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# UGS

*Transforming the  
process of innovation*



## Case Studies in High Speed Milling

Edwin Gasparraj  
May, 2006



- ▶ Why HSM
- ▶ Requirements for HSM
- ▶ CAM Elements of HSM
  - ▶ Rate of Metal Removal
  - ▶ Amount of Material Left / Rest Milling
  - ▶ Tool Engagement in finishing
  - ▶ Smooth/Quality Tool Path
  - ▶ Machining Data
- ▶ Case Study 1 (Demo)
- ▶ Case Study 2 (Demo)
- ▶ Other Practical Tips for HSM



- ▶ Get the Parts out Faster
  - ▶ Minimize EDM work
  - ▶ Better Finish out of the machine
  - ▶ Minimize bench work
- ▶ Hardware
  - ▶ Longer tool Life
  - ▶ Longer machine Life



# Requirements for HSM



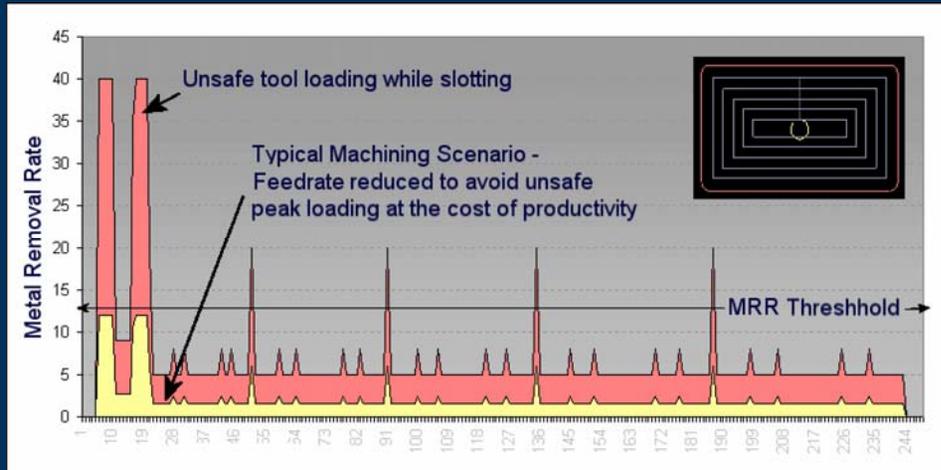
“It is only as good as the weakest link.”



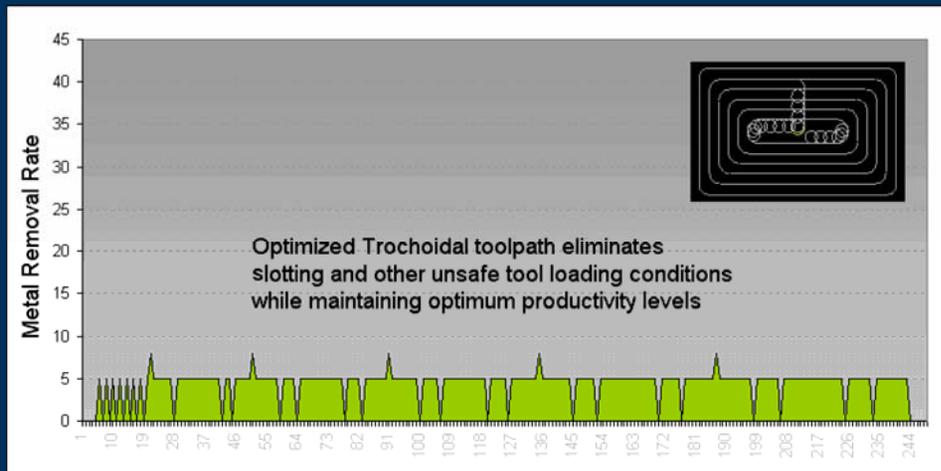
- ▶ Optimize the rate of metal removal.
- ▶ Precisely identify rest material.
- ▶ Leave uniform stock for smaller finishing tools.
- ▶ Manage tool engagement and tool deflection.
- ▶ Maintain and use accurate machining data.
- ▶ Better finish.
- ▶ Provide smooth tool path for the controller.



# Rate of Metal Removal

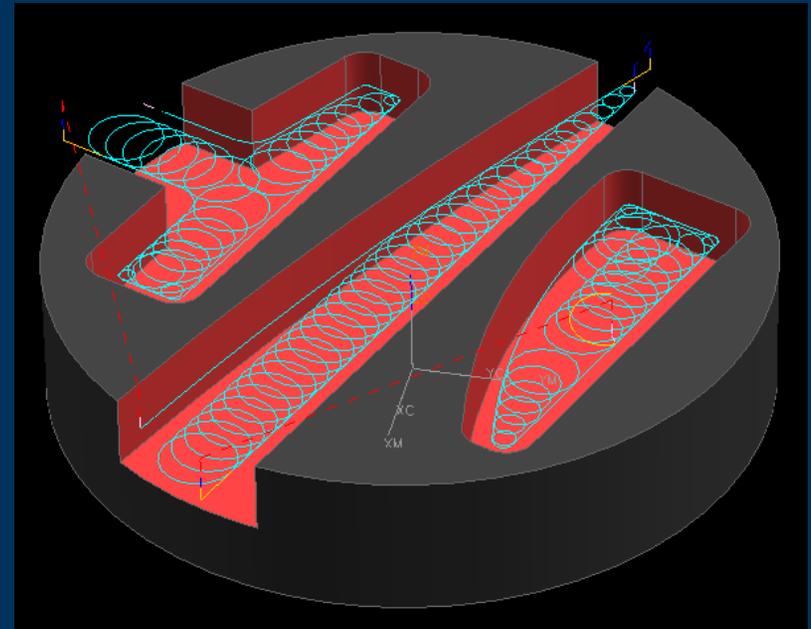
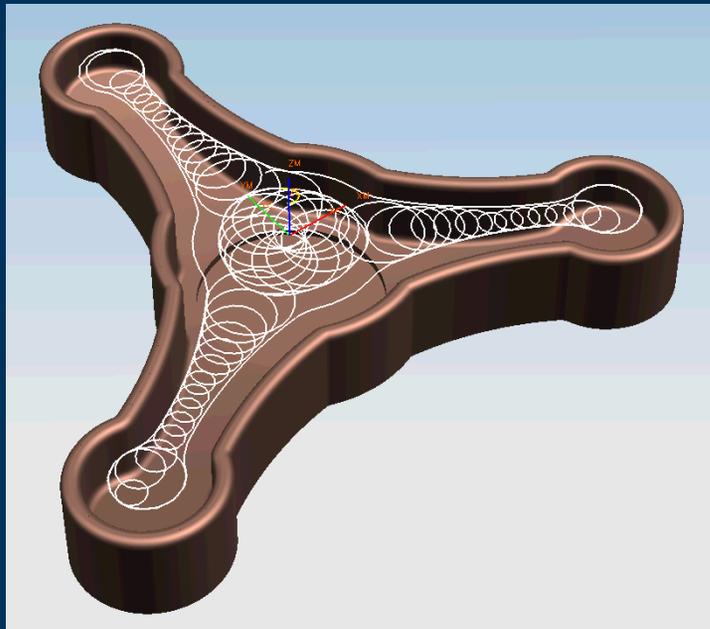


- ▶ MRR could peak 10 times at slots and corners.
- ▶ With traditional tool paths if you are not breaking tools, you are not cutting fast enough.





