Building a Return on Investment for a CNC Machine Tool

White Paper

DATRON

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Building that ROI

Researching and qualifying the right piece of CNC equipment to meet your manufacturing needs can be arduous and stressful. Once you have found the technology you determined will accomplish the work, you need to justify the expense. This can also be a complicated and involved process.

To help you feel confident in your decision, this article intends to enlighten you about any costs and expenses that you should consider when building that return on investment (ROI).

An ROI should be an analysis that determines the length of time it will take to break even on your investment. It should include the cost to produce each part, including all associated expenses. From the analysis, you might conclude it is not a good investment because the total cost might exceed the earnings from the work. In order to make a confident decision, you must be diligent with your analysis that the earning potential outweighs the cost.

There are many ways you can create an ROI. How you develop one depends on your manufacturing situation. You might be building the ROI to compare against a manufacturing process you have in place today. It might be a new project, and you have no equipment to produce the parts. It would be nearly impossible to cover all possible variations. To keep things simple, we are creating a scenario of a hypothetical production requirement, to build an example ROI.

Our example ROI will be based on purchasing a CNC machine versus outsourcing parts. We will be considering a **DATRON neo**, leased over four years with a $1 buyout. The neo is used to machine an OEM aluminum part (as shown below) that will be used in an assembly of parts for a final product. There is enough production volume that the neo will be solely dedicated to one part. It will be nested on a vacuum table, milling four pieces at a time out of a sheet of aluminum. For purposes of the ROI, it will be compared to a quote we have for the parts machined by an outside CNC job shop.

We understand this example might not be exactly your situation, but there should be enough information to support you for other ROI scenarios.

Now onto building the ROI...

Step One

The Machine Cost & Term

Before you get started, you need to determine the cost of the equipment you are buying and a timeframe for your ROI justification.

1

First, obtain a quote for the CNC machine with all necessary options, installation, training, and delivery. If you intend to finance the equipment, you will need all your financial costs, including interest and if leasing, buyout details.

2

Second, you need to establish the term you expect the equipment to pay for itself to justify the expense. This term could be the length of time for financing, the length of time the equipment will be depreciated, or the life of a particular contract of parts to be manufactured.

You should also consider the ROI unit you are measuring the expense against. This can be the cost per hour, week, or month. For example, you may choose per month because it will be factored against the monthly finance cost of the equipment. You might choose an hourly unit because you are a job shop that will bill the equipment at an hourly rate. You should decide the term and unit of measurement that makes the most sense for your situation.

For our example case of a leased **DATRON neo**, we are going to calculate the ROI monthly over the four-year term. This way, we can determine if the machine will pay for itself over the lease. The cost of the equipment and all accessories will be leased at $3,123.93 per month over four years with a $1 buyout (based on rates at the time of this article). At the end of our ROI analysis, the cost, including all other associated expenses, will be compared to a quote we received from a reputable machine shop. The quote from the job shop for our example part is $132.46 per part based on machining 1,000 parts with a $1,945.64 one-time cost to make a fixture to hold the parts.

Quoted By

Date: **7/21/2023**
Prepared by: [redacted]
FOB: [redacted]
Terms: **Net 30**

Client

Company: [redacted]
Contact: [redacted]
Phone: [redacted]
Email: [redacted]
Project:

Quantity	Delivery Date	Part Number	Rev Ltr	Description	Cost Per Part	Total Cost
4	2 Weeks	PLATE-1432	A	Aerospace Plate - Aluminum	486.41	$1945.64
1000	6 Weeks	PLATE-1432	A	Aerospace Plate - Aluminum	132.46	$132460.00

Terms & Conditions

Please call if you have any questions or if you would like to confirm this quote. Following are the terms and

Step Two

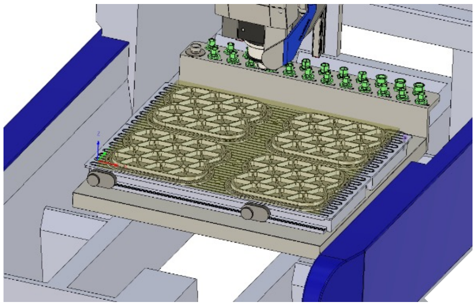
Chip to Chip (throughput)

This is one of the most critical pieces of information and often the make or break to proceed with a purchase. We must determine the throughput of parts you can expect one machine to manufacture.

1. To do this, first, you will need to find out the cycle time of your parts. This is a simple process if you are making the same part over the term of your ROI. If you are making a range of parts or machining parts you haven't even quoted yet, for the ROI, choose one part that is typical to the kind of work you plan to do on the equipment. If you currently outsource and don't manufacture the part, you will still need to do a time study of a typical part you outsource to understand your potential output. Your machine seller should be able to help you with this.

