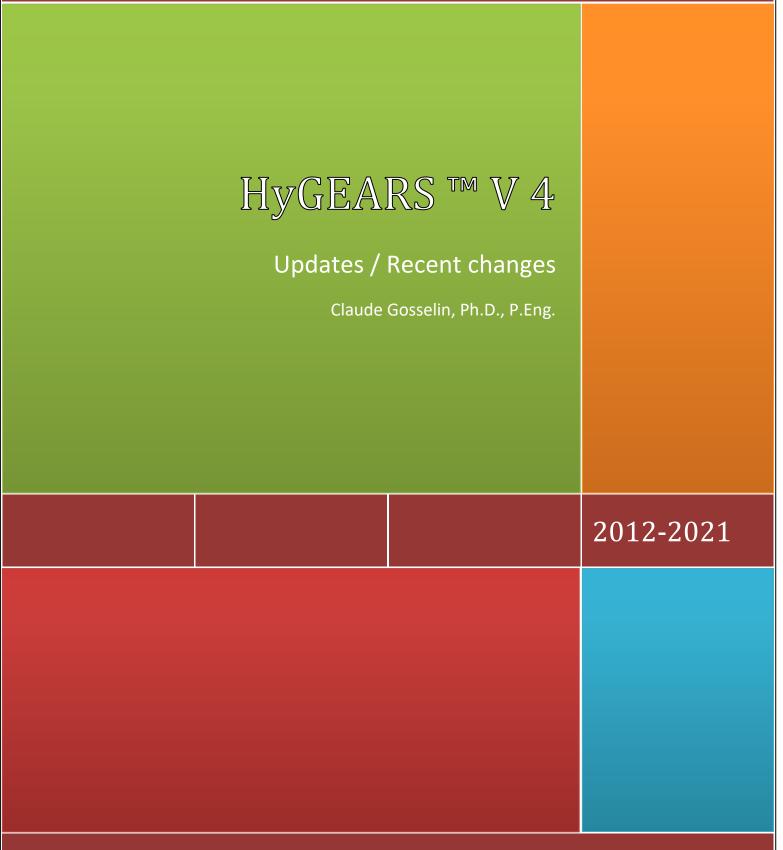


Involute Simulation Softwares Inc.



www.HyGEARS.com

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HyGEARS update -29 November 2017 - Build 405.90 - 462

1) In 5Axis, the 5Axis CnC window is not imposed to be in front of the Graphic Parent window anymore, and 2 icons appear in the Tool Bar: one for HyGEARS itself, the other for the 5Axis CnC window. Therefore, the 5Axis CnC window can sit anywhere on the screen. If the 5Axis CnC window is hidden by the Graphic Parent window, it can be accessed through the icon on the Windows tool bar.

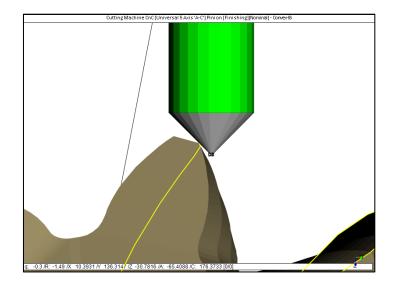


2) In 5Axis, all Tool definitions now include entry fields for *Tool ID* and *TLU ID*. The *Tool ID* and *TLU ID* are fields used in the Operation to inform the controller of the tool used.

5Axis CnC - F	Pinion [Finishing] 6			i.HyG - [mm]		
Nachine/Tool	Cycle Cycling Tim	e Arbor E	nd Mill Op	eration Proc	ess Stock	
End Mill Det	ails Name	90 Cone Too	ol	90	Cone Tool	•
	Tool ID:	2			lear Save	Delete
	TLU ID:	201				Delete
Diameter /	0.0500			1		
Edge Radius	0.0000		Г			1
Cone Ingle	90.0000	Holder D	Diameter		Hold	ler Length
R. Curvature	0.0000					
Cutting Length	5.0000	-				* *
Cutting Length	in 5.0000	Stem Di	ameter	• • •	1	
ool Length	34.0000	1		+++-	<u>+</u>	
Taper Length	0.0000				aper Length	Tool Length
Stem Diameter	10.0000	Cone Ar	ngle		To	ol Length
5Axis CnC - P	inion [Finishing] 6>	37 Spiral-75	mmFwidth	HyG - [mm]	•	
				aration Proce		
achine/Tool (Cycle Cycling Time	e Arbor En	nd Mill Ope	eration Proce	ss Stock	
Operation						
Name Test						
ID # 6001	ŀ	nternal Subrout	tine 📝			•
Save	Delete Impo	ort STEP		Output		
Tool Change	Tool ID 2		0	0	0	0
	TLU ID 201	0	0	0	0	0
	Gap # 1	0	0	0	0	0
Switches		<u> </u>				
	Coolant On		t On Code	M07		
		Coolan	t Off Code	M08		
	Spindle CW					
	Spindle CCW	Spi	indle RPM	1200.0		
	Detum Tri-	1				
	Return Trip # Steps	11				
Feeds Imm/n	Rapid Move	1500.0				
Feeds [mm/n		500.0				
Feeds [mm/n	Plunge					
Feeds (mm/n	Plunge Cutting	IB Toe->H	eel IB Hee	el->Toe OB	Toe->Heel O	B Heel->Toe
Feeds (mm/n	-		eel IB Hee 500.0			B Heel->Toe
Feeds (mm/n	-	IB Toe->H				
Feeds (mm/n	-	IB Toe->H	500.0	500		

3) In 5Axis, Chamfer Tool Side / Toe / Heel, HyGEARS now detects if a Chamfering End Mill tool is used. A

Chamfering End Mill tool [Cone Tool for short] is an End Mill with a 45° to 90° cone angle at the tip, as shown below.

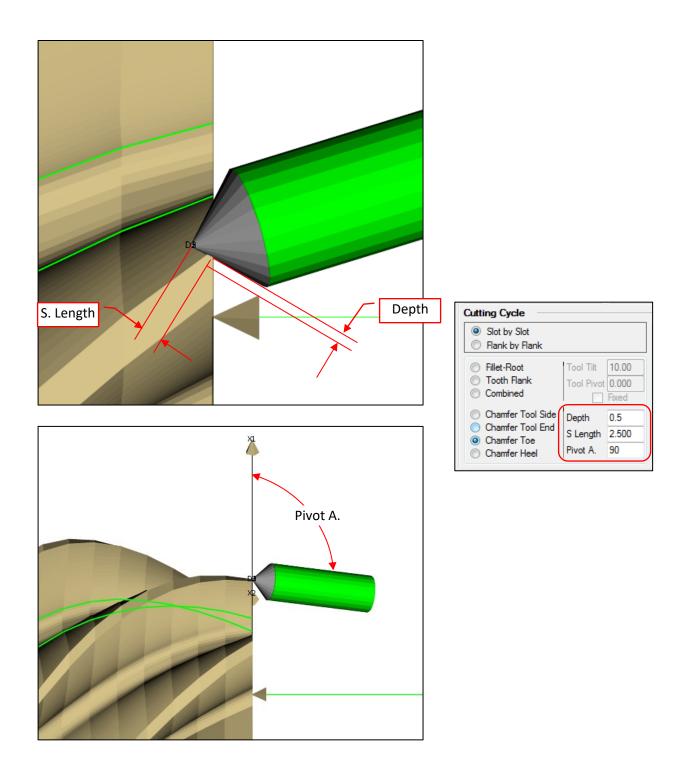


The Cone Tool is described as a usual End Mill, except that the Diameter is expected to be nearly zero (0.050 mm, figure below), the Edge Radius is zero, and the Cone Angle ranges from 45° to 90°.

	Cycling Time	Arbor End Mill Operation Process Stock
End Mill Details	Name Tool ID: TLU ID:	Clear Save Delete
Diameter Edge Radius Cone Angle	0.0500 0.0000 90.0000	Holder Diameter
R. Curvature Cutting Length Cutting Length in Tool Length	0.0000 5.0000 5.0000 34.0000	[Stem Diameter]
Taper Length Stem Diameter Holder Diameter	0.0000 10 50.0000	Cone Angle Tool Length Tool Length Couting Length
Holder Length Holder Angle Tip Reference	0.0000	Diameter
Fillet Rad. [Toe] Fillet Rad. [Heel]	2.9953	Tool Center Point Tip Reference
Slot Width [Toe] Slot Width [Heel]	6.9541 7.1272	RPM 1200.0 Rapid Move 1500.0 Plunge 500.0 Cutting 500.0

Whenever a Cone Tool is detected, in the Chamfer Toe / Chamfer Heel cycles, HyGEARS offers a different set of entry fields, as follows:

- Depth: depth to which the chamfer is to be cut;
- S.Length: distance along the edge of the Cone Tool;
- Pivot A.: angle to pivot the Cone Tool out of the gap (+ value) or into the gap (- value);



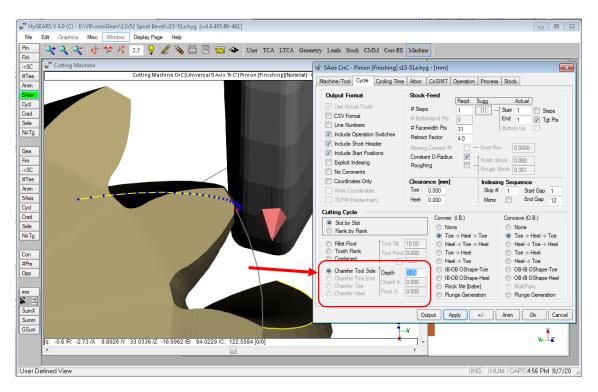
4) In 5Axis, Chamfer Toe / Chamfer Heel, HyGEARS offers Stock for both Fillet and Flank, such that the location of the tool can account for the fact that, for example, the Flank may have a +Stock, while the Fillet has a protuberance, and thus –Stock.

In addition, the *Start* step is now imposed as 0.

Finally, when the Output button is clicked, the starting tooth flank is based on the CW or CCW spindle rotation as defined in the Operation tab.

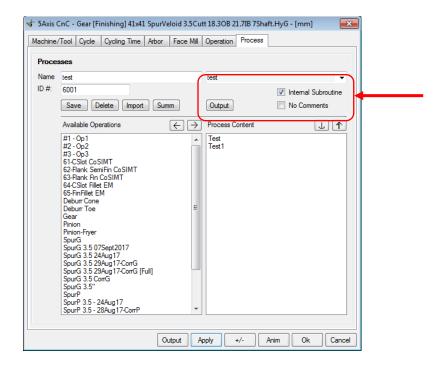
🐝 5Axis CnC - Pinion [Finishing] 6	37 Spiral-75mmFwidth.HyG - [mm]
Machine/Tool Cycle Cycling Time	Arbor End Mill Operation Process Stock
Output Format Use Actual Tooth CSV Format Une Numbers Include Operation Switches Include Short Header Include Start Positions Explicit Indexing No Comments Coordinates Only	Stock-Feed Reqd. Sugg. Actual # Steps 11 [11] Start 0 Steps # Bottomland Pts 0 End 1 Tgt.Pts # Facewidth Pts 11 Bottom Up Bottom Up Retract Factor 4.0 Moving Contact Pt Over Run 0.0000 Constant D-Radius Image: Contact Pt 0.000 Image: Contact D-Radius Image: Contact Pt 0.000
Work Coordinates	Clearance [mm] Indexing Sequence Toe 0.000 Skip # 1 Start Gap 1
TCPM (Heidenhain)	Heel 0.020 Mirror End Gap 6
Slot by Slot Plank by Plank Fillet-Root Tooth Plank Combined	Convex (I.B.) Concave (0.B.) None None Toe > Heel > Toe None Heel > Toe > Heel Toe > Heel Fixed Heel > Toe
Chamfer Tool Side Chamfer Tool End Chamfer Toe Chamfer Heel Pivot A.	0.5 0.8-08 OShape-Toe 0.8-18 OShape-Toe 2.500 0.18-08 OShape-Heel 0.8-18 OShape-Heel 90 Rock Me [babe] MultiPass 91 Plunge Generation Plunge Generation
	Output Apply +/- Anim Ok Cancel

5) In 5Axis, Tip Chamfer, Tool Side, is now allowed with a CoSIMT.



6) In 5Axis, *Process* tab, addition of the *No Comments* switch, which allows imposing or disabling comments globally to all the Operations of a given Process, without having to edit each individual Operation.

Also, the *Output* button has been moved such as to stand out and be more visible.



7) In 5Axis, *Process* tab, the *Summ* button now prints out the Process Summary in column form rather than the original linear form. This allows addition of more info, and makes for easier consultation of each step.

File Edi	it						
		nion : 23x109 Helical-TIF-					V4
Seq#	1	2	3	4	5	6	the
DpID	92	93	95	94	97	98	
DpName	92-Rough Flank CSlot [1-2	93-Rough Flank CSlot [4-5	95-Finish Right [0-11/11]	94-Finish Left [0-11/11]	97-Fillet Left-CoSIMT Fin	98-Fillet Right-CoSIMT	Fi
Machine	Mori NT4250 / C1 [B-]	Mori NT4250 / C1 [B-]	Mori NT4250 / C1 [B+]	Mori NT4250 / C1 [B+]	Mori NT4250 / C1 [B-]	Mori NT4250 / C1 [B-]	
larget	Flank	Flank	Flank	Flank	Fillet	Fillet	
Iool	CoSIMT	CoSIMT	CoSIMT	CoSIMT	CoSIMT	CoSIMT	
DLen	-0.7282	-0.3404	-0.3404	+0.3404	+0.3404	-0.3404	
	001_229263R75_D1	S-327.2PP2.A	S-327.2PP2.A	S-327.2PP3.A	S-327.2PP3.A	S-327.2PP2.A	
IoolID	1027	1029	1029	1031	1031	1029	
ApxLoc	-13.2500	-13.2500	-13.2500	-13.2500	-13.2500	-13.2500	
#Steps	3	5	11	11	7	7	
Start	1	4	0	0	1	1	
End	2	5	11	11	6	6	
IoeClr	20.000	15.000	15.000	15.000	15.000	15.000	
	5.000	5.000	5.000	5.000	5.000	5.000	
Stock					-0.020	-0.020	
<pre>[']</pre>	2.2	2.0	10.5	10.7	5.4	5.3	
Est.Time	0.60 H						

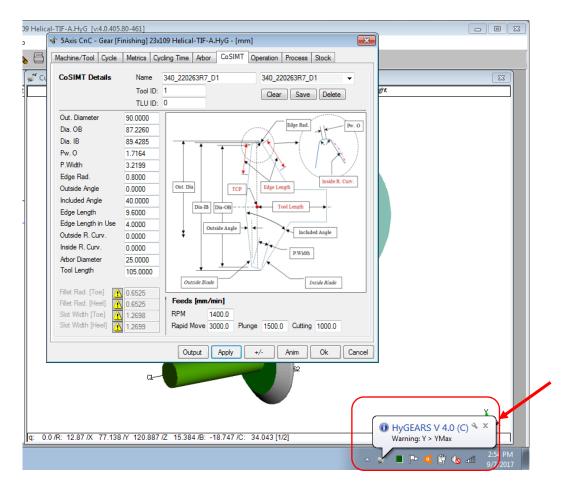
8) In 5Axis, *Machine/Tool* tab, it is now possible to selectively display the machine's Turn Table on which the work piece and its supporting arbor are installed.

* 5Axis CnC - Pinion [Finishing] 23x109 Helio Machine/Tool Cycle Metrics Cycling Time	
Machine Selection	Cutting Tool
 3 Axis CnC 4 Axis CnC 5 Axis CnC "B-C" [Type M] 	Face Mill Cutter Hide Cutter Body CoSIMT Nvert Arbor Outside Blade
 5 Axis CnC "A-C" [Type P] 5 Axis CnC "A-B" [Type P] 5 Axis CnC "B-A"]Type T] 	End Mill Invert work
● Specific Machine Mori NT4250 / C1 [B-] ▼ New Edit Delete List	Ball Mill -
Apex Location 60/2500 Alignment Angle 0.0000 3Avis Tool Tilt 0.0000 Image: Conter Point [TCP] Absolute Differential Differential	Display Display Machine Head Display Arbor Display T.Table Display Target Grid Display Tool Path Display Section C.L.C.K on Tool Detect Gouging Display Warning Workpiece is Fixed
u0	tput Apply +/- Anim Ok Cancel

The Turn Table dimensions are defined in the machine's data, *Controller-Machine Head* tab:

Mach. Definit Controller Controller Linear De Angle De Macro Sta	cimals 3	uc	ntroller-Machine Head External C Lead spi C Blank Li Upper C C Slot Cou	Subs Use CYCL aces Use ORIA) nes Feed String ase Impose Co	19 KES/ORIVECT g on Single Line mpensation Nork Coords.		EPEAT x DE GR(
Pgm Start	#	5001	Main Program Prefi	× 00	Coolant	On Code	8
			Sub Program Prefix	00	Coolant	Off Code	9
Pgm Star	Char		Main Pgm File Ext.		Dwell C	ode	
Pgm End	Char		Sub Pgm File Ext.		T.Table	Index Code	G52
1st Codel	Line Prefix		Spindle CW	M3	Subrout	ine End	M99
			Spindle CCW	M4	Program	n End	M30
					Subrout	ine Call	
Machine	Head			Machine Limits			
	Length	Diameter	Square		Minimum	Maximum	
1	00.000	220.0000		X Coordinate	-100.00	600.00	
0	.0000	0.0000		Y Coordinate	-105.00	105.00	
0	.0000	0.0000		Z Coordinate	-100.00	600.00	
0	.0000	0.0000		Tum Table tilt	-95.00	95.00	
0	.0000	0.0000	Clear	Tool Head tilt	-95.00	95.00	
Turn Tab	le						
1	0.0000	200.0000					

9) In 5Axis, when animating (*Anim* button) or single stepping (+/- button) an Operation HyGEARS now checks the min and max X Y Z A B values and outputs a balloon in the lower right corner of the screen if any of these exceeds the machine limits.



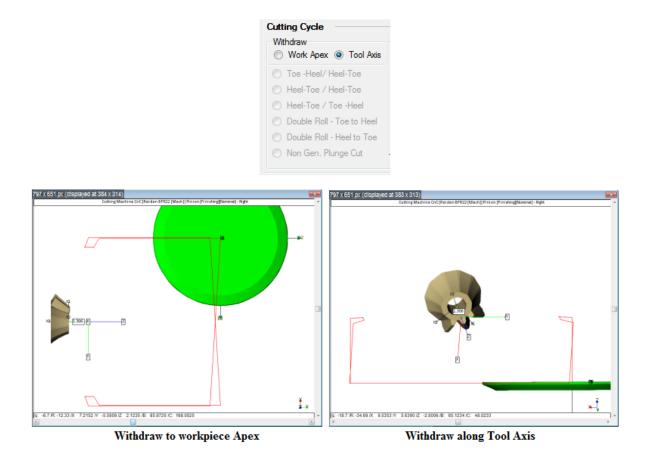
For this warning to be displayed, the machine's limits must have been defined by editing the desired machine and entering the values in the *Controller-Machine Head* tab, Machine Limits section, as shown below.

ntroller	nuc	External S	iubs 🗌 Use CYCL	19	Use RE	PEAT xx P=(1)
	nuc	Lead space		KES/ORIVECT	Use CO	DEGROUP
Linear Decimals 3	_	🔽 Blank Line		on Single Line		
Angle Decimals 3		Upper Cas Slot Count		mpensation Vork Coords		
Macro Start # 56	0	Slot Court	ter 🔄 Universal V	Vork Coords.		
Pgm Start #	6001	Main Program Prefix	00	Coolant	On Code	8
		Sub Program Prefix	00	Coolant	Off Code	9
Pgm Start Char		Main Pgm File Ext.		Dwell C	ode	
Pgm End Char		Sub Pgm File Ext.		T.Table	Index Code	G52
1st CodeLine Prefix		Spindle CW	M3	Subrout	ine End	M99
		Spindle CCW	M4	Program	n End	M30
				Subrout	ine Call	
lachine Head			Machine Limits			
Length	Diameter	Square		Minimum	Maximum	
100 0000	220 0000		X Coordinate	-100.00	600.00	
0.0000	0.0000		Y Coordinate	-105.00	105.00	-
0.0000	0.0000		Z Coordinate	-100.00	600.00	
0.0000	0.0000		Tum Table tilt	-95.00	95.00	_
0.0000	0.0000	Clear	Tool Head tilt	-95.00	95.00	Cear
um Table						
10 0000	200 0000					
10.0000	200.0000					

Since HyGEARS is distributed with the master Machine definition file, each time HyGEARS is installed, the current Machine file is updated and therefore, any machine limits entered by a user should be transferred to Involute Inc. in order to maintain the master Machine file.

10) In 5Axis, for Coniflex gears cut with a Coniflex Dish type cutter, the tool can now be withdrawn to either the *Work Apex* or along the *Tool Axis*.

For example, in AC type machines, retracting to the Work Apex is usually not an issue because of a large volume; this is not so in a Gleason Phoenix machine where travel along the work piece is limited, and then withdrawing along the Tool Axis becomes compulsory. This has limited effect on cycle time, and is usually based on what the machine can allow.



11) In 5Axis, the Non Gen Plunge cutting cycle (Face Mill cutter), the Retract Factor now relates to tooth depth at Heel rather than at mid-face.

12) In 5Axis, HyGEARS now estimates the Torque and Power required for a cutting operation. This is subdivided in 2 data pages:

- *Operation page:* Next to the Spindle RPM, tool cutting data is given; when the Spindle RPM or Cutting Feed is modifed, *Vc* and *fz* are updated (*fz* is based on the largest of the enabled Cutting Feeds).
 - Vc: cutting speed, i.e. tangential speed at the tool OD;
 - fz: feed / tooth, i.e. size of the cutting bite / tool blade or flute;
 - *ae*: working engagement, i.e. shape of the cut; may be disabled and replaced by "*N/A*" when *Not Applicable*, for for Face Mill tools;

 Kc: material constant; see tables in the documentation (https://www.sandvik.coromant.com/enus/knowledge/milling/formulas_and_definitions/formulas).

Switches						
Cincinco	Coolant On	Coolant On Code	8			
		Coolant Off Code	9			
	Spindle CW	Spindle RPM	100	Vc:	378.1	[ft/min]
	Spindle CCW	- Spindle RPM	160	fz:	0.0031	[in]
		1		ae:	N/A	[in]
	Return Trip			Kc:	1800.0	
	# Steps	11				

Cycling Time page: the estimated average spindle Torque and Power is displayed below the cycling time. Cutting torque and power are based on the relations provided by Sandvik.

-			
e Times			
Right			
Face:	10.16	[sec]	
Plunge:	6.40	[sec]	
Retract:	0.27	[sec]	
Return:	10.59	[sec]	
Flank:	27.42	[sec]	
Total/Flank:	27.42	[sec]	
Indexing:	16.63	[sec]	
# Slots:	11		
Withdraw:	9.78	[sec]	
Operation:	13.26	[min]	
Cutting Feed:	11.80	[in/min]	
Plunge Feed:	4.90	[in/min]	
Rapid Move Feed:	118.10	[in/min]	
Tool RPM:	160.00		
1	Pov	ver Required	
Matl const Kc:	1800.0		
Tooth Volume:	0.21	[in^3]	
1/2 Gap Volume:	0.09	[in^3]	
Cutting Time:			
Ave. Power:	0.16	(Hp)	
Ave. Torque	63.29	[lb-in]	
-			

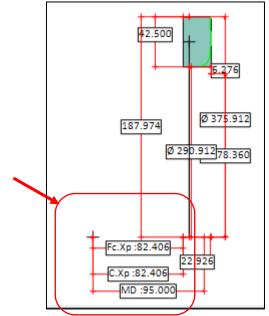
13) For Spur/Helical gears, in the Geometry Summary Editor (*Pin / Gea* function buttons), the X Factor (i.e. the Profile Shift factor) can now be edited. This allows adjusting the X Factor to reach a target tooth thickness.