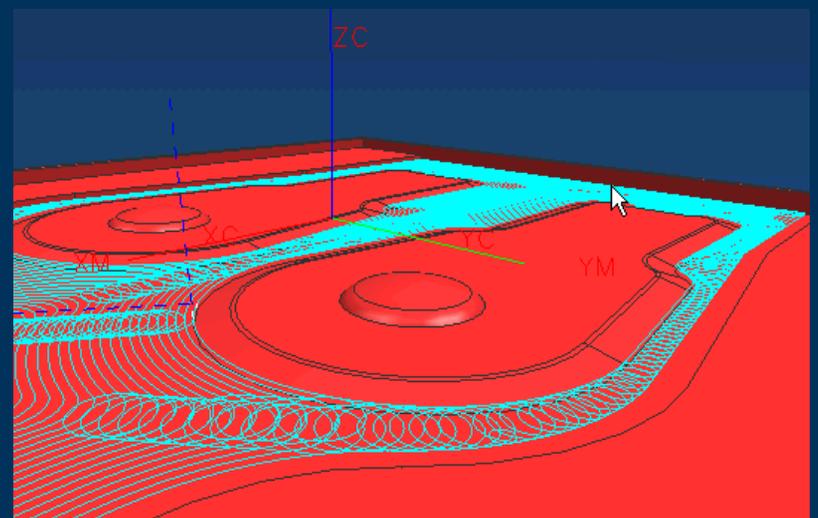
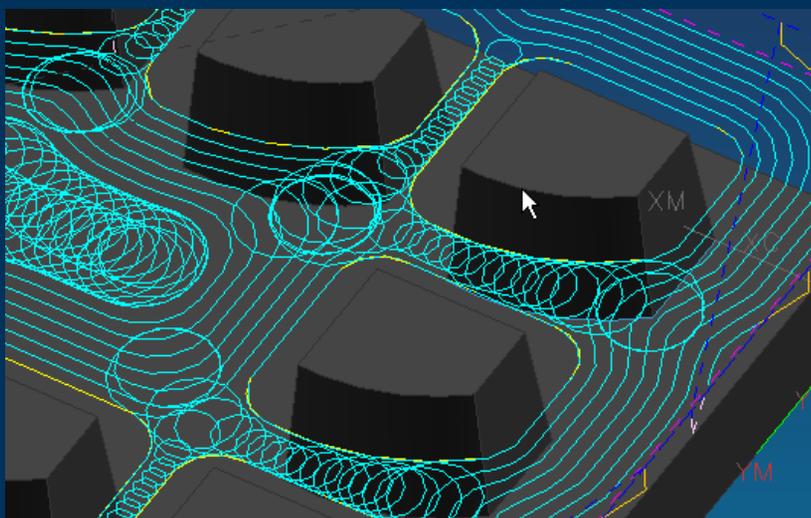
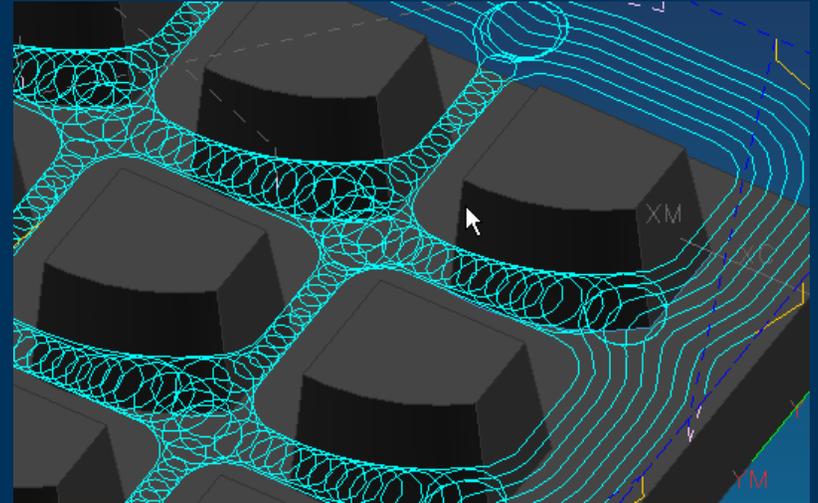
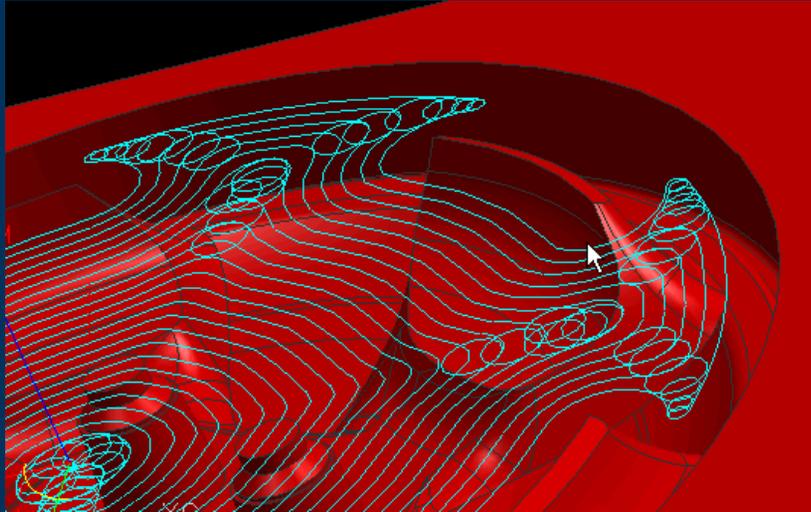
# Rate of Metal Removal

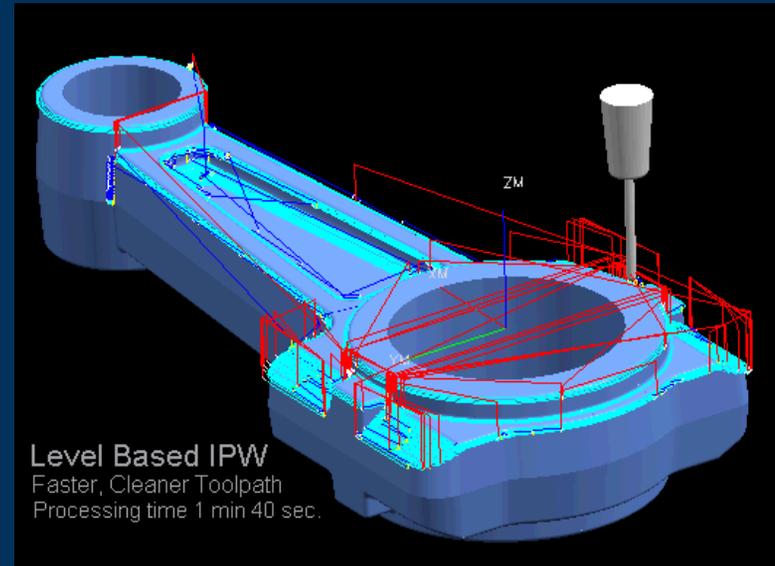
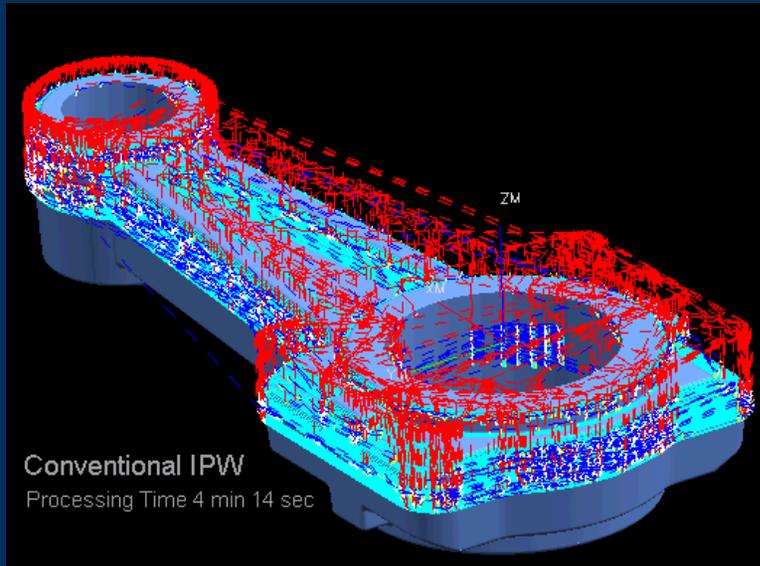


Self adjusting loops fit into narrow channels and corners to avoid tool embedding.

