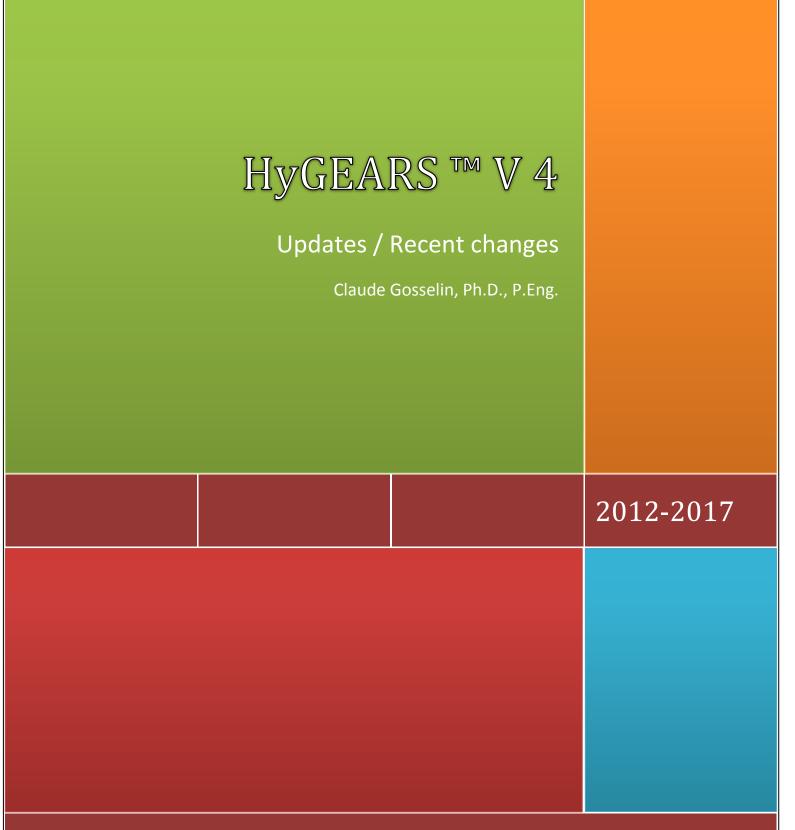


Involute Simulation Softwares Inc.



www.HyGEARS.com

HyGEARS ™ Updates Contents

HyGEARS update –29 November 2017 - Build 405.90 - 462	
- Hyde/ HS update 25 Hovember 2017 Baild 405.50 402	

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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.

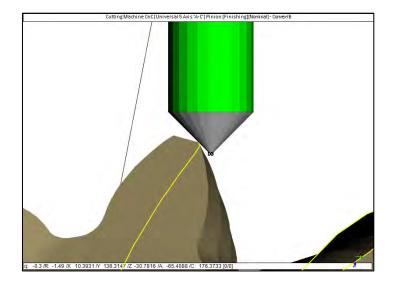


2) In 5Axis, all Tool definitions now include entry fields for *Tool ID* and *TLU ID*. The *Tool ID* and *TLU ID* are fields used in the Operation to inform the controller of the tool used.

