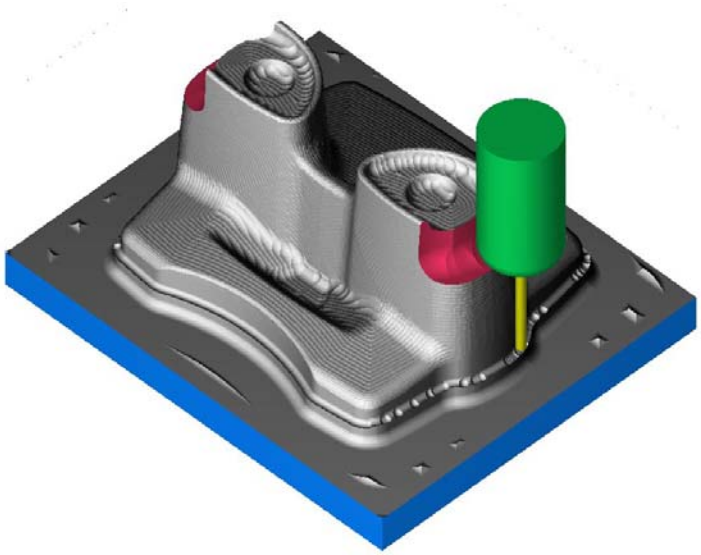
Predator Virtual CNC™ - White Paper

Features and benefits of CNC verification and simulation

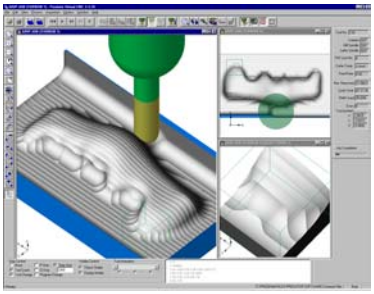
Abstract

This document outlines the benefit of using Predator Virtual CNC. Predator Virtual CNC can be customized to address the unique requirements of each manufacturer with an off the shelf shrink-wrapped software-based solution. Predator Virtual CNC runs stand alone or integrated with Predator Desktop™. Predator Virtual CNC is a member of a suite of applications all designed to share data and resources. They all share a common design and philosophy with Predator's unique understanding of manufacturing processes.

This document is based on features in Predator Virtual CNC v3.4.107



Predator Virtual CNC



What is Predator Virtual CNC?

Predator Virtual CNC is a software application that simulates a CNC controller and proves out CNC manufacturing processes offline. Predator Virtual CNC starts by processing actual CNC programs through your machine, tooling, stock and fixture definitions, and it identifies problems in the manufacturing process. With the motto "Verify your CNC process before making scrap." Predator Virtual CNC helps improve the manufacturing process by reducing or eliminating scrapped parts, broken tools, damaged CNC machines, first article setups, programming errors, and wasted time.

CAM systems have proven that for most applications CNC programming is best-performed offline on PCs. Predator Virtual CNC takes this principal to the logical next step by simulating a CNC offline on any Windows® based PC.

Predator Virtual CNC allows for an unlimited number of virtual dry runs, part inspections and "what if" style process improvements to CNC programming, tooling and fixturing. Once the correct virtual first article part is "manufactured," setup sheets can be printed, the job can be released to the shop floor and real world production can begin.

Predator Virtual CNC answers the following tough questions:

- Verify is it the toolpath or the CNC?
- Will the CNC run without scrapping, crashing or gouging the part, machine table or fixtures?
- Are the correct tools being used?
- Are the machine's offsets set correctly?
- Will the part run correctly within the machine's capacity?
- Will any tools break during the machining process?
- Are the CNC programs edited and formatted correctly?
- Will parametric or custom macro programming work?
- Are the CNC programming standards being upheld?
- What will the actual cycle time be?
- How much material is removed?
- What if operations are spread across multiple machines?
- Why do setup off-line?
- How will setup sheets get made?

Consistent and dependable answers to the above can be yours if Predator Virtual CNC is properly used prior to releasing jobs to the shop floor. Solving problems offline before they hit the shop floor increases productivity for every manufacturer.