🕷 Pinic	on (Ext. S	Spur-Helical]	(Finishing][Nom	nal] Test-1-	Ext.hyg - [mn	n] [dd.mm	💌
Blank	Cutter	Cutter Edge	Machine	Other	Operating	Rim-Material	Bearings	A + >
				(in)	(mm)	1		
Ope	er. C. Dist	ance		15	4000	_		
XF	actor			0.5	273	-		
Ger	nerating F	Pitch Dia.		80	390873			
Тос	l Center	Distance		57.	278497			
Too	th Crown	ning		0.0	00000			
Cro	wning Ty	pe		Sp	cified 🔻	•		
Cro	wning On	der		2		•		
Dist	ance to I	Edge		8.7	500			
						Apply	ок	Cancel

In addition, whenever the Minor Diameter (i.e Root Diameter) or Major Diameter (i.e. Outside Diameter) is changed and the *Apply* button is clicked, the cutting blades are adjusted in order to produce the required diameters.

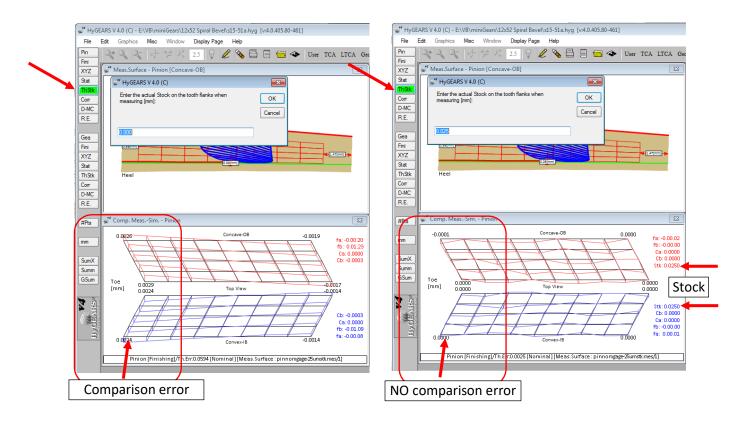
Pinion [Ext. Spur-He	lical] [Finishing]	[Nominal] Test-	1-Ext.hyg -	[mm] [dd.mi	m 💌
ank Cutter Cutter	Edge Machine	Other Operatir	ng Rim-Mate	erial Bearings	s A + ►
Pinion [Finishing]	- Ext. Spur-Heli	cal	C)[in] 🔘	[mm]
Misc					6
# Teeth	40	Pitch D	iameter	80.3909	
Module	1.94000				
Part #					
Tooth		Blank			
Tooth Hand	Left	Minor [Diameter	76.1884	
Face Width	35.0000	Major [Diameter	86.7774	
Addendum Factor	1.1187	Addend	dum	3.1933	
Dedendum Factor	1.7710	Deden	dum	2.1013	
Fillet Factor	0.2500				
Front Angle	0.0000				
Back Angle	0.0000				
			Apply	ОК	Cancel

14) For Face gears (gear member only), the Fc.Xp, C.Xp and MD values are now displayed in the Blank Child window. These are used to locate the pinion axis of rotation in reference to the Face Gear.



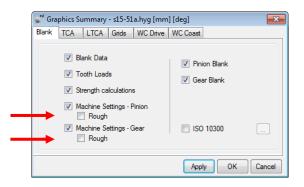
15) In *Corr-RE* display mode, addition of the "ThStk" function button. This is used to enter the desired Stock used to define the CMM Nominal target (*CMM* display mode).

For example, suppose the CMM Nominal target has been defined with +0.025 mm stock on each flank, since the targeted cut is roughing. When measuring, the requested stock will be accounted for. However, when importing the CMM output into HyGEARS, the CMM output is *always* compared to the nominal tooth, i.e. without any stock.



An error will therefore appear in the comparison because of the difference in stock between the nominal and actual teeth, as is shown, left figure above. If the Stock used in defining the CMM Nominal is entered, as in the right figure above, then no error is generated. The Stock value is also shown in the display – right figure above.

16) In the Graphic Summary selection window, *GSum* function button, it is now possible to define whether the Roughing machine settings are outputted or not. By default, this option is unselected.



17) In ISO-10300, load cycles can now be entered such as to estimate the cumulative damage caused by contact and bending stresses.

Load cycles are entered as a series of pinion Torque, pinion RPM and # Hours runtime. Up to 20 values can be entered.

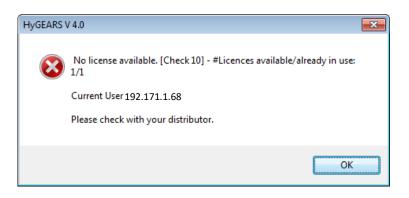
	l						
	Torque [Nm]	RPM	# Hours	1	Torque [Nm]	RPM	# Hours
#1	70	1000.00	200	# 11	0.00	0.00	0.00
#2	200	1500	25	# 12	0.00	0.00	0.00
#3	10	2000	15	# 13	0.00	0.00	0.00
#4	0.00	0.00	0.00	# 14	0.00	0.00	0.00
#5	0.00	0.00	0.00	# 15	0.00	0.00	0.00
#6	0.00	0.00	0.00	# 16	0.00	0.00	0.00
#7	0.00	0.00	0.00	# 17	0.00	0.00	0.00
#8	0.00	0.00	0.00	# 18	0.00	0.00	0.00
#9	0.00	0.00	0.00	# 19	0.00	0.00	0.00
# 10	0.00	0.00	0.00	# 20	0.00	0.00	0.00

Output gives the results for each load cycle, and the cumulative Contact and Bending damage at the end of the document.

Spiral-Bevel / ISO-10300:20] Duplex Helical Pinion Spread Blade Gear	l4 (Method B1	L)		Date / Time : 9/7/2017 / 2:30; General Units : [mm] [dat.m.ss] Cutter Units : [in] Prepared by : Claude Gosselin Version : 4.0.405.80-461			R
DUTPUT - Contact		PINION	GEAR	OUTPUT - Bending		PINION	GEAF
SURFACE DURABILITY (PITTING)				TOOTH ROOT STRENGTH			
[Zone of action for pitting resists	ance]			[Zone of action for tooth root strength]	I		
Distance from the centre, Tip Distance from the centre, Middle Distance from the centre, Noot Length of contact line, Tip Length of contact line, Middle Length of contact line, Root Exponent 4 load on contact line, Middle 4 load on contact line, Root	[mm] : [mm] : [mm] : [mm] : [mm] : : [*] : [*] : [*] :	0. -3. 2. 2. 1. 8.	4028 0000 4028 6082 1465 6082 5000 4851 0829 4581	Distance from the centre, Hidde Distance from the centre, Midde Distance from the centre, Modie Lamph of contact line, Modie Lamph of contact line, Modie Emponem contact line. Tip * load on contact line, Root	[mm] : [mm] : [mm] : [mm] : [mm] : [mm] : [*] : [*] : [*] :	0.00 -3.40 9.1 2.60 1.50 0.43 8.0	000 038 082 082 082 082 082 082 082
Transverse load factor Face load factor Hidrone factor Distinct factor Distinct factor Velocity factor Saughne factor Saughne factor Saughne factor Distinct factor Distance factor Distance factor	[Sqre(N/mm2)]	1. 0. 0.	0000 9111 9115 0000 0754 1.0214 0.9482 1.0856 1.0514 1.0000 0.8692 0.8590	Transverse load factor Lengthuse curvature factor Fore load factor Load shaing factor Bevil spiral angle factor Bevil spiral angle factor Size factor Noth for social status (factor Size factor Tooh for thord Bending moment ann Took for factor Store factor Stress correction factor Life factor	[mm] [mm] [mm] [mm] :	0.63 0.83 1.1200 0.9835 1.0000 0.0000 1.8003 3.7155 0.8982 6.8373	057 916 150 808
RESULTS - ISO10300		PINION	GEAR	RESULTS - ISO10300		PINION	GEAF
Torque ‡1 Speed Running Time	[Nm] : [RPM] : [h] :	5.0000 1000.0000 200.0000					
Nominal contact stress Contact stress Contact stress Safety factor for contact stress Allowable contact stress Safety factor for contact stress Pitting damage	[MPa] : [MPa] : [MPa] : [MPa] : :	646.1168 1036.1872 1219.0438 1172.3199 1373.1056 1.3252 0.0001	646.1168 1036.1872 1219.0438 1172.3199 1534.1438 1.4806 0.0000	Nominal tooth root stress Tooth root stress Allowable stress number Permissible tooth root stress Safety factor for bending stress Bending damage	[Mpa] : [Mpa] : [Mpa] : [Mpa] :	591.2764 134.4720 288.1177	75.7073 193.6161 134.4720 305.7260 1.5790 0.0000
Torque #2 Speed Running Time	[Nm] : [RPM] : [h] :	12.0000 1500.0000 25.0000					
Nominal contact stress Contact stress Comparative contact stress to LTCA Allowable stress number Permissible contact stress Safety factor for contact stress Pitting dumage	[MPa] : [MPa] : [MPa] : [MPa] : [MPa] :	1000.9598 1472.9516 1732.8843 1172.3199 1567.2402 1.0640 0.4402	1000.9598 1472.9516 1732.8843 1172.3199 1751.0465 1.1888 0.1016	Nominal tooth root stress Tooth root stress Allowable stress number Fermissible tooth root stress Safety factor for bending stress Bending damage	[Mpa] : [Mpa] : [Mpa] : [Mpa] : :	1194.7885 134.4720	181.6975 391.2385 134.4720 370.2831 0.9464 1.6177

Spiral-Bevel / ISO-10300:2014 (Duplex Helical Pinion Spread Blade Gear	(Method B	1)		Date / Time : 9(7)(2017 / 2:3 General Date : [mm] [dd.mm.se Frepared by : Claude Gossel] Version : 4.0.405.80-461	=] in /		Wa
DUTPUT - Contact		PINION	GEAR	OUTPUT - Bending		PINION	GEAR
Torque #3 Speed Running Time	[Nm] : [RPM] : [h] :	3.0000 2000.0000 15.0000					
Nominal contact stress Contact stress Comparative contact stress to LTCA Allowable stress number Permissible contact stress Safety factor for contact stress Floting damage	[MPa] [MPa] [MPa] [MPa] [MPa]	500.4799 806.0921 948.3437 1172.3199 1601.3555 1.9866 0.0000	500.4799 806.0921 948.3437 1172.3199 1789.1629 2.2196 0.0000	Nominal tooth root stress Tooth root stress Allowable stress number Fermissible tooth root stress Safety factor for bending stress Bending damage	[Mpa] : [Mpa] : [Mpa] : [Mpa] :	138.7197 357.8355 134.4720 314.0666 0.8777 3.1268	45.4244 117.1748 134.4720 379.8610 3.2418 0.0000
Sum Pitting damage		0.4403	0.1016	Sum Bending damage	:	10000537.8410	1.6177

18) If the Network option has been purchased, and a user attempts to run HyGEARS, a message notifying the user that no license is available is displayed when all licenses are currently used; the IP address of the last user to log into HyGEARS is also displayed, such that one can ping this user to check for how long he will be busy with HyGEARS.



19) When developing Cyclo-Palloid gear sets (*BPat* function button), the cutting cycle is now seen as a semi-completing process and therefore, machine settings for both the IB and OB flanks are available. This also means that the Vertical Position of the Bearing Pattern on each tooth flank can be controlled individually.

🚀 Pinion [Spiral-Bevel] [Finishing]][Nominal] 66809943400 11x47	_m6,4806.hyg - [🎫	
Blank Cutter Machine Hi Order	Other Operating Rim-Mate	rial Bearings Arbor	🛫 B.Pattern Development - Gear Convex-IB
Cutting Machine	Phoenix	🔘 [in] 💿 [mm]	BP Definition D-MSett [mm] LTCA E/P Prop. Links
	Concave-OB	Convex-IB	Nean Point / Convex-IB Mean Point / Concave-OB
Radial Distance	184.72866	182.72495	Horizontal Position 52.2 % Horizontal Position 52.5 %
Cutter Tilt	0.0000	0.0000	Vertical Position 50.0 % Vertical Position 50.0 %
Swivel Angle	0.0000	0.0000	Diff. in Radius / Convex-IB Diff. in Radius / Concave-OB
Offset	0.00000	0.00000	Free Free
Machine Root Angle	13.1726	13.1726	○ Fixed 3.0000 [mm] ○ Fixed 3.0000 [mm]
Machine Center To Back	0.00000	0.00000	
Sliding Base	-5.36527	-5.36527	Profile Crowning / Pinion Profile Crowning / Gear O Free O Free
Rate of Roll	4.390069	4.390069	○ Fixed 0.0400 [mm] ○ Fixed 0.0450 [mm]
Cradle Angle	50.2296	48.4454	
			Backlash
			© Free
			Fixed 0.161 [mm]
	Арр	y OK Cancel	Apply < <back next="">> Reset Print OK Cance</back>

20) When using the *File -> Save As* command to save an existing gear set under a new name or in a different folder, HyGEARS checks to see if the geometry is saved in a different folder and, if so, HyGEARS copies the *Operations.fil* and *Processes.fil* files from the origin folder to the destination folder.

21) Improvement in the stability of the *RemT* function (Remove Tilt) where cutter tilt is replaced by a combination of Ratio of Roll and Helical Motion in generated gear sets.

22) Addition of the *DXF* function button [optional] to the *Geometry* display mode. The DXF function exports the different aspects of the tooth of the selected member:

- the Tooth Section,
- the Gap Section,
- the 3D Tooth Model (with 1 to Z teeth).

The Tooth and Gap sections can be obtained:

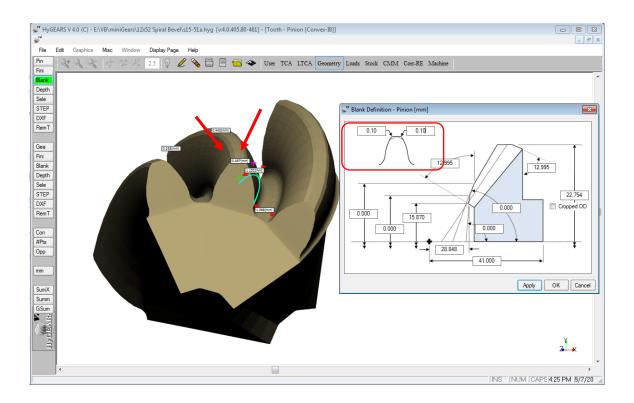
- at Toe,
- at Mid Facewidth,
- at Heel.

Furthermore, the Tooth and Gap sections can be obtained:

- In the Transverse plane, with the axial coordinate Z = 0,
- In the Transverse plane, with the actual axial coordinate Z,
- In the Normal plane.



23) Addition of Tip Chamfer to the Blank definition. The Tip Chamfer value is assumed to bisect the tooth flank and topland in equal parts to the given depth. It is used **solely** for kinematic purposes, i.e. to determine how large the chamfer should be in order to prevent tip to fillet interference, and therefore has no connection with any Operation in 5Axis mode.



24) When creating a New Geometry, the various gear types offered in HyGEARS are now displayed in an alphabetically sorted list.

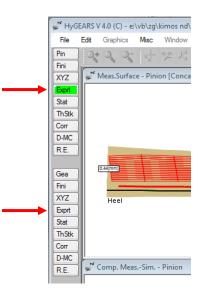
Names			
Geometry Name	Test-1-Spiral-Bevel		
Directory	E:\VB\		
Geometry Source File	SpirBevl.lst		
Types			
Geometry Type	Spiral-Bevel		
Material	Beveloid Coniflex		
Pinion Tooth Hand	CurFace		
Tooth Taper	Ext. Spur-Helical Face Clutch		
	Face Gear		
Misc	Heningbone		
Power [Kw] / Torque [N-m]	Int. Spur-Helical		
Pinion Speed (RPM)	Involute Spline Spiral-Bevel		
Number of Teeth [Pinion - Gear]	Spurved		
Module/Pitch Diameter	Straight Bevel (Generated) Worm Gear		
Gear Tooth Face Width	Zerol		
Shaft Angle	90.00.00		
Depth Factor (Gear)	3.530 AGMA / ISO		
Addendum Factor (Gear)	0.103 O AGMA		
Clearance Factor	0.125 O ISO		

25) When creating a new Face Gear geometry, the desired Backlash is now offered as an input field, as shown below.

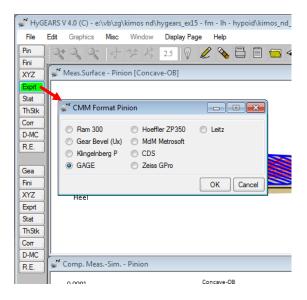
Geometry Name	Test-25-Face Gear
Directory	E:\VB\
Geometry Source File	Facegear.lst
Types	
Geometry Type	Face Gear 🔹 👻
Material	AISI 4140 👻
Pinion Tooth Hand	Left 🗸 🗸
Misc Power [Kw] / Torque [N-m]	375.00 2237.09
Pinion Speed (RPM)	1600.00
Number of Teeth [Pinion - Gear] Module/Pitch Diameter	17 1.647 28 10,000000 / 279,9999
Gear Tooth Face Width	10.000000 / 279.9999 42.500
Pinion Offset	42.500
Backlash	0.2500

If the entered Backlash is less or equal to zero, HyGEARS will use as is the given XFactor (i.e. Profile Shift factor) for the Gear member. If the entered Backlash is greater than zero, then HyGEARS will adjust the XFactor for the Gear member to reach the desired Backlash.

26) In the Corr-RE display mode, addition of the "*Exprt*" function button to the Pinion and Gear groups.

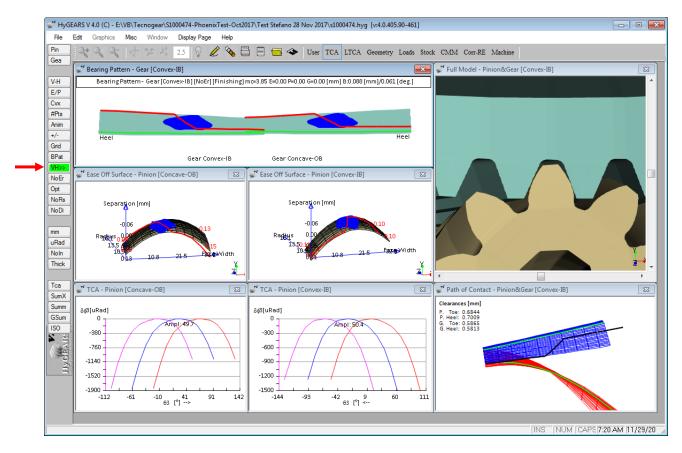


The *"Exprt"* button calls the CMM Nominal Format window, figure below, where one can select the format in which the currently loaded CMM file will be exported (can be a Nominal or an actual CMM output file).



This means than the coordinates of the currently loaded CMM file will be exported in the selected format (GAGE is selected in the figure above), whatever the format the CMM coordinates came in. Since the tooth flank normal vector at each point of the original CMM file are not conserved - often, they simply are not given in a CMM output file - HyGEARS will provide normal vector values based on the machine settings of the digitized tooth, Pinion or Gear. Therefore, slight differences in normal vector components can be expected if there is a significant difference between the digitized tooth and the CMM data. In practice, the noted differences in normal vector components are at the 2nd or 3rd decimal, and are therefore rather insignificant in effect.

27) Addition of the VH>> function to the TCA mode.



The VH>> function is used during Bearing Pattern Development to convert actual E, P and G V-H Settings into machine settings changes used to produce the desired Bearing Pattern. This avoids using Gleason's Proportional Changes.

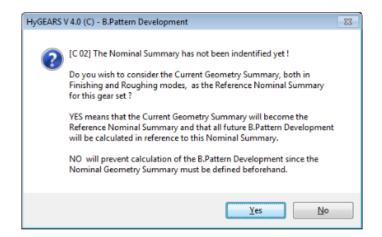
At the manufacturing stage of a gear set, it is common practice to use surface measurement to quantify the difference between the theoretical tooth surfaces and those produced on actual machines, which requires the use of a Coordinate Measurement Machine, or CMM.

When a CMM is not available, the V-H test is used, where the pinion and gear members are operated under a light load using marking compound to locate the Bearing Pattern on the tooth flank and modify the relative operating positions of the pinion and gear member until the desired Bearing Pattern is obtained.

Once the E P G positions needed to produce the desired Bearing Pattern are found, they must be converted to actual pinion machine settings changes. The VH>> function is used to convert the E P G values of the V-H test into actual machine settings.

As for Corrective Machine Settings, before calculating any VH>> machine settings changes, the Nominal Summary must be defined. This is done by HyGEARS upon confirmation by the user the first time the VH>> machine settings changes algorithm is accessed (see figure below).

Once the Nominal Summary has been defined, all VH>> machine settings changes will be calculated in reference to the defined Nominal.



The E P G values required for the VH>> function are entered through the following *V*-*H Settings* window, which is displayed after the above confirmation has been done:

e-P-G	mm] - Hy	poid BMW_M3	_8-38 💌
E: (Pinion Offset)	0.0000]	
P: (Pinion Axial)	0.0000	Pinion Radial	0.0000
G: (Gear Axial)	0.0000	Gear Radial	0.0000
	Apply	Reset OK	Cancel

The E P G values and signs are as recorded on the VH tester, i.e.:

- P+: when the Pinion moves away from the Xp
- G+: when the Gear moves away from the Xp;
- *E*+: when a LH Pinion goes up (the movement is considered on the Pinion).

In short, the VH>> algorithm uses the Nominal Summary to evaluate the differences between the theoretical and actual (meaning under E, P and G changes) Bearing Pattern location, and bases the modification of each machine setting on the amount of change in Bearing Pattern position.

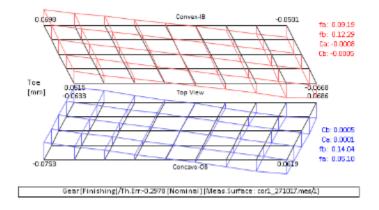
Each machine setting modification is then added to the latest Summary version in the history of the considered pinion. It is therefore imperative that the geometry data file be saved on disk after VH>> machine settings changes have been calculated and applied. HyGEARS automatically proposes to do so.

HyGEARS maintains a history of the different VH>> machine settings changes that were calculated for the pinion, provided the geometry is saved after VH>> machine settings changes have been calculated and applied. The Bearing Pattern Development History can be reset, or completely erased, using the Main Menu *Edit->Reset Bearing Pattern History* function.

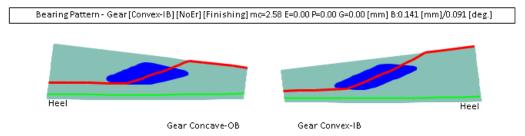
Up to 7 VH>> machine settings changes steps are currently allowed in HyGEARS, which should be sufficient for most applications.

Example:

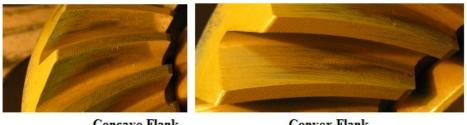
A 9x37 RH spiral bevel gear set is being developed. The gear member is already cut - but differs from the original design as shown below - and the pinion needs to be cut to mesh correctly with the gear.



