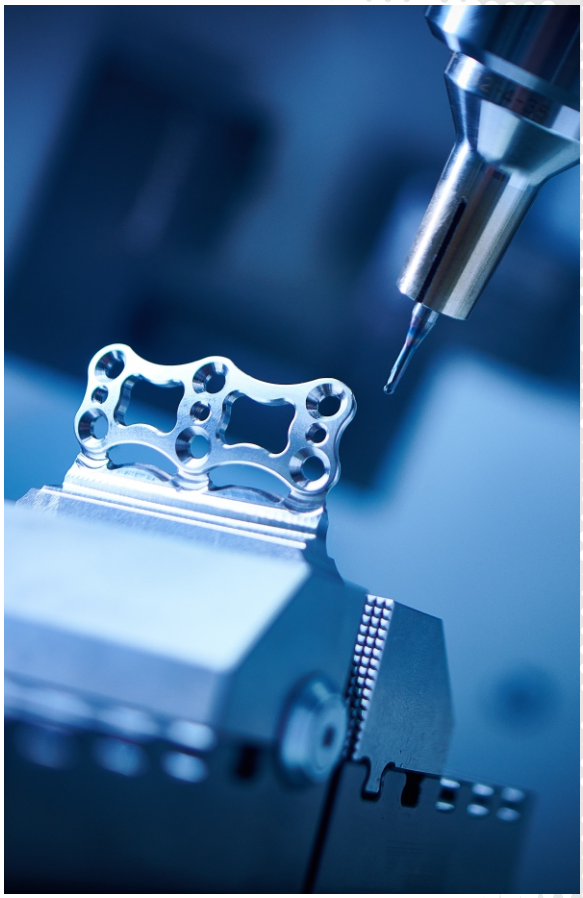
Dynamic-Production Machining Center ROI

Conclusions

To be competitive today, manufacturers must take advantage of the most advanced technology available on the market and put it to work in its full capacity. Buying a dynamic-production machine tool can dramatically improve a company's ROI by delivering long-term reliability, accuracy and performance.

- Low-cost machines have minimal value at the end of three years, but a high- quality, dynamic-production machine retains about 50 percent of its value.
- The design and construction of a dynamic-production machine improves operating costs and productivity.
- Buying the low-cost solution ends up costing a business more in higher part costs, shorter tool life, increased scrap, unplanned downtime and higher maintenance costs.
- The high-performance machine retains its value over time.
- The way the machine is financed can affect long-term cost of ownership.

Investing in high-performance machining centers instead of the lower-cost option can ultimately be a better, more profitable solution for the business.



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