Within this white paper we also answer the following frequently asked questions:

- Who uses Predator Virtual CNC?
- What do first article setups or prove outs cost per year?

Verify is it the toolpath or the CNC?

Predator Virtual CNC provides two verification methods. Toolpath simulation and verification processes a CAM systems toolpaths while CNC simulation and verification processes the actual CNC programs. Each method answers specific questions and identifies critical problems.

Toolpath Simulation and Verification

Toolpath simulation and verification insures that the correct toolpath methods are used to derive the correct part for manufacturing. For example:

- How much material is being removed by each tool
- Is the spot drilling depths deep enough
- Will roughing passes leave uncut material when stepover distances are too great
- Are too many finishing passes being used
- How big of a chamfer is the chamfer tool really making
- What really happens when tool diameters and stock to leave values are "fudged" in the CAM system

Toolpath style simulation and verification include direct support for the following CAM systems:

- Mastercam™ via NCI and a Predator C Hook for Virtual CNC
- Pathtrace™ via APTCL
- Surfcam™ via INC, APTCL and Surfcam Verify Plus
- Unigraphics™ via APTCL

Additional toolpath simulation and verification with other CAM systems are supported with a user configurable APTCL reverse post processor.

CNC Simulation and Verification

CNC simulation and verification proves outs the actual prove out or first article setup by taking into account fixtures, machine offsets, actual CNC programs and CNC behavior with support for custom macro programming, manual programming, edited programs, and post processor issues. For a complete list of benefits, refer to this white paper.

CNC style simulation and verification includes direct support for the following CNC controls:

Turning:

- Anailam GXL
- EIA 274
- Fagor 800T
- Fanuc 6T, 11TA and 0T
- GE 550
- Haas SL
- Hardinge CNCII

- Hitachi
- Mazak T32 and T Plus
- Meldas 5100C

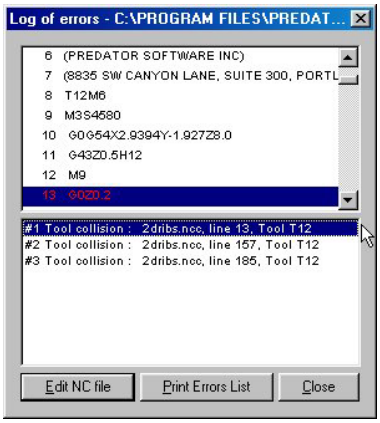
Milling:

- Boss 4, 5 and 6
- Bostomatic
- Dynapath
- EIA 274
- Fadal CNC88 and 32MP
- Fagor 800M and 8050
- Fanuc 10MA, 11MA, 12MA, 16MA, 18MA and 0MA
- Haas VB and VF
- Heidenhain ISO and Conversational TNC 410, 426 and 430
- Hurco Ultimax II
- Maho CNC 432
- Mazak EIA
- MDSI Open CNC
- Siemens Sinumerik 8M
- Toshiba Tosnuc
- Vickers 2100
- Yasnac

Predator Virtual CNC includes support for 150 direct CNC translators and 100 user configurable reverse posts. Reverse posts can be configured to support your standards and CNC specifics. Your local reseller and Predator Software both provide customization and training services. The above examples are just a sample of some of the 250 CNC translators and reverse post processors that are included with every license of Predator Virtual CNC.

How does Predator Virtual CNC reduce scrap?

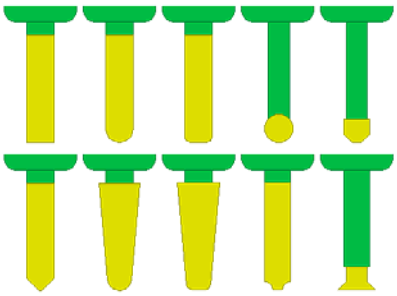
By simulating the entire CNC machining process offline, even multiple operations across multiple machines, Predator Virtual CNC catches mistakes in the CNC process that typically get caught during initial setup and first article runs. Depending on the number of scrapped parts and the cost of materials, Predator Virtual CNC's return on investment is often measured in weeks.



How does Predator Virtual CNC reduce machine crashes?

