

HIGH-PERFORMANCE MACHINING CENTER ROI:

HOW TO DETERMINE A MACHINE'S TRUE VALUE



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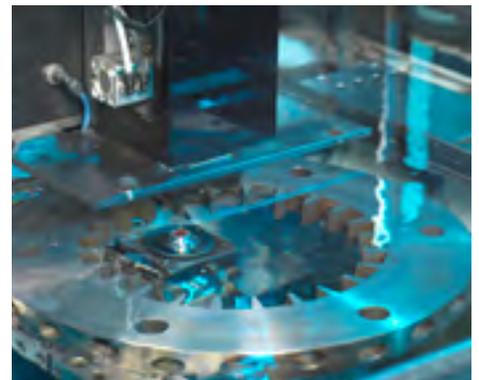
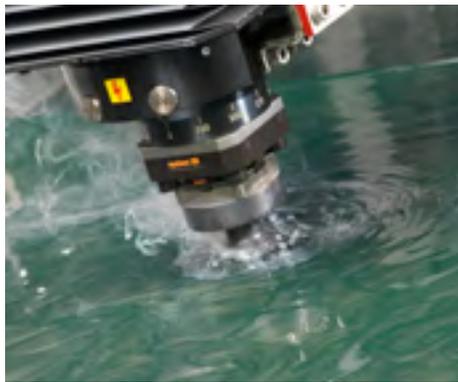
HIGH-PERFORMANCE MACHINING CENTER ROI: HOW TO DETERMINE A MACHINE'S TRUE VALUE

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 a solid decision about which equipment to purchase, as it

can ultimately determine the payback period for the machine. This white paper discusses how to make a complete ROI calculation by addressing these four areas:

- The factors of high-performance machines that impact ROI
- How automation can improve ROI
- How leasing versus buying affects ROI
- ROI examples



FACTORS THAT IMPACT ROI

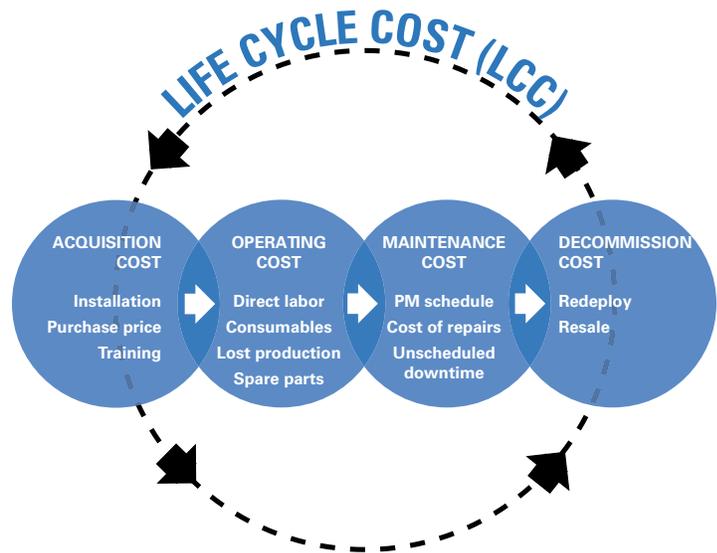
Manufacturers typically purchase new equipment to obtain higher capacity or improved methods and technologies for production. In determining ROI for these new machines, the manufacturer carefully examines the purchase price. However, the costs for operating, maintaining and decommissioning these new 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 high-performance machining center has a high-power spindle that facilitates high-speed cutting and low-force machining. It also has the acceleration and deceleration available to reduce non-cut time. The spindle bearing is the main support for the tool, and a larger spindle bearing is better able to handle cutting forces. This bearing's type and position can also affect machine stiffness and the types of forces it can handle. A stepped column design contributes to machine strength and can be more stable. Machines that have a single-piece casting, three-point leveling and a tiered column design can reduce machine vibration.