	ycle Cycling Time	e Arbor E	nd Mill Op	eration Proc	ess Stock	
End Mill Detai	ls Name	90 Cone To	ol	90	Cone Tool	
	Tool ID:	2		1	Clear Save	e Delete
	TLU ID:	201		6		e Delete
Diameter	0.0500			- 1		
Edge Radius	0.0000		Г	1	-	+
Cone Ingle	90.0000	Holder	Diameter 🛶	1 1	Hol	der Length
R. Curvature	0.0000	Tonici			1	
Cutting Length	5.0000			TTT		* +
Cutting Length in	1 5.0000	Stem D	ameter		1	
ool Length	34.0000			11	·	
Taper Length	0.0000			11/1	aper Length	Tool Length
Stem Diameter	10.0000	Cone A	ngle		n	ior Length
Save	Delete Impor	t STEP		Dutput		
	Tool ID 2	0	0	0	0	0
Save	Tool ID 2 TLU ID 201	0	0	0	0	0
Tool Change	Tool ID 2	0	0	0		
Tool Change	Tool ID 2 TLU ID 201	0 0 0 Coolar	0	0	0	0
Tool Change	Tool ID 2 TLU ID 201 Gap # 1	0 0 0 Coolar Coolar	0 0 0 t On Code	0 0 0 0 M07	0	0
Tool Change Switches	Tool ID 2 TLU ID 201 Gap # 1 V Coolant On Spindle CW Spindle CCW Return Trip # Steps	0 0 0 Coolar Coolar	0 0 0 t On Code t Off Code	0 0 0 0 M07 M08	0	0
Tool Change Switches	Tool ID 2 TLU ID 201 Gap # 1 Coolant On Spindle CW Spindle CCW Return Trip # Steps n]	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 t On Code t Off Code	0 0 0 0 M07 M08	0	0
Tool Change Switches	Tool ID 2 TLU ID 201 Gap # 1 Coolant On Spindle CW Spindle CCW Return Trip # Steps n] Rapid Move	0 0 0 Coolar Coolar Coolar 11 1500.0	0 0 0 t On Code t Off Code	0 0 0 0 M07 M08	0	0
Tool Change Switches	Tool ID 2 TLU ID 201 Gap # 1 Coolant On Spindle CW Spindle CCW Return Trip # Steps n] Rapid Move Plunge	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	0 0 0 t On Code t Off Code indle RPM	0 0 0 M07 1200.0	0	
Tool Change Switches Feeds [mm/mi	Tool ID 2 TLU ID 201 Gap # 1 Coolant On Spindle CW Spindle CCW Return Trip # Steps n] Rapid Move	0 0 0 Coolar Coolar Coolar 11 1500.0	0 0 0 t On Code t Off Code indle RPM	0 0 0 0 1200.0 el>Toe OB	0 0 Toe->Heel C	

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.

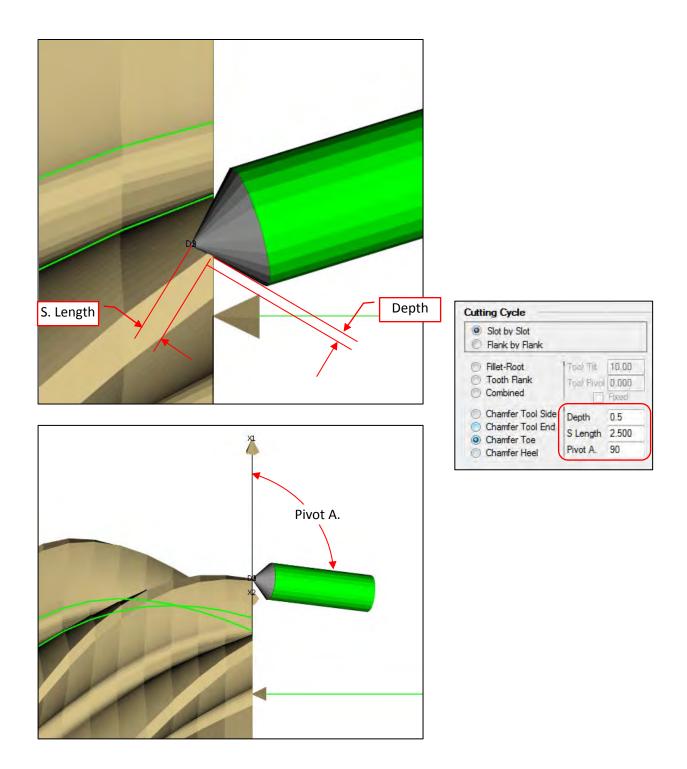


The Cone Tool is described as a usual End Mill, except that the Diameter is expected to be nearly zero (0.050 mm, figure below), the Edge Radius is zero, and the Cone Angle ranges from 45° to 90°.

