





MAL MANUFACTURING AUTOMATION

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NPRO Help File







Contents

1. Getting Started	3
1.1 What is NPRO?	4
1.2 License Information	4
1.3 System Requirements	4
2. User Interface Overview	5
2.1 Dashboard: Main Window	8
2.1.1 Stock Material Selection	9
2.1.2 Machine Spacification	11
2.1.3 Main Window	12
2.2 Actions Menu	13
2.3 Results	14
3.0 Settings	14
3.1 Feed Optimization	16
3.2Cutting Simulation	
3.3 Equipment Settings	
3.4 Advanced	19
4.0 Results	20





1. Getting Started

Introduction



Npro is the most advanced physics based process simulation and NC program optimization NX plug-in available.

Unlike geometry and post-process based solutions, Npro allows process planners to visualize, simulate, and optimize NC tool paths directly in NX.

For this reason, Npro is the ultimate machining optimization tool for process planners and NC programmers.





1.1 What is NPRO?



Npro is the most advanced physics based process simulation and NC program optimization NX plug-in available.

Unlike geometry and post-process based solutions, Npro allows process planners to visualize, simulate, and optimize NC tool paths directly in NX.

For this reason, Npro is the ultimate machining optimization tool for process planners and NC programmers.

1.2 License Information

To Be Announced

1.3 System Requirements

Required hardware and software:

- PC: PC with a Intel/AMD processor with a minimum of 2 cores at 2.8Ghz
- Operating System: Windows 7, 8 or later.
- Software: Siemens NX
- Video Card: Direct X 10.0 compatible VGA card.
- **Memory:** We recommend a minimum of 6GB of RAM, upwards to 16gb or even 32gb if the part size is • large.
- License: Will be provided when the software is purchased.



<u>2. User Interface Overview</u>

To access Npro, open a project and click on the Npro tab. Under the Npro tab, click on the **Analysis** button to access the main interface.



Npro's Analysis interface consists of three main sections:

- 1. **Dashboard**: The Main Window where you can set your simulation and optimization requirements
- 2. <u>Actions Menu</u>: Consists of Buttons which are used to control the Dashboard / Main Window
- 3. **<u>Results</u>**: Graphs indicating values which were Simulated/Optimized

Npro's Machine Manager is used to enter physical constraints of the machine:

ò	Mac	hine Sett	ings			່ s x
	Spindl	e				
1	Speed	[rpm]			7.00	000
	Power	[kW]			8.00	000
	Torque	[Nm]			9.00	000
	#	Speed	Power	Torque		*
						X
	<				>	
	Actio	ıs				^
	2					
				ОК	Can	cel





Spindle Speed [rpm] 7.0000 Power [kW] 8.0000 Torque [Nm] 9.0000 # Speed Power Torque 7 8 9 Add New Set <	O Machine Sett	ings		JX
Speed [rpm] 7.0000 Power [kW] 8.0000 Torque [Nm] 9.0000 # Speed Power Torque Add New Set 1 7 8 9 Add New Set Add New Set Add New Set	Spindle			
Power [kW] 8.0000 Torque [Nm] 9.0000 # Speed Power Torque Add New Set <	Speed [rpm]		7.0	0000
Torque [Nm] 9.0000 # Speed 1 7 8 9 Add New Set Add New Set Cancel	Power [kW]		8.0	0000
# Speed Power Torque 1 7 8 9 Add New Set Add New Set Cancel	Torque [Nm]		9.0	0000
Add New Set	# Speed	Power	Torque	*
Add New Set	1 7	8	9	
Actions A				Add New Set
Actions A	<		>	
	Actions			
	-		OK Ca	ncel

0	Mac	hine Setti	ngs			JX
ſ	Spindl	e				
:	Speed	[rpm]			7.00	000
	Power	[kW]			8.00	000
Ŀ	Torque	[Nm]			9.0	000
	#	Speed	Power	Torque		1
	1	7	8	9		
						Remove
	<	1	1	1	>	
	Actio	ns				^
	2					
				ок [Can	cel



Npro

The Advanced Settings area is used for setting up the sampling distance of Npro's engine calculations:

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	^
pling	
ОК	Cancel
	pling





Npro

2.1 Dashboard: Main Window

The Dashboard is the main window where you can set your simulation and optimization requirements:

achines\	MV-100	3 Vertical Ma	achining Cent	re.VMSMAC			
Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings	
		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
4		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
		Complete	N/A	N/A	N/A		
	Achines\I Opti 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	achines\MV-100 Opti Simu Opti Simu	Copti Simu Status Opti Simu Status Image: Simu Status Image: Simu Status Image: Simu Image: Simu Complete Complete Image: Simu Image: Simu Complete Complete Image: Simu Image: Simu Complete Simu Simu Image: Simu Image: Simu Image: Simu Simu Simu Simu Image: Simu Image: Simu Image: Simu Image: Simu <	Opti Simu Status Ref Time Opti Simu Status Ref Time Image:	Opti Simu Status Ref Time Opt Time 0pti Simu Status Ref Time Opt Time 0 Image: Complete N/A N/A 1 Image: Complete N/A Image: Complete 1 Image: Complete N/A <t< td=""><td>Achines\MV-1003 Vertical Machining Centre.VMSMAC Opti Simu Status Ref Time Opt Time Prod % Image: I</td><td>Opti Simu Status Ref Time Opt Time Prod % Settings Image: Image:</td></t<>	Achines\MV-1003 Vertical Machining Centre.VMSMAC Opti Simu Status Ref Time Opt Time Prod % Image: I	Opti Simu Status Ref Time Opt Time Prod % Settings Image:



Npro

2.1.1 Stock Material Selection

Npro has **20**+ commonly used materials available in it's database. If your material is not available, please <u>contact us</u>.

tock Material				Aluminum	7075-T6		
Aachine Specification :							
D:\Documents\MACHproVT\Ma	chines\/	MV-100	3 Vertical Ma	chining Cent	e.VMSMAC		
Name	Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings
Operations							
🖻 📴 PROGRAM_TOP							
📴 ROUGH_TOP			Complete	N/A	N/A	N/A	
UL PROFILE_LEVEL 1			Complete	N/A	N/A	N/A	
UL PROFILE_LEVEL2			Complete	N/A	N/A	N/A	
LE SLOT_TOP			Complete	N/A	N/A	N/A	
E PROGRAM_BOTTOM							
			Complete	N/A	N/A	N/A	
陆 SLOT_MILL_BOTTOM			Complete	N/A	N/A	N/A	
POCKET_BOTTOM			Complete	N/A	N/A	N/A	
E PROGRAM_SIDE1							
E ROUGH_CORNER_S			Complete	N/A	N/A	N/A	
🖻 📴 PROGRAM_SIDE2							
E ROUGH_CORNER_S			Complete	N/A	N/A	N/A	
G OPT_MACHPRO							
ctions							
	Sin	nu ON	Settings			Run	
		nu. ON	J settings	儿		Kull	

Materials Available:

- 1. Aluminum 7075-T6
- 2. Aluminum 356.0-T6
- 3. AISI P20 Mold Steel
- 4. Aluminum 705i-T74
- 5. AISI 4340 StSel





- 6. Aluminum 7050-T7451 Low Speed V<200 m/min
- 7. Aluminum 7050-T7451
- 8. Titanium lloy Ti6Al4V (Orthogonal to Oblique)
- 9. AISI P20 Steel Ballend mill calibrated with axial depth of 0.05in
- 10. NRC MDF
- 11. CAST Iron C450
- 12. Gray Cast Iron
- 13. Titanium Alloy Ti6AL4V (Average)
- 14. AISI P20 Steel Ballend mill a=0.065in
- 15. Inconel 718
- 16. Inconel 625
- 17. Niobium
- 18. Thermo-Span Superalloy
- 19. Alumiuum 6061-T6
- 20. Waspaloy
- 21. AISI 630 Steel
- 22. AISI 1050 Steel
- 23. Aluminum 319.0-T6
- 24. Alumec 89



Npro

2.1.2 Machine Spacification

Npro uses the machine's specifications as part of its simulation/optimization criteria. To define a machine, please refer to section '2.0 User Interface'.