- Putting these high-performance machine design attributes to work, a true evaluation of part **cycle time** can

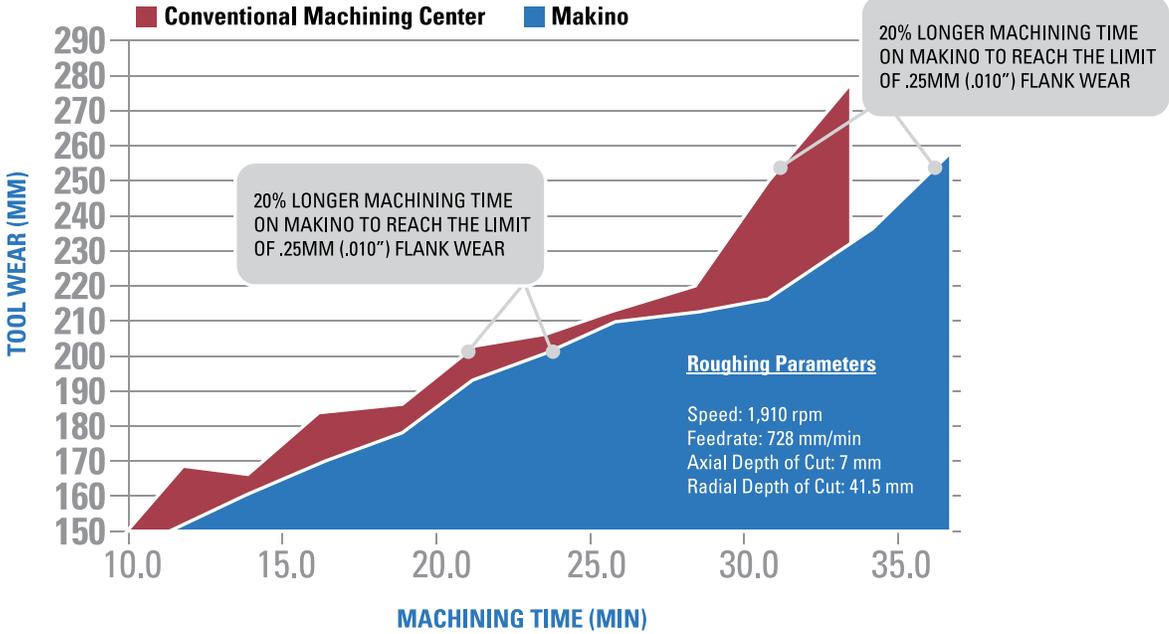


FACTORS THAT IMPACT MACHINE TOOL ROI EXTEND THROUGHOUT THE LIFE CYCLE OF A MACHINE. ALTHOUGH THESE FACTORS MAY NOT DEMONSTRATE IMMEDIATE ROI, IT'S IMPORTANT FOR MANUFACTURERS TO REALIZE THAT A BOTTOM-LINE IMPACT WILL BE FELT.

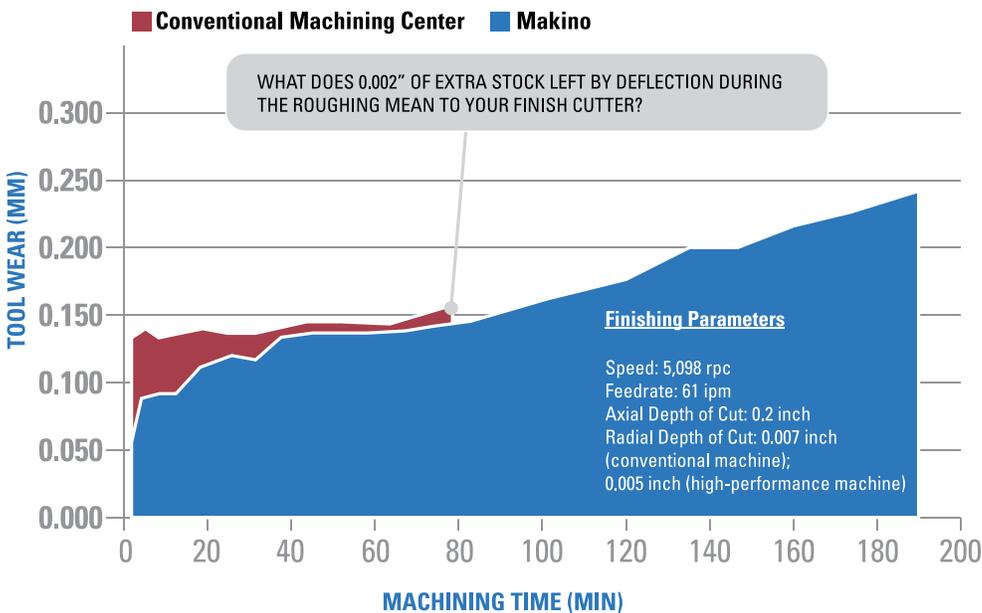
be completed. Multiple workpieces can be prepared in a single setup and the machine preprogrammed for each job. More parts per shift can be completed over commodity machines. Producing more parts and saving labor automatically lower the actual cost per part and easily overcome the original discounted purchase price.