The target contact patterns appear below:



Upon running the gear set on the VH tester with the design MD (mounting distance), the contact patterns came out as show below, i.e Toe heavy on the gear convex flank, and a bit towards Heel on the gear concave flank:

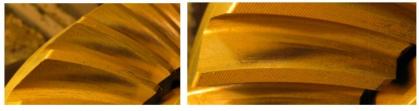


Concave Flank

Convex Flank

In order to center the contact pattern on the tester, the following E P G values were required, which yielded the contact patterns shown below:

- E: -0.62 mm
- P: +0.70 mm
- G: -0.35 mm



Concave Flank

Convex Flank

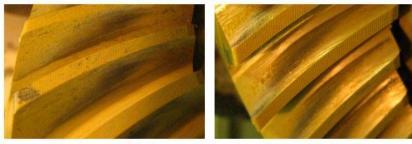
Using the VH>> function, the above values were entered in HyGEARS, a new pinion Summary was obtained and used to cut the pinion, and the following contact patterns were obtained on the gear:



Concave Flank

Convex Flank

Clearly, the contact patterns went where desired by the developer at the 1^{st} iteration.. The fact that the gear member was not cut to target does affect the precision of the solution, but does not prevent obtaining a good solution. Doing a 2^{nd} iteration yielded the following result:



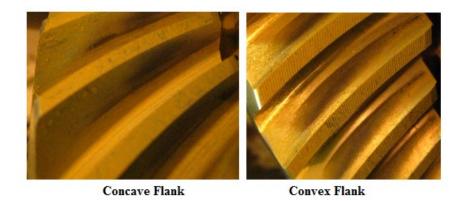
Concave Flank

Convex Flank

Here, what would be needed is to :

- Reverse Engineer the gear to the CMM data using the HyGEARS R.E. function,
- develop the contact pattern by modifying the pinion machine settings using the HyGEARS *BPat* function,
- use the HyGEARS VH>> function as explained above.

Doing so, the results shown below are obtained after 1 iteration. Clearly, the results converge very quickly. A 2nd iteration could be applied in order to improve a bit more the contact pattern on the Concave flank.



28) Addition of a 2nd manufacturing method for Beveloid gears [external].

Up to HyGEARS Build 405.80, [external] Beveloid gears were based on a *Pivoted Work*, i.e. the work piece axis would be pivoted by the specified pitch angle such that the tool would move in a straight direction that would be at an angle to the axis of the work.

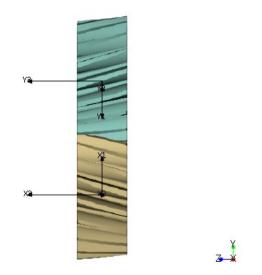
From Build 405.90, figure below, the *Plunging Tool* option is also offered where the axis of the work is installed in the machine as if cutting a spur gear, but the tool plunges progressively as the tool advances along the face width: in effect, the *Profile Shift* factor changes continuously as the tool moves along the face width.

The *Pivoted Work* approach produces a gear set which is slightly not-conjugate. In both cases, *Pivoted Work* and

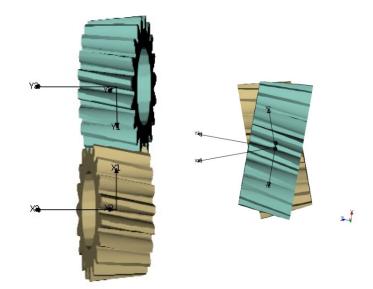
Plunging Tool, the helix and blades angles of the pinion are adjusted in order to center the Contact Pattern.

Wew Geometry Definition - [mm] [definition - [mm]] [definition - [d.mm.ss]	
Names		
Geometry Name	Test-1-Beve	loid [Ext]
Directory	C:\HyGEAR	S40Data\
Geometry Source File	Beveloid.lst	
Types		
Geometry Type	Beveloid [Ex	t] 🗸
Material	AISI 4140	•
Pinion Tooth Hand	Left	•
Cutting Method	Pivoted Wor	k 🔽
Misc	Pivoted Wor Plunging To	
Power [Kw] / Torque [N-m]	26.19	249.98
Pinion Speed (RPM)	1000.00	
Number of Teeth [Pinion - Gear]	19	1.000 19
Module/Pitch Diameter	1.750000	/ 33.250
Gear Tooth Face Width	15.000	Input Plane
Number of Planets	0	Normal Plane
Backlash	0.0020	💿 Transv. Plane
Shaft Angle	0.0000	
Pitch Angle [Pinion - Gear]	6.0000	-6.0000
Offset	0.0000	
	Import	< <back next="">> Canc</back>

In addition, the Pitch Angle of both the Pinion and Gear can now be entered such that both members, or only 1, can be Beveloid, and can be of same value but opposite signs such that the axes of the Pinion and Gear are //, as is shown in the figure below.



Finally, a Shaft Angle and a Pinion Offset can be imposed. For example, figure below, the Pinion and Gear Pitch Angles are respectively +6 and -6 deg, and a 20 deg. Shaft Angle is imposed. The resulting parts have // axes in one plane (left, below), and non // axes in the perpendicular plane (right, below).



As another example, for the same Pinion and Gear Pitch Angles and Shaft Angle, the left gear set below has no Pinion Offset while the right gear set has a 10mm Pinion Offset.

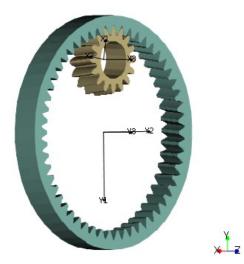


0 mm Pinion Offset

10 mm Pinion Offset

29) Introduction of *Internal Beveloid* gears [new HyGEARS option] where either the Pinion, Gear or both can be Beveloid, and cut either with a *Pivoted Work* or *Plunging Tool* like external Beveloid gears.

For example, left figure below, the Pinion has a -5 deg. Pitch Angle while that of the Gear is +5 deg. The end result is a gear set with // axes where shifting the Pinion axially allows backlash control. By contrast, right figure below, both the Pinion and Gear have the same Pitch Angle, and the result is a gear set where the axes are not //; however, shifting the pinion axially still allows backlash control.





HyGEARS update - 09 September 2019 - Build 406.00 - 463

1) HyGEARS can now be used in German, thanks to the work of Dr. Ing. Joachim Thomas of ZG Hypoid (see www.zg-hypoid.de). Although HyGEARS is not entirely translated in German, it is substantially so, and this will improve as time allows.

To change to German, click on the menu sequence Edit -> Configuration to access the General data page and select Deutsch. When the language has been modified, HyGEARS must be restarted; a message is displayed to that effect.

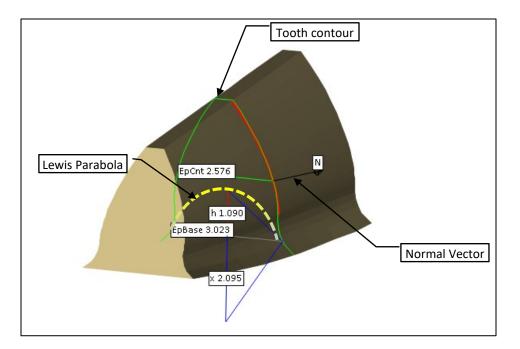
	🕷 Cont	figuratio	on HyG	EARS V 4.0 ((C)			>	<
	General	Units	Fonts	Graphics	Colors	Displa	y		
	Bell			No		~			
	Langu	lage		English		~			
	Log Fi	ile		Francais					
	Num.	Diff. Incr	ement	English Deutsch			-		
	AutoS	ave Inte	rval	1000					
		etry Fold		E:\VB					
		ort Folder		C:\Users\c	-			-	
	Tool F	older		C:\Users\c	gosselica	\Docur	ments\ł	łу(
					Apply	(ок	Cancel	
HyGE	ARS V 4.0) (C)							
-									
				figuration restarted.	has be	en ac	cessed	i. Hyge/	ARS
	Plea	se clos	e HyGE	ARS and s	tart a n	ew se	ssion		
								0	K

2) For Hypoid pinions, the effective face width for the LTCA Bending Stress is now calculated slightly differently such as to produce results more consistent with FVA's Becal 6.

3) For all supported gears, the calculation of the tooth form factor used for the bending stress has been reviewed to be more general, and especially to be closer to the original Lewis Parabola.

In the following figure,

- **N** is the local tooth flank normal vector for one given position on the Path of Contact (PoC);
- the green outline is the intersection between the plane in which vector **N** lies and the tooth itself;
- at the given position along the PoC, *EpCnt* is the tooth thickness on the green outline;
- vVector **N** is extended until it crosses the center of the tooth;
- the Lewis Parabola (yellow dashed line below) is then calculated from this position, i.e. it is centered at the upper end of dimension *h* (in red) and is tangent to the fillet where *EpBase* touches the fillet contour.
- dimension **x** is an intermediate value used in the calculation of the tooth form factor.



4) In the Strength Calculation of the GSumm output, the TOOTH LOADS now have either a + or – sign in order to be consistent with the KISSSoft output.

Graphics Summary - rr-2-12-37.spe	ecial_analysis.hyg [mm] [deg] 🛛 🗙	
TCA LTCA Grids WC Driv	ve WC Coast	
Blank Data Tooth Loads Strength calculations Machine Settings - Pinion Rough	☑ Pinion Blank ☑ Gear Blank	Strength Calculations
Machine Settings - Gear	☐ ISO 10300	PINION GEA
	Apply OK Cancel	Pinion Driving Side : CONCAVE-OB Transmitted Power [Kw] : 74.60 Rotating Speed [Rpm] : 1000.00 Torque [N-m] : 712.05 Operating Pitch Dia [mm] : 51.75 159.5
		TOOTH LOADS - Based on ACTUAL angles Pinion Concave-OB : Tangential Load [N] : +12519.40 Axial Load [N] : +18278.69 Radial Load [N] : +1529.51 Normal Load [N] : 31463.89 Applied Load [N] : 31704.22
		Tangential Load [N]: +2.519.40 +2.719.4 Axial Load [N]: -11446.55 +1554.5 Radial Load [N]: +1163.62 +1147.0 Normal Load [N]: 3440.64 382.1 Applied Load [N]: 3616.87 3130.9

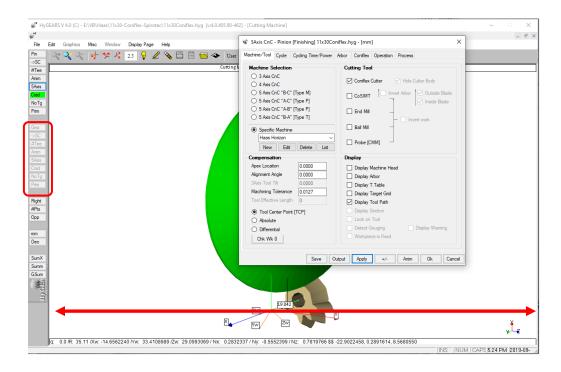
5) In the Strength Calculation of the GSumm output, addition of the "TOOTH LOADS – Based on REFERENCE angles" where the REFERENCE angles are the pressure and spiral angles that are either calculated when a New Geometry is created, or else obtained when importing from a KIMoS or a Gleason Spa file.

TOOTH LOADS - Based on	REFERENCE a	ingles	
Pinion Concave-OB Tangential Load Axial Load Radial Load	[N] : [N] : [N] :	+27519.40 +18681.43 +6099.99	+27519.40 +6099.99 -18681.44
Pinion Convex-IB Tangential Load Axial Load Radial Load	[N] : [N] : [N] :	+27519.40 -11545.25 +15903.24	+27519.40 +15903.24 +11545.25

6) In Machine mode, when accessing 5Axis through the [5Axis] button, HyGEARS now:

- maximizes the display Child Window for the selected member, pinion or gear, and
- disables the function buttons for the non-selected member, gear or pinion,

such as to give more display area and avoid clicking on a wrong button or in the non-selected member's display area whence HyGEARS will exit the current 5Axis session. When the 5Axis window is exited, the Child Window returns to its normal 2 Child Window state.

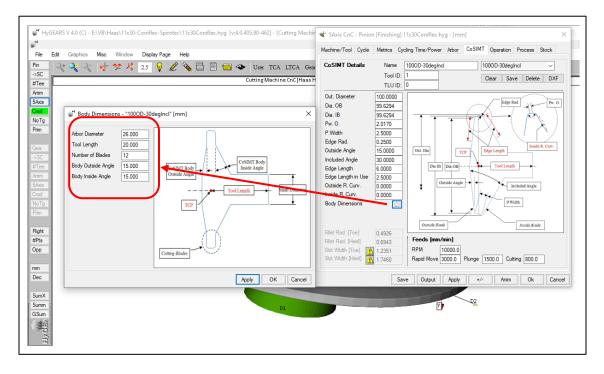


7) In 5Axis, for CoSIMT tools, the Body Dimensions are now accessed from a different window through the Body Dimensions [...] button, as shown below. Body Dimensions include:

- Arbor Diameter;
- Tool Length;
- Number of Blades;
- Body Outside Angle;

• Body Inside Angle.

The 2 last values were previously taken as being the same as the Outside Angle and Included Angle; they are now variables that can be changed to suit a specific CoSIMT body geometry.



8) In 5Axis, it is now possible to select the "Rock Me [babe]" cycle for either of the flanks or both; to select only one flank, it is simply required to make the opposite flank as "None". In this case, the movement will be only on the selected flank.

Machine/1001 Cycle Methos C	yoling Time/Power Arbor CoSIMT Operation Process Stock	eometry Loads Stock CMM Corr-RE Machine
Output Format Use Actual Tooth CSV Format Line Numbers Include Operation Switches Include Short Header Include Short Header Explicit Indexing No Comments Coordinates Only Work Coordinates	Stock-Feed Reqd. Sugg. Actual # Steps 9 [9] Stat 1 Steps # Botomland Pts 0 End 9 Tgt.Pts # Facewidth Pts 11 Bottom Up Tgt.Pts Retract Factor 1.5 0.0000 0.0000 Constant D-Radus Fnink Stock 0.100 0.000 Clearance [mm] Indexing Sequence 1.00 1.00	-840D] Pinion (Finishing)(Nominai) - Right
Tool (Seeners) Haas Horizon Cutting Cycle Sot by Sot Rank by Rank Filet-Root Conbined Charrier Tool Side Charrier Tool Side Charrier Tool Side Charrier Tool Side Charrier Real	(□.000) O Toe → Heel O Toe → Heel Fixed Heel → Toe Heel → Toe Heel → Toe 0.800 0.800 Shape-Toe ORLB OShape-Toe ORLB OShape-Toe 0.000 0.1800 Shape-Heel OB-18 OShape-Heel OB-18 OShape-Heel	
S	ave Output Apply +/- Anim Ok Cance	

9) In 5Axis, Process tab, it is now possible to over-ride the Apex Location imposed in individual Operations of a given Process by entering the desired value in the Apex Loc. field, as shown below. When the Process is saved, this value is saved such as to be available the next time the same Process is used.

acrime	/Tool Cycle Metric	s Cycling Tir	ne/Power	Arbor	Ball Mill	Operation	Process	Stock	
Proce	sses								
Name	66811232800_Rou_	L		668	1123280	0_Rou_L			\sim
ID #:	6001						🗹 Internal		ine
	Save Delete	Import Su	mm Outp	out		Apex Loc.	No Com 200	iments	
	Available Operations		← -	> Pro	cess Con	tent		1	↑
	FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_Fin_CC_ FG_C_BM_R_CC_0 FG_C_BM_R_CC_0 FG_C_BM_R_CC_1 FG_C_BM_R_CC_1 FG_C_BM_R_CC_1 FG_C_BM_R_CC_1 FG_C_BM_R_CC_1 FG_C_BM_R_CC_1 FG_C_BM_R_CC_1 FG_C_BM_R_CC_3 FG_C_5FG_C_3 FG_C_5\\FG_C_5\\	FHT_0-55/60 FHT_0-75/70 FHT_0-75/77 FHT_0-75/77 FHT_0-75/77 FHT_0-75/77 FHT_0-75/77 FHT_0-75/77 FHT_0-75/77 FHT_0-75/77 FHT_0-97/99 O(20_010 0/20_010 9/20_010 </td <td>_D4_B+ _D4_B+ _D5 _D5_B+ _D5_B+ _D3_B+ _D3_B+ _D5_B+ _A+ _A+ _A+ _A+ _A+ _A+ _A+ _A+ _A+ _A</td> <td>FG FG FG FG FG FG</td> <td>C_BM_F C_BM_F C_BM_F C_BM_F C_BM_F C_BM_F C_EM_C C_EM_C</td> <td>{ CS 11-11 { CC 0-12 { CC 0-12 { CC 1-14/ { CC 1-7-24 { CC 2-7-28 { CC 32-37 h ∏p-0.25 h _ Tp-0.25 h _ Heel-0.5</td> <td>4_D12_B- 24_D12_B- /30_D8_B- /34_D6_B- /38_D5_B- _D19_B- _D6_B-</td> <td></td> <td></td>	_D4_B+ _D4_B+ _D5 _D5_B+ _D5_B+ _D3_B+ _D3_B+ _D5_B+ _A+ _A+ _A+ _A+ _A+ _A+ _A+ _A+ _A+ _A	FG FG FG FG FG FG	C_BM_F C_BM_F C_BM_F C_BM_F C_BM_F C_BM_F C_EM_C C_EM_C	{ CS 11-11 { CC 0-12 { CC 0-12 { CC 1-14/ { CC 1-7-24 { CC 2-7-28 { CC 32-37 h ∏p-0.25 h _ Tp-0.25 h _ Heel-0.5	4_D12_B- 24_D12_B- /30_D8_B- /34_D6_B- /38_D5_B- _D19_B- _D6_B-		

10) In 5Axis, the Short Header now includes the Apex Location entry such as to allow the engineer/operator ensure Operations within a Process all use the correct value.

🕷 Part	Program for : Gea	r (Finisl	ing] BMW_M3_Rad_li_V1-2. — 🗆 🚿	×
File	Edit			
; PROC	6001		V4	1
;****	******	****	***************************************	
; PROG	RAM NAME			
; PROG	RAM DATE		12-04-2018 / 08:05:02	
; SUMM	ARY VERSION		[Nominal]	
;TOOL	ID		1	
;TOOL	DIAMETER		2.54[mm]	
;TOOL	LENGTH		18.75[mm]	
	LOCATION			
;****	*****	****	******	
	;		Start Definitions	-
DEF I	NT TOTAL_TEE	TH	= 49	
<	_		>	

11) In 5Axis, all the CnC cycles are now enabled when roughing with a CoSIMT.

🐝 5Axis CnC - Pinion	[Finishir	ng] 11x30Coniflex.hy	g - [mn	ן ו				×
Machine/Tool Cycle	Metrics	Cycling Time/Power	Arbor	CoSIMT	Operation	Process	Stock	
Output Format Use Actual Tooth CSV Format Line Numbers Include Operation Include Short Hea Explicit Indexing No Comments Coordinates Only Work Coordinates	Stock-Feed # Steps # Bottomland Pl # Facewidth Pts Retract Factor Moving Contact Constant D-Rad Roughing	0 3 1 19.743 1.5 Pt - Over Run 0.0000 iius - Finish Stock 0.100 Ø - Rough Stock 0.100						
Traori (Siemens) Haas Horizon Cutting Cycle Slot by Slot Flank by Flank Fillet-Root Tooth Flank Combined Chamfer Tool Side Chamfer Tool End Chamfer Toe Chamfer Heel	Depth	it 10.00 ivot 0.000 Fixed 0.000 A. 0.000 0.000 0.000	Heel -> T Foe -> H Heel -> T B-OB OS B-OB OS Center SI	Min eel -> Toe oe -> Heel eel oe Shape-Toe Shape-Heel ot enter Slot		End Ga	-> Toe -> Heel pe-Toe pe-Heel eration	
		Save Output	Apply	+/-	Anim	Ok	Cano	cel

12) In 5Axis, addition of the Feed Rate to the Haas Horizon non-generated cycle output where the plunging rate is therefore controlled.

∰ [™] Pa	art Program for : Gear [Finishing] BMW_M	I3_Rad_li_V1-2.HyG		-		×
File	Edit					
FOOL TLDA' MSYS, \$\$ c. PAIN' PAIN' FEDRJ GOTO, FEEDD GOTO, FEEDD	PATH/Tooth# 0,TOOL,MILL PATH/Tooth# 0,TOOL,MILL IA/MILL,76.7872582,0.000000 (0.0000000,0.0000000,0.00000 enterline and contact point I/PATH I/SPEED,10 I/COLOR,31 AT/1.0000000 /2.5156845,76.5103932,-28.81 AT/1.0000000 /-3.0266079,76.5103932,-26.81 AT/0.5500000	00,0.0000000,-1.0 1700838,0.9234876,0	000000,0.0000000,1.000 0.0000000,-0.3836283 .0000000,-0.3836283	00000,0.	0	14
GOTO	/-2.6802146,76.5103932,-26. RAT/0.1500000	217725,0.9234876,	0.0000000,-0.3836283			
PAIN PAIN	/-4.7585742,76.5103932,-25.8 I/SPEED,10 I/TOOL,NOMORE DF-PATH	3583959,0.9234876,	0.0000000,-0.3836283			ļ
<						> .

13) In 5Axis, slight modification to the Return Trip to give a more predictable path when in Work coordinates: the retracted tool position at the end and beginning of the cutting cycle are used to establish start and end positions of the tool; the axial location of the tool is then interpolated linearly over the requested # Steps in the Return Trip, and when reaching the start position, the other coordinates and angles are imposed.

14) In 5Axis, the Process summary - [Summ] function button – now adds the Feeds used for the cutting cycle.

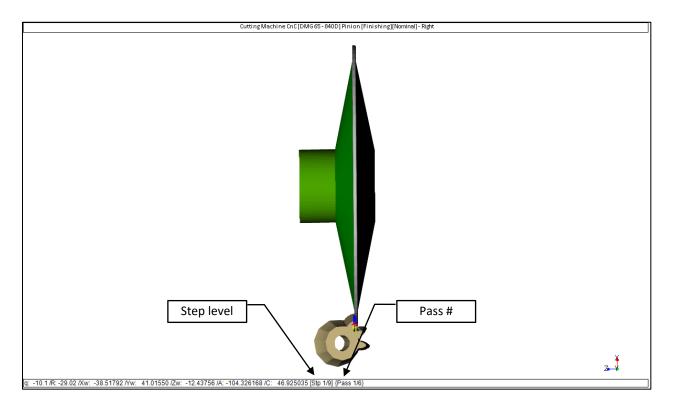
	dit					
PROCESS: XXXX : 14x44_m6.hyg [mm]						
Seq#	1	2	3	4	5	6
OpID OpName Machine	6001	6001	6001	6001	6001	6001
Target	Combined	Combined	Combined	Combined	Combined	Combined
Tool	EndM	BallM	BallM	BallM	BallM	BallM
DLen	N/A	N/A	N/A	N/A	N/A	N/A
ToolName	JHP993080D2C.0Z4-SIRA	JH970100-TRIBON	JH970100-TRIBON	JH970080-TRIBON	JH970080-TRIBON	JH970080-TH
ToolID	1	1	1	1	1	1
in O	p 1	1	1	1	1	1
Dia	8.0000	10.0000	10.0000	8.0000	8.0000	8.0000
ApxLoc	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
#Steps	20	20	20	20	30	40
Start	11	0	1	9	18	33
End	11	0	9	12	23	39
ToeClr	12.000	12.000	12.000	11.000	10.000	9.000
HeelClr	10.000	10.000	10.000	10.000	8.000	8.000
Gaps	1->44	1->44	1->44	1->44	1->44	1->44
Stock	+0.500	-0.119				
	e 20000.0	20000.0				
Plunge						995.0
Feedl						995.0
Feed2						995.0
Feed3			2400.0	2300.0	1780.0	
Feed4		2350.0	2350.0	2285.0	1400.0	
Time[']	2.8	3.0	19.0	8.6	17.5	33.4

15) In 5Axis, the [Save] button has been added to the action buttons at the bottom of the 5Axis window. The [Save] button saves the current Operation and eliminates the need to always go back to the Operations page to be able to save any change made on another page.