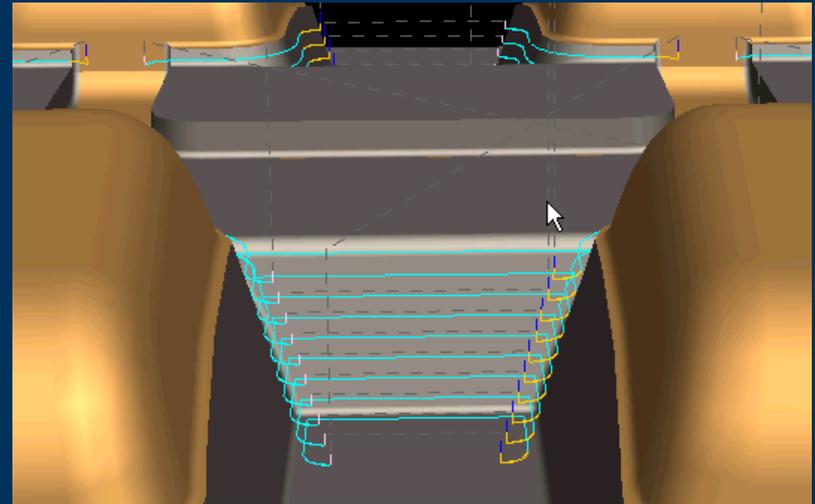
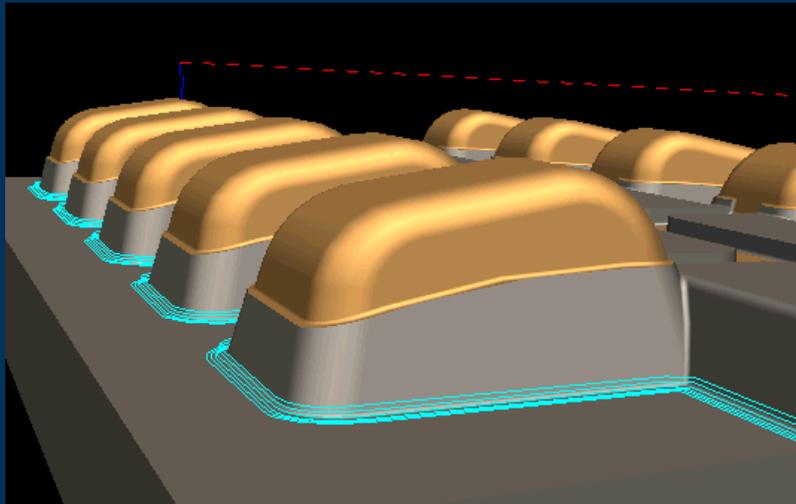


# Rate of Metal Removal





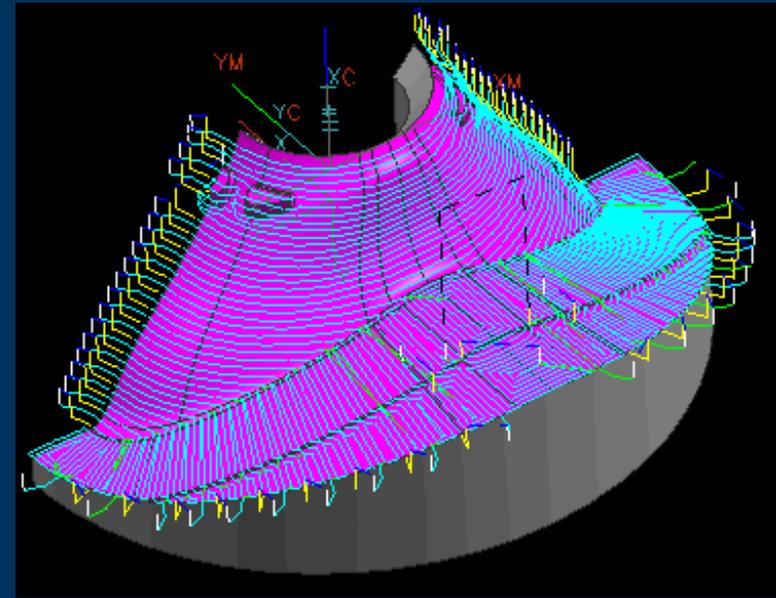
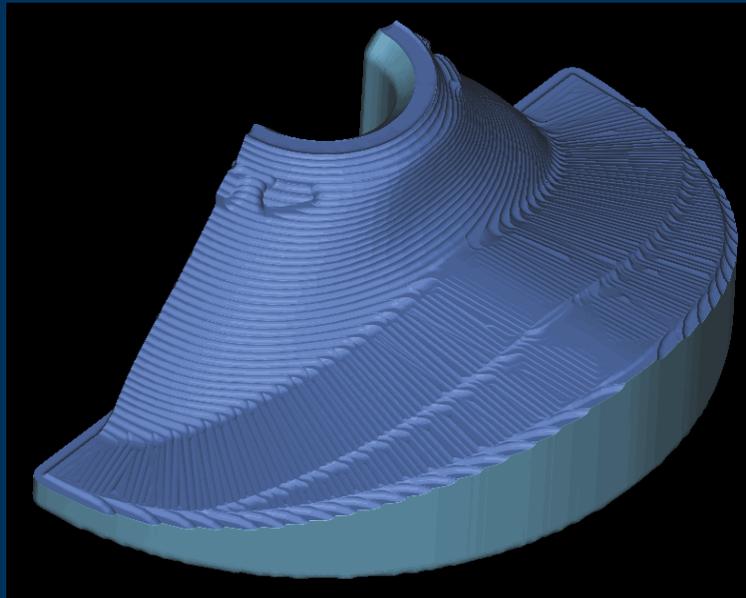
NX CAM's Level based IPW precisely identifies rest material and creates cleaner tool path faster.