- A high-performance machining center has been shown to deliver improved **tool life** and performance. Its rigid construction means fewer passes with the tool are needed, reducing processing times. Rotational deflection usually reduces tool life by leaving heavier stock or stock variations for the finish tools. A high-performance machine eliminates this. By controlling the forces and deflection, finish tool life is also extended because it does not have to take extra passes for certain features. For such features, this control can save up to 50 percent on perishable tooling costs. The

TOOL WEAR VS. MACHINING TIME



MACHINING DEFLECTION & TOOL LIFE ON THE FINISH TOOL



THE GRAPHS ABOVE DEPICT TOOL-LIFE TESTS PERFORMED BETWEEN A CONVENTIONAL AND HIGH-PERFORMANCE MACHINING CENTER DURING BOTH ROUGHING (TOP) AND FINISHING (BOTTOM) OPERATIONS IN 65-45-12 DUCTILE IRON. DURING ROUGHING OPERATIONS WITH THE HIGH-PERFORMANCE MACHINING CENTER PROVIDED A 20 PERCENT INCREASE IN MACHINING TIME BEFORE REACHING AN IDENTICAL LEVEL OF TOOL WEAR. IN ADDITION, THE CONVENTIONAL MACHINING CENTER EXPERIENCED SEVERE DEFLECTION, LEAVING BEHIND A 0.002-INCH LAYER OF MATERIAL. THIS EXTRA LAYER OF MATERIAL WAS THEN COMPENSATED FOR DURING FINISHING OPERATIONS, 0.007-INCH RADIAL DEPTH OF CUT, WHILE THE HIGH-PERFORMANCE OPTION HAD A 0.005-INCH RADIAL DEPTH OF CUT.



TOOL WEAR OBSERVED ON A HIGH-PERFORMANCE MACHINING CENTER AFTER 38 ROUGHING PASSES IN 4140 ALLOY STEEL. REPLENISH COST WAS \$60 FOR FOUR NEW INSERTS.



TOOL WEAR OBSERVED ON A CONVENTIONAL MACHINING CENTER AFTER 28 ROUGHING PASSES IN 4140 ALLOY STEEL. REPLENISH COST WAS \$924 FOR FOUR NEW INSERTS AND A TOOL BODY REPLACEMENT.

stability of the high-performance machine allows for deeper axial depths, increasing the metal removed by each tool. A high-performance machine also maintains the integrity of the coolant, keeping out tramp oil and metal particles, which extends tool life.