🐝 5Axis CnC - Gear [Finishing] 60	5813738000 14x44_m6.	hyg - [mm]	×
Machine/Tool Cycle Metrics Cy	cling Time/Power Arb	or Ball Mill Ope	eration Process Stock
Output Format	Stock-Feed	Reqd. Sugg.	Actual
Use Actual Tooth CSV Format Line Numbers Include Operation Switches Include Short Header Include Short Header Explicit Indexing No Comments Coordinates Only Work Coordinates Traori (Siemens) Haas Horizon	# Steps # Bottomland Pts # Facewidth Pts Retract Factor Moving Contact Pt Constant D-Radius Roughing Clearance [mm] Toe 8.000 Heel 4.000	60 [60] - 0 21 1.5 - Over R - Fillet St Flank S	Start 0 Steps End 60 Ø Tgt.Pts Bottom Up 0.0000 0.000 0.000 ock 0.0000 0.000 0.000 ock 0.000 0.000 0.000 ing Sequence # /4 Start Gap 1
Cutting Cycle	Left		Right
 Slot by Slot Flank by Flank 	O None	- > Heel -> Toe	○ None ● Toe -> Heel -> Toe
 Fillet-Root Tool Tilt Tool Flank Combined 	t 0.000 O Toe Eived O Heel	-> Toe -> Heel > Heel -> Toe 3 OShape-Toe	 Heel -> Toe -> Heel Toe -> Heel Heel -> Toe OB-IB OShape-Toe
Chamfer Tool Side Chamfer Tool End Chamfer Toe Chamfer Heel	0.000 O IB-OI 0.000 O Rock	3 OShape-Heel Me [babe] ge Generation	OB-IB OShape-Heel MultiPass Plunge Generation VCut Heel-Toe
	ive Output Apr		Anim Ok Cancel

16) In 5Axis, when using the MultiPass cutting cycle, the current "Step #" and "Pass #" are added to the coordinates, along with the # of passes required for the considered Step level. For example, figure below, the current Step level is

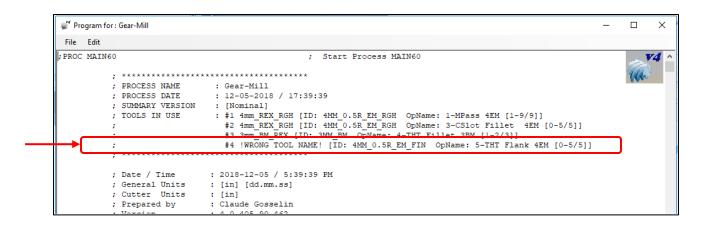
given as [Stp 1/9], which means there are a total of 9 steps considered, and the tool is at Step 1; the current Pass # is given as {Pass 1/6} which means there are 6 passes required at Step 1, and the tool is currently at Pass 1.



17) In 5Axis, when a requested tool is not found, a warning message is displayed where the missing tool name is given, as shown below.

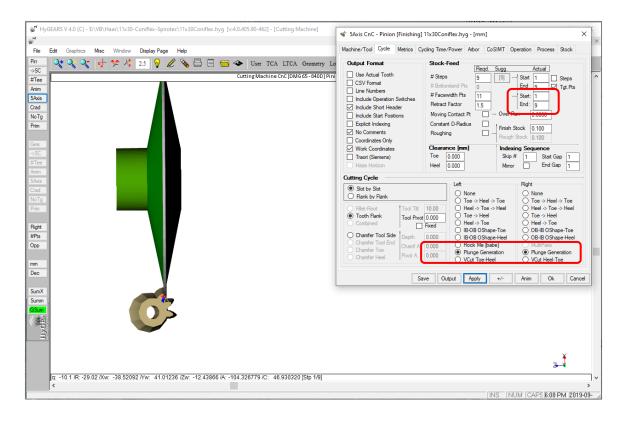


In addition, in a Process Summ or in the Short Header, the "!WRONG TOOL NAME!" string replaces the requested tool name.



18) In 5Axis, for CoSIMT tools, HyGEARS now offers the Plunge Generation cutting cycles, one for each flank. Plunge Generation moves the CoSIMT from Tip to Fillet along the profile of the tooth at the requested position along the tooth flank.

As before, the tooth flank is subdivided as imposed by the "# Facewidth Pts"; however, in Plunge Generation, it is possible to instruct HyGEARS to start and finish at specific locations, such that the same plunge generation movement used for Coniflex gears can be used with CoSIMT tools.



For example, figure below, the tooth is subdivided in 7 points (# Facewidth Pts); Start and End points are 4, and therefore, the path will be in the center of the tooth (red arrow). Toe and Heel clearances have conveniently been set to zero such that the location of the tool path is not affected.

N et t	CONTRACTOR AND A CONTRACTOR ANTE ANTE ANTE ANTE ANTE ANTE ANTE ANTE	_
WHYGEARS V 4.0 (C) - E\VB\Haas\11x30-Coniflex-Spirotec\11x30Coniflex.hyg [v:4.0.405.90-462] - [Cutting Machine]	📽 5Axis CnC - Pinion [Finishing] 11x30Coniflex.hyg - [mm]	۲_
N. Contraction of the second sec		×
File Edit Graphics Misc Window Display Page Help	Machine/Tool Cycle Metrics Cycling Time/Power Arbor CoSIMT Operation Process Stock	
Pn SCC SCC Crad NoTg Ptm Gea SCC STEE SCC SCC SCC SCC SCC SCC SCC S	Output Format Stock-Feed Regd. Sugg. Actual	~
Anin SAus Crad No Tg Prin Refit #Prin Cop mm	Cutting Cycle Left Right © Bank by Bank Once Toe > Heel > Toe Toe > Heel > Toe © Flank by Bank Tool Tix 10.00 Toe > Heel > Toe Toe > Heel > Toe © Tooth Rank Tool Tix Tool Tix 10.00 Toe > Heel > Toe Toe > Heel > Toe © Control Flank Tool Tix Tool Tix 0.00 Toe > Heel > Toe Toe > Heel > Toe Onamfer Tool Side Depth for Down for 0.000 OB/B00 Shape-Toe OB/B0 Shape-Toe Onamfer Tool End Duarf A 0.000 Punge Generation VCut Toe-Heel Onamfer Tool End Punge Generation VCut Toe-Heel VCut Toe-Heel VCut Heel-Toe	
Dec SumX Sum GSum	Seve Output Apply +/- Anim Ok Cancel	
q: 10.3 /R: 29.53 /Xw: 39.39243 //w: 40.79063 /Zw: -11.15069 /A: -75.719342 /C: -47.436877 [Stp 1/9]		 ~
<		>
	INS NUM CAPE 6:19 PM 2019-0	9- //

19) Introduction of a limited Math Expression interpreter to allow simple math operations in input fields. For example, it is sometimes required to add or subtract a value, such as shown below where the angle of "21.30.00" is increased by "0.5"; HyGEARS interprets this as 21.5 to which 0.5 is added.

		Links
Point Diameter 80.0000 Point Diameter 80.0000 Blade Angle 21.30.00+0.5 Blade Angle 22.0000 Cutter Tilt 23.0000 Cutter Tilt 23.0000 Point Width 1.0160 Dish Angle (Beta) 0.2540 Dish Angle (Beta) 1.0000 Black Angle 0.0000 Blade Thickness 1.0000 Black Angle 1.0000	[in]	(m)

Some basic rules to follow:

- For DDMMSS angles, the SS portion must have 2 digits; for example, 3.05.03 is Ok; 3.05.3 is not;
- The + * / operators are supported;
- The operator + * / must be followed by a value; if the integer portion of the value is less than 1, then a 0 must precede the decimal point; for example, "5.2+0.5" is Ok; "5.2+.5" is not;

- operations within parenthesis are not accepted; for example, 5.2 + 0.5 is Ok; 5.2 + (0.5 * 2) is not;
- Only 1 operation at a time; for example, "5.2+0.5" is Ok; "5.2+(0.5 * 2)" is not.

20) In Corr-RE mode, for the [Corr] and [RE] function buttons applied to generated spiral-bevel and hypoid gears, the Helical Motion is now used as an additional degree of freedom to control tooth bias (or warping) if, and only if, the reference machine used is of Phoenix type. This allows for much better control of tooth warping sometimes found in Spread-blade teeth.

21) In Corr-RE mode, for the [Corr] and [RE] function buttons, it is now possible to tell HyGEARS to "drop" some points at the bottom of the CMM grid. When undercutting is present at the bottom of the tooth, or if the bottom line of the measurement grid is near the fillet line, divergence can occur when HyGEARS is looking for the solution. When divergence occurs, the results displayed on-screen clearly show that something is not correct, and the cause is usually because the bottom line of the CMM grid is too close to the Fillet line. In such a case, HyGEARS can be told to drop, 1, 2, 3 lines at the bottom of the grid, such as to use the lines which are further away from the Fillet.

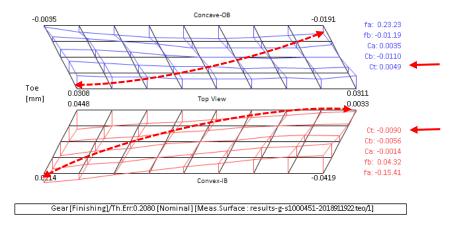
By default, this value is set to 0; it cannot exceed N-2, where N is the number of lines / flank in the CMM grid, such that at least 2 CMM grid lines are always conserved.

🛒 Reverse	Engine	ering Pini	ion - [Finishing]	×
Tolerance	Order	Machine	Links	
● 0rd ● 1st ● 2nd	Change I Middle Ra Middle Ca	ow	Tooth Flank Selection Con-OB All Spiral Angle Cvx+iB Pressure Angle Con-OB + C # lines to drop from bottom of CM Drop @ bottom: Bias	M grid
# Iterat Max. #	ions ‡ Iteratio	60	Machine Crowning Profile Phoenix V Twist	
_	Dampin alc Jacol	g bian each l	Maintain Point Width Maintain Tooth Thickness Maintain Tooth Depth	
			Apply Reset Print OK Ca	ncel

22) In Corr-RE mode, introduction of a new criterion to Correct / RE the tooth flanks: Twist. Twist is defined as the curvature along the diagonal from (figure below):

- 1. Concave Flank: Toe Tip to Heel Bottom
- 2. Convex Flank: Toe Bottom to Heel Tip

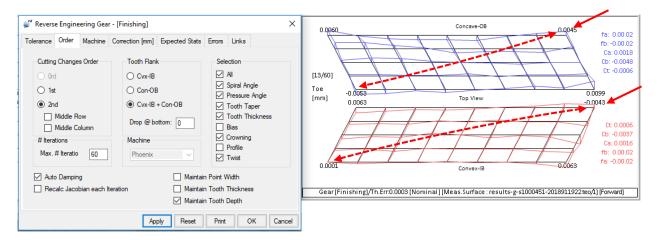
The Ct value in the figure below gives the calculated amount of Twist



For example, figure below, selecting 2nd Order with Crowning, the following result is obtained for RE; one can see that along the diagonals, some significant curvature remains.

🛒 Reverse Engir	neering Gear -	[Finishing]			× 0.0021 Concave-08 0.0162 fa: 0.000
Tolerance Order Cutting Chang Ord Ist Ord Middle Hiterations Max. # Iterati	ges Order Row Column	Correction [mm] Tooth Flank Cvx-IB Con-OB Cvx-IB + Drop @ bo Machine Phoenix	• Con-OB ttom: 0	Selection All Spiral Angle Pressure Angle Tooth Taper Tooth Thickness Bias Crowning Profile Twist	(12/60) Toe [mm] 0.0052 0.0066 Top View 0.0101 C: -0.001 C:
☑ Auto Damp □ Recalc Jac	ing cobian each Iter	ration App	│ Maintain Po │ Maintain To │ Maintain To	oth Thickness	Gear (Finishing)/Th.Err.0.0006 [Nominal] [Meas.Surface : results-g-s1000451-2018911922teo/1] [Forward]

By contrast, adding Twist to the selection yields the following result where it is clear that the curvature along the diagonals has been almost entirely eliminated.

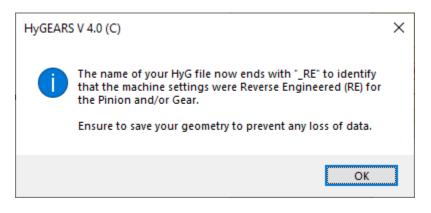


Twist is available only if the reference machine is a Phoenix.

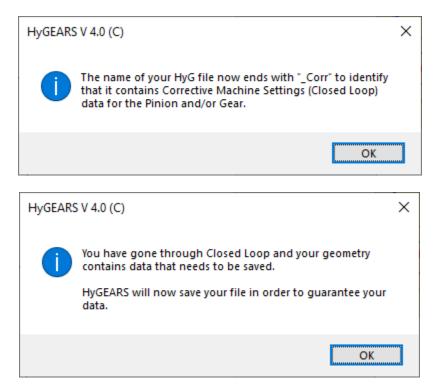
22) When using the [Corr] (Closed Loop) or [RE] (Reverse Engineering) functions, when calculations have completed and the "Ok" button is clicked, HyGEARS now automatically appends "_CORR" or "_RE" at the end of the HyG file name such as to force a "clean" use of file names. In addition, for Closed Loop (i.e. [Corr] function button), the renamed HyG file is automatically saved in the source folder such as to avoid "forgetting" to save the file after Correction is completed.

A message is then displayed on screen to inform the user of what happened.

a) [RE] (Reverse Engineering):



b) [Corr] (Closed Loop):



23) In Geometry mode, the optional DXF Export function now allows 2 more options for the Tooth Section:

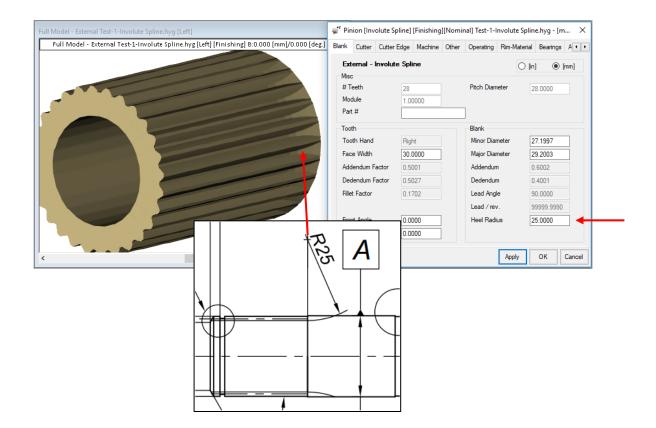
🕷 DXF Export - Pinior	n [mm] ×
 Tooth Section Gap Section Stock: 0.0000	Transverse Z=0 Transverse Z<0 Normal Toe Mid Facewidth Heel
O 3D Tooth Model	#Teeth 1
	Apply OK Cancel

- the # Teeth to be exported in the DXF file can be imposed; minimum = 1, maximum = Z;
- Stock, positive or negative, can be imposed; this can be useful for wire cutting of an internal gear or spline.

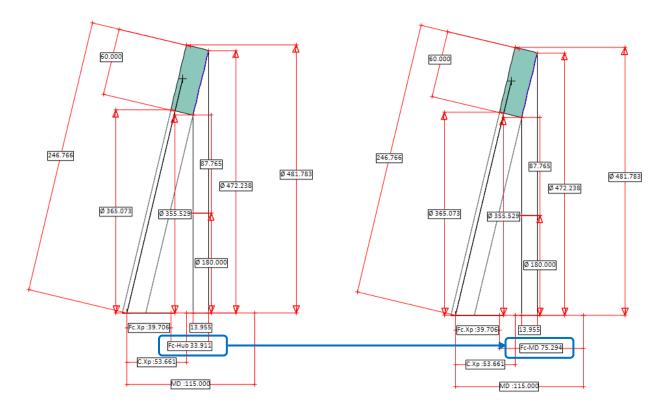
24) Machine settings for non-generated gears, i.e. Formate, now include Work Offset on Phoenix machines.

Cutting Machine Phoenix Image: Image
20:00125 Cutter Tilt 0:0000 Swivel Angle 0:0000 Offset 0:00000 Machine Root Angle 77:2019 Machine Center To Back 0:03226 Sliding Base 0:00000
Swivel Angle 0.0000 Offset 0.0000 Machine Root Angle 77.2019 Machine Center To Back 0.03226 Sliding Base 0.0000
Offset 0.00000 Machine Root Angle 77.2019 Machine Center To Back 0.03226 Sliding Base 0.00000
Machine Root Angle 77.2019 Machine Center To Back 0.03226 Sliding Base 0.00000
Machine Center To Back 0.03226 Sliding Base 0.00000
Sliding Base 0.00000
Rate of Roll 1.000000
Cradle Angle 48.5961

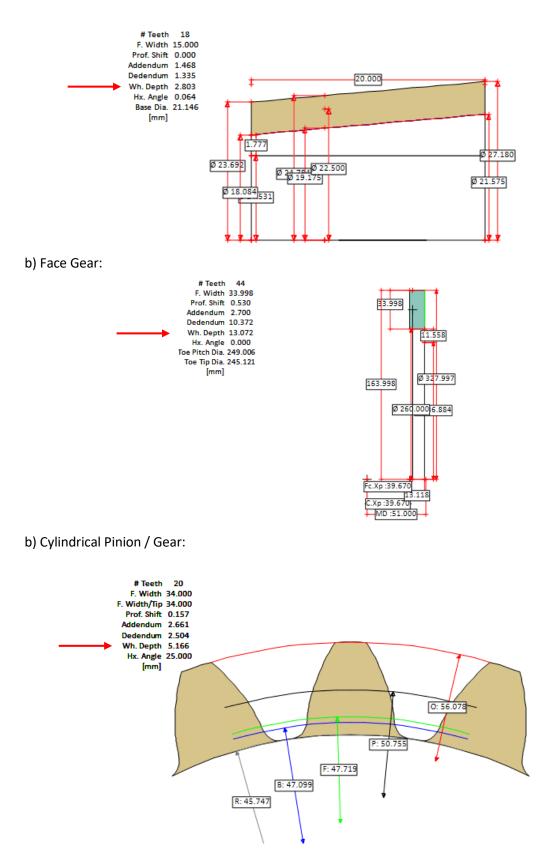
25) In Splines, the external (male) member of a spline set can now have a circular end at Heel, as shown below. The radius of the circular end at Heel is entered in the Blank data page of the Pinion Summary editor ([Pin] function button).



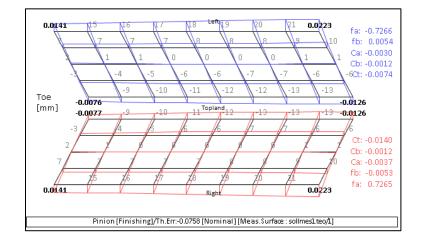
26) For bevel gears, the Blank Child Window now displays the Front Crown to Mounting Distance (Fc-MD) rather than the Front Crown to Hub (Fc-Hub) as this is deemed a more useful value to locate the part in CnC manufacturing.



27) For Beveloid, Face and Cylindrical gears, the Blank Child Window now displays the Whole Depth of the tooth.a) Beveloid Pinion / Gear:



28) When importing CMM results, HyGEARS now displays intermediate values within the gird in integer numbers, such as to allow better interpretation of the displayed results. Below, the intermediate values are rounded to the nearest μm.

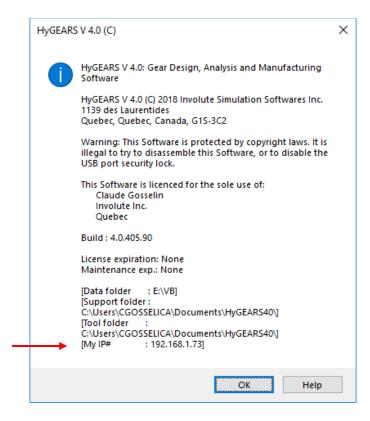


29) When importing CMM results, HyGEARS now maintains the CMM type and displays the IB and OB results in the same position as on the CMM display in order to ease comparison.

30) When creating a CMM target file for the Klingelnberg P machine, HyGEARS now ensures that the mid-points of the IB and OB grids are exactly at the same radial and axial locations, in order to make thickness errors consistent.

🐞 sollmes1.dat						_		< 🖓 🕯	ollmes2.dat						-	
File Edit								File	Edit							
2	3	-14.3520	19.7999	84.2853	5143	2242	- V4	^	2	3	-14.3335	19.6441	84.3167	.0421	.8032	V
2	4	-14.4355	21.1016	84.0295	5168	1711	- Thinks		2	4	-16.0197	19.8382	84.0451	0425	.8167	Torne to
2	5	-14.4034	22.4571	83.7738	5148	1240	- 114		2	5	-17.8393	19.8378	83.7738	1257	.8206	the
3	1	-9.6209	19.2553	81.3070	5598	2446	7917		3	1	-7.1767	20.0492	81.3599	.3737	.6841	.6263
3	2	-9.6888	20.3754	81.0687	5637	1685	8086		3	2	-8.3045	20.7933	81.1080	.2950	.7402	.6042
3	3	-9.6283	21.5448	80.8303	5597	1080	8216		3	3	-9.6110	21.4278	80.8564	.2174	.7819	.5843
3	4	-9.4506	22.7501	80.5920	5512	0568	8325		3	4	-11.0824	21.9374	80.6051	.1399	.8127	.5656
3	5	-9.1610	23.9814	80.3537	5396	0119	8418		3	5	-12.7080	22.3055	80.3537	.0620	.8343	.5478
4	1	-5.2136	20.1336	77.8225	6069	1105	7870		4	1	-2.8390	20.4115	77.8661	.5149	.5944	.6177
4	2	-5.0451	21.1714	77.6002	5946	0389	8031		4	2	-3.7107	21.3024	77.6326	.4512	.6646	.5956
4	3	-4.7556	22.2278	77.3780	5782	.0176	8157		4	3	-4.7593	22.1312	77.3994	.3859	.7209	.5757
4	4	-4.3560	23.2936	77.1558	5595	.0650	8263		4	4	-5.9752	22.8831	77.1666	.3187	.7668	.5571
4	5	-3.8528	24.3612	76.9336	5392	.1058	8355		4	5	-7.3522	23.5426	76.9336	.2494	.8043	.5394
5	1	8016	20.0306	74.3426	6221	.0315	7823		5	1	1.3812	19.8487	74.3778	.6356	.4725	.6106
5	2	4538	20.9024	74.1451	5966	.0936	7971		5	2	.7735	20.8235	74.1614	.5892	.5537	.5884
5	3	.0000	21.7761	73.9453	5701	.1429	8090		5	3	.0000	21.7765	73.9457	.5390	.6215	.5686
5	4	.5929	22.7063	73.7299	5412	.1866	8200		5	4	9363	22.6975	73.7294	.4848	.6800	.5501
5	5	1.2893	23.6211	73.5135	5118	.2234	8295		5	5	-2.0297	23.5690	73.5135	.4272	.7308	.5324
6	1	3.4028	18.9738	70.8687	6039	.1746	7777		6	1	5.2994	18.4159	70.8948	.7280	.3221	.6052
6	2	3.9284	19.7324	70.6749	5647	.2301	7926		6	2	4.9525	19.4128	70.6944	.7011	.4106	.5829
6	3	4.5496	20.4630	70.4811	5276	.2726	8046		6	3	4.4546	20.4258	70.4941	.6678	.4868	.5631
6	4	5.2564	21.1626	70.2872	4919	.3068	8148		6	4	3.8084	21.4421	70.2936	.6291	.5547	.5446
6	5	6.0417	21.8280	70.0934	4573	.3349	8238		6	5	3.0156	22.4470	70.0934	.5856	.6158	.5271
7	1	7.1995	17.0285	67.3983	5525	.3111	7733	~	7	1	8.7433	16.2013	67.4162	.7846	.1486	.6020
1							>									

31) In Help -> About HyGEARS ..., the IP# of the current computer is now displayed.



32) When the "Save As" function is used to save the current geometry as a Klingelnberg ND file, it is now possible to tell HyGEARS whether to use the Theoretical or Actual tooth root by specifying which Root Apex to Crossing Point, i.e. RApxXp, is to be used.