2. Once you have the part cycle time, you need to factor in the changeover time of your parts. Depending on the complexity, it might require specialized work holding. It might take a few minutes to unload the part from a specialized fixture or jig before reloading the next part. What we are trying to determine is the chip-to-chip time. This is the time from the first chip produced on one cycle run to the start of the first chip of the next cycle run. It is important to use this time because we need to include the loading of parts and not just the cycle time to determine your throughput. The changeover time may be the same as the cycle time in certain cases.

There are ways to minimize this chip-to-chip time. For example, you can add a pallet changer system to your machine that exits the machined parts out of the machining area and starts the next pallet of material in just a few seconds. Typically, these automated systems are expensive and take up additional floor space. You can also mount or nest several parts at one time on the machining table and reduce the changeover time of parts. You might think that removing ten parts at one time is the same as removing one part at ten different times would be equal, but it is not. There is a wait time for the machine to come to a safe stop, plus opening and closing the door and physically reaching into the machine all add to the changeover time. Removing multiple parts at one time is much more efficient. Machining multiple parts at once reduces your chip-to-chip time per part because you can eliminate numerous tool changes. Tool changes take a few seconds to execute. Therefore, if three different tools are required, you would have thirty tool changes over ten individually run parts. Comparing this to three tool changes running ten parts at once would significantly reduce your chip-to-chip time per part.



For our **DATRON neo** example, we determined with a time study by DATRON that you can machine four parts at a time using the permeable card stock on a vacuum table within the machining area. The time study determined you can machine the four parts in 70 minutes. We also determined it takes 6 minutes to remove the four parts from the card stock and reload a fresh card stock with the material before hitting the cycle start button. Therefore, our chip-to-chip time is 76 minutes for four parts or 19 minutes per part. In an 8-hour shift (480 minutes), we determined you can machine 24 parts per shift.
Our throughput would consist of 6 runs x 76 minutes = 456 minutes, leaving 24 minutes of extra buffer. This would equate to 528 parts per month.

Step Three

Commissioning and Facility Preparation

This third step has a one-time impact on your overall ROI but still needs consideration. Commissioning your equipment and preparing your facilities can be, in some cases, a significant investment in time and costs.

Depending on your environment, getting the equipment installed on your floor can be involved. Extra costs and delays caused by special electrical power requirements, compressed air requirements, floor space, special rigging needs, floor reinforcement, and safety signoffs can complicate your ROI. Additionally, teaching your operators how to run the equipment could be another time-consuming factor. In some cases, your investment starts when the equipment is delivered. Any extra costs or time needed to get the equipment production ready must be factored into your ROI. For example. if there are delays between when your equipment is delivered and when a technician arrives to commission the equipment, this also needs consideration. Waiting weeks or months for an installer and trainer only negatively impacts your ROI. During your buying process, find out what is a realistic timeframe from when your equipment is delivered to fully implemented and producing parts.

For our **DATRON neo** example, we are leasing therefore are not factoring any commission time because we would not start making payments until the machine has been fully commissioned.

This is one big advantage of leasing. The compact size fits through a standard doorway, so no extra costs are required for special rigging or wall removal. No floor reinforcement is needed because of the weight of the neo. The 120-volt single-phase power requirements and standard shop air allow it to be installed easily within standard shop systems. The next control software is intuitive and easy to use and typically takes only two days of training to be fully operational and produce parts. Therefore, we do not have to consider additional preparation costs for the neo machine and nothing for the training because it will be implemented into production by the time the lease starts. To be safe, we will buffer $1000 in miscellaneous costs that may arise during the implementation.

Step Four

Set–up, Work Holding and Programming

As you are aware, to mill a part, it needs to be secured to the machine table. In most cases, the work holding can be purchased or constructed before delivery of your machine.

Most parts can use standard fixtures such as a vice or vacuum table. The cost of the work holding needs to factor into the ROI. If the parts you plan to machine vary and you will use different types of fixturing devices, you need to factor in possible downtime to set up the work holding. In some cases, this can be time-consuming if it needs to be precisely trammed.

Just like work holding, programming of the part can be done before delivery of your machine. If you are running different parts, the programming is typically created offline while the machine is milling, but you still need to account for that labor. Depending on the complexity of your part or parts, you might need to factor in extra time to program, run test samples, correct any problems, optimize cycle times, use measuring equipment to validate your parts, and time to correct any tolerance or tooling issues. If you have no feel or experience in what is involved in this stage, consult with the equipment seller to get information on the time you need to budget for your types of parts.