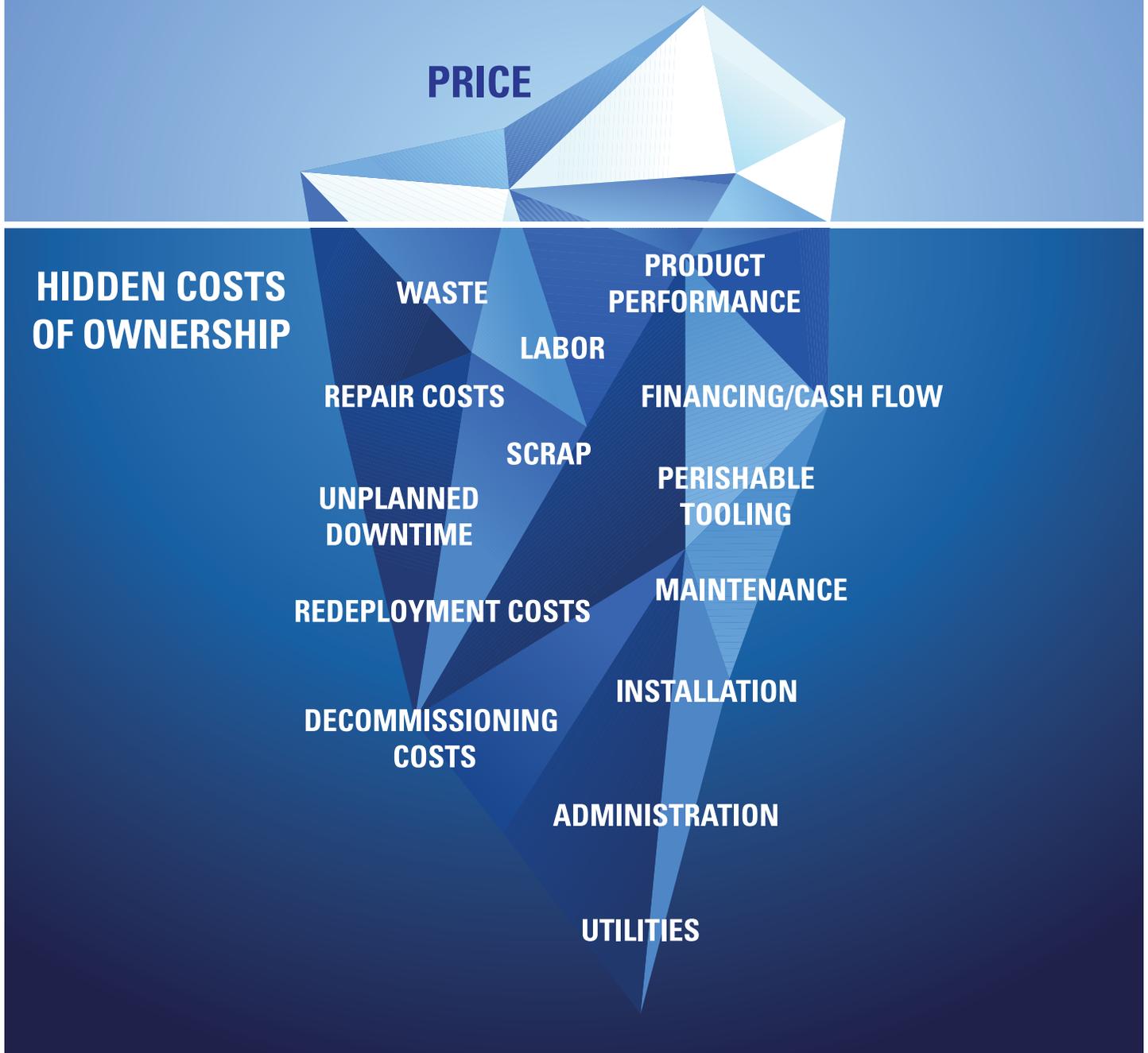
The costs related to better tool life include more than just the tool itself. Improved tool life leads to less operator intervention and reduces the cost per part. There's the added labor related to swapping tools in the machine, updating tool information, transporting to the tool room, changing tools and measuring new tool length. Manufacturers benefit with increased part quality, accuracy and consistency, as well as reduced scrap costs.

In side-by-side testing between a high-performance machine and a commodity machining center, the design of the high-performance machine can increase tool life by as much as 36 percent. Just a simple 15 percent improvement in tool life has been shown to reduce part cost by as much as 2 percent, increase return on capital by 6 percent, and improve gross profit margin by 2 percent.