🕷 Klingelnberg ND Output - BMW_M3	Rad_li_V1 >	<
Use Theoretical RApxXp		
◯ Use Actual RApxXp		
Г	OK Cance	ł

33) When creating a New Geometry of Straight Bevel [Generated] type, the "Differential Gears" option is now offered.

When this option is selected, the usual Depth Factor (Gear), Addendum Factor (Gear) and Clearance Factor are no longer available and the default Gleason tooth proportion factors for differential gears are rather used where (units: inches):

- Mean working depth $H_k = 1.600 / DP$
- Mean whole depth H = 1.788 / DP + 0.002"
- Clearance C = 0.040 "
- Gear outer addendum $aoG = 0.430 / DP + 0.370 / (DP * (Z_2 / Z_1)^2)$
- Pinion outer addendum aoP = H aoG

- Gear outer dedendum
- Pinion outer dedendum

boG = 1.788 / DP – aoG boP = 1.788 / DP – aoP

"New Geometry Definition - [mm] [dd.mm.ss] \times 🕷 New Geometry Definition - [mm] [dd.mm.ss] \times General Cutter Units General Cutter Units Pinion Gear Names ... Test-1-Straight Bevel [Generated] Geometry Name Directory E:\VB Geometry Source File StraBevlGen.lst T. Error (uRad) 0 Helix Angle 0.00.00 Types ... Pressure Angle 25.00.00 Straight Bevel [Generated] Geometry Type \sim AISI 4140 Material ~ Pinion Tooth Hand Right Tooth Taper Standard Misc . Power [Kw] / Torque [N-m] 5.24 100.03 Pinion Speed (RPM) 500.00 Clear Number of Teeth [Pinion - Gear] 1.500 15 10 Module/Pitch Diameter 4.970100 1 74.5520 Switches Pinion Process Gear Process Gear Tooth Face Width 🗹 Bal. Strength Fixed Setting Generated 0.000 Differential Gears Duplex Helica Duplex Helical Shaft Angle O Non Generated P. Len. Crown.) Modified Ro Depth Factor (Gear) 1.4962 G. Len. Crown. SimplexT) Helixfo 0.3598 Auto Damping Semi-completing Clearance Factor Cyclo Palloid Preview Kurvex Import <<Back Next>> Cancel Import <<Back Next>> Cancel

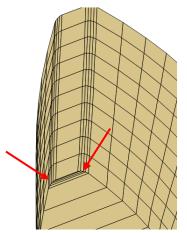
It is also possible to select on which of the Pinion and/or Gear lengthwise Crowning will be applied by selecting "P. Len Crown." for the Pinion and "G. Len Crown." for the Gear.

General Cutter L	Jnits	
	Pinion	Gear
T. Error (uRad) Helix Angle Pressure Angle	0 0.0000 20.0000	
		Clear
Switches Bal. Strength		Gear Process Generated Duplex Helical
Bal. Strength	Generated Duplex Helical Modified Roll Simplex T	Gear Process

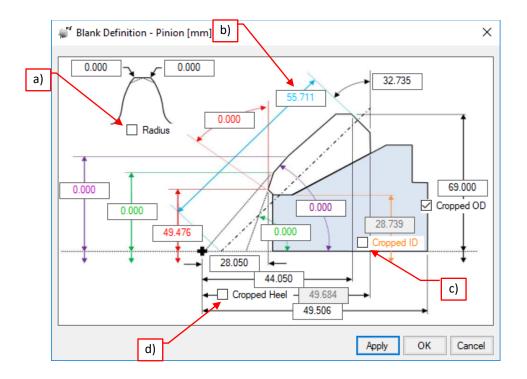
34) The Circular Pitch has been added to the Blank section of the Summary ([SumX], [Summ] and [GSum] buttons).

HyGEARS V 4.0	0 (C) - Geom	etry Summary	
Qt	lebec, Canad	a	
Pinion [Nominal]; Gea	ar [Nominal] Coniflex	- 11x30Conifl	e x. hyg
Date / Time : 9/3/2 General Units : [mm] Cutter Units : [mm] Prepared by : Claux	[D.dec]	22 AM	
Version : 4.0.4			
GENERAL DATA		PINION	GEAR
Number of Teeth	:	11	30
Speed Ratio	:	2.7273:1 [Speed Reducer
Diametral Pitch	:	14.5143	
Module	:	1.7500	
Mean Normal Module		1.5306	1.5396
Circular Pitch	:	5.49	78
race width	:	8.0000	7.0100
Outer Cone Distance	:	27.9590	
Mean Cone Distance	:	23.9590	24.4540
Shaft Angle		90.0000	

- 35) The Blank definition window for Straight bevel gears now includes the following new possibilities:
 - a) The Tip Chamfer may be defined as a radius by selecting the Radius option;



- b) The Outer Cone Distance may be modified; it appears in light blue below;
- c) The Toe ID may be imposed; when checking "Cropped ID" below, the relevant field becomes available; the Toe ID must be larger than the current value and smaller than the Toe OD;
- d) The Heel may be cropped by checking the "Cropped Heel" option; the relevant field then becomes enabled and a value larger than the current Crown to Xp may be entered;



36) When creating a new Face Gear (New Geometry), it is now possible to impose the # teeth on the gear shaper. By default, this would be equal to Z1 + 1, i.e. Z pinion + 1; however, increasing this value now allows imposing more crowning to the gear member, if required.

Names	
Geometry Name	Test-1-Face Gear
Directory	E:\VB
Geometry Source File	Facegear.lst
Types	
Geometry Type	Face Gear
Material	AISI 4140
Pinion Tooth Hand	Left
Power [Kw] / Torque [N-m]	0.10 1.06
Power [Kw] / Torque [N-m] Pinion Speed (RPM)	900.00
Number of Teeth [Pinion - Gear]	14 3.000 42
Module/Pitch Diameter	0.700000 / 29.4000
Gear Tooth Face Width	5.050
Pinion Offset	0.0000
Backlash	0.0500
Number of Teeth (Shaper)	15.0
	15.0

37) When creating a new Hypoid gear set, it is now possible to impose the spiral angle on the gear rather than on the pinion. Until now, for Hypoid gears, the spiral angle had to be imposed on the pinion, which is usually, but not always, known.

As shown in the following figures, if the Spiral Angle field for the pinion is left blank and that of the gear is filled, HyGEARS will take the gear's value as the target and find the pinion spiral angle that matches the desired gear value for the given set of parameters.

For example, the following input data will cause HyGEARS to create a Hypoid gear set where the pinion spiral angle is 45° and that of the gear is 32.5°.

🐺 New Geometry Definition - [mm] [D	.dec] X	🕷 New Geometry Defin	ition - [mm] [D.dec]	>
General Cutter Units		General Cutter Units		
Names Geometry Name Directory Geometry Source File	Test-4-Hypoid E:\VB Hypoide lst	Machine	(OB) Pinion (IB) Phoenix ~	(IB) Gear (OB) Phoenix ~
Types Geometry Type Material Pinion Tooth Hand Tooth Taper	Hypoid ~ AISI 4140 ~ Left ~ Duplex ~	Spiral Angle Sum Pressure Angles Stock Allowance [mm] Cutter Diameter [mm] Blade Angle Profile Curvature [mm]	45 43.0000 0.3810 17.0000 0.000 0.000 0.000	0.3810 0.0000 28.0000 17.0000 0.000 0.000
Misc Power [Kw] / Torque [N-m] Pinion Speed (RPM) Number of Teeth [Pinion - Gear]	107.49 1000.00 17 2.118 36	Blade Edge Rad. [mm] Point Width [mm] Mounting Distance MIn Toe ID	0.0000	0.0000 0.0000 32.0000
Module/Pitch Diameter Gear Tooth Face Width Shaft Angle Depth Factor (Gear) Addendum Factor (Gear) Clearance Factor Offset	12.777778 / 460.0000 80.000 / 460.0000 90.0000 AGMA / ISO 0.317 0.125 ISO ISO	Switches Bal. Strength Sel. TopRem No Cutter Tilt No Gear Tilt Auto Damping Preview	Pinion Process Fixed Setting © Duplex Helical Modified Roll SimplexT Semi-completing Cyclo Palloid Kurvex	Gear Process Generated Duplex Helical Non Generated Helioform VP Fixed Setting

It is also possible to obtain a similar result by entering the data as follows:

🕷 New Geometry Definition - [mm] [[).dec] X	🖋 New Geometry Definitio	n - [mm] [D.dec]	×
General Cutter Units		General Cutter Units		
Names Geometry Name Directory Geometry Source File Types Geometry Type Material	Test-4-Hypoid E:\VB Hypoide lst Hypoid AISI 4140	Machine Spiral Angle Sum Pressure Angles Stock Allowance [rm]		B) Gear (OB) oenix
Pinion Tooth Hand Tooth Taper Misc Power [Kw] / Torque [N-m] Pinion Speed (RPM) Number of Teeth [Pinion - Gear]	Left ~ Duplex ~ 107.49 1025.98 1000.00 17 2.118 36	Cutter Diameter [mm] Blade Angle Profile Curvature [mm] Blade Edge Rad. [mm] Point Width [mm] Mounting Distance Min Toe ID		0.000 0.0000 0.00000 0.0000 0.0000 0.00000 0.00000 0.0000 0.0000 0.0000 0.00
Module/Pitch Diameter Gear Tooth Face Width Shaft Angle Depth Factor (Gear) Addendum Factor (Gear) Clearance Factor Offset	12.77778 / 460.000 90.0000 AGMA / ISO 4.000 AGMA / ISO 0.317 ISO 0.125 ISO	Bal. Strength Sel. TopRem No Cutter Tilt No Gear Tilt Auto Damping	Fixed Setting Image: Constraint of the set of t	ar Process Generated Duplex Helical Non Generated Helixform VP Fixed Setting
	Import < <back next="">> Cancel</back>		Import < <back< td=""><td>k Next>> Cancel</td></back<>	k Next>> Cancel

It is also possible to impose a minimum ID to the pinion at Toe, such as to satisfy bore conditions when the pinion is mounted on a shaft. If this value is imposed, HyGEARS will modify the OD such as to move the teeth out radially in order to satisfy the Mid Toe ID condition.

38) The [BPat] function, used to develop the contact pattern (CP) on spiral bevel, straight bevel, Coniflex bevel and Beveloid gears, now allows targeting either the Pinion or Gear.

By default, the Pinion is modified when developing the CP, and most of the possibilities are offered, as is shown in the figure below.

💭 B.Pattern Development - Gear Conve	ex-IB ×
BP Definition D-MSett [mm] LTCA E/P	Prop.
Mean Point / Convex-IBHorizontal Position40.3Vertical Position50.0	Mean Point / Concave-OB Horizontal Position 39.8 % Vertical Position 50.0
PoC Bias / Convex-IB ● Free ○ Fixed 69.7 deg	PoC Bias / Concave-OB Free Fixed Fixed 69.8 deg
T.E. ● Free ○ Fixed 74	T.E. ● Free ○ Fixed 73 ↓ [uRad
Backlash Free Fixed 0.103 [mm]	Target Machine →
Apply < <back next="">></back>	Reset Print OK Cancel

By clicking on the "Develop Gear Machine" option, some of the available choices are disabled. While these choices are somewhat limited, they offer some degree of control over the CP by addressing only the Gear machine settings. For Coniflex, straight and spiral-bevel gears, the Horizontal and Vertical positions of the CP, plus the Backlash, are available.

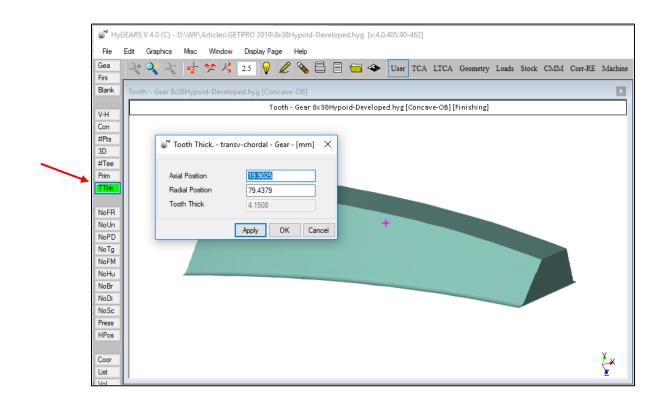
👹 B.Pattern Development - Gear Conv	vex-IB ×
BP Definition D-MSett [mm] LTCA E/	P Prop.
Mean Point / Convex-IB	Mean Point / Concave-OB
Horizontal Position40.3%Vertical Position50.0%	Horizontal Position39.8%Vertical Position50.0%
PoC Bias / Convex-IB Free Fixed 69,7 deg	PoC Bias / Concave-OB ● Free ● Fixed 69.8 deg
T.E.	T.E.
 ○ Fixed 74	◯ Fixed 73 🚖 [uRad
Backlash O Free Fixed 0.103 [mm]	Target Machine O Develop Pinion Machine O Develop Gear Machine
Apply < <back next="">></back>	Reset Print OK Cancel

For Beveloid gears, the Horizontal position of the CP, plus the Backlash, are available.

👹 B.Pattern Development - Gear Right	×
BP Definition D-MSett [mm] LTCA E/P	
Mean Point / Left	Mean Point / Right
Horizontal Position48.8%Vertical Position50.0%	Horizontal Position50.6%Vertical Position50.0%
PoC Bias / Left	PoC Bias / Right
Free Fixed -6.7 deg	Free Fixed 6.6 deg
T.E. ● Free ● Fixed 50	T.E. ● Free ○ Fixed 50 🗼 uRad
Backlash O Free Fixed 0.000 [mm]	Target Machine O Develop Pinion Machine O Develop Gear Machine
Apply < <back next="">></back>	Reset Print OK Cancel

39) In User mode, for the "Tooth" Child Window, addition of the [TThk] function button which can be used to obtain the transverse chordal tooth thickness at any combination of Radial and Axial position.

When the "Tooth Thick." Input window is displayed, the default location is at the Mean Point, i.e. mid face-width on the Pitch cone or cylinder.



40) In the Summary editor ([Pin] / [Gea] function buttons), for all bevel gears, addition of the "Ref. Vals" button to allow entering / editing the Reference Pressure and Spiral angles.

💓 Pin	ion [Stra	aight Bevel [G	enerated]]	[Non	ninal/Refere	nce Value	s - Pinion	
Blank	Cutter	Cutter Edge	Machine	F				
Misc	eeth	ishing] - Stra 10 4 77	night Bevel	Re	f. Outer Cone f. Face Width minal Spiral A minal Press, /	ngle	45.00 15.00 0.000	0
Part	#			-	minal Press. /	-	19.00	-
Toot	h	~					ОК	Cancel
Too	th Hand	Left					UK	Cancel
Fac	e Width	16.0	584		Face Angle	•	39.19.59	
Add	endum	4.63	22		Root Angle	•	27.23.06	
Ded	lendum	3.53	16		P.Apex to 3	Хp	0.0000	
Add	. Angle	7.19	.40		F.Apex to >	γ ρ	-1.4043	
Ded	Ded. Angle 4.37.13			R.Apex to Xp		-0.1227		
From	nt Angle	0.00	.00		Outside Dia	ameter	49.5000	
Bac	k Angle	32.0	0.18		FCrown to	Хp	24.0003	
						Apply	ОК	Cancel

When clicked, the Nominal/Reference Values window is displayed where the default values can be edited. These include:

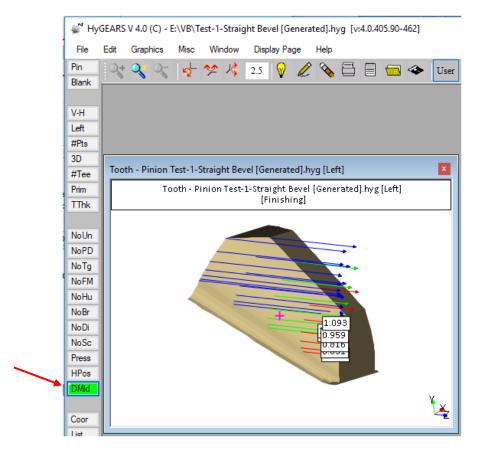
- Outer Cone Distance,
- Face Width
- Spiral Angle
- Pressure Angle IB

Pressure Angle OB

The Nominal Spiral and Pressure angles are used in the Graphic Summary ([GSum] function button) to calculate the Transverse, Radial and Axial loads.

41) In User mode, for the "Tooth" Child Window of Straight bevel gears, addition of the [DMld] function button which instructs HyGEARS to display a series of axial vectors, // to the axis of rotation, and originating at different axial locations on the tooth profile. This function is useful to establish if there is sufficient clearance to allow "demolding" a part manufactured by Powder Metallurgy, Forging or Injection.

At Toe, a series of values are given that indicate the minimum amount of clearance between the vector and the profile. The vectors change color along the face width to allow better visualization.

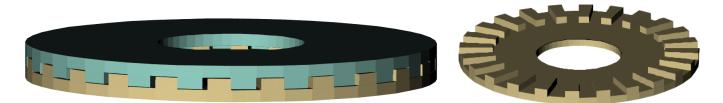


42) Addition of the Hirth Couplings (optional) to the list of HyGEARS geometries. A Hirth Coupling is a pair of nongenerated straight "bevel" gears with an equal number of teeth and a 180 ° Shaft angle. Tooth taper can be Uniform or Standard. The Tooth Thickness angles can be imposed – which imposes the effective tooth thickness - or left free by entering 0 and HyGEARS will define the proper values based on the required Backlash. The Helix Angle is always 0, and the teeth are non-generated which means any pressure angle can be accommodated. The figures below show the relevant input screens to create a Hirth Coupling.

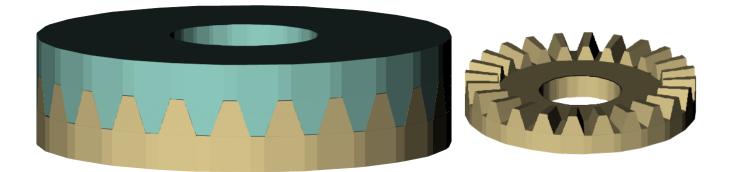
🕷 New Geometry Definition - [mm] [d	ld.mm.ss] X	👹 Y New Geometry Defin	nition - [mm] [dd.mm.ss]	×
General Cutter Units		General Cutter Units		
Names			Pinion	Gear
Geometry Name Directory Geometry Source File	Test-10-Hirth Coupling E:\VB HirthCoupling.lst	T. Error (uRad)	0	
Types		Helix Angle Pressure Angle	0.000	
Geometry Type Material	Hirth Coupling ~ AISI 4140 ~	Thickness Angle	0.000	0.000
Pinion Tooth Hand	Left ~			
Tooth Taper	Uniform V			
Misc	Standard Uniform			
Power [Kw] / Torque [N-m] Pinion Speed (RPM) Number of Teeth [Pinion - Gear]	74.60 712.05 1000.00 24 1.000 24			Clear
Module/Pitch Diameter	3.4915000 / 83.796	Switches	Pinion Process	Gear Process
Gear Tooth Face Width	11.670	Bal. Strength	Fixed Setting	Generated
Shaft Angle Depth Factor (Gear)	180.00.00 0.5342 AGMA / ISO	Differential Gears P. Len. Crown.	Duplex Helical Modified Roll	Duplex Helical Non Generated
Addendum Factor (Gear)	0.5342 0.5000 • AGMA	G. Len. Crown.	O SimplexT	O Helixform VP
Clearance Factor	0.1250 O ISO	Auto Damping	 Semi-completing Cvclo Palloid 	
		Preview	O Kurvex	
	Import < <back next="">> Cancel</back>		Import	< <back next="">> Cancel</back>

🕷 New	Geometry Definition - [mm] [dd.	mm.ss]	×
General	Cutter Units		
	Blank Data		
	Backlash	Pinion	Gear 0.000
	FCrown to Xp	0.000	
		0.000	0.000
	Zero Front Angle		
	Outside Diameter(Heel)	0.000	0.000
	Face Angle	0.000	0.000
	Root Angle	0.000	0.000
	Dedendum Angle	0.000	0.000
	Whole Depth 🔘 @Mid-F	2.400	2.400
	@Heel		
	Bore Diameter	0.000	0.000
	Min Bore to Root @Toe	0.000	0.000
			Clear
	Units		
	Linear Units	mm	~
	Angular Units	Deg.Min.Se	ec 🗸
	Cutter Units	mm	~
			¥
		Import <	<back next="">> Cancel</back>

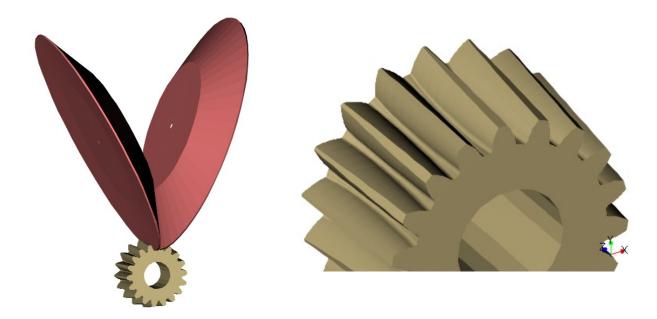
The figure below is really a "cogged teeth coupling" where the pressure angles are null and the Thickness Angles are imposed at respectively 6.5° and 7° for the "Pinion" and "Gear". Given the imposed Thickness Angles, backlash results which can be seen as a separation between the teeth.



The next figure is a more standard Hirth Coupling, where the teeth are tapered, the pressure angle is 20° and the Thickness Angles have not been imposed in which case, the imposed Backlash of 0 mm is enforced and we can see that there is no space between the teeth.



43) Addition of the Spurniflex gears (optional) to the list of HyGEARS geometries. A Spurniflex gear is a spur gear cut using a Coniflex dish type cutter, hence the names Spur and Coniflex contracted into Spurniflex. Generation on a 5Axis CnC machine is therefore possible, with good cycle times.

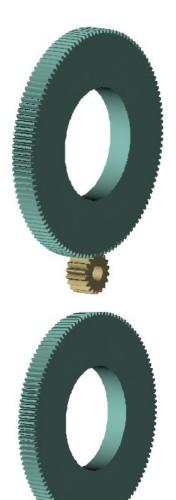


Spurniflex gear sets can take several different arrangements:

• Parallel axes, like conventional spur gears; backlash is therefore controlled by the center distance.

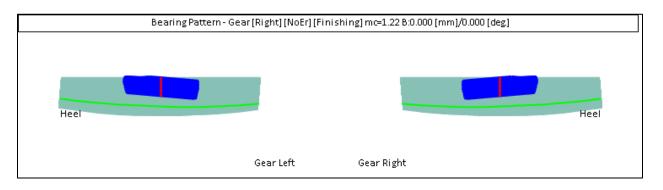
 Parallel axes, like conventional spur gears; however both the pinion and gear have the same non-null pitch angle opposed in sign such that the next Shaft angle is null. Backlash may be controlled by center distance and/or the axial position of the parts.

 Concurrent axes, where both the pinion and/or gear may have non-null pitch angles such that a non-null Shaft angle exists between the pinion and gear axes. Backlash is controlled by the axial position of the parts.

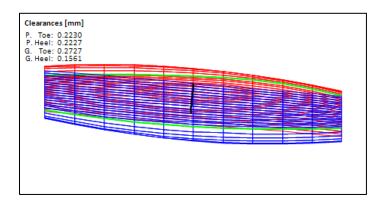




Because the teeth are generated using a dish-type cutting tool such as a Gleason Coniflex cutter, lengthwise crowning is controlled by the dish angle of the cutter and results in a localized contact pattern as is shown below.



The root line of the teeth is circular, which has no significant downside as long as the facewidth is limited. A breakedge may be applied at each end of the facewidth to prevent tip to root interference caused by the circular root line.