lachine/Tool Cycle	Cycling Time	Arbor End Mill Operation Process Stock
End Mill Details	Name	90 Cone Tool 90 Cone Tool 🗸
	Tool ID:	1 Clear Save Delete
	TLU ID:	
Diameter	0.0500	
Edge Radius	0.0000	
Cone Angle	90.0000	Holder Diameter
R. Curvature	0.0000	
Cutting Length	5.0000	
Cutting Length in	5.0000	Stem Diameter
Tool Length	34.0000	++++
Taper Length	0.0000	Taper Length Tool Length
Stem Diameter	10	Cone Angle Tool Length
Holder Diameter	50.0000	R. Curvature
Holder Length	0.0000	N. Culyature
Holder Angle	0.0000	Diameter
Tip Reference	V	Edge Radius
		Tool Center Point
Fillet Rad [Toe]	2.9953	[
Fillet Rad. [Hee]]	3.0326	Feeds [mm/min]
Slot Width [Toe]	6.9541	RPM 1200.0
Slot Width [Heel]	7.1272	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);



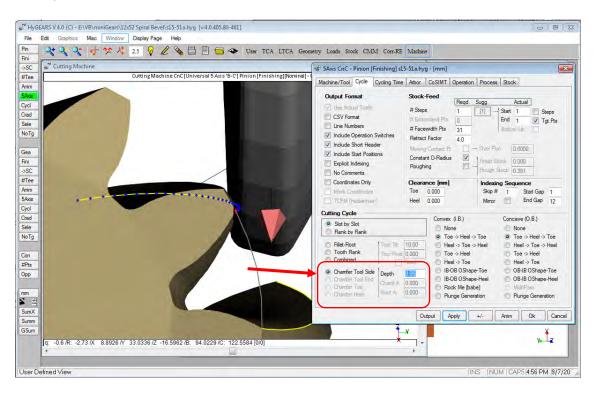
4) In 5Axis, Chamfer Toe / Chamfer Heel, HyGEARS offers Stock for both Fillet and Flank, such that the location of the tool can account for the fact that, for example, the Flank may have a +Stock, while the Fillet has a protuberance, and thus –Stock.

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.

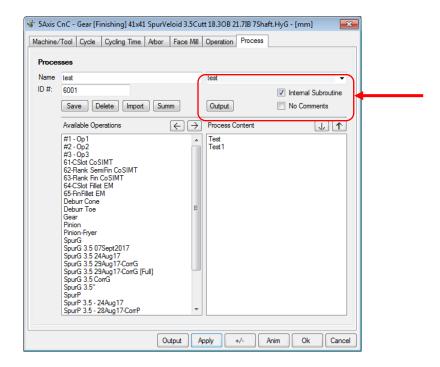
5Axis CnC - Pinion [Finishing]	6x37 Spiral-75mmFwidth.HyG - [mm]
Machine/Tool Cycle Cycling Tir	me Arbor End Mill Operation Process Stock
Output Format	Stock-Feed
 ✓ Use Actual Tooth CSV Format Line Numbers ✓ Include Operation Switches ✓ Include Short Header ✓ Include Start Positions Explicit Indexing No Comments Coordinates Only Work Coordinates TCPM (Heidenhain) 	Reqd. Sugg. Actual # Steps 11 [11] Start 0 Steps # Bottomland Pts 0 End 1 Tgt.Pts # Facewidth Pts 11 Bottom Up Retract Factor 4.0 Moving Contact Pt Over Run 0.0000 Constant D-Radius Imake Stock 0.000 Roughing Fillet Stock 0.000 Clearance Imm Indexing Sequence Skip # Toe 0.000 Skip # Stat Gap Moror End Gap 6
Cutting Cycle	
Slot by Slot Flank by Plank Fillet-Root Tool T Tool T Tool Ph Combined	Convex (I.B.) Concave (0.B.) None Toe -> Heel -> Toe None 10.00 Toe -> Heel -> Toe Heel -> Toe -> Heel Toe -> Heel Toe -> Heel Toe -> Heel Toe -> Heel Toe -> Heel Toe -> Heel Fixed Heel -> Toe Heel -> Toe
Chamfer Tool Side Chamfer Tool End Ochamfer Toe Chamfer Heel	O Rock Me babe O MultiPass
	Output Apply +/- Anim Ok Cance

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.