Once a machine's specifications have been entered you may select the machine from the **Dashboard**:

tock Material				Aluminum	7075-T6			
achine Specification :								
D:\Documents\MACHproVT\Mac	hines\N	√V-100	3 Vertical Ma	chining Centr	e.VMSMAC			
Name	Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings	
∃. Operations							-	
PROGRAM_TOP								
- E ROUGH_TOP			Complete	N/A	N/A	N/A		
PROFILE_LEVEL1			Complete	N/A	N/A	N/A		
PROFILE_LEVEL2			Complete	N/A	N/A	N/A		
L SLOT_TOP			Complete	N/A	N/A	N/A		
🖻 📴 PROGRAM_BOTTOM								
			Complete	N/A	N/A	N/A		
💾 SLOT_MILL_BOTTOM			Complete	N/A	N/A	N/A		
POCKET_BOTTOM			Complete	N/A	N/A	N/A		
🖻 📴 PROGRAM_SIDE1								
💾 ROUGH_CORNER_S			Complete	N/A	N/A	N/A		
🖻 🛅 PROGRAM_SIDE2								
E ROUGH_CORNER_S			Complete	N/A	N/A	N/A		
tions								
All ON All OFF Opti. ON	Sin	nu. ON	Settings			Run		



2.1.3 Main Window

Npro's main window displays the general process simulation & optimization information of the

tock Material				Aluminum	7075-T6			-			
Aachine Specification											
D:\Documents\MACHproVT\Machines\MV-1003 Vertical Machining Centre.VMSMAC											
Name	Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings	-			
Operations											
E PROGRAM_TOP											
💾 ROUGH_TOP			Complete	N/A	N/A	N/A					
PROFILE_LEVEL1			Complete	N/A	N/A	N/A					
PROFILE_LEVEL2			Complete	N/A	N/A	N/A					
LE SLOT_TOP			Complete	N/A	N/A	N/A					
E PROGRAM_BOTTOM											
🕒 ROUGH_BOTTOM			Complete	N/A	N/A	N/A					
💾 SLOT_MILL_BOTTOM			Complete	N/A	N/A	N/A					
POCKET_BOTTOM			Complete	N/A	N/A	N/A					
PROGRAM_SIDE1											
ROUGH_CORNER_S			Complete	N/A	N/A	N/A					
PROGRAM_SIDE2											
ROUGH_CORNER_S			Complete	N/A	N/A	N/A					
OPT_MACHPRO											
ctions											
			Cattings			Dim		_			
AILON AILOFF JOPT. ON	J SIN	nu. ON	J Settings	1		ĸun					

project:

The columns used are described as follows:

- Namem The name of the program as set within NX.
 Opti: Displays a green check mark if optimization is enabled for the select program
- program/operation.
 Simu: Displays a green check mark if simulation is enabled for the select program
- program/operation.
- Status: Displays the status of the simulation/optimization results.
 Ref Time: Displays the current, non-optimized machining time for the select
- program/operation.
- **Opt Time:** Displays the new, optimized machining time for the select program/operation. **Prod %:** Displays the new increased/decreased production percentage. **Npro** will decrease
- productivity if incorrect feeds were originally entered.



• Settings: Displays a brief overview of the program settings.

2.2 Actions Menu

The Action Menu consists of the following buttons which are used to control the Dashboard / Main Window:

tock Material				Aluminum	7075-T6			
Achine Specification :								
D:\Documents\MACHproVT\Ma	chines\I	MV-100	3 Vertical Ma	chining Cent	re.VMSMAC			
Name	Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings	
□ Operations								
E PROGRAM_TOP								
陆 ROUGH_TOP			Complete	N/A	N/A	N/A		
🕒 PROFILE_LEVEL1			Complete	N/A	N/A	N/A		
PROFILE_LEVEL2			Complete	N/A	N/A	N/A		
LE SLOT_TOP			Complete	N/A	N/A	N/A		
E 📴 PROGRAM_BOTTOM								
🕒 ROUGH_BOTTOM			Complete	N/A	N/A	N/A		
💾 SLOT_MILL_BOTTOM			Complete	N/A	N/A	N/A		
POCKET_BOTTOM			Complete	N/A	N/A	N/A		
🖻 🛅 PROGRAM_SIDE1								
EROUGH_CORNER_S			Complete	N/A	N/A	N/A		
🖻 📴 PROGRAM_SIDE2								
ROUGH_CORNER_S			Complete	N/A	N/A	N/A		
OPT_MACHPRO								
ctions								
All ON All OFF Opti. ON	Sin	nu. ON	Settings			Run		
			л					