HyGEARS update - 09 September 2020 - Build 406.10 - 464

1) In 5Axis, the "Center Slot" roughing cutting cycle, which was originally defined as Toe-Heel-Toe, has been expanded as "Center Slot – T-H-T" and "Center Slot H-T-H" such that the movement can now be initiated either at Toe (for the T-H-T variant) or at Heel (for the H-T-H) variant.

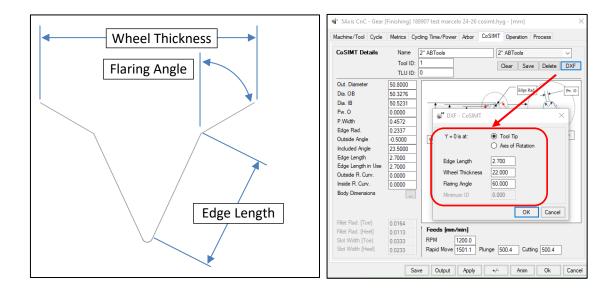
achine/Tool Cycle Metrics Cyc	cling Time/Power Arbor CoSIMT	T Operation Process
Output Format Use Actual Tooth CSV Format Line Numbers Include Operation Switches Include Short Header Include Start Positions Explicit Indexing No Comments Coordinates Only	Constant D-Radius	
Work Coordinates TCP (Mazak)	Toe 0.160	Image: Sequence Skip # /1 Start Gap 1 Mirror End Gap 21 1
Cutting Cycle	Convex (I.B.)	Concave (O.B.)
 Slot by Slot Flank by Flank 	O None O Toe -> Heel -> Toe	None
Fillet-Root Tool Tilt Tooth Flank Combined	0.00 Heel -> Toe -> Heel	el O Heel -> Toe -> Heel O Toe -> Heel O Heel -> Toe
 Chamfer Tool Side Chamfer Tool End Chamfer Toe Chamfer Toe Chamfer Heel 	0.000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000 0.0000	

2) In 5Axis, whenever a given Operation is selected by a double-click in the Process tab, the Cycle tab is now automatically displayed such that the user can review the cutting cycle directly unless the selected tool exceeds some limits and then the given tool tab is displayed.

3) In 5Axis, for the CoSIMT DXF output (optional), the following inputs now allow defining the tool such that on a grinder, the dressing software can account for the desired shape outside of the actual grinding area.

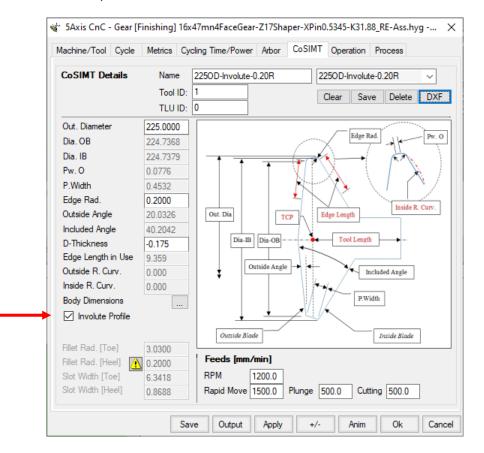
In particular, the following can be defined:

- Y = 0 is at: where is the radial 0 value;
- Edge Length; default is that in the CoSIMT definition; same value for both sides;
- Wheel Thickness: thickness of the grinding wheel disk; default is 22 mm;
- *Flaring Angle:* from the grinding edge, the angle at which the dresser must travel to reach the ends of the grinding wheel disk. Same value for both sides.



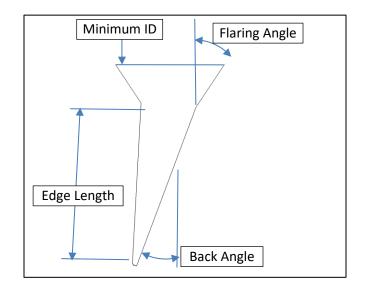
4) In 5Axis, when the reference tool is a Shaper (for Face Gears for example), CoSIMT tools can now be defined with an Involute profile by clicking on the appropriate switch as is shown below.

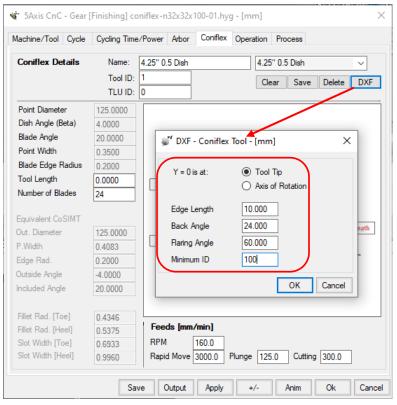
When doing so, the same Involute profile as defined for the shaper is used on the CoSIMT, but it is shifted radially such as to satisfy the entered OD. The only variables for this CoSIMT become:



- Out. Diameter: Outside diameter of the CoSIMT;
- Edge Rad.: Edge radius;
- D-Thickness: Change in thickness at the pitch circle; this can be used to ensure the CoSIMT does not simultaneously touch both tooth flanks when grinding such as not to suffer side movements.

5) In 5Axis, for the Coniflex cutter DXF output (optional), the following inputs now allow defining the tool such that on a grinder, the dressing software can account for the desired shape outside of the actual grinding area. The following can be defined:



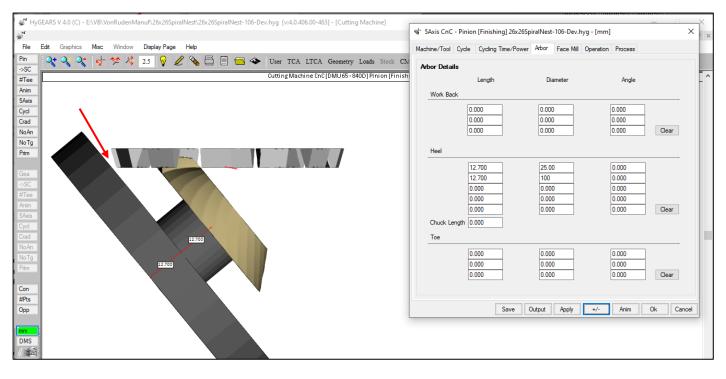


- Y = 0 is at: where is the radial 0 value;
- *Edge Length*; length of the grinding edge; default is 10 mm;
- *Back Angle*: back angle of the grinding wheel;
- *Flaring Angle*: from the grinding edge and the back side, the angle at which the dresser must travel to reach the ends of the grinding wheel disk.
- *Minimum ID*: where the DXF stops; if zero, then the DXF stops at the end of the grinding edge.

6) In 5Axis, addition of the ^G keyboard shortcut, which toggles the Detect Gouging option to On and Off.

7) In 5Axis, Arbor tab, addition of the Chuck Length variable. "Chuck Length" moves the workpiece relative to the defined arbor without having to modify the arbor. This way, one can assess what change in Chuck Length is required to avoid the tool hitting the support arbor behind the workpiece.

For example, figure below, the Face Mill cutter is seen quite close to the support arbor behind the part. The Chuck Length is null in this setup.



Because of the configuration of the installation, the Chuck Length must be increased by 10 mm to have better support. In this condition, we can see (figure below) that the Face Mill cutter will hit the support and an alternative approach must be found.

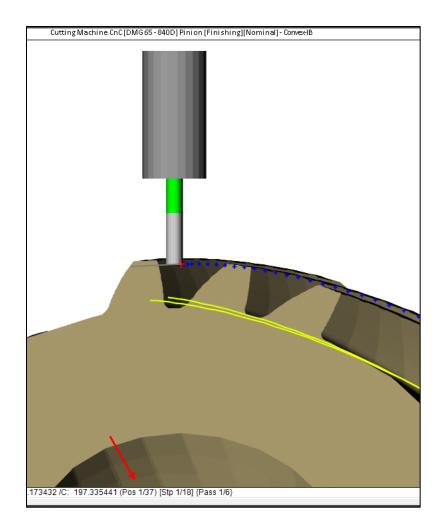
a H	rGEARS V 4.0 (C) - E:\VB\VonRudenManuf\26x26SpiralNest\26x26SpiralNest-106-Dev.hyg [v:4.0.406.00-463] - [Cutting Machine]				_		×
14		📽 5Axis CnC - Pi	nion [Finishing] 26	5x26SpiralNest-106-Dev.hyg	- [mm]	×	(×
File	Edit Graphics Misc Window Display Page Help	Machine/Tool Cyc	cle Cycling Time/I	Power Arbor Face Mill Op	peration Process		
Pin	🔍 🔍 🔩 🖕 ⋟ 🦂 2.5 💡 🖉 🍋 🗐 🗐 🍲 User TCA LTCA Geometry Loads Stock CM						-
->SC	Cutting Machine CnC (DMU 65 - 840D) Pinion (Finish	Arbor Details					- ^
#Tee Anim			Length	Diameter	Angle		-
5Axis		Work Back					
Cycl			0.000	0.000	0.000		
Crad			0.000	0.000	0.000		
NoAn			0.000	0.000	0.000	Clear	
NoTg							
Prim		Heel					
Gea			12.700	25.00	0.000		
->SC			12.700	100	0.000		
#Tee			0.000	0.000	0.000		
Anim			0.000	0.000	0.000	Clear	
5Axis	[12,700]			0.000	0.000	Ciedi	
Cycl		Chuck Length	10				
Crad	12700	Toe					
NoAn NoTg			0.000	0.000	0.000		
Prim			0.000	0.000	0.000		
			0.000	0.000	0.000	Clear	
Con							
#Pts							4
Орр			Save	e Output Apply	+/- Anim Ok	Cancel	

8) In 5Axis, when outputting the summary for a Process, i.e the [Summ] button as shown below, HyGEARS now adds the *RPM*, *Vc* and *fz* values to help review and assess each Operation part of the Process:

	; CnC - Gear [Finishing] 188907 test marcelo 24-26 cosimt.hyg - [in] /Tool Cycle Metrics Cycling Time/Power Arbor CoSIMT Operation Process
Proces	
Name ID #:	COSIMT RGH FIN COSIMT RGH FIN 130 Internal Subroutine Save Delete Import Summ Output Apex Loc. 0.000
	Available Operations ← > Process Content ↓ ↑ 1- MPASS .0938EM [1-6/6] 2- CSLOT FILL .0315EM [1-3/3] COSIMT ROUGH SLOT 1. MPASS .050EM [1-4/6] 2. CSLOT FILL .033EM [1-3/3] 2. CSLOT FILL .035EM [1-3/3]
	2 - CSLOT FILL .035EM [1-3/3] 3 - CSLOT FILL .035EM [1-3/3] 3 - FIN THT FILL .035EM [1-3/3] 3 - FIN THT FILL .035EM [0-11/11] 4 - FIN THT FLL .005EM [0-15/15] Cosimt Rough COSIMT ROUGH FLANK
	Save Output Apply +/- Anim Ok Can

	1	2	3
OpID	131	132	133
OpName	COSIMT ROUGH SLOT	1- MPASS .050EM [1-4/6]	2- CSLOT FILL .035EM [1-3/
Machine	Mazak Integrex i200	Mazak Integrex i200	Mazak Integrex i200
Target		Flank	Fillet
Tool	CoSIMT	EndM	EndM
DLen	CadModl	N/A	N/A
ToolName	2" ABTools	.050 4FL .015R	.035 4FL .01R
ToolID	1	1	1
in Op	1	1	46
Dia	2.0000	0.0500	0.0350
ApxLoc	0.0000	0.0000	0.0000
#Steps	12	5	5
Start	12	1	1
End	12	3	5
ToeClr	0.160	0.050	0.050
HeelClr	0.118	0.050	0.050
Gaps	1->21	1->21	1->21
Stock		+0.0060	
RapidMove	100.0	120.0	120.0
Plunge		60.0	60.0
Feedl		3.0	1.0
	5.0	3.0	1.0
Feed3		4.0	
Feed4		4.0	
	1200	250	10000
	628.3	3.3	91.6
fz		0.0040	0.0000
Time[']	5.9	24.6	59.2

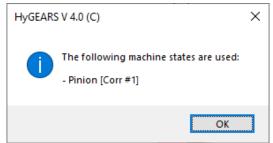
9) In 5Axis, the current position of the tool is now displayed as (Pos x/y), right after the tool coordinates, where x is the current lengthwise position number and y is the total number of Face Width Pts required, as shown below. This position corresponds to the position of the red dot indicating the current point in the milling cycle.



10) When clicking on the Machine Mode, HyGEARS now looks to see if Corrections were done to the pinion and the gear. When such a condition is found, HyGEARS selects the last correction found and toggles the machine settings summary to this correction. This has two advantages:

- When calling 5Axis, the user cannot recut exactly the same part as what was done for the 1st cut, as it is assumed that if corrections are found, then the correction is what ought to be cut;
- The user does not have to use the [Sele] function to identify the desired Correction.

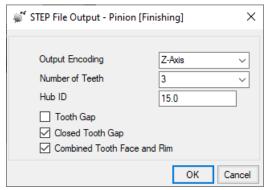
When Corrections are found, HyGEARS displays a message to inform the user that the machine state has been modified as shown below.

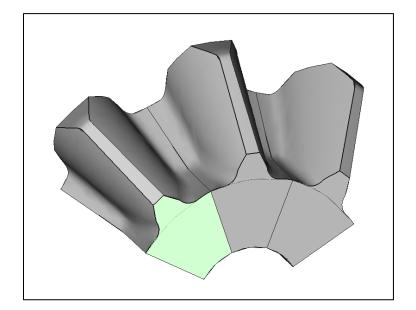


11) For the STEP output function, HyGEARS now offers additional choices, as shown below:

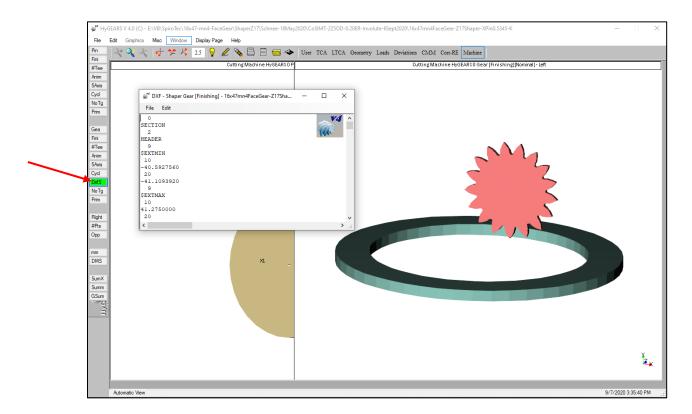
- Output Encoding: the output can be with the axis of rotation aligned along X, Y or Z;
- Number of Teeth: from 1 to the part's tooth number;
- *Hub ID*: diameter of the hub under the teeth; the hub can now be included in the STEP file; this is especially useful when considering a differential Straight bevel gear where the tooth is cropped at Toe, resulting in a discontinuous tooth root line;
- *Tooth Gap*: instead of the tooth, the gap between the teeth can be outputted in the STEP file;
- Closed Tooth Gap: whether the coordinates defining the tooth roots of each flank are left with a small space as
 digitized or have the same coordinates; note that a closed tooth gap does not imply that the lines bounding the
 tooth roots will be exactly // to each other since the fillet area on each tooth is different and in the STEP file is
 modelled as a B-Spline;
- *Combined ...:* whether the tooth front and back faces are continuous or separate B-Splines; works best when *Tooth Gap* is **not** used.

For example, the following exports 3 teeth of a differential Straight bevel pinion where the tooth Toe end is cropped (since it is forged), along with its underlying hub of 15 mm internal diameter. The front (light green) and back faces are continuous with the underlying hub.

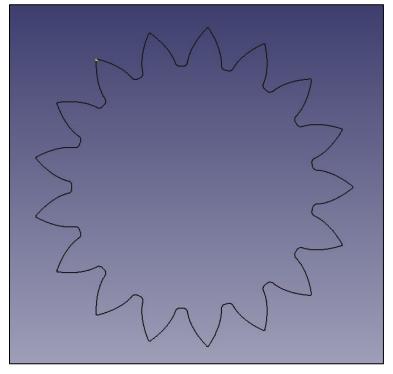




12) In Machine mode, if the reference tool is a Shaper such as for a Face Gear, the [DxfS] function button is displayed if the DXF option has been purchased. Clicking on the [DxfS] button generates a Dxf file containing the coordinates of the shaper tool.



Import of the shaper Dxf file in a CAD software generates the desired shape, as is shown below.



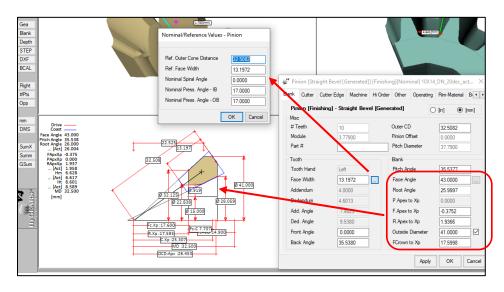
13) For Straight bevel gears, in Corr-RE mode, when calling either the [Corr] or [RE] functions, HyGEARS now offers the possibility to select how Pressure angle is controlled. Choices are:

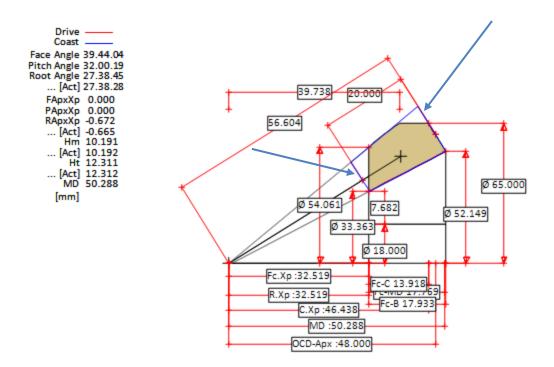
- Roll Rate (i.e., ratio of roll)
- Blade Angle

🕷 HyG	EARS V 4.0
File	Edit Graphics Misc Window Display Page Help
Pin	🔍 🔍 🖓 🚽 💯 🧏 2.5 😡 🖉 🏹 🗒 🗐 🖼 👁 User TCA LTCA Geometry Loads
XYZ	
Exprt	💕 Corrective Machine Settings Pinion - [Finishing] 🛛 🕹 🗙
Stat	Tolerance Order Machine
ThStk	Tolerance Order Machine
Corr	Pressure Angle Control
R.E.	
Gea	Roll Rate
XYZ	Cutter Lead
Exprt	O Blade Angle
Stat	O Cutter Tit-Decimal Petio
ThStk	
Corr	Lengthwise Crowning
R.E.	O Cutter Diameter
#Pts	Offset
	O Cutter Tilt + Offset
mm	
DMS	
	Apply Reset Print OK Cancel 9 fa: 1.2479

14) For bevel gears, in Geometry mode, HyGEARS now displays in blue the contour of the theoretical tooth as defined by:

- the Ref. Face Width value;
- the F.Apex to Xp value;
- the R.Apex to Xp value;
- the Root Angle value.

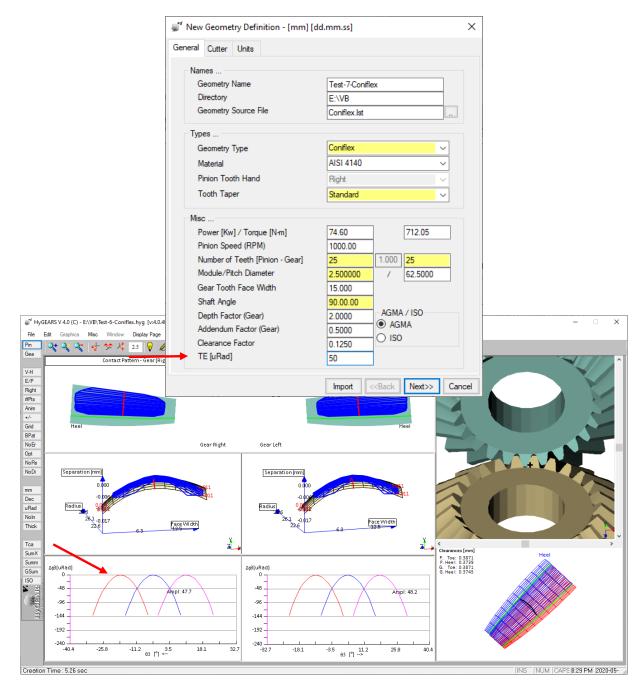




This allows assessing the differences between the theoretical and actual teeth which, of course, affect the tooth bending strength model.

15) For Coniflex bevel gears, it is now possible to impose the desired Transmission Error (TE) at the transfer points. Of course, then this gearset cannot be cut on a conventional Gleason machine since Modified Roll, used to control the TE, is not available in the mechanical machines.

When creating a New Geometry of Coniflex type, the General data page now offers inputting the desired TE in µRad, as shown below. TE is controlled by Modified Roll and it can therefore be practically any value. If left at 0, then the gearset is conventional and no modification is done to alter TE.



Therefore, the Higher Order changes for Modified Roll are then accessible in the Summary editor, as is shown below.

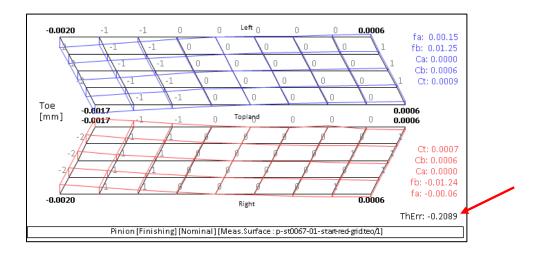
Blank	Cutter	Machine	Hi Order	Other	Operating	Rim-Material	Bearings	Arboi 🔹	
	\sim								
	Modif	ied Roll		– Upj	ber		ower	```	
		1A		- i - [0.00000		0.00000		
		2C			0.05605		0.05605		
6D					0.00000		0.00000		
24E 120F				0.00000					
				0.00000	0.00000				
		720G			0.00000	0.00000			
	Helica	al Motion							
		1st			0.00		0.00		
2nd 3rd 4th 5th				0.00		0.00	0.00		
				0.00	0.00 0.00 0.00				
				0.00					
				0.00					
		6th			0.00		0.00		

16) For Straight and Spiral bevel gears, Tip Relief is now offered. Tip Relief is accessed from the Summary Editor, TopRem data page, as shown below. The following values can be edited:

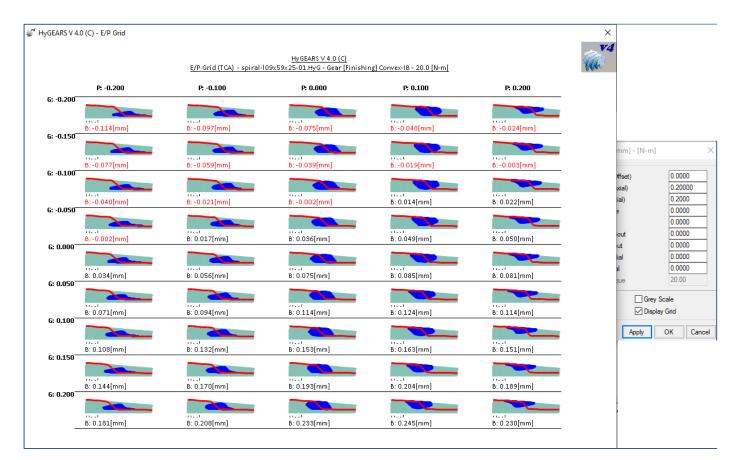
- Blade Height: height of the cutter blade; by default, equal to the sum of tooth depth at Heel; •
- Tip Relief Height: distance from the upper part of the blade where Tip Relief begins;
- Tip Relief Angle:
- if Tip Relief is linear, then an angle is entered here; • Tip Relief Radius: if Tip Relief is circular, then a radius is entered here.