- The accuracy and precision of a high-performance machine also affect *part quality*. When secondary operations like spotting, hand finishing or long EDM processes can be eliminated or reduced, turnaround times and lead-times are affected. Even parts with complex geometries come off the machines with tight tolerances and high-quality surface finishes, lowering labor costs and enabling a manufacturer to take on more orders.
- *Reliability* also factors in to ROI, especially when it is related to both the machine and the supplier providing that machine. When machine suppliers can maintain close ties with customers and support them on a high level, it saves time in the long run. Special programming features also mean that operators do not have to continually stand at the machine to recall programs, and the equipment can run uninterrupted or unattended. It is also important to remember that warranties are not an insurance against downtime. Free replacement parts do not make up for the cost of lost productivity resulting from machine downtime. The ability to reliably and consistently produce parts is more valuable than the perceived benefits of a warranty.

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 IN ORDER TO UNDERSTAND TRUE ROI.

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 factors:

- 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 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 machine should be accounted for in the actual ROI. Typically,

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.

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.

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 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. 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 reduces 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. All of these factors reinforce the fact that automation should be included in any ROI calculations.



THE IMPACT OF LEASING VERSUS 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'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.

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

Leasing can save cash flow on a monthly basis that making 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.

just for the machine's depreciation; yet the company is still receiving the full benefits of a high-performance 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 high-performance machine.

AN EXAMPLE OF EQUIPMENT ROI

To compete in manufacturing, it is often the best technical product and solution that likely yield the superior return on investment. Two examples illustrate this point.

VMC

1) When comparing a low-cost vertical machining center (VMC) to a high-performance VMC that costs 50 percent more, if a company considers that the high-performance machine is 10 percent faster, yield 32 percent lower cost

per part, and has 65 percent gross profit margin, even though this machine costs 50 percent more, it can actually be a better return on investment and yield a better overall part cost.

PART PRICE SENSITIVITY OF LOW-COST VERSUS HIGH-COST INVESTMENT SOLUTIONS

ADVANTAGE

DESCRIPTION	UNIT	LOW-COST VERTICAL MACHINING CENTER	HIGH-PERFORMANCE PS95 VERTICAL MACHINING CENTER
PRODUCTION			
Production volume per year	87,500 PPY	87,500	87,500
Machining cycle time per part	min	18	16
Scrap rate		1.50%	0.75%
Total production hours required	hrs	26,650	23,510
Uptime		80%	85%
Efficiency (utilization)		65%	75%
Gross production hours required		41,000	31,346
Production hours per year / machines required	6,000 hrs	7	5
CAPITAL			
Machine cost (each)		\$90,000	\$145,000
Total machine cost		\$930,000	\$725,000
Rigging foundation setup	\$5,000	\$35,000	\$25,000
Fixture costs per machine / total cost	\$25,000	\$175,000	\$125,000
Durable tooling cost per machine / total cost	\$15,000	\$105,000	\$75,000
Total durable investment		\$945,000	\$950,000
Depreciation per year	7 years	\$135,000	\$135,714
EXPENSE			
Operator \$ / hr / yr (1 Oper/2 Mach)/ total cost	\$65 hr	\$1,365,000	\$975,000
Financing costs	Cash sale	\$ -	
Maintenance costs per machine / yr		\$6,000	\$3,000
Total maintenance costs		\$42,000	\$15,000
Perishable tooling	\$2.00 part	\$175,000	\$148,750
Utilities	\$3,000 machine	\$21,000	\$15,000
Floor space		???	??? certainly less!
Unplanned downtime cost		???	??? probably less!
Total operating costs		\$1,603,000	\$1,153,750
Annual costs		\$1,738,000	\$1,289,464
Cost per piece		\$19.86	\$14.74
Sell price per part / gross profit	\$24.83	\$2,172,500	\$2,172,500
Total gross profit per year		\$434,500	\$863,036
Gross profit percentage		20%	41%
Profit total per contract	3 years	\$1,303,500	\$2,649,107
Total capital invested		\$945,000	\$950,000
Machine value at end of term		\$126,000	\$290,000
Net cost after three years		\$819,000	\$660,000
Return on capital invested	60% target	153%	401%
Total revenue over three years		\$6,517,500	\$6,517,500
Costs over three years		\$5,214,000	\$3,868,393
Total gross margin percentage		25%	68%

DOWNLOAD THE INTERACTIVE ROI SPREADSHEET

(click image to view larger)

2) Comparing a low-cost horizontal machining center (HMC) with a high-performance HMC: Though the high-performance machine costs 50 percent more than the low-cost option, the high-performance machine pro-

duces more parts, is 15 percent faster, costs 19 percent less per part, and has double the return on capital. Gross profit margin is 25 percent on the low-cost machine versus 54 percent on the high-performance machine.