- > All ON: Turns on Simulation and Optimization for all program operations.
- > All OFF: Turns off Simulation and Optimization for all program operations.
- > Opti. ON/OFF: Tunns on/off Optimization from the selected operation.
- **Simu. ON/OFF:** Turns **on/off** Simulation from the selected operation.
- > Settings: Opens the settings window for the selected operation.
- **Run:** Runs simulation and/or optimization of all operations based on the user's selection.





2.3 Results

Npro's Results consist of two main areas:

- 1. Graphs showing simulation results and/or optimization results
- 2. New tool paths generated instantly with optimized feed rates

3.0 Settings

The Settings pop-up dialogue is used to edit simulation/operation constraints for the selected operation.

ې Settings ک
Feed Optimization
Constraints A
Maximum Chip Thickness (A01) 0.1 mm 💌
Spindle Torque and Power (A10)
Tool Bending Force (A04) 1000 N -
Settings A
Minimum Feed Change (B02) % 10
Air Cut Optimization (B03)
Extra Toolpath Segments (B04)
Status 🔥
Active
Cutting Simulation
Maximum Chip Thickness (C08)
Spindle Torque and Power (C05)
Tool Bending Force (C01)
Chatter Detection (C10)
Status A
Active
Equipment Settings V
Advanced A
Copy to all operations utilizing the same tool

OK Cancel



Npro

To access the settings of an operation, first click on the operation, and then click on settings. Alternatively, you may double-click the desired operation:

achine Specification :					07.5-10		
D:\Documents\MACHproVT\Ma	chines\/	4 √-100	3 Vertical Ma	chining Centr	e.VMSMAC]
Name	Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings
- Operations							
PROGRAM_TOP							
- EROUGH_TOP			Complete	N/A	N/A	N/A	
PROFILE_LEVEL1			Complete	N/A	N/A	N/A	
📴 PROFILE_LEVEL2			Complete	N/A	N/A	N/A	
Let SLOT_TOP			Complete	N/A	N/A	N/A	
E PROGRAM_BOTTOM							
- 💾 ROUGH_BOTTOM			Complete	N/A	N/A	N/A	
💾 SLOT_MILL_BOTTOM			Complete	N/A	N/A	N/A	
POCKET_BOTTOM			Complete	N/A	N/A	N/A	
PROGRAM_SIDE1							
💾 ROUGH_CORNER_S			Complete	N/A	N/A	N/A	
PROGRAM_SIDE2							
💾 ROUGH_CORNER_S			Complete	N/A	N/A	N/A	
OPT_MACHPRO							
tions							
	Sin	nu ON	Settings	9		Run	

The Settings window is divided under four categories as follows:

- 3.1 Feed Optimization
- 3.2 Cutting Simulation
- 3.3 Equipment Settings
- 3.4 Advanced



3.1 Feed Optimization

The Feed Optimization dialogue is where the user sets physical constraints to the operation.