Blank Cutter TopRer	n Machine Hi Or		Operating		Angle Tip Relief
TopRem (TM) TopRem Depth TopRem Angle TopRem Radius		Concave-OB No 0.0000 0.00.00 0.0000		Convex-IB 0.0000 0.00.00 0.0000	Height Radius Blade Height
Blade Height Tip Relief Height Tip Relief Angle Tip Relief Radius		27.0000 5.0000 0.00.00 200.0000		27.0000 5.0000 5.00.00 0.0000	

17) In Corr-RE mode, the tooth thickness error is now given in the display area, as shown below, rather than in the description text line at the bottom of the display as was the case before.



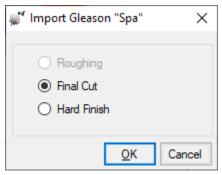
18) In TCA and LTCA modes, when using the [Grid] function, the calculated backlash is now displayed for each combination of E-P-G etc. pinion and gear positions. This allows a better idea of the acceptable pinion and gear positions.



In addition, negative backlash values are displayed in red to enhance assessment.

19) When importing data from a Gleason Spa file, HyGEARS now looks ahead to see if *Final Cut* and *Hard Finish* data is present in the file. If so, the user is presented with the choice of what to import and the resulting HyG file name adds the relevant data type.

For example, figure below, both *Final Cut* and *Hard Finish* data are found in a Spa file. The user is thus offered which variant is desired.



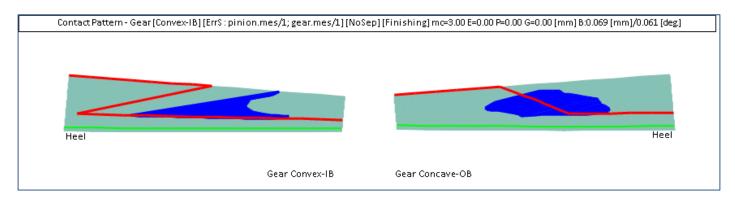
Depending on the user's choice, if the Spa file name was 11x39.spa, the resulting HyG file name will be:

- 11x39_*FinCut*FromSPA.hyg
- 11x39_*Grind*FromSPA.hyg

where either "FinCut" or "Grind" is added to identify the imported data.

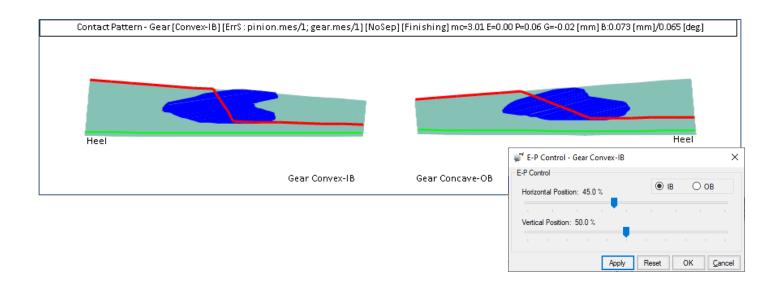
20) In TCA mode, when using the [E/P] function, HyGEARS now detects if CMM data is used to calculate the kinematics. If so, the P and G values will be used to locate the contact pattern (CP) where desired rather than E and P since in an actual gearbox, the E value cannot be changed.

For example, the following CPs are obtained using the CMM data for a spiral bevel gearset in nominal position, i.e. with E = P = G = 0.



If we attempt to improve the CP on the Gear Convex-IB flank, the following is obtained and can be used in an actual gearbox.

- E = 0
- P = 0.06
- G = -0.02



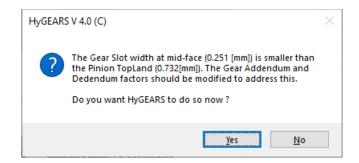
21) Face Gear design has changed: you can now impose the Profile Shift factor on the shaper and on the pinion, but that of the gear is a consequence of both the selected shaper and pinion.

" New Geometry Definition - [mm] [dd.mm.ss] X		nition - [mm] [dd.mm.ss]	
General Cutter Units		General Cutter Units		
Names			Pinion	Crown Gear
Geometry Name	Test-1-Face Gear			
Directory	E:\VB			
Geometry Source File	Facegear.lst	Shaft Angle	90.00.00	
Types		Helix Angle	0.00.00	
Geometry Type	Face Gear	Pressure Angle	20.00.00	
Material		X Factor	0.4000	0.000
		Addendum Factor	1.0000	1.0000
Pinion Tooth Hand	Left	Dedendum Factor	1.2500	1.2500
		Fillet Factor	0.250	0.2500
Misc		Minor Diameter [mm]		0.0000
Power [Kw] / Torque [N-m]	31.430 59999.30	FC.Xp [mm]		0.0000
Pinion Speed (RPM)	5.00	Center Distance [mm]	0.0000	
Number of Teeth [Pinion - Gear]	14 3.071 43			Clear
Module/Pitch Diameter	1.750000 / 75.2500	Switches	Pinion Process	Gear Process
Gear Tooth Face Width	13.200	Bal. Strength	Fixed Setting	Generated
Pinion Offset	0.0000	Sel. TopRem	Duplex Helical	 Duplex Helical
Backlash	0.1000	No Cutter Tilt	O Modified Roll	Non Generated
Number of Teeth (Shaper)	15.0	No Gear Tilt	 SimplexT Semi-compl.(Gen) 	Helixform VF Fixed Setting
X Factor (Shaper)	0.330	Auto Damping	Cvclo-Palloid	- Fixed Setting
		Use data as is	O Cyclo-Milling	
	Import < <back next="">> Cancel</back>		Import	< <back next="">> Ca</back>

A new value, called the FC.Xp, can also be entered. This value is the distance between the axis of the mating pinion and gear tooth tip at Toe. The requested FC.Xp value affects gear tooth depth and thus also the contact ratio.

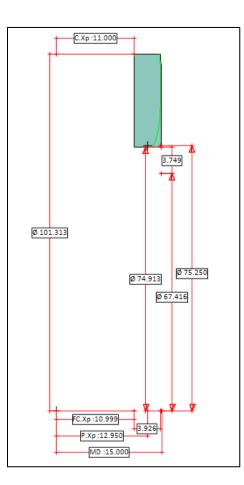
As HyGEARS develops the requested Face gearset, if the pinion Topland is found to be much different than the gear fillet tooth gap width at mid-face is null or negative, then a message such as below is issued to check whether it is accepted to modify the gear tooth proportions in order to obtain an acceptable

gear tooth.

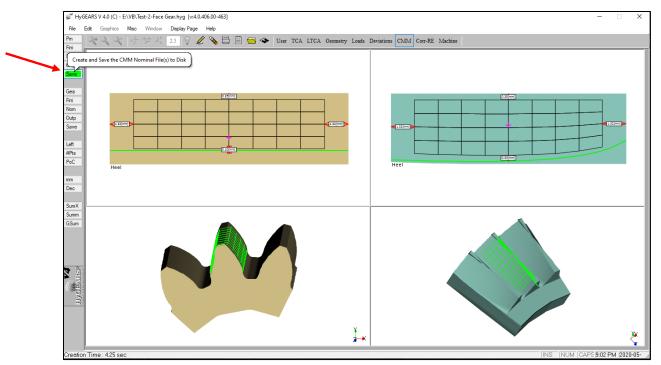


The display of the Face gear has also changed to incorporate more installation info, as is shown below. In particular, the following values are given:

- C.Xp: distance between the mating pinion axis and the gear tooth tip at Heel;
- FC.Xp: distance between the mating pinion axis and the gear tooth tip at Toe;
- *P.Xp*: distance between the mating pinion axis and the pitch point on the gear;



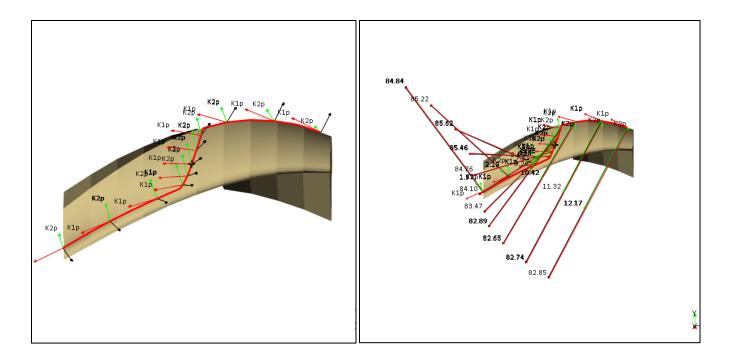
22) CMM Nominal: when comes the time to output the defined CMM Nominal, some CMMs such as the Klingelnberg P machine require up to 4 files, and it is tedious to have to Select, Save, Delete the window with the text, and move on to the next output.



The [Save] button calls the output from the [Outp] button, saves the content of all the generated text windows with CMM data, and then deletes the text windows, all in one Click. A real time saver.

23) In User Mode, for the Path of Contact Child Window (in Kinematics), when the display of the Principle Curvatures is toggled On by clicking on the [NoPD] button, the [NoCur] button is displayed immediately below the [PDir] button. The [NoCur] button can then be toggled into [Curv] which tells HyGEARS to display also the radii of curvature at different points along the PoC.

For example, left figure below, the principle directions are displayed as K1 and K2, where K1 is the direction of the major principle curvature and K2 is the direction of the minor principle curvature. The same are displayed in the right figure, but in addition the value of each radius of curvature is given.



24) When creating a New Straight Bevel (Generated) gear set (New Geometry), several values can now be imposed to facilitate the initial design.

Referring to the figure below:

- Crowning [mm] / 5[mm]:
- Thickness @ Mid-Face:
- Thickness @ Heel:
- Edge Radius:

the desired tooth thickness at Heel; ignored if 0;

the desired tooth thickness at mid-facewidth; ignored if 0;

the desired amount of crowning per 5[mm] face width, pinion and gear;

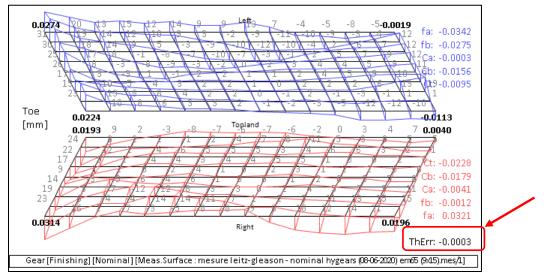
the desired cutter edge radius; ignored if 0.

New Geometry Definit	ion - [mm] [dd.mm.ss]	×
General Cutter Units		
	Pinion	Gear
T. Error (uRad)	19	
Helix Angle	0.00.00	
Pressure Angle	20.00.00	
Crowning [mm]/ 5[mm]	0.00203	0.00203
Thickness @ Mid-Face	0.0000	0.0000
Thickness @ Heel	0.0000	0.0000
Edge Radius [in]	0.000	0.000
Switches Bal. Strength Differential Gears Develop Geom. G. Len, Crown.	Pinion Process Fixed Setting Duplex Helical Modified Roll Simplex T Semi-compl.(Gen) Cyclo-Palloid Cyclo-Milling	Clear Gear Process Generated Duplex Helical Non Generated Helixform VP
	Import	< <back next="">> Cancel</back>

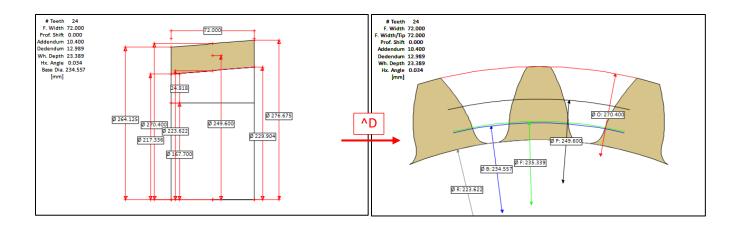
25) When creating a New Geometry, Spiral Bevel / Zerol / Hypoid, the Edge Radii can be different on the IB and OB blades even for completing processes.

General Cutter Units				
	(OB)	Pinion (IB)	(IB) Ge	ar (OB
Machine	Phoenix	~	Phoenix	
Bias factor (-10 to +10)	0	.00		
Spiral Angle	3	5.0000		
Sum Pressure Angles	4	0.0000		
Stock Allowance [in]	0	.0150	0.015	50
Cutter Diameter [in]			4.500	00
Blade Angle	14.0000	26.0000	0.0000	0.0000
Profile Curvature [in]	0.000	0.000	0.000	0.000
Blade Edge Rad. [in]	0.0000	0.0000	0.0000	0.0000
Point Width [in]	0.	.0000	0.000	00
Mounting Distance	14	41.0000	70.00	000
			Clear	
Switches	Pinion Proc	cess	Gear Process	3
Bal. Strength	Fixed S	etting	⊖ Generated	d
Sel. TopRem	Duplex		O Duplex He	
No Cutter Tilt	O Modifie		Non Gene	
No Gear Tilt	 Simplex Semi-or 	ompl.(Gen)	Helixform Fixed Sett	U
Auto Damping	O Cyclo-P		- Theo Sea	ang
Use data as is	O Cyclo-N			

26) In Corr-RE mode, the thickness error value has been moved from the text line at the bottom of the display to a more visible part of the screen, as shown in the figure below.

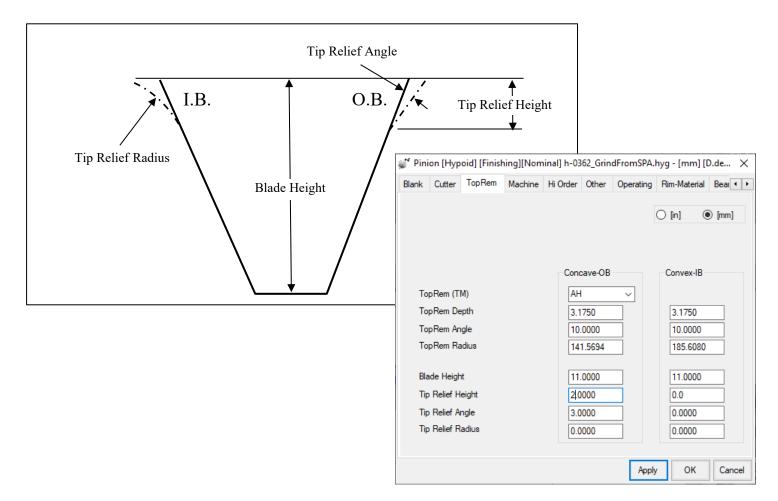


27) In Geometry mode, addition of the ^D keyboard shortcut. For Beveloid gears, Shapers and Skiving tools. ^D toggles the Blank display between the Side and Front views, the latter providing the diameters at tooth mid-face as is shown below.



28) In Machine mode, addition of the [Corr] And [RE] functions for Face Gears.

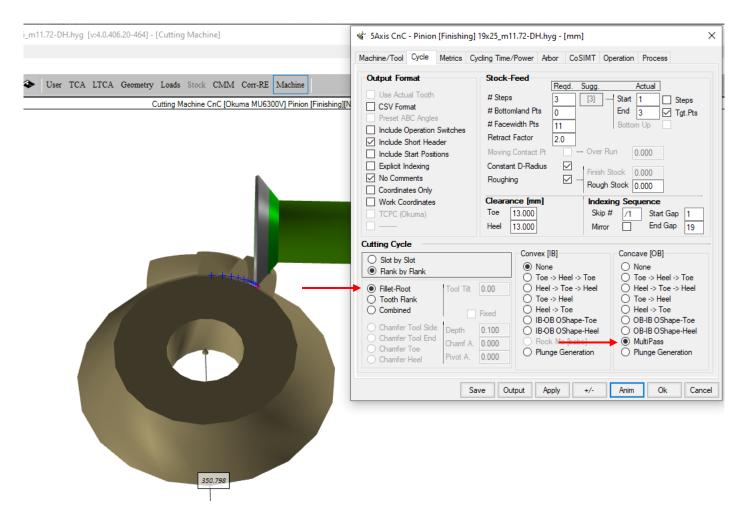
29) Addition of Tip Relief to the blade definition of Spiral-bevel gears. This is accessed through the TopRem data page of the Summary Editor – [Pin] and [Gea] function buttons.



When non-zero TopRem Angle and Radius are both entered for one blade side, preference is given to Circular TopRem, i.e. the TopRem Radius. The same rule applies for Tip Relief when non-zero values are both present: Circular Tip Relief is given preference.

HyGEARS update - 27 September 2021 - Build 406.20 - 464

1) In 5Axis, the MultiPass cycle is now allowed in the fillet for CoSIMT tools.



2) In 5Axis, Process tab, when an Operation is selected in the Available Operations list, a right mouse-click offers to Duplicate or Rename the selected Operation, in addition to the already existing "->"used to transfer the selected Operation from the Available list to Process Content list, and "Delete" to delete the selected Operation.

If the right mouse-click is done on a selected Operation in the Process Content list, then only the "Rename" option is offered, along with the "<-" used to transfer the selected Operation from the Process Content list to the Available Operations list.

	: CnC - Pinion [Finishing] 19x25_m11.72-DH.hyg - [mm]
achine/	Tool Cycle Metrics Cycling Time/Power Arbor CoSIMT Operation Process
Proces	sses
Name	Pinion V
ID #:	10 Internal Subroutine
	Save Delete Import Summ Output Apex Loc. 458.088
	Available Operations \leftarrow \rightarrow Process Content \downarrow \uparrow
	0P: OD Test 1G: MPass CMP162 [1-7/7] 3G: THT 8E 2G: CSLot Fillet CMP162 [2-3/3] 2G: CSLot Fillet CMP162 [2-3/3]
	-> 3G: THT Fillet 4BM [1-4/6] Delete 4P: THT 6EM [0-13/13]
	Delete 5P: THT 6EM HardFinish [0-19/19]
	Rename
	Kendine
	Save Output Apply +/- Anim Ok Cance

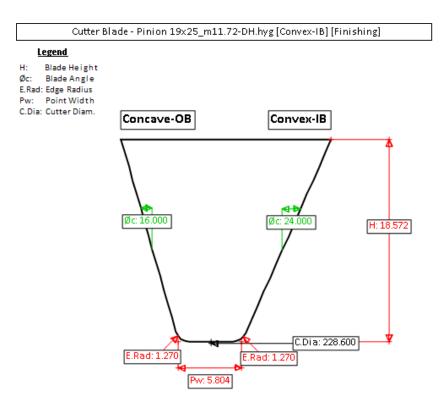
When either "Duplicate" or "Rename" is selected, an input window is shown where the desired name is to be entered.

HyGEARS V 4.0 (C)	×
Please enter a name for this NEW Operation:	ОК
	Cancel
3G: THT 8EM [0-15/15]	

3) STEP output: the STEP output interface has been expanded and now allows to impose that the fillet and tooth flank surfaces be encoded in separate B-Splines, and also allows specifying the # points desired along the tooth Face width, in the Fillet and on the Profile.

Output Encoding	Z-Axis ~	
	Z-Axis V	
Number of Teeth	1 ~	
Hub ID	62.544	
Tooth Gap		
Closed Tooth Gap		
Combined Tooth Fa	ce and Rim	
✓ Fillet and Profile Sep	parate BSplines	
Axial #Pts	11	
Fillet #Pts	5	
Profile #Pts	19	
	OK Cancel	

4) The Cutter Blade is now displayed in a revised format, with more d Graphics Summary ([GSum] function button).



5) When defining the CMM Nominal - [Nom] function button – the Probe Sphere can now be displayed, as is shown below, by entering the diameter of the used probe and by checking the "Show Probe Ball" option.

This allows one to size the required probe prior to making the actual measurement.

In addition, the Toe and Heel widths of the tooth gap at the fillet line are now given to quickly gage the correct probe

he

ci	70	
SI	ze	•

👹 CMM Interface - Pinion - [mm]	×
Axial # Points 15 Radial # Points 5	
Bottom Clearance 2.5000	
Top Clearance 2.3440 Toe Clearance 5.2000	
5.2000	
5.2000	8.591[mm]
0.0000	
0.0000	
Stock (perflank)	
Rectangular Grid Make a Plane	
○ Ram 300 ○ Hoeffler ZP350 ○ Leitz	
◯ Gear Bevel (Ux) ◯ MdM Metrosoft ◯ Mitutoyo	
◯ Klingelnberg P ◯ CDS	8.513[mm]
● G-AGE	
Probe Diameter B Show Probe Ball	
Anim +/- Apply OK Can	

6) When creating a new bevel gearset, until now HyGEARS would limit the shaft angle to prevent the pitch cone angle of the gear from reaching 90 deg, where the tangent becomes infinite. This limit is now removed.

7) When editing a Cyclo Palloid geometry with the Summary Editor, on the Other data page, the desired tooth thickness can now be entered directly. HyGEARS will then adjust the cradle angles of the IB and OB to match the entered thickness.

Blank	Cutter	Machine	Hi Order	Other	Operating	Rim-Material	Bearings	Arboi 🔹
						0	[in] ([mm]
Misc						0	find 6	e) fuuri
Spe	ed Increa	iser						
Mg			1.0000		- Numeric			
Sha	ft		90.0000		Numeno	,ai		
Too	th Taper		Uniform		Numerical Diff000500)
M. E	Distance		β9.0000		Calculation Trace Not			
Roll	er-Ball Dia	ameter	3.0000		Err. Surface No			
Too	th Thick		2.5663					
Тор	land		1.3015		Backlas	h		
Add	endum Fa	actor	0.500		Minimu	m	0.0508	
Dep	th Factor		3.994		Maximu	m	0.1016	

8) When editing a geometry in metric units with the Summary Editor, on the Blank data page, HyGEARS now displays both the Outer Transverse Module (i.e. *Module*) and the Mean Normal Module (i.e. *mn*) as shown below.

Blank	Cutter	TopRem	Machine	Hi Order	Other	Operating	Rim-Mater	rial Be	ai 🔹
Pinie	on (Fini	ishing] - D	uplex He	lical		[🔾 [in]	• [n	nm]
Misc									
#Te	eth	1	9		Outer	CD	184.0	078	
Modu	ule / mn	1	1.72000 / 8	3.23877	Pinion	Offset	0.000	0	
Part	#				Pitch I	Diameter	222.6	798	
Tooth	1				Blank				
Toot	h Hand	L	eft		Pitch	Angle	37.23	48	
Face	Width	5	1.9989		Face	Angle	39.63	18	
Adde	endum	1	1.0140		Root	Angle	35.66	37	
Dede	endum	7	.2447		P.Apex to Xp		0.000	0	
Add.	Angle	1	2.3970		F.Ape	x to Xp	5.186	7	
Ded.	Angle	1	1.5711		R.Ape	x to Xp	-3.766	8	
Front	Angle	3	7.2348		Outsid	le Diameter	240.2	180	
Back	Angle	3	7.2348		FCrow	ın to Xp	99.75	34	1

9) In the outputted Summary – [Summ], [GSum], [SumX] function buttons – the section where the diameters were given has been removed and replaced with more tooth thickness details, as shown below.

The Normal and Transverse thicknesses are given at the Mean Point and at Heel; in addition, the Axial and Radial positions of the Mean Point and Heel Point are provided for reference.

Fillet Radius @ Mid-Face			
Drive - Root Diameter	:	0.8651	0.8216
Coast	:	0.8319	0.8400
Drive - Form Diameter	:	0.6605	0.5687
Coast	:	0.5997	0.6223
Theo. Finish Thickness @ M.Po	:	2.6617	2.6617
Meas. Addendum (Chordal)		1.7409	1.7656
Theo. Finish Thickness @ M.Po	+	2.6617	2.6617
Normal Thick. @ M.Point	:	2.5663	2.7185
Trans. Thick.	:	3.3861	3.5869
Axial Position	:	30.3278	30.3278
Radial Position	:	30.3278	30.3278
Angular Thick. [deg]	:	6.3999	6.7802
Normal Thick. @Heel	:	2.5114	2.9476
Trans. Thick.	:	3.6480	4.2826
Axial Position	:	35.0057	35.0057
Radial Position	:	35.0055	35.0057
Angular Thick. [deg]	:	5.9731	7.0137
Topland (Mid-Face - Normal Pl	:	1.3015	1.4742
Topland (Toe - Normal Plane)	:	1.1632	1.0936
Topland (Heel - Normal Plane)	:	1.4242	1.9138
Topland (Toe - Transv. Plane)		1.5348	1.4429
Topland (Heel - Transv. Plane	:	1.8792	2.5252

10) In 5Axis, the Short Header now includes the machine used for the current part program.