The machine is delivered with the vacuum table installed and will be trammed during the commissioning phase. Additionally, since the neo is machining only this one part, we have elected to hire DATRON to prove out and optimize the part before delivery and is included in the machine quote or lease per month cost. DATRON offers these turn-key-type services when needed. This way, after commissioning and training, we will be immediately in production. Therefore, no extra costs for work holding or programming need to be factored in this example because it is covered in the machine quotation.

In the case of our example with the **DATRON neo**, since we are using a standard vacuum table, no time needs to be budgeted for the set-up.

Step Five

Labor

When calculating the labor cost to operate your machine, consider how much time the operator will work to produce parts. For example, if you have a robotic arm feeding parts in and out of the machine, you will likely require minimal labor to supervise the work cell.

If you have a short cycle time, you may need to dedicate the operator 100% of the time to the machine, swapping parts in and out, with no extra time to do other job functions. For parts with a longer cycle time, you may use that operator to do other tasks such as running another piece of equipment. Try to estimate the number of hours per day required to support the manufacturing of your parts.

To calculate the cost of labor, there are additional expenses to include other than what you pay your operator. A job shop has a billable rate that helps them for quoting purposes, but in our ROI example, it is an OEM part and one component of an overall assembly. The entire assembly will have a markup for a profit margin. Therefore, in this case, we need to calculate a rate that covers the cost you pay the employee plus an extra margin for its share in overhead to run your business. These extra expenses include employee benefits, holiday time, overtime, and a small percentage of overhead costs such as rent and utilities. Without getting into a complicated formula, a rough estimate you can use is to multiply your operator's hourly rate by four.

For our example with the **DATRON neo**, we are using a $30 per hour labor rate for the machine operator multiplied by four which equals a $120 company operating rate.

Earlier, we calculated 36 minutes (6 cycle starts x 6 minutes of changeover) is required. However, we are going to build a buffer and use two hours for the production of the parts per day to cover any unforeseen issues. This operator will therefore have six extra hours of capacity to perform other manufacturing functions. This totals $240 per day in labor and operating costs.

Step Six

Materials and Consumables

To calculate the cost of your part for the ROI, you need to consider the material and consumable costs.

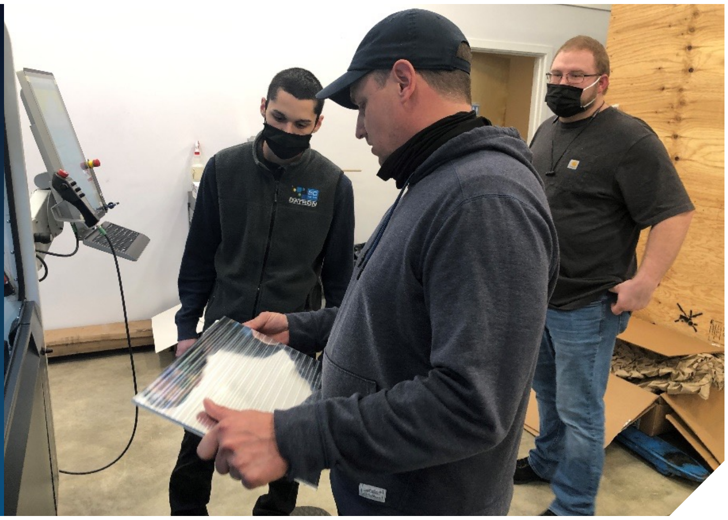
The material costs are straightforward, but you need to allow for any waste incurred. Calculate your material costs on the blank that enters the machine, not the size of the finished part.

There are many types of consumables required to machine a part.

- For example, you need to consider the cutting tools and how many parts you can manufacture before replacing them because they get dull.
- You will also need to consider tool breakage costs that will inevitably occur as you prove your parts out and optimize the cutting times. The tooling or machine supplier can help you if you don't know this information.
- You will also need to calculate the cost of any coolants required to machine your parts. Even with recycled flood systems, coolants break down and need to be replaced.
- You will likely incur environmental disposal fees as well.

Again, the company you purchase the machine from can help support you in determining these costs. You may also have other consumables needed to produce your parts, such as vacuum card substrates. Any materials that need to be replaced to maintain the production of your parts should be calculated and factored into the ROI.

In our example of the **DATRON neo**, we will calculate the cost of the aluminum blank sheet held on the vacuum table of the machine. The blank measures .5" thick x 15.75" x 18" and costs $57 each.