Flow cut and Z Level corner finishing options enable smaller, slender tools to machine tight corners which would otherwise require EDM



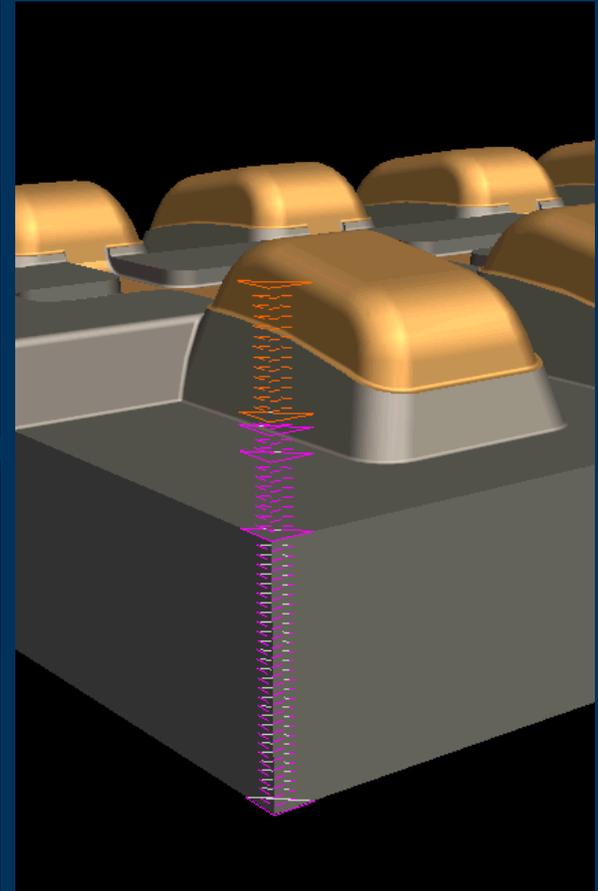
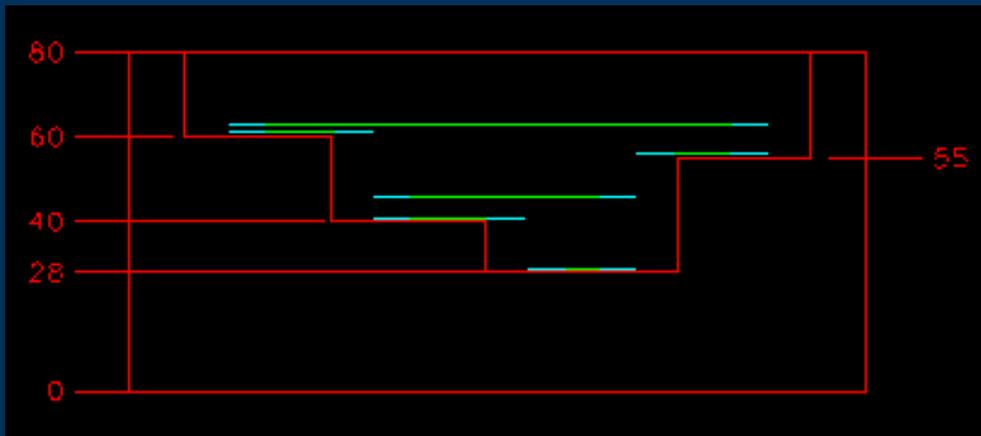
# Uniform Stock for smaller tools



Z Level Plus adds additional tool path in shallow regions where larger scallops are left otherwise.



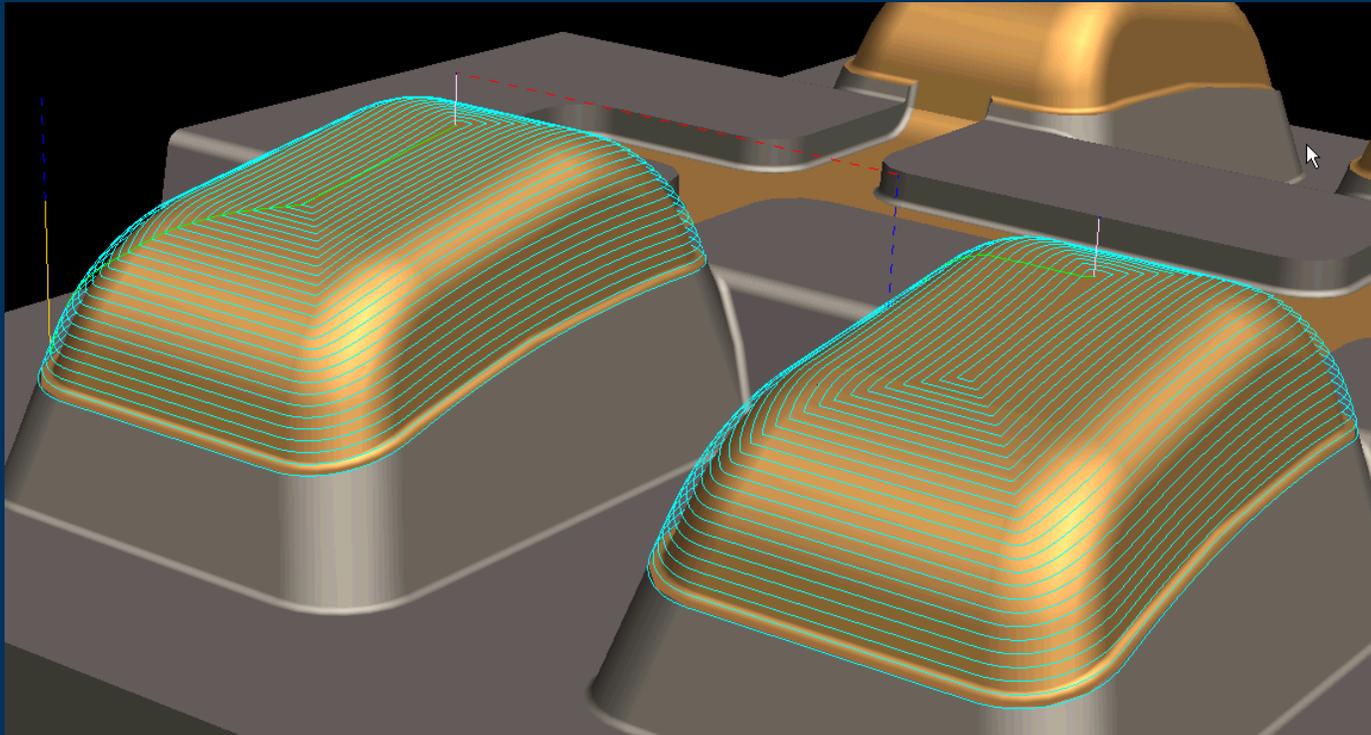
# Uniform Stock for smaller tools



Flat regions are automatically identified and machined in Cavity Mill and Z Level operations.



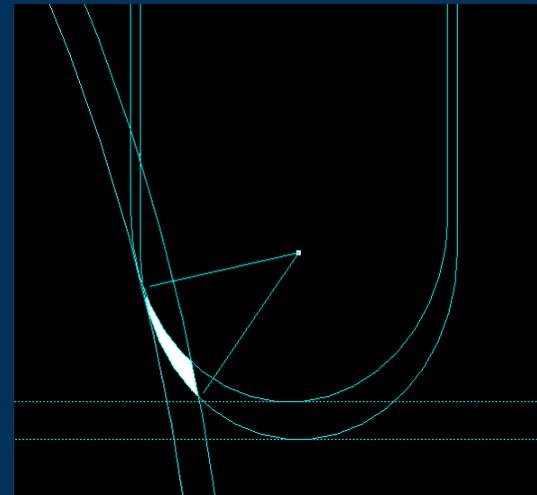
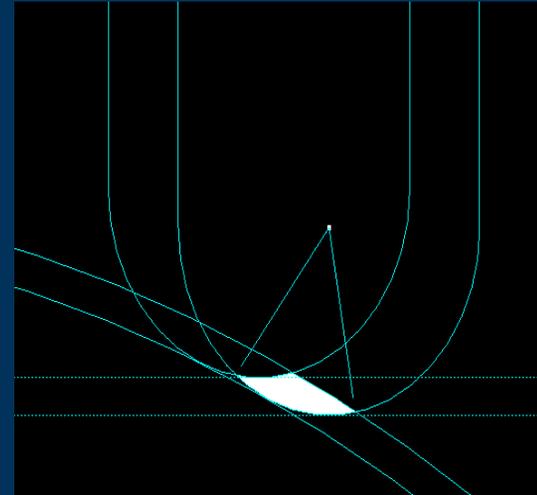
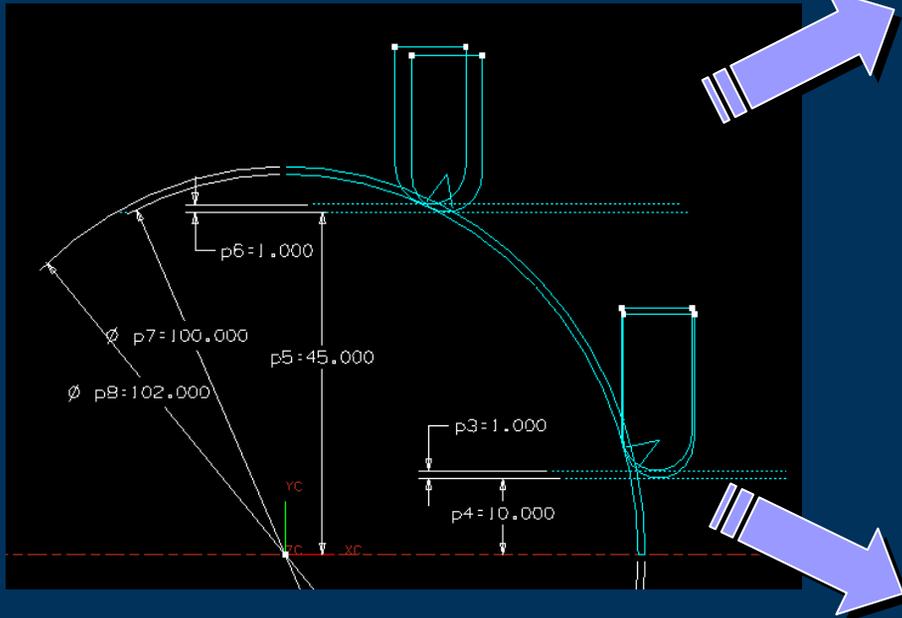
# Uniform Stock for smaller tools