PART PRICE SENSITIVITY OF LOW-COST VERSUS HIGH-COST INVESTMENT SOLUTIONS			ADVANTAGE	
DESCRIPTION	UNIT	LOW-COST HORIZONTAL MACHINING CENTER	HIGH-PERFORMANCE a51mx HORIZONTAL MACHINING CENTER	
PRODUCTION				
Production volume per year	37,500 PPY	37,500	37,500	
Machining cycle time per part	min	34	29	
Scrap rate		1.00%	0.75%	
Total production hours required	hrs	21,465	18,262	
Uptime		85%	96%	
Efficiency (utilization)		75%	85%	
Gross production hours required		28,620	21,485	
Production hours per year / machines required	6,000 hrs	5	4	
CAPITAL				
Machine cost (each)		\$ 250,000	\$ 375,000	
Total machine cost		\$ 1,250,000	\$ 1,500,000	
Rigging foundation setup	\$ 10,000	\$ 50,000	\$ 40,000	
Fixture costs per machine / total cost (2 each)	\$ 50,000	\$ 250,000	\$ 200,000	
Durable tooling cost per machine / total cost	\$ 20,000	\$ 100,000	\$ 80,000	
Total durable investment		\$ 1,650,000	\$ 1,820,000	
Depreciation per year	7 years	\$ 235,714	\$ 260,000	
EXPENSE				
Operator \$ / hr / yr (1 Oper / 2 Mach) / total cost	\$ 65 hr	\$ 975,000	\$ 780,000	
Financing costs	Cash sale	\$ -		
Maintenance costs per machine / yr		\$ 20,000	\$ 5,000	
Total maintenance costs	\$ 2.50 hr	\$ 100,000	\$ 20,000	
Perishable tooling	\$ 3,000 machine	\$ 83,750	\$ 78,888	
Utilities		\$ 15,000	\$ 12,000	
Floor space		???	??? certainly less!	
Unplanned downtime cost		???	??? probably less!	
Total operating costs		\$ 1,183,750	\$ 891,688	
Annual costs		\$ 1,418,464	\$ 1,151,688	
Cost per piece		\$ 37.85	\$ 30.71	
Sell price per part / gross profit	\$ 47.32	\$ 1,774,330	\$ 1,774,330	
Total gross profit per year		\$ 354,866	\$ 622,643	
Gross profit percentage		20%	35%	
Profit total per contract	3 years	\$ 1,064,598	\$ 1,867,929	
Total capital invested		\$ 1,650,000	\$ 1,820,000	
Machine value at end of term		\$ 250,000	\$ 750,000	
Net cost after three years		\$ 1,400,000	\$ 1,070,000	
Return on capital invested	60% target	76%	175%	
Total revenue over three years		\$5,322,991	\$5,322,991	
Costs over three years		\$ 4,258,393	\$3,455,063	
Total gross margin percentage		25%	54%	

DOWNLOAD THE INTERACTIVE ROI SPREADSHEET

(click image to view larger)

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 high-performance 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-performance machine retains about 50 percent of its value.
- The design and construction of a high-performance 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.

To compete in manufacturing, the best technical product and solution typically yield the highest return on investment. Investing in high-performance machining centers instead of the lower-cost option can ultimately be a better solution for the business.

RESOURCES

VISIT US ON THE WEB:

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[High-Performance Machining Center ROI: True Value Revealed](#)

[How Much Is Your Outdated Machinery Costing You?](#)

[An Economic Overview of Automated Pallet Handling Systems \(Part 1\)](#)

[An Economic Overview of Automated Pallet Handling Systems \(Part 2\)](#)



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Perishable tooling	\$ 3,000 machine	\$ 93,750	\$ 79,688
Utilities		\$ 15,000	\$ 12,000
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