စ္ Settings ပ	X						
Feed Optimization	^						
Constraints A							
Maximum Chip Thickness (A01) 0.1 mm 💽							
Spindle Torque and Power (A10)							
Tool Bending Force (A04) 1000 N -							
Settings A							
Minimum Feed Change (B02) % 10							
Air Cut Optimization (B03)							
Extra Toolpath Segments (B04)							
Status 🔨							
Active							
Cutting Simulation	^						
Maximum Chip Thickness (C08)							
Spindle Torque and Power (C05)							
Tool Bending Force (C01)							
Chatter Detection (C10)							
Status A	•						
Active							
Equipment Settings	v						
Advanced	٨						
Copy to all operations utilizing the same tool							
~~~							
OK Cancel	]						

Maximum Chip Thickness (A01): Enter the upper limit for the chip thickness during machining

**Spindle Torque & Power (A10):** Uses the Torque/Power limits of the selected machine for simulation/optimization. If selected, the new tool path will not violate the machine's limits.

**Tool Bending Force (A04):** Enter the limit of the tool bending force, feeds will be adjusted with the tool bending limit in mind.

Minimum Feed Change % (B02): Enter a minimum limit on the feed change from the original tool path.

Air Cut Optimization (B03): Also optimizes air movements based on machine limits.

Extra Tool path Segments (B04): Splits/adds toolpath segments to acheive best optimization results. Status: Activates/Deactivates Feed

Optimization.



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# **3.2Cutting Simulation**

The Cutting Simulation dialogue is where the user enables/disables simulation of existing tool path operations.

ତ Settings ୍ତ୍ର ୦	X						
Feed Optimization	^						
Constraints A							
Maximum Chip Thickness (A01) 0.1 mm 💽							
Spindle Torque and Power (A10)							
Tool Bending Force (A04) 1000 N -							
Settings A	Ē						
Minimum Feed Change (B02) %							
Air Cut Optimization (B03)							
Extra Toolpath Segments (B04)							
Status A	Ē						
Active							
Cutting Simulation	^						
Maximum Chip Thickness (C08)							
Spindle Torque and Power (C05)							
Tool Bending Force (C01)							
Chatter Detection (C10)							
Status A							
Active							
Equipment Settings	v						
Advanced A							
Copy to all operations utilizing the same tool							
~~~							
OK Cancel)						

Maximum Chip Thickness (C08): Simulates the maximum chip thickness during machining

Spindle Torque & Power (C05): Simulates the variation in spindle torque and power during machining

Tool Bending Force (C01): Simulates the variation in tool bending forces during machining

Chatter Detection (C10): Detects chatter locations during machining (Requires tool flexibility data, refer to Equipment Settings)

Status: Activates/Deactivates Cutting Simulation.



3.3 Equipment Settings

The Equipment Settings dialogue is only enabled when Chatter Detection is Activated