Since we are machining four parts from the blank, the material cost for each part would be $14.25. Additionally, the vacuum table permeable card stock needs to be in the calculation because it will be discarded after each four-piece run costing $2.86 each or .715 cents per part. We will also calculate the cost of the cutting tools over a month's production based on advice from DATRON's tooling experts. They calculated that $790 in tools would be a comfortable allowance required for a month's production for this part. We are also going to calculate the cost of the Ethanol used per part based on typical usage. There are no recycling or disposal costs as the Ethanol evaporates. For one month's production, $380 of Ethanol will be required.

Step Seven

Downtime

In a perfect world, you would machine parts all day without interruptions. As we all know, there are obstacles that get in the way to making this the case.

Machines require downtime to do maintenance, replace worn out cutting tools or troubleshoot unexpected issues with the equipment. Machining centers that use flood water-based oil coolants often require weekly maintenance and downtime to maintain those systems.

Typically, a 15% - 20% downtime is a safe percentage for most CNC machines that should be factored in your throughput.

For our example of a **DATRON neo**, it does not have flood cooling and does not require any time-consuming weekly maintenance. Because the work envelope and vacuum table can run multiple parts at a time, the operator can run an extra job at the end of the day and produce another four parts or 16% more production beyond the 8-hour daily shift. This extra production negates any budgeted downtime required. We will still base our throughput on 24 parts per day even though we will produce 28 parts. Therefore, the anticipated downtime will average the throughput of 24 parts per day over the month.

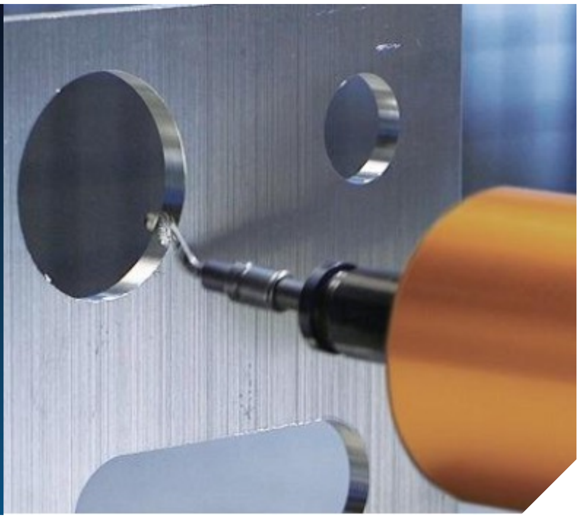
Step Eight

Secondary Operations

At this point, we have calculated everything regarding machining your parts. Now we must consider other factors contributing to your overall costs to produce the parts.

Secondary operations are procedures required to have your part deemed acceptable or finished. For example, you might have to consider the part with a 'paint ready' finish, so deburring edges and removing oils is necessary. You might require the part to be inspected by your quality control department. These extra steps can be required before it is deemed a finished part. In the case of painted finishes, degreasing is often required to remove the cutting oils. In some instances, these secondary operations can be performed by the machine operator while the machine is running, but you will need to account for the labor in your calculation. Depending on the part design or level of extra operations required, you must factor in extra time required to meet the 'finished part' status. It needs to be in a comparable state to how you would receive parts from an outsourced supplier.

In the case of the **DATRON neo**, we are not going to factor in any extra time. The reason for this is the oilless coolant requires no degreasing operations. Also, the edges are basically burr free and require no deburring because of the tooling we are using from DATRON.



The tolerances required are much less than what the machine requires, so no extra time for measuring is required. A caliper and measuring pin spot-check by the machine operator, every other cycle start, should suffice and can be easily absorbed in our conservative two-hour labor calculation. Therefore, the parts coming off the machine should be deemed a finished part.

Step Nine

Energy Costs

Depending on your equipment, costs can vary greatly to power them. A larger vertical machining center with massive weight and high torque spindles requires a lot of energy to operate them.

You should be able to obtain the power consumption of your machine from the machine specifications. Calculate the power to operate the machine based on your chip-to-chip, hourly, weekly, or monthly throughput. Now multiply this by your kwatt per hour cost.

https://www.youtube.com/watch?v=aF04QRs6-Uc

> In our example of the **DATRON neo**, we will calculate the electrical costs based on the machine running continuously for 8 hours. We determined the energy consumption is 1.3 kwatts per hour (see the video link below on how the calculation was achieved). Taking a rate of 30 cents per kwatt per hour calculates to 39 cents per hour, $3.12 per shift, or $68.64 per month (based on 22 production days). This seems relatively insignificant, but with much larger and heavier equipment, this cost can be substantial and therefore needs to be considered.