Every G- and M-code within every line of every CNC program per CNC machine is processed against a set of stock, table, pallet, and fixture components. Automatic tool, tool shank and tool holder collision detects machine crashes as subtle as 50 millionths. Common culprits include rapid moves through the stock or fixtures, forgotten appropriate G- and M-codes, incorrect program logic, incorrect offset usage, and incorrect tooling or machine selection. CNC machine crashes often occur when subtle mistakes are made. Whether the mistake is subtle or obvious Predator Virtual CNC double checks every potential issue and reports every problem. When Predator Virtual CNC identifies a problem it also reports which line of code within which CNC program and the current tool number. There is also a live link to the Predator CNC Editor™ so changes to the CNC program can be made quickly and easily.

Are the correct tools being used?



Many tooling problems are identified during the CNC programming and first article prove out process. Predator Virtual CNC can be used by both CNC programmers and lead setup personnel to identify the correct set of tools for every job.

Predator Virtual CNC provides a comprehensive tool, tool shank and tool holder definition. Ten standard milling tool shapes along with custom tool shapes, shanks and holders insure that accurate tool definitions are maintained.

Six standard turning tool shapes along with custom tool shapes, shanks and holders insure that accurate tool definitions are maintained. 1,100 standard tools, tool libraries and tool kits for specific machines or family of parts simplify the verification process so that it is used consistently on every job.

During the verification process every G- and M-code within every line of every CNC program is processed to continuously update the tool's position in relation to the part and fixture. If at any time a cut or tool motion that requires more flute length, could break a tool, or could cause a holder collision Predator Virtual CNC identifies the specific block of code.

Are machine offsets being used correctly?

Just like a CNC control, Predator Virtual CNC maintains a complete set of fixture, diameter and length offsets. Fixture offset support includes both G54 style and G54.1 styles. G10 style fixture offset values within your CNC program are also supported by Predator Virtual CNC. Multiple parts with multiple offsets can be quickly verified with Predator Virtual CNC.

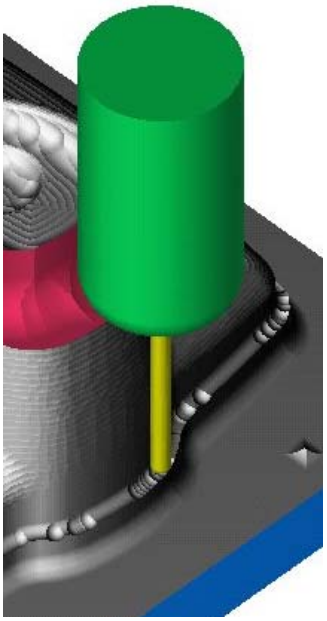
Diameter offset and cutter compensation support includes both tool wear and part edge style programming. Finally, length offsets and length compensation support are also included.

Will the part run correctly within the machine's capacity?

Predator Virtual CNC verifies that the machine's travel limits for all linear and rotary axis are not exceeded by the CNC program.

In addition, Predator Virtual CNC verifies that the machine's maximum feed rates and spindles speeds are not exceeded.

All machine parameters are stored in a machine library.



Will any of the tools break during the machining process?

Within every job, Predator Virtual CNC maintains a complete set of tooling details and usage.

During the verification process every G- and M-code within every line of every CNC program is processed to continuously update the tool's position in relation to the part and fixture. Predator Virtual CNC can catch tool breakage caused by using tools that require more flute length, improper rapid motion, or cause a holder or fixture collision. When Predator Virtual CNC identifies a problem it also reports which line of code within which CNC program and the current tool number.

Predator Virtual CNC can also catch tool breakage situations when the machine's maximum feed rates or maximum spindle speeds are exceeded. In addition, Predator Virtual CNC can catch tool breakage problems caused by improper tool compensation usage with an option to enforce their usage.

Finally, tool breakage due to a lack of coolant or spindle rotation, can also be enforced during the material removal process.

Are my CNC programs edited and formatted correctly?