On Part Step over option solves leaves uniform stock in semi-finishing operations and creates consistent finish in steep and shallow areas.

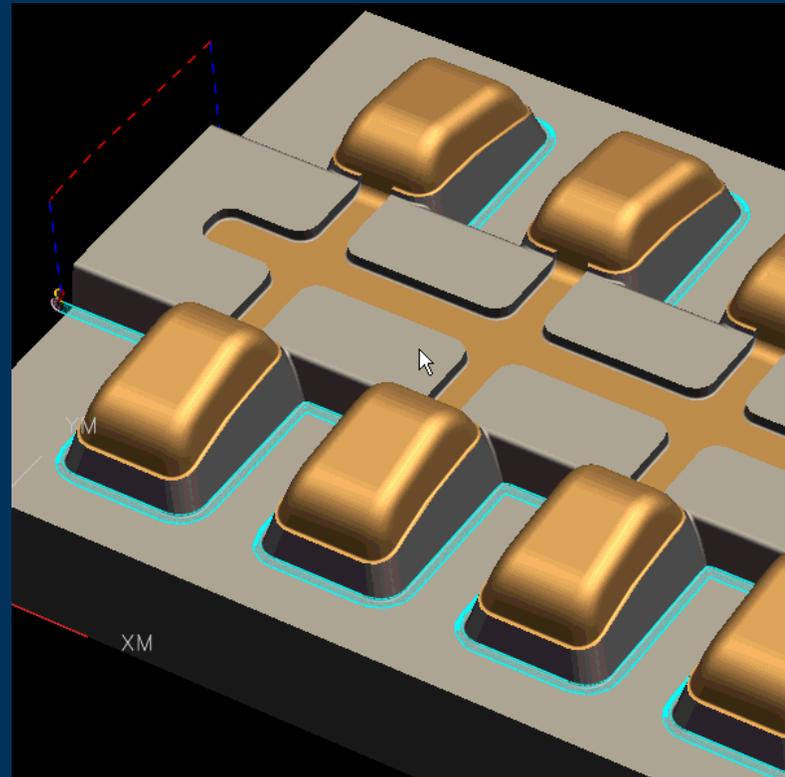
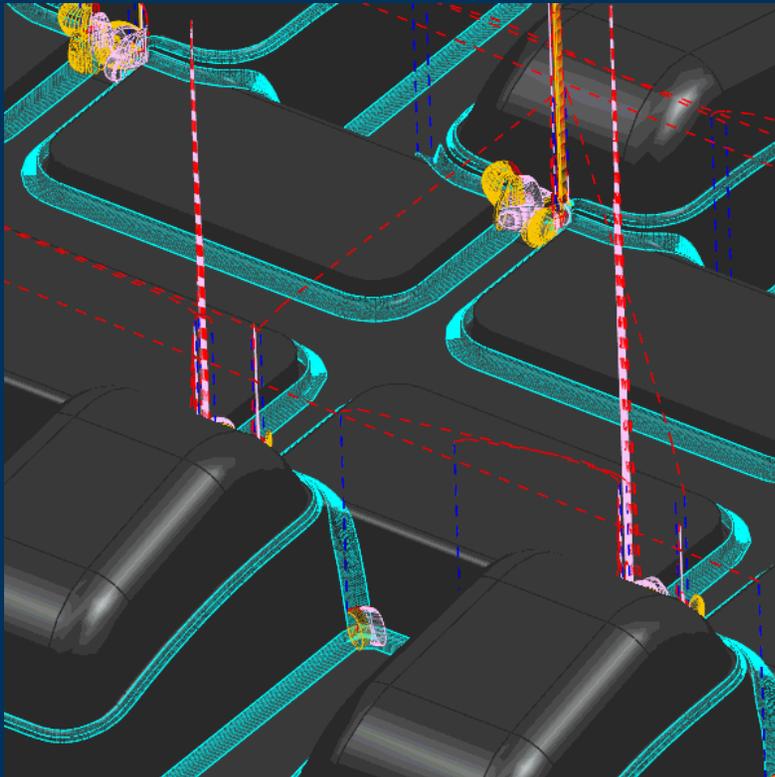


# Maintaining Tool Engagement





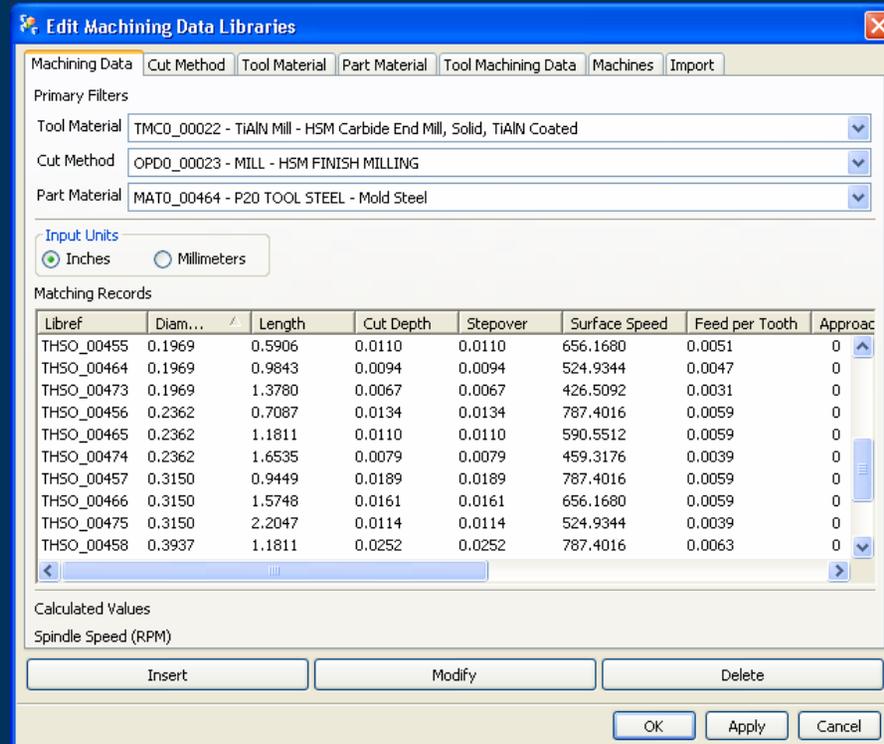
# Maintaining Tool Engagement



Any sudden change in tool engagement angle could peak MRR and break the tool.