Step Ten

Maintenance Costs

The final cost calculation is for worn parts or general break-fix components required to maintain your equipment. Even though you will write the equipment off over the ROI term, you will likely need to invest additional funds to keep the equipment operating over this period. Consult with the company you are purchasing your equipment from, as they should be able to provide you with an estimated operational cost per year.

In some cases, machine sellers offer annual service agreements outside of warranty periods. This will give you an established and safe rate on your fixed operating cost for any potential break-fix service or component replacements. If you are purchasing new and reputable equipment, the servicing cost of your equipment should be much lower.

In the case of the **DATRON neo** example, we will factor in the cost of replacing the spindle bearings two times over the 4-year term. With high-speed spindles, ceramic bearings wear out faster compared to larger higher horsepower spindles. Think of it as tires that will wear out faster on a formula one car compared to a passenger vehicle. Typically, this extra cost is easily made up with the higher throughput of machining. We will also factor in the estimated cost of potential part replacements.

Compared to other traditional machine tools, almost all the neo components are plug-and-play and can be serviced by the customer. This keeps the costs down as it does not require the expense of a service technician to visit your facility to replace any mechanical or electronic parts. We are going to factor $500 per month or $6,000 per year to cover any worn components and spindle bearing replacements.

Maintenance Costs

Totaling Up Our Results of our Example ROI

(the following calculations are based values at the time of this article dated July 2023)

1. **Machine cost:** $3,124 monthly lease payment ($149,952 total cost over for 4 years)
2. **Throughput:** 528 parts per month (24 parts per day x 22 production days in a month)
3. **Commissioning and Facility Preparation:** $1,000 one-time cost (20.84 per month x 48)
4. **Work Holding and Programming:** $0 (covered in the machine cost)
5. **Labor:** $240 per day or $5,280 per month ($253,440 over 4 years)
6. **Materials and Consumables:**
    a. **Aluminum:** $14.25 material per part / 528 parts per month = $7,524
    b. **Vacuum Substrate:** .715 per part / 528 parts per month = $376
    c. **Cutting Tools:** $790 per month
    d. **Ethanol:** $380 per month

    Totals: $9,070 per month ($435,360 over 4 years)

7. **Downtime:** $0 (because of the extra production beyond the daily shift)
8. **Secondary Finishing:** $0 (the machined parts are oil and burr free)
9. **Energy Costs:** $68.64 per month ($3,295 per year)
10. **Maintenance Costs:** $500 per month

Total Monthly Cost: $18,063.48
Cost per Part: $34.21 ($18,063.48 divided by 528 parts)
Total Investment Cost Over the 48 Month Lease: $867,047 ($18,063.48 x 48)

Maintenance Costs

ROI Compared to Outsourcing

If you take the $132.46 cost per part quoted by the job shop and add $.20 per part to cover the cost of the fixture (meaning it would last about 10,000 parts before replacement) totals $132.66 per part. Your cost per part of $34.21 means you will save $98.45 per part by not outsourcing and machining it internally.

Total Investment Over 4 Years = $867,047 / $98.45 savings per part = 8,806 parts to breakeven.

Producing 8,806 parts to break even at a pace of 528 parts per month equals to approximately 16.5 months of production to break even.

An Alternative ROI Example: Manufacturing the Parts for Sale

As an alternative ROI, let's assume we are going to sell the parts for slightly under the competitive job shop quote at $125. So, with a part cost is $34.21 you would be netting $90.79 of profit per part.

Total Machine Investment of $867,047 divided by $90.79 per part profit = 9,550 parts would pay the investment. Based on 528 parts per month, the return on investment in this scenario would be approximately 18 months to breakeven.

Conclusions

You can easily conclude that this is a low-risk investment for an OEM manufacturer compared to the cost of outsourcing parts, if you have a steady volume of production parts over an 18-month period. You can see outsourcing is more applicable for a small volume production run.

For job shops, the investment would also pay for itself in approximately 18 months. So, if the machine was only running half of the time, it would still be a safe investment to purchase with this 48-month neo-ROI calculation. The machine operating at 38% capacity, one-shift per day, would cover the investment over the 4-year lease period.

If you are still on the fence about making your decision, there is still one more thing to consider; Everything produced after the 48-month lease period would have a significant increase in profit without the lease payment factored into the cost. This could either give you more room for competitive pricing or achieve even a greater profit margin on your parts beyond the lease period.

We trust this article has helped you build an ROI case and solidified a confident decision.