PROCESS: Z1		nion : 23x109 Helical-TIF-2	A. HVG [mm]				
Seq# 1							V4
	1	2	3	4	5	6	the
pID 9	92	93	95	94	97	98	
pName 9	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 M	Mori NT4250 / C1 [B-]	Mori NT4250 / C1 [B-]	Mori NT4250 / C1 [B+]	Mori NT4250 / C1 [B+]	Mori NT4250 / C1 [B-]	Mori NT4250 / C1 [B-]	
arget F	Flank	Flank	Flank	Flank	Fillet	Fillet	
Cool C	CoSIMT	CoSIMT	CoSIMT	CoSIMT	CoSIMT	CoSIMT	
Len -	-0.7282	-0.3404	-0.3404	+0.3404	+0.3404	-0.3404	
CoolName 0	001_229263R75_D1	S-327.2PP2.A	S-327.2PP2.A	S-327.2PP3.A	S-327.2PP3.A	S-327.2PP2.A	
CoolID 1	1027	1029	1029	1031	1031	1029	
pxLoc -	-13.2500	-13.2500	-13.2500	-13.2500	-13.2500	-13.2500	
Steps 3	3	5	11	11	7	7	
Start 1	1	4	0	0	1	1	
Ind 2	2	5	11	11	6	6	
CoeClr 2	20.000	15.000	15.000	15.000	15.000	15.000	
leelClr 5	5.000	5.000	5.000	5.000	5.000	5.000	
Stock					-0.020	-0.020	
'ime['] 2	2.2	2.0	10.5	10.7	5.4	5.3	
st.Time 0	0.60 H						

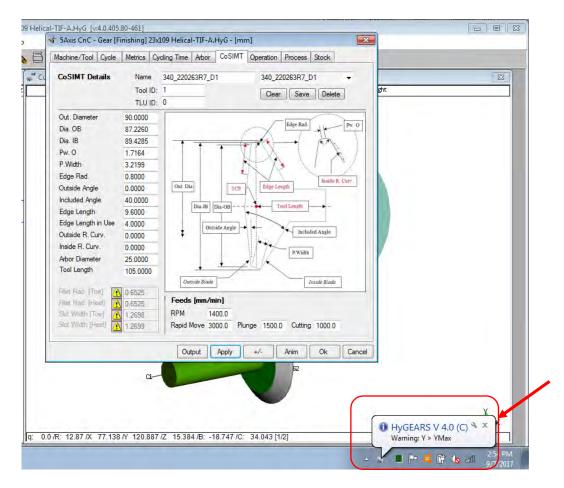
8) In 5Axis, *Machine/Tool* tab, it is now possible to selectively display the machine's Turn Table on which the work piece and its supporting arbor are installed.

🐝 5Axis CnC - Pinion [Finishing] 23x109 Hel	ical-TIF-A.HyG - [mm]
Machine/Tool Cycle Metrics Cycling Time	Arbor CoSIMT Operation Process Stock
Machine Selection	Cutting Tool
3 Axis CnC 4 Axis CnC 5 Axis CnC "B-C" [Type M] 5 Axis CnC "A-C" [Type P]	Face Mill Cutter Hide Cutter Body CoSIMT Konvert Arbor Colside Blade Konvert Arbor Konver
S Axis CnC "A-B" [Type P] 5 Axis CnC "B-A"]Type T] Specific Machine	
Mori NT4250 / C1 [B-] - New Edit Delete List	Probe [CMM]
Compensation Apex Location 60[2500 Alignment Angle 0.0000 3Avis Tool Tilt 0.0000 Image: Tool Center Point [TCP] Absolute Differential	Display Machine Head Display Achor Display Achor Display Trable Display Target Grid Display Tool Path Display Section U Lock on Tool Detect Gouging Display Warning Workpiece is Fixed
0.	utput Apply +/- Anim Ok Cancel