: MyTest
: 09-04-2021 / 14:41:
: DMU 65 - 840D
: [Nominal]
: 1
: 41.05[mm]
: 35.00[mm]
: 0.000[mm]

11) In 5Axis, machines using the Fanuc controller can now be told to "Preset ABC Angles". In short, some controllers pretty much come to a crawl when the X Y Z coordinates and A B or B C or A C angles are changed simultaneously. This can become a serious cycle time issue the changes in the A, B and/or C angles are large (for example after tool retract and when indexing for the next tooth gap) and the controller comes to a crawl.

In order to use this feature,

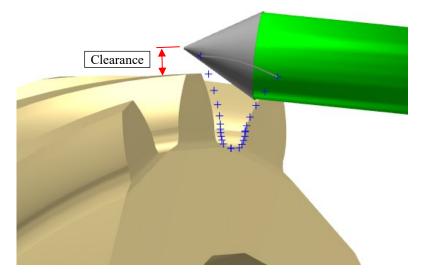
- The machine definition must be adjusted to use this feature;
- In the Output Format of the Cycle tab, the "Preset ABC Angles" option must be selected.

SAxis CnC - Pinion [Finishing] 27x27-ZP-Base-A.hyg - [mm]					
Machine/Tool Cycle Metrics Cy	cling Time/Power Arbor End Mill Operation	Process			
Output Format	Stock-Feed Reqd. Sugg.	Actual			
Use Actual Tooth	# Steps 9 7 - Start	1 Steps			
CSV Format	# Bottomland Pts 0 End	9 Tat.Pts			
Preset ABC Angles	# Facewidth Pts 11 Botto	om Up			
Include Operation Switches	Retract Factor 4 0				
Include Short Header	Moving Contact Pt - Over Run	0.0000			
Include Start Positions Explicit Indexing		0.0000			
No Comments	Constant D-Radius Roughing Finish Stock	0.000			
Coordinates Only	Rough Stock	0.381			
Work Coordinates	Clearance [mm] Indexing Se	quence			
TCP (Fanuc)	Toe 0.000 Skip # 1	Start Gap 1			
	Heel 0.000 Mirror	End Gap 27			
Cutting Cycle					
Slot by Slot		cave [OB]			
O Flank by Flank	None None O Toe -> Heel -> Toe O	None Toe -> Heel -> Toe			
O Fillet-Root Tool Tilt	0.00 O Heel -> Toe -> Heel O	Heel -> Toe -> Heel			
Tooth Flank Tool Pivot	0.000 O Toe -> Heel O	Toe -> Heel			
O Combined	Fixed	Heel -> Toe			
Chamfer Tool Side Depth		OB-IB OShape-Toe OB-IB OShape-Heel			
Chamfer Tool End	0.000 O Rock Me [babe] O	Rock Me [babe]			
O Chamfer Toe	0.000 O Plunge Generation	Plunge Generation			
Chamfer Heel	0.000				
Sa	ve Output Apply +/- Anin	n Ok Cancel			

HyGEARS will then output 2 single lines of code to move the A, B and / or C angles individually in order to get good cycle time. The moves can be either GOO - which is dangerous as it is the fast machine move - or GO1 - which is recommended since the operator can slow down the machine when testing an operation.

0600	111							_		
	_	51.5454 136.2738	в							
F#5(66							-		
G01	х	30.0888	Y	17.7498	Z	66.2176	в	51.5454	С	136.2738
F#5(67									
G01	х	30.0888	Y	17.7498	Z	50.9161	в	51.5454	С	136.2738
F#5(68									
G01	х	28.9295	Y	18.3608	Ζ	50.8644	в	51.5907	С	134.0968
G01	х	27.7930	Y	18.9879	z	50.7964	в	51.6520	С	131.8659
G01	х	26.6698	Y	19.6316	z	50.7179	в	51.7184	С	129.5811
G01	х	25.5742	Y	20.2945	Ζ	50.6210	в	51.8042	С	127.2373
G01	х	24.5016	Y	20.9775	z	50.5082	в	51.9040	С	124.8336
G01	х	23.4532	Y	21.6820	z	50.3789	в	52.0180	С	122.3673
G01	х	22.4308	Y	22.4097	Ζ	50.2320	в	52.1474	С	119.8352
G01	х	21.4362	Y	23.1623	Ζ	50.0663	в	52.2929	С	117.2338
G01	х	20.4715	Y	23.9416	Z	49.8803	в	52.4559	С	114.5590
G01	х	19.5391	Y	24.7495	z	49.6724	в	52,6377	С	111.8061

12) In 5Axis, when deburring / chamfering the Toe and Heel tooth edges, HyGEARS now extends the tooth OD such that a small clearance accounting to 25% of tooth depth is provided; this allows for faster plunge feeds.



13) When using the "Save As" function, HyGEARS now offers to save the geometry in the format of an earlier HyGEARS release. This is based on the file version number as shown below.

🕷 File Version Number		×
File Version Number:	463	\sim
	464 463	^
	462	
	461	
	460 459	
	458	

The following table gives the equivalence between the HyGEARS version and the HyG file version.

HyGEARS Version	"HyG" file version
406.20	464
406.10	464
406.00	463
405.90	462
405.80	461
405.70	461
405.60	461
405.50	460
405.40	459
405.30	459
405.20	459
405.10	458

405.00	457
404.90	457
404.80	457
404.70	457
404.60	457
404.50	457
404.40	457
404.30	457
404.20	457
404.10	457
404.00	457

.

14) When editing a cylindrical gear, HyGEARS now offers different Generating Pitch Diameter and Crowning values for the Left and Right tooth flanks, thereby opening the door for Closed Loop and Reverse Engineering.

Blank C	utter Cutter Edge	Machine Other	Operating	Rim-Material	Bearings	A I
		🔿 [in]	● [mm]			
		Left		Righ	t	
Oper. (C. Distance	98.1	883			
X Fact	or	0.00	00			
Genera	ating Pitch Dia.	44.2	87864	4	4.287864	
Tool C	enter Distance	37.2	01808			
Tooth	Crowning	0.00	0000	0	.000000	
Crowni	ing Type	Spec	cified ~	1		
Crowni	ing Order	2	~			
Distan	ce to Edge	17.0	000			

15) HyGEARS now sports Closed Loop and Reverse Engineering (RE) for cylindrical gears, including Face Gears. For the [Corr] and [R.E.] to work, measurement data must be present and displayed.

Both 1st and 2nd Order algorithms are offered; for 1st order, as is usual, pressure and helix angles are accounted for, plus tooth thickness.

Correct	tive Mac	hine Setti:	ngs Pinion - [Finishin	ig]		×
Tolerance	Order	Machine				
0 0rd	t d Middle Ri Middle Co	ow olumn	Tooth Rank Right Left Right + Left Drop @ bottom Machine 0	: 0	Selection All Spiral Angle Pressure Angle Tooth Taper Tooth Thickness Bias Crowning Profile	
	o Dampin calc Jacol	g bian each l	teration	Maintain	n Point Width 1 Tooth Thickness 1 Tooth Depth	
			Apply	<u>R</u> eset	Print OK Ca	ncel

For 2nd Order, tooth lengthwise Crowning is added.

👹 Corrective Machine Setting	ıs Pinion - [Finishing]	×
Tolerance Order Machine		
Cutting Changes Order Ord 1st 2nd Middle Row Middle Column # Iterations Max. # Iteratio 20	Tooth Flank Pight Left Right + Left Drop @ bottom: 0 Machine	Selection All Spiral Angle Pressure Angle Tooth Taper Tooth Thickness Bias Crowning Profile
 Auto Damping Recalc Jacobian each Iter 	ration Maintai	in Point Width In Tooth Thickness In Tooth Depth

In both 1st and 2nd Order, the Machine tab allows selecting the control parameter for the Pressure angle, as shown below:

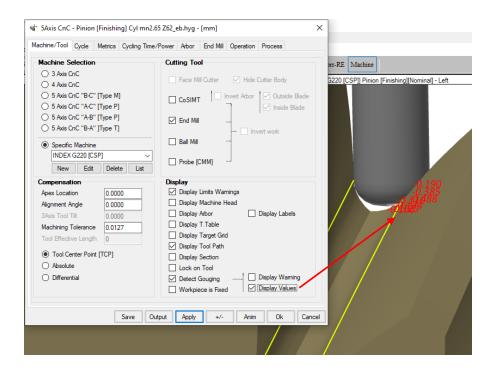
- Roll Rate is equivalent to changing the Generating Pitch diameter; this is the most likely scenario and is therefore the default;
- Alternately, the Blade Angle can be chosen as the control parameter; note that the tool is then changed.

For tooth lengthwise Crowning, only the Crowning value can be selected.

👹 Corrective Machine Settings Pinion - [Finishing]		
Tolerance Order	Machine	
	Pressure Angle Control Roll Rate Cutter Lead Blade Angle Cutter Tilt 	
	Eengthwise Crowning Tooth Crowning Offset Cutter Tilt + Offset	
	Apply Reset Print OK	Cancel

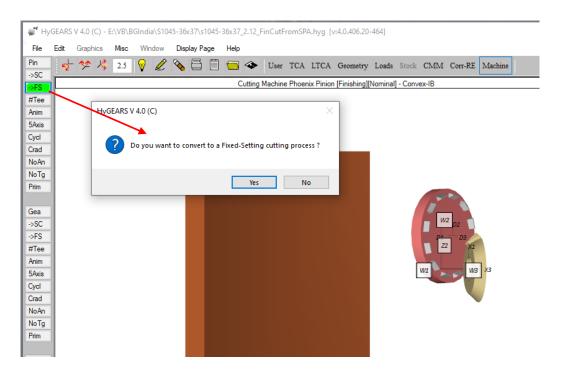
15) In 5Axis, when using the Detect Gouging feature (Machine/Tool tab), one can ask to have the gouging values displayed instead of the location where gouging is occurring. By default only the gouging locations are displayed.

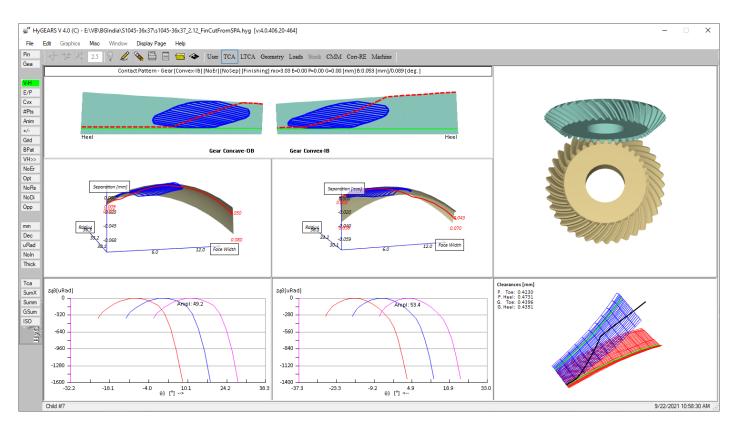
	ime/Power Arbor End Mill Operation Process	
Machine Selection	Cutting Tool	prr-RE Machine
O 3 Axis CnC	Face Mill Cutter Hide Cutter Body	G220 [CSP]] Pinion [Finishing][Nominal] - Left
4 Axis CnC		
5 Axis CnC "B-C" [Type M] 5 Axis CnC "A-C" [Type P]	CoSIMT Invert Arbor Outside Blade	
• • • •	✓ Inside Blade	
5 Axis CnC "A-B" [Type P] 5 Axis CnC "B-A" [Type T]	End Mill	
O S Adis Cric B-A [Type 1]	- Invert work	
Specific Machine	Ball Mill -	
INDEX G220 [CSP]		
New Edit Delete List		
Compensation	Display	/ ++
Apex Location 0.0000	Display Limits Warnings	+++++++
Alignment Angle 0.0000	Display Machine Head	
3Axis Tool Tilt 0.0000	Display Arbor Display Labels	
Machining Tolerance 0.0127	Display T.Table	
Tool Effective Length 0	Display Target Grid	
Tool Center Point [TCP]	Display Tool Path	
	Display Section	
	□ Lock on Tool ☑ Detect Gouging □ □ Display Warning	
C) Sinclothia	Workpiece is Fixed	
Save	Output Apply +/- Anim Ok Cance	



16) In Machine mode, spiral bevel gears cut using completing cycles such as Duplex Helical, Spread Blade, or Formate, can now be converted to equivalent Fixed Setting cycles for the Convex and Concave tooth flanks. Doing this generates the same machine settings for both flanks, but using different cutters; therefore initially the Contact Pattern may have moved and the backlash may be different. Using the [BPat] function in TCA mode allows moving the Contact Patterns where desired.

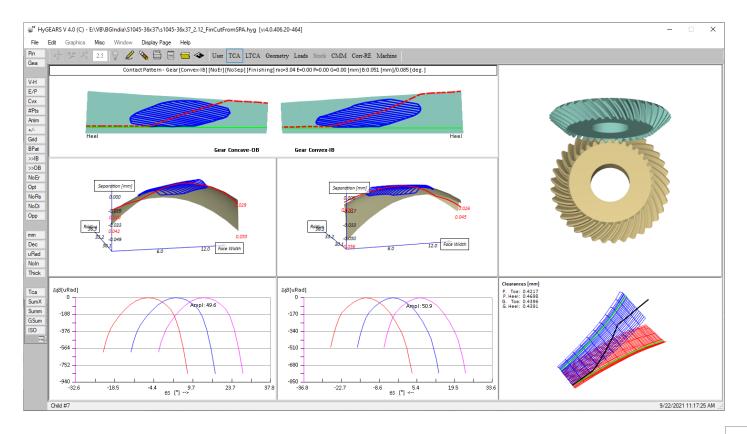
This function is not useful per se for manufacturing; however, it can prove useful if an unknown gear - whose manufacturing details are not known - is to be replicated by milling; Reverse Engineering a Fixed Setting part usually allows a very close fit.



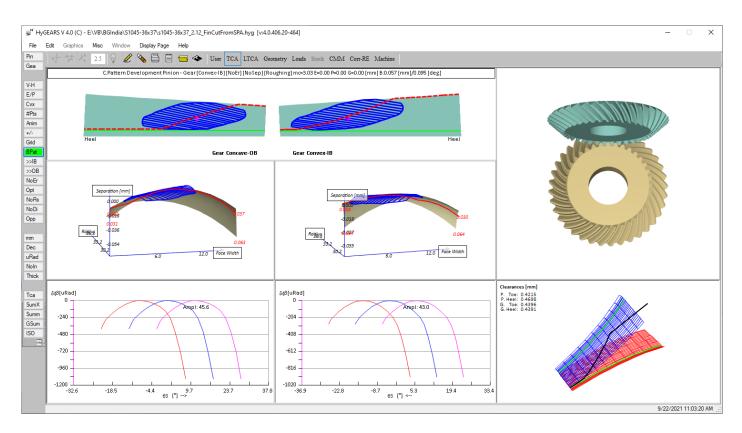


For example, the spiral bevel gearset shown below has a Duplex Helical pinion.

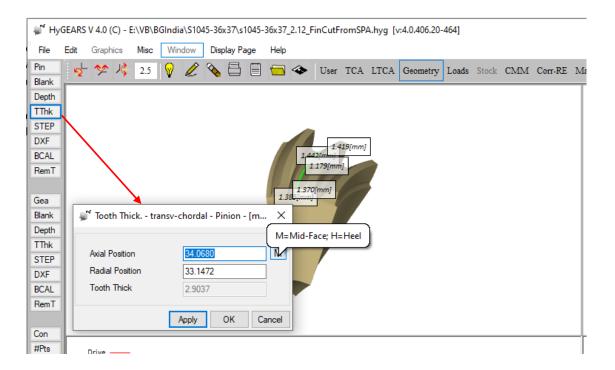
After converting the pinion from Duplex Helical to Fixed Setting, the TCA shows the following where HyGEARS has centered the CPs on the tooth flanks.



Using the [BPat] function in TCA mode allows moving the Contact Patterns where desired and the backlash back to its desired value.

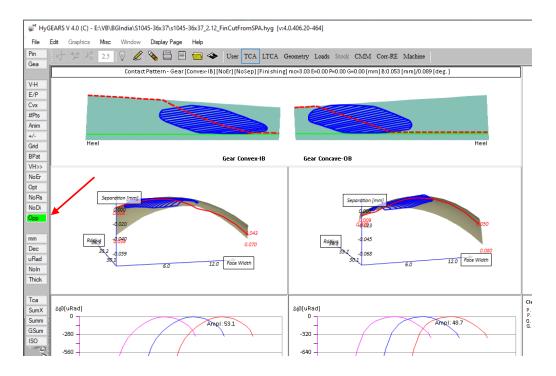


17) In Geometry mode, addition of the [TThk] function button, giving access to the Tooth Thickness function in which one enters the Axial and Radial locations of the point where the thickness is desired.

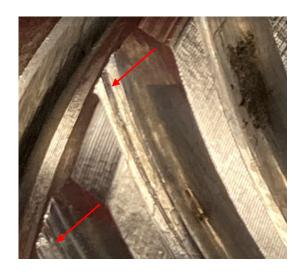


By default, tooth thickness is given at Mid-face as indicated by the [M] button at the right of the Axial Position; however, clicking on the [M] button toggles it to [H], indicating that tooth thickness is now given at Heel. For bevel gears, [M] and [H] are on the pitch cone. Entering any Axial and Radial value tells HyGEARS to calculate tooth thickness at the given position.

18) In TCA mode, addition of the [Opp] function button used to invert the tooth hand of spiral bevel, straight and helical gears. The [Opp] button still appears in Geometry mode.



19) In 5Axis, for Semi-Completing (SC) spiral bevel gears, addition of the Center Roll cutting cycle. When generating SC gears, it is not uncommon to leave a ridge at the center-bottom of the tooth gap if the point width of the Face Mill cutter is significantly smaller than the tooth gap – see figure below. The Center Roll cycle is introduced to allow removing this ridge efficiently.

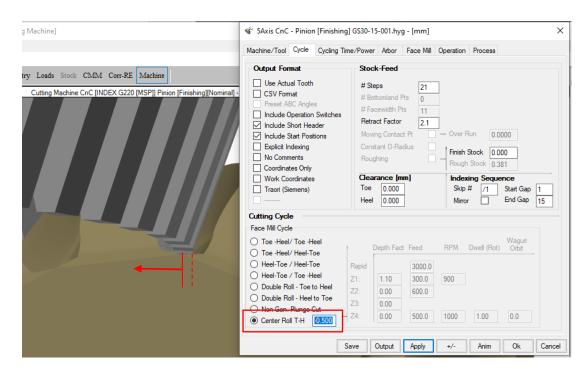


Machine/Tool Cycle Cycling Tim	e/Power Arbor Face Mill Operation Process
Output Format	Stock-Feed
 Use Actual Tooth CSV Format Preset ABC Angles Include Operation Switches ✓ Include Short Header ✓ Include Start Positions Explicit Indexing No Comments Coordinates Only Work Coordinates Traori (Siemens) 	# Steps 21 # Bottomland Pts 0 # Facewidth Pts 11 Retract Factor 2.1 Moving Contact Pt — Over Run 0.0000 Constant D-Radius — Finish Stock 0.000 Roughing — Finish Stock 0.381 Clearance [mm] Indexing Sequence Skip # /1 Stat Gap 1 Heel 0.000 Mirror End Gap 1
Cutting Cycle	
Face Mill Cycle	
O Heel-Toe / Toe -Heel O Double Roll - Toe to Heel	Depth Fact Feed RPM Dwell (Rot) Waguri Orbit Rapid 3000.0 3000 900 Z1: 1.10 300.0 900 Z2: 0.00 600.0 900
Double Roll - Heel Center Roll Non Gen. Plunge Com Center Roll T-H 0.000	Z4: 0.00 500.0 1000 1.00 0.0

The Center Roll cycle moves the cutter to the center of the tooth gap; the cutting cycle is then calculated on the roll angles at the fillet limit of the tooth flank. Toe and Heel Clearances are generally NOT required, and although a soft plunge feed is recommended, cutting feed can be much higher than for the tooth flanks given very little material is removed.

The "Center Roll delta position", shown above, can be used to move the tool away from the Convex flank (+ value) or closer to the Convex flank (- value) should the center of the Point Width not be exactly where desired, as the 2 figures below show.

J Machine]	📽 5Axis CnC - Pinion [Finishing] GS30-15-001.hyg - [mm] 🛛 🗙
	Machine/Tool Cycle Cycling Time/Power Arbor Face Mill Operation Process
ry Loads Stock CMM Corr-RE Machine Cutting Machine CnC [INDEX G220 [MSP]] Pinion [Finishing][Nomina]]-	Output Format Stock-Feed Use Actual Tooth # Steps CSV Format # Bettomland Pts Preset ABC Angles # Bottomland Pts Include Short Header 0 Include Short Header Moving Contact Pt Include Short Header Moving Contact Pt Include Short Header Moving Contact Pt Ocordinates Only Constant D-Radus Coordinates Only Finish Stock 0.000 Correntiates Only Indexing Sequence Traori (Siemens) Toe Toe - Heel/ Toe Finish Stock 0.000 Mirror End Gap 15 Catting Cycle Face Mill Cycle Face Mill Cycle Rapid Toe - Heel/ Toe Depth Fact Feed Waguri Double Roll - Toe to Heel 22: 0.00 600.0 Double Roll - Heel Tore 22: 0.00 600.0 0.00 Output Roll - Heel Tore 22: 0.00 000 1.00 0.0 Output Roll - Heel To Toe to Heel 22: 0.00 100 0.0 0.0 Output Roll - Heel Tore 22: 0.00
	Save Output Apply +/- Anim Ok Cancel



20) When creating a New Geometry, the mean normal module "*mn*" is now displayed for bevel gears, in order to facilitate relationship with data sometimes given in metric drawings. The mean normal module is derived from the already entered dimensions such as module, shaft angle, tooth number, face width and spiral / helix angle and is updated as any of these values is changed.

neral Cutter Units					
Names					
Geometry Name	Test-1-Spiral-Bevel				
Directory	E:\VB				
Geometry Source File	SpirBevI.lst				
Types					
Geometry Type	Spiral-Bevel ~				
Material	AGMA A-1 🗸				
Pinion Tooth Hand	Left V				
Tooth Taper	Duplex ~				
Misc					
Power [Kw] / Torque [N-m]	523.84 5000.00				
Pinion Speed (RPM)	1000.00				
Number of Teeth [Pinion - Gear]	19 2.263 43				
Module/Pitch Diameter	11.719997 / 503.9599				
Gear Tooth Face Width / mn	52.000 8.69437				
Shaft Angle	90.0000				
Depth Factor (Gear)	4.000 AGMA / ISO				
Addendum Factor (Gear)	0.398 O AGMA				
Clearance Factor	0.125 O ISO				

21) In the HyGEARS configuration (File -> Edit -> Configuration), for all bevel gears, it is now possible to tell HyGEARS to default to ISO or AGMA tooth proportions when creating a New Geometry; when HyGEARS is initially installed, this defaults to AGMA. The selection appears on the Units tab of the Configuration editor, as shown below.

Configuration HyGEARS V 4.0 (C)								
General	Units	Fonts	Gra	phics	Colors	Display	1	
Angle Units				Decimal				~
Linear Units				mm				~
Cutter Units				mm				~
TE Units				uRad				~
AGMA/ISO input				AGM/				\sim
				ISO AGM/	1			
					Apply	0	к	Cancel