ତ Settings ଧ୍ୟ										
Feed Optimization										
Constraints A										
Maximum Chip Thickness (A01) 0.1 mm 🗣										
Spindle Torque and Power (A10)										
Tool Bending Force (A04) 1000 N -										
Settings A										
Minimum Feed Change (B02) %										
Air Cut Optimization (B03)										
Extra Toolpath Segments (BO4)										
Status A										
Active										
Cutting Simulation										
Maximum Chip Thickness (C08)										
Spindle Torque and Power (C05)										
Tool Bending Force (C01)										
Chatter Detection (C10)										
Status A										
Active										
Fauinment Settings										
Dynamics										
X C:\Program Eiles (x86)\CutPro\Examples\Mo(
C. \rrogram Files (x80)\CutPro\Examples\Mo(
C:\Program Files (x86)\CutPro\Examples\Moc										
Advanced A										
Copy to all operations utilizing the same tool										
~~~										
OK Cancel										

- Chatter Detection (C10): Detects chatter locations during machining (Requires tool flexibility data)
- Dynamics X/Y: The Dynamics dialogue is where the user imports impact test (also known as a tap test) FRF results in*.CMP file format

For more details on impact testing, please refer to our website.

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# 3.4 Advanced

The Advanced window is used when the user wishes to **copy all simulation/optimize settings to other programs with the same tool number.** 

ତ Settings ଧ 🗙							
Feed Optimization							
Constraints A							
Maximum Chip Thickness (A01) 0.1 mm 💽							
Spindle Torque and Power (A10)							
✓ Tool Bending Force (A04) 1000 N -							
Settings A							
Minimum Feed Change (BO2) %							
Air Cut Optimization (B03)							
🛃 Extra Toolpath Segments (B04)							
Status A							
Active							
Cutting Simulation							
Maximum Chip Thickness (C08)							
Spindle Torque and Power (C05)							
Tool Bending Force (C01)							
Chatter Detection (CTO)							
Status							
Active							
Equipment Settings							
Dynamics A							
X C:\Program Files (x86)\CutPro\Examples\Mod							
C:\Program Files (x86)\CutPro\Examples\Moc							
Advanced							
Copy to all operations utilizing the same tool							
~ ~ ~ ~							
OK Cancel							





# 4.0 Results

Npro's Results consist of two main areas:

1. Graphs showing **simulation results** and **optimization results**, such as these, as an example:

#### Material Removal Rate







Feed Speed















#### Spindle Power





















# Chip Load







#### Axial Depth of Cut





#### Radial Depth Of Cut





#### Radial Depth of Cut/Daameter Ratio





#### Area of Material Removed





#### Energy Consumption







#### 2. New tool paths generated instantly with optimized feed rates:

# Increased (room for improvement)

ashboard									
Stock Material							Aluminum 7075-T6		
Machine Specification :									
D:\Documents\MACHproVT\Machines\SH-403 Horizontal Machining Centre (High Speed).VMSMAC									
Name	Opti	Simu	Status	Ref Time	Opt Time	Prod %	Settings		
Operations									
E TROGRAM_TOP									
陆 ROUGH_TOP			Complete	N/A	N/A	N/A			
			Complete	N/A	N/A	N/A			
🕒 PROFILE_LEVEL2			Complete	N/A	N/A	N/A			
Le SLOT_TOP	V		Complete	00:00:57	00:00:38	51.59 %	A01(0.1); A04(1000); A10; B02(10%); B03; C01; C05; C08		
E Ta PROGRAM_BOTTOM									
陆 ROUGH_BOTTOM			Complete	N/A	N/A	N/A			
陆 SLOT_MILL_BOTTOM			Complete	N/A	N/A	N/A			
POCKET_BOTTOM			Complete	N/A	N/A	N/A			
E I PROGRAM_SIDE1									
ROUGH_CORNER_S			Complete	N/A	N/A	N/A			
E PROGRAM_SIDE2									
ROUGH_CORNER_S			Complete	N/A	N/A	N/A			
<									
ctions									
All ON All OFF Opti. OFF	Sir	nu. OFF	Settings				Run		
<u>^</u> ^^									









#### Decreased (improper feed selection in original toolpath)

N-Pro (powered by Apps)	Pro)							<u>ວ x</u>		
Dashboard								^		
Stock Material Aluminum 7075-T6										
Machine Specification :										
D-\Documents\MACHproVT\Machines\SH-403 Horizontal Machining Centre (High Speed).VMSMAC										
Name Opti Simu Status Ref Time Opt Time Prod % Settings										
- Operations	- opti							^		
PROGRAM_TOP										
🕒 ROUGH_TOP	Image: A start of the start	1	Complete	00:05:51	00:41:53	-86.03 %	A01(0.1); A04(1000); A10; B02(10%); B03; C01; C05; C08	↓		
р <u></u>										
Actions A										
All ON All OFF Opti.	OFF Si	mu. OFF	Settings	][			Run			
						~ ~ ~				
								OK Cancel		
@ Operation Navigator Proc	aram Orde									
be operation Navigator - Prog	gram orde									
Name NC PROCRAM	Foolcha	nge								
INC_FROGRAM										
	18									
	13									
	13									
	18									
	10					_				
	18									
	13									
	18									
	13				4 YM					
	18				† 🏒					
	- 13									
						//				
					$\langle \rangle$					
NPRO_ROUGH_TOP										
				V . /						
				i 🔣						
				- <b></b>						
								X X		
			7							
<	1	>								
Dependencies		V								

These new tool paths will be generated under "NPRO_OPT" in the Operation Navigator.

The generated tool paths are color coded as follows:

Red: Rapid movements

Blue: Feedrate Optimized = Feedrate Original

Yellow: Feedrate Optimized < Feedrate Original (Decreased)

Green: Feedrate Optimized > Feedrate Original (Increased)