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

Controlle Controlle Linear De Angle De Macro St	r Fan ecimals 3 cimals 3		ntroller-Machine Head External S C Lead spac Blank Line Upper Cas Slot Count	iubs Use CYCL 1 ces Use ORIAX es Feed String se Impose Com	ES/ORIVECT on Single Line pensation	Use RE	
Pgm Star	t#	6001	Main Program Prefix	00	Coolant	On Code	8
			Sub Program Prefix	00	Coolant	Off Code	9
Pgm Star	t Char		Main Pgm File Ext.		Dwell C	ode	
Pgm End	Char		Sub Pgm File Ext.		T.Table	Index Code	G52
1st Code	Line Prefix		Spindle CW	M3	Subrout	ine End	M9
			Spindle CCW	M4	Program	End	M3(
					Subrout	ine Call	
Machine				Machine Limits			
_	Length	Diameter	Square		Minimum	Maximum	
	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						
	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.



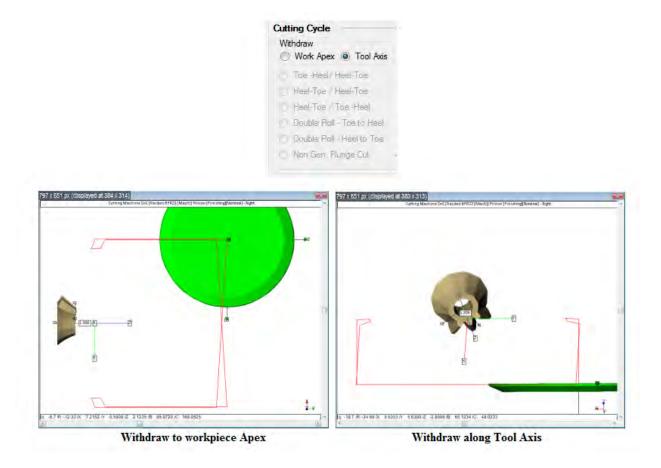
For this warning to be displayed, the machine's limits must have been defined by editing the desired machine and entering the values in the *Controller-Machine Head* tab, Machine Limits section, as shown below.

ontroller		External S	ubs 🔲 Use CYCL 1	19	Use BE	PEAT xx P=(1)
	nuc	 Lead space 	es 🗌 Use ORIAX	ES/ORIVECT		DEGROUP
Linear Decimals 3		🔽 Blank Line	is 📃 Feed String	on Single Line		
Angle Decimals 3		Upper Cas	·			
Macro Start # 560	D	Slot Count	er 📃 Universal W	/ork 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			\sim			

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						
	🔽 Coolant On	Coolant On Code	8			
		Coolant Off Code	9			
	Spindle CW			Vc:	378.1	[ft/min]
	Spindle CCW	Spindle RPM	160	fz:	0.0031	[in]
				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				
	10.16	[sec]		
Plunge:				
Retract:				
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:		[in/min]		
Tool RPM:	160.00			
1	Pot	ver Required	1	
Matl const Kc:				
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]		

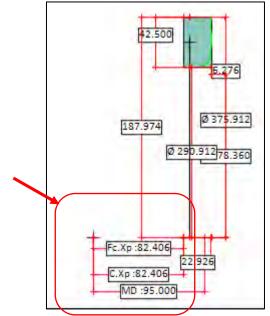
13) For Spur/Helical gears, in the Geometry Summary Editor (*Pin / Gea* function buttons), the X Factor (i.e. the Profile Shift factor) can now be edited. This allows adjusting the X Factor to reach a target tooth thickness.

🚀 Pinio	on (Ext. S	pur-Helical]	(Finishing][N	omir	nal] Test-1-	Ext.hyg - [mn	n] [dd.mm	n 💌
Blank	Cutter	Cutter Edge	Machine	O	her	Operating	Rim-Material	Bearings	A
				\bigcirc	[in]	(mm)	1		
				-			<u>.</u>		
Ope	er. C. Dist	ance			152	4000	_		
XF	actor				0.52	73		_	
Ger	nerating F	itch Dia.			80.3	90873	-		
Тос	l Center I	Distance			57.2	78497			
Тос	th Crown	ing			0.00	0000			
Cro	wning Ty	pe			Spec	cified 🖣	•		
Cro	wning Or	der			2	•	•		
Dist	ance to E	Edge			8.75	00			
							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.