For CNC programmers, machinists, or operators that program manually program or edit existing programs, Predator Virtual CNC verifies the syntax, modality, and usage of the G- and M-codes used within the CNC program. Leading and trailing zero problems, exceeding CNC maximums for variables, nested subs, parameter passing, and logic problems with custom macro branching and looping. Even illegal or improper G- and M-codes and combinations of codes are detected and reported.

Finally, Predator Virtual CNC verifies each R, I, J and K values to insure that they are within circular, spiral and helical tolerances.

```
N7M1(11.50 DRILL)
M6T7
M68#2=0
WHILE[#2LE270]DO1
G65P#598B#2Z10.0H7
G0G90G54.1P2
M98P8805
WHILE[#1EQ1.]DO2
X56.0Y56.0S5535M3
G43Z6.45H7M8
G81G98Z-32.0R3.5F1384
G80
#1=0
END2
#2=#2+90
END1
```

Will parametric or custom macro programmming work?

Typically parametric or custom macro programming logic could only be proved out at the CNC. With Predator Virtual CNC parametric and custom macro programming can now be proven offline on a PC. Predator Virtual CNC includes full support for variables, math functions, looping and branching. Syntax checking and illegal or improper G- and M-codes and combinations of codes are detected and reported.

An unlimited number of family of parts can be virtually built by simply changing the appropriate variables within the CNC program and running them through Predator Virtual CNC.

Finally, Predator Virtual CNC includes a “digital readout” of the tool position and feature based inspection to insure that the desired part, part size, and shape will be made.

Are my CNC programming standards being upheld?

Predator Virtual CNC verifies that preferred programming standards, styles and rules are enforced. For example:

- All subroutines must follow the main program
- Fixture offsets must be used
- Diameter compensation is required but length compensation is optional
- Subroutines and sub programs must be nested only two levels deep
- Variables and expressions should only be used for feed rates and rotary axis motion
- Only certain canned cycles or G- and M- codes should be used
- Use of coolant M-codes are required
- I, J and K values must be specified with every G2 and G3 even though they are modal

These programming standards are stored in a library and can be shared over a network for multiple users.

What will the actual cycle time be?

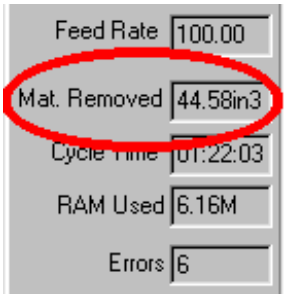
Predator Virtual CNC provides a robust machine definition with an emphasis on calculating accurate cycle times. Every major machine behavior or component that can affect a part’s cycle time is stored in it’s definition. Predator Virtual CNC simulates every time related CNC process and calculates an extremely accurate cycle time in real-time block by block. Typical cycle time calculations are based on theoretical CNC performance. Predator Virtual CNC’s cycle times are extremely accurate because of the realistic simulation and level of detail. For example:

- Linear and rotary motion with independent axis acceleration and decceleration
- Feed per minute, feed per revolution and inverse time feed rates
- Actual rapid feed rates with independent axis rates and optional dog leg motion

- Tool change and home position distances and delays
- Canned cycles for hole operations including pecking, lathe roughing cycles and threading cycles
- Fixture, diameter and length compensation
- Subroutines and sub programs
- Custom Macro style programming with looping, variables and math operations
- Airblast time and dwells
- Part loading and unloading
- Pallet change time
- Clamp and unclamp time
- Program stop and end time
- Linear overrides, canned cycle overrides and an overall override

Finally, Predator Virtual CNC provides linear overrides, canned cycle overrides and an overall override to allow for machine wear and tear, age and any other factor that can affect a machine's performance.

Predator Virtual CNC's accurate cycle times allow for an unlimited number of what if scenarios to be tried to optimize the cycle times for long production runs.



How much material will be removed?

Predator Virtual CNC calculates the actual amount of material removed by any tool shape in real-time block by block on any CNC machine. Typical material removed calculations are estimates based on simple methods. Predator Virtual CNC's material removal values are extremely accurate because of our solid modeling engine and boolean subtraction calculations.