# Machining Data



- ▶ User friendly database to maintain custom data
- ▶ Machining Data automatically set in operations.
- ▶ Smart interpolation between known data points.
- ▶ Import mechanism supports external spread sheets.



# Machining Data



Part Material		Tool Material		Code	
SOFT Tool Steels		HSS		TMC0_00001	
P20		HSS TiN		TMC0_00006	
M416		BallNose TiAlN		TMC0_00024	
HARD Tool Steels		EndMill TiAlN		<b>Operation Type</b>	
H13		Hog Insert		<b>Roughing</b>	
Calmax		EndMill Insert		<b>Semi Finishing</b>	
D2		BallNose Insert		<b>Finishing</b>	
Non Ferrous		HogNose TiAlN		<b>Drilling</b>	
7079		EndMill HardC		OPD0_00011	
Copper		HogNose Micro Inserted		TMC0_00029	
		SlotDrill TiAlN		TMC0_00030	
		Chamfer		TMC0_00031	

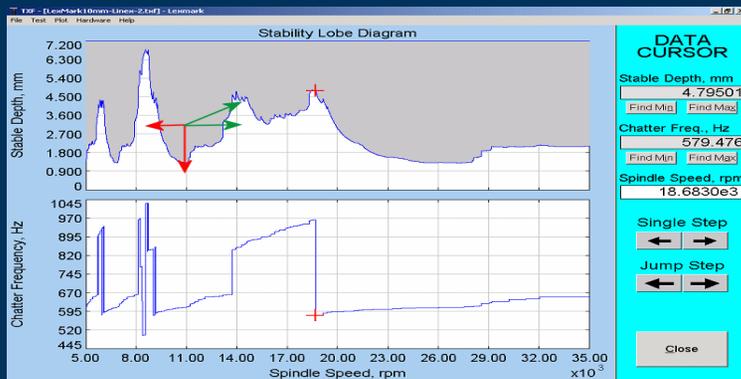
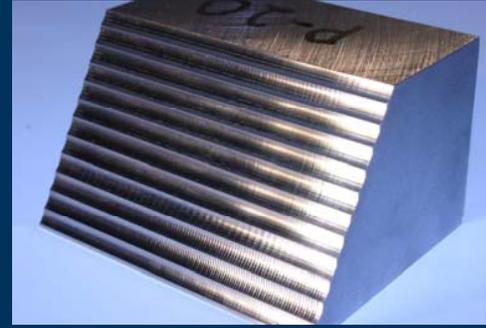
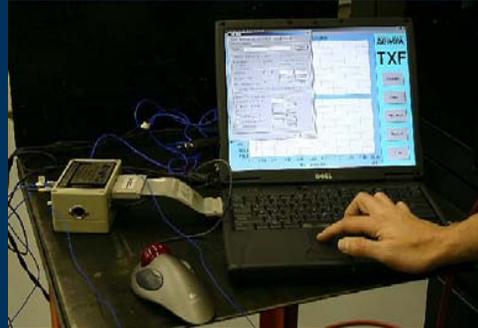
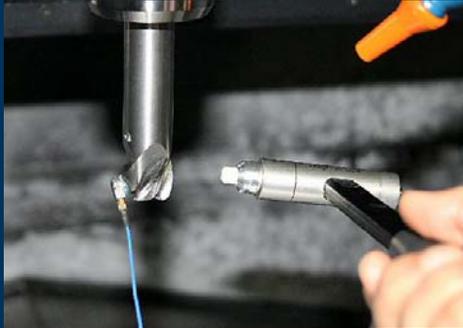
  

OPERTYP	PARTMAT	TOOLMAT	DIAM_MM	LENGTH	DPT_CUT	STEPSOVE	SURF_SPI	FEED_MM	APPROAC	ENGAGE	FRSTCUT	STEPSOVE	RETRACT	RETURN	DEPART
OPD0_000	MATO_006	TMC0_000	0.58	1.8	0.06	0.06	27.33186	0.018675	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	0.98	3	0.1	0.1	46.18141	0.031125	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	1.48	4.5	0.15	0.15	69.74336	0.046688	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	1.98	6	0.2	0.2	93.3053	0.06225	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	2.48	7.5	0.25	0.25	116.8672	0.077813	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	2.98	9	0.3	0.3	140.4292	0.09	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	3.98	12	0.4	0.4	187.5531	0.1125	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	4.98	15	0.5	0.5	234.677	0.124342	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	5.98	18	0.6	0.6	260	0.140625	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	7.98	24	0.8	0.8	260	0.15	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	9.98	30	1	1	260	0.163125	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	11.98	36	1.2	1.2	260	0.16875	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	0.58	3	0.02	0.06	27.33186	0.018675	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	0.98	5	0.04	0.1	46.18141	0.031125	0	60	60	60	100	0	0
OPD0_000	MATO_006	TMC0_000	1.48	7.5	0.06	0.15	69.74336	0.046688	0	60	60	60	100	0	0