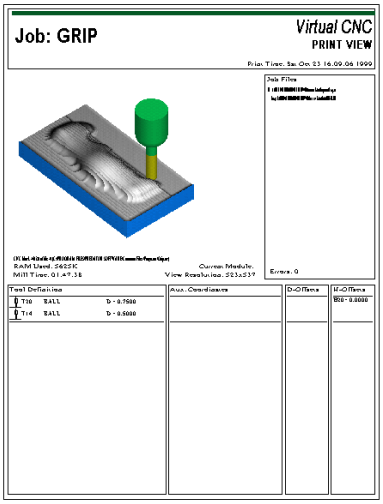
Using one of the many stop options you can easily identify the amount of material removed for each tool, program or setup.

With our multiple operations feature material removal calculations are support across multiple CNC programs and CNC machines.

What if operations are spread across multiple CNC machines?

Predator Virtual CNC provides an easy method of creating a job that can contain up to 128 different operations with the option of having each run on the same machine or across multiple machines. In process stock is automatically transferred between each operation. Optional in process stock rotations will automatically rotate the stock from a horizontal to a vertical machining center or rotate a lathe part to allow both ends of the cylindrical stock to be machined. There is no limit to the sequence of machine type so the first operation could be a turning center, the next operation could be a vertical machining center and the final operation could be horizontal machining center.

Using one of the many stop options you can also include manual operations for repositioning the work piece or manual indexing.



Why do off-line setup?

Off-line setup is a tremendous boost to a manufacturer's productivity. Manufacturer's make money when their machines are making parts. Setup time is downtime and minimizing setup time directly translates into increased profitability.

Setup time at the CNC typically requires multiple prove-outs before getting it right. Predator Virtual CNC simulates first article setup and the prove out process offline with the ability to test and confirm tooling, stock, fixtures, CNC programs, offsets and machining processes with a level of detail that is equivalent to running an actual CNC machine on a Windows based PC.

Virtual scrapped parts, broken tools, machine crashes and other issues can be interactively identified and resolved. Virtual first article parts can be measured and analyzed until confidence is built off-line. With two mouse clicks a graphical setup sheet can be printed with an appropriate amount of details to facilitate a quick setup with the correct part being manufacturing the first time.

How will setup sheets get made?

Predator Virtual CNC offers three choices for setup sheets. The first provides a setup sheet with a standard layout intended to be printed on a color or black and white printer.

The second choice is user configurable and HTML based that can provide multiple before and after JPEG graphics per tool or per CNC program. These can be printed but are designed for interactive use by the shop floor in a true paperless enviroment by integrating Predator Desktop or compatible browser.

The final choice is to create custom setup sheets with a third party application such as Word, Excel or a Desktop publishing application while relying on Predator Virtual CNC for statistical and graphical details. Predator Virtual CNC provides complete machining statistics in ASCII files and graphic images are stored in an industry standard JPEG format. In addition, any machined image can be copied to the clipboard and pasted into any application with a few mouse clicks.

With any choice, you will have the confidence of knowing that your setup sheets are based on running your actual CNC programs, not toolpaths, on your CNC machines off-line with Predator Virtual CNC.

Who uses Predator Virtual CNC?

Predator Virtual CNC is used by thousands of manufacturing engineers, CNC programmers, CNC operators, CAM developers, post processor developers, students and educators worldwide.

What does first article setups or prove outs cost per year?

Estimating the amount of money Predator Virtual CNC can save can be calculated by identifying the following:

Number of new or modified CNC programs per month x _____

Average number of first article setups or prove outs x _____

Average time per first article setup or prove out x _____

Hourly machine rate x _____

Monthly Cost = _____

Yearly Cost x 12 _____

Cost of scrapped parts, broken tooling, etc x 50% _____

Total Costs include: Yearly cost + above _____

For example:

8 New or modified CNC programs per month

x 2 Prove outs per CNC program

x 4 Hours per first article or prove out

x $100 Hourly machine rate

= $6,400 per month or $76,800 per year

Consider scrapped parts, broken tooling, damaged fixtures, extra machine maintenance and estimate 50% of the above costs. In our example, that is another $38,400 for a grand total of $115,200 per year and a ROI that is measured in weeks.

For more information

For the latest information on Predator Virtual CNC, check our web site at http://www.predator-software.com