- ▶ Over 5000 part/ tool/ operation combinations
- ▶ Proven Die/Mold Data



# Machining Data

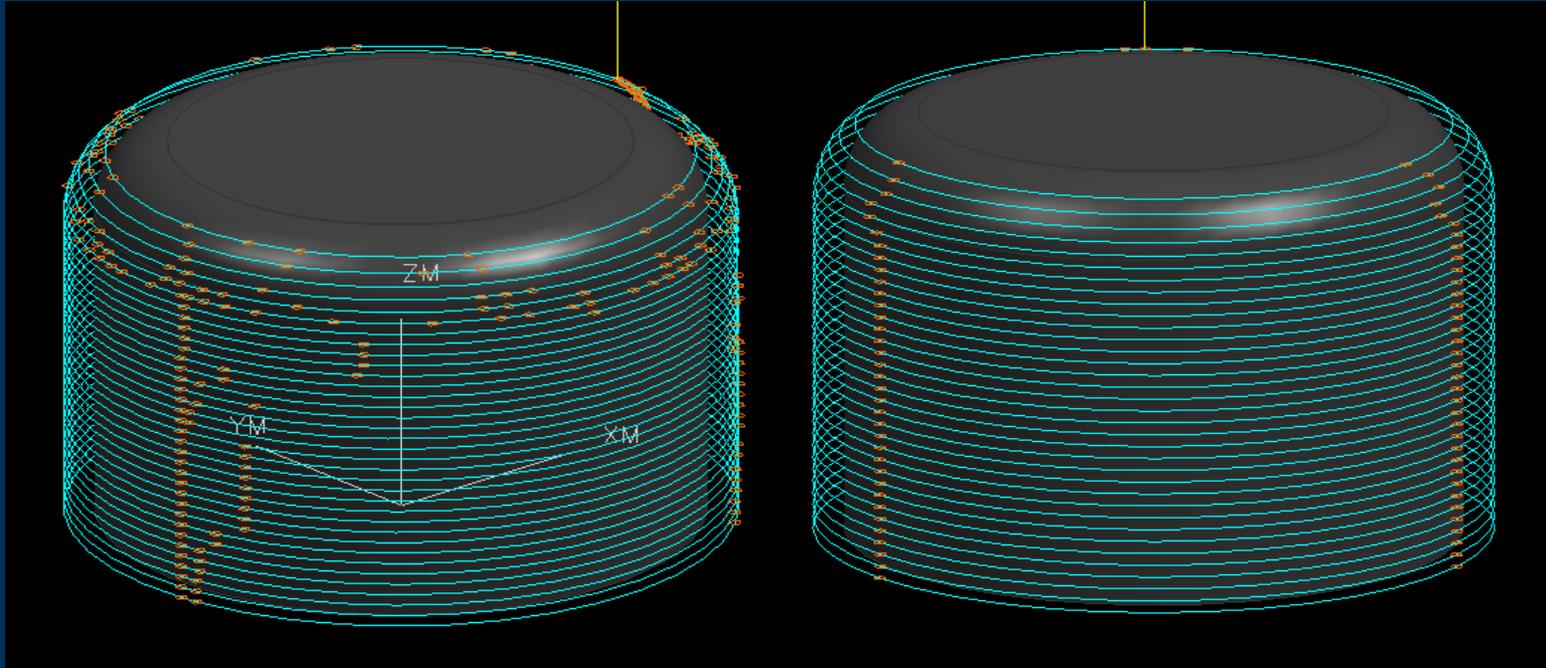


Spindle Speed (rpm)	Feed rate (mm/min)	Chip Load (mm/teeth)	Depth of Cut (mm)	Side Step Over (mm)							
				0.5	1.0	1.5	2.0	2.5	3.0	3.5	
6000	840	0.072	4								
6500	910	0.072	4								
7000	980	0.072	4								
7500	1050	0.072	4								
8000	1120	0.072	4								
8500	1190	0.072	4								
9000	1260	0.072	4								
9500	1330	0.072	4								
10000	1400	0.072	4								
10500	1470	0.072	4								
11000	1540	0.072	4								
11500	1610	0.072	4								

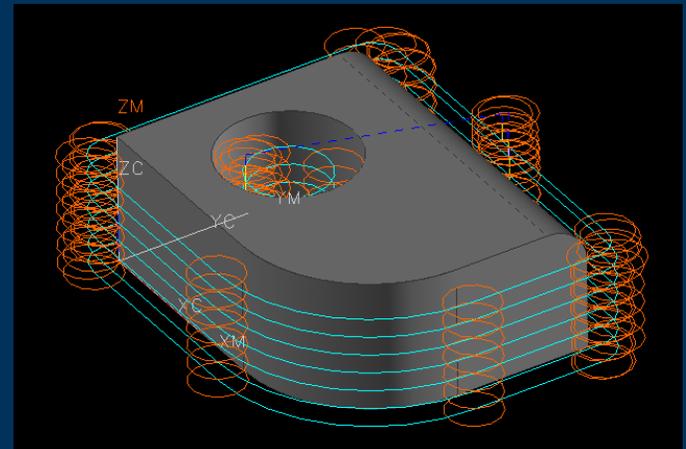
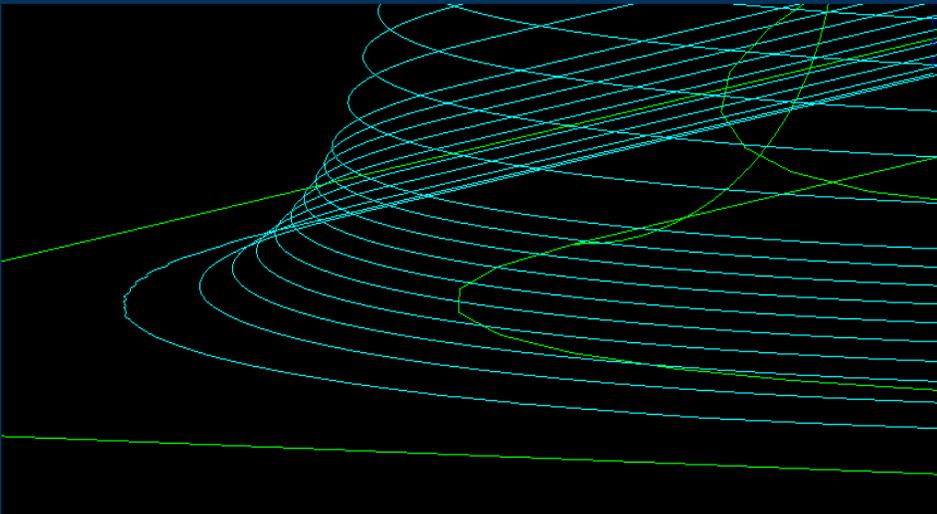
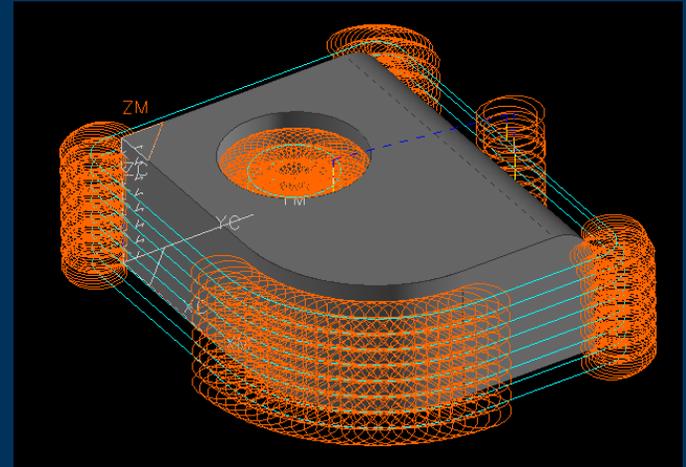
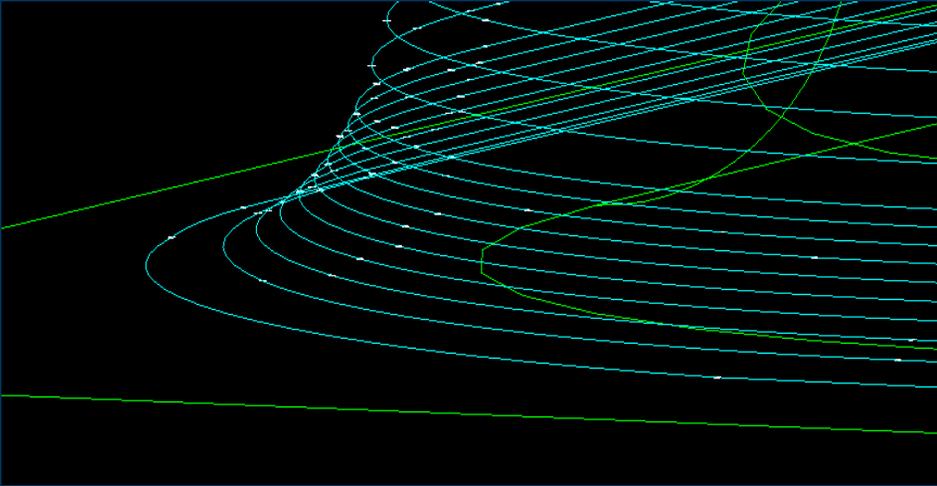
► Patented Chatter Free Machining Data identification process.



# Fine tuned Data for Machine Controllers



NX 4 computes mathematically exact tool path for conical and planar geometry.

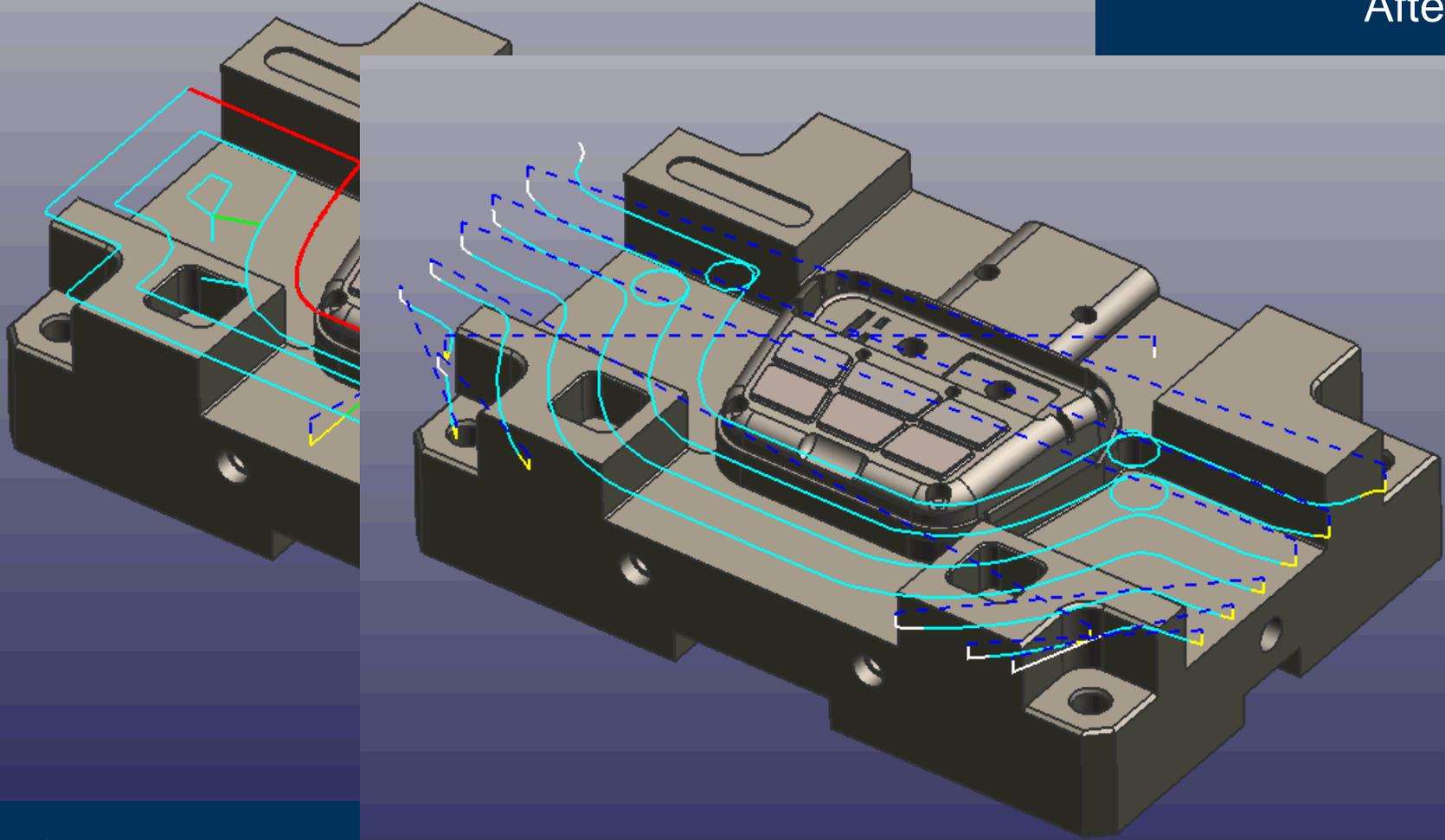




# Case Study 1 - Demo



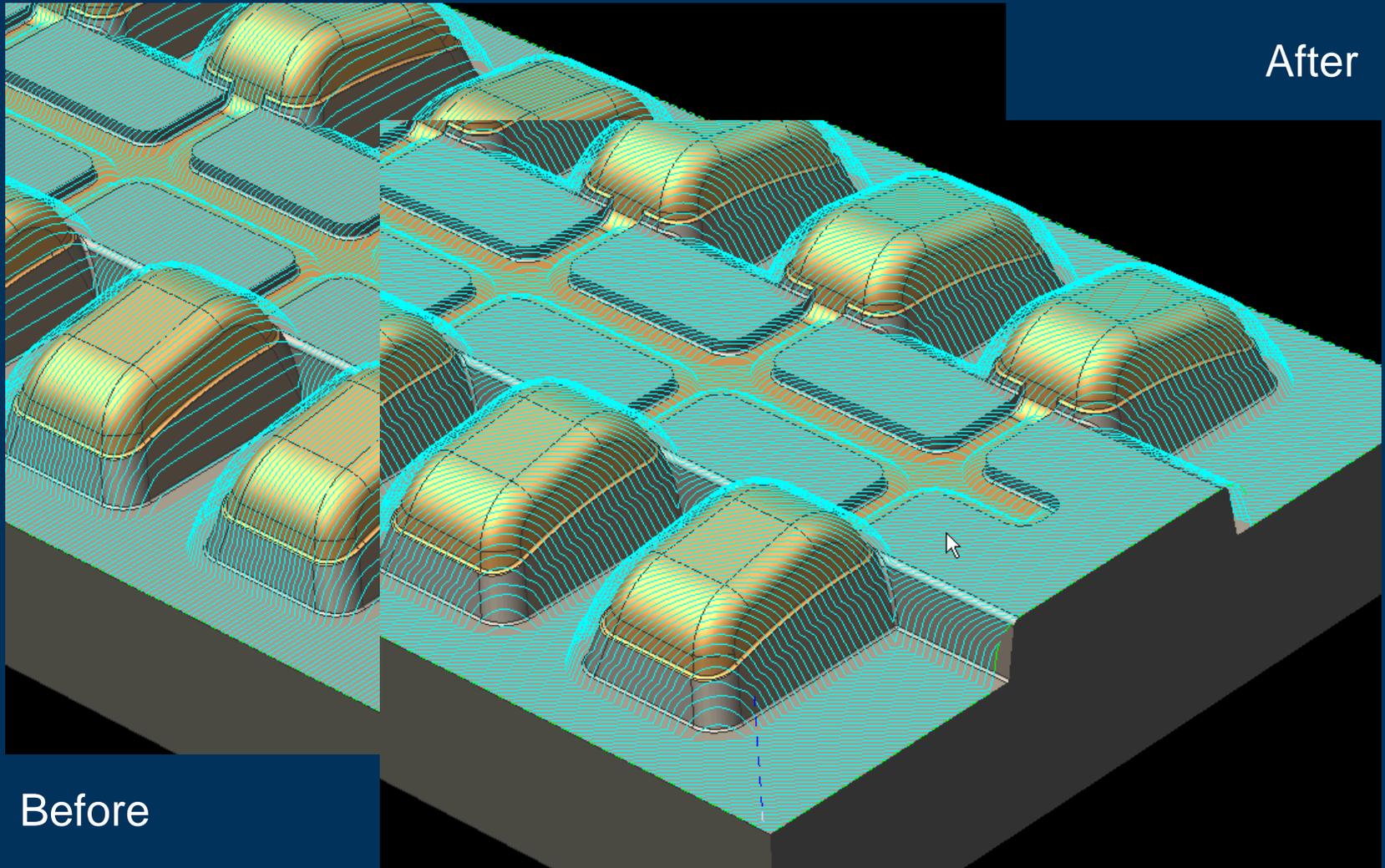
After



Before



# Case Study 2 - Demo



After

Before



## Other Practical Tips for HSM



- ▶ Tooling Design Vs Machining
- ▶ Machine Controller Tweaks
- ▶ Tool Length



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Thank You