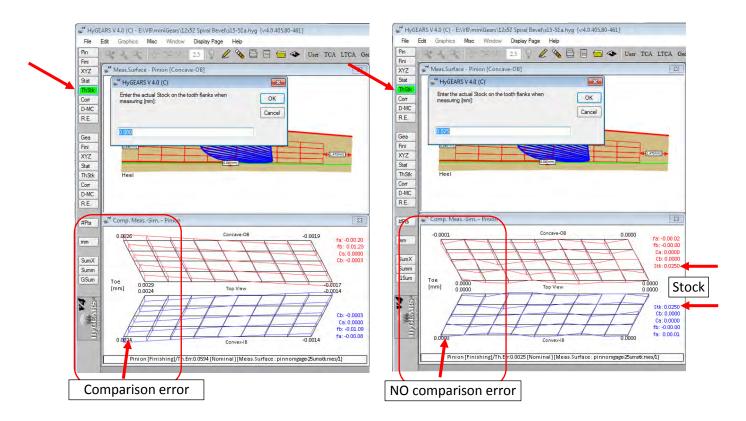
Pinion [Ext. Spur-He	elical] [Finishing][Nomir	nal] Test-1-Ext	.hyg -	[mm] [dd.mm	1 📄	×
ank Cutter Cutter	Edge Machine	Other	Operating R	im-Mat	erial B	earings	A	•
Pinion [Finishing]	- Ext. Spur-He	lical		C) [in]	۲	[mm]	
Misc						0		
# Teeth	40		Pitch Diamete	er	80.3	909		
Module	1.94000							
Part #								
Tooth			Blank				_	ΞI
Tooth Hand	Left		Minor Diamet	er	76.1	884	٦)	
Face Width	35.0000		Major Diamet	er	86.7	774	٦J	
Addendum Factor	1.1187		Addendum		3.19	33		
Dedendum Factor	1.7710		Dedendum		2.10	13		
Fillet Factor	0.2500							
Front Angle	0.0000							
Back Angle	0.0000							
			ſ	Apply	0	к	Cance	el

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.



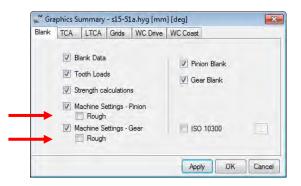
15) In *Corr-RE* display mode, addition of the "ThStk" function button. This is used to enter the desired Stock used to define the CMM Nominal target (*CMM* display mode).

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.

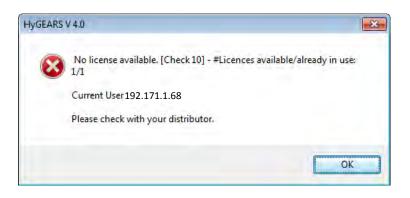
	l						
	Torque [Nm]	RPM	# Hours	1	Torque [Nm]	RPM	# Hours
#1	70	1000.00	200	# 11	0.00	0.00	0.00
# 2	200	1500	25	# 12	0.00	0.00	0.00
# 3	10	2000	15	# 13	0.00	0.00	0.00
‡ 4	0.00	0.00	0.00	# 14	0.00	0.00	0.00
‡ 5	0.00	0.00	0.00	# 15	0.00	0.00	0.00
# 6	0.00	0.00	0.00	# 16	0.00	0.00	0.00
‡ 7	0.00	0.00	0.00	# 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-10300:2014 Duplex Helical Pinion Spread Blade Gear	(Method B)	1)		Date / Time : \$/7/2017 / 2:3 General Units : [um] [dd.mm.ss Cutter Units : [in] Prepared by : Claude Gosseli Version : 4.0.405.80-461	1 n /		W
OUTPUT - Contact		PINION	GEAR	OUTPUT - Bending		PINION	GEAR
SURFACE DURABILITY (PITTING) [Zone of action for pitting resistan	ce]			TOOTH ROOT STRENGTH [Zone of action for tooth root streng	th]		
Distance from the centre, Tip Distance from the centre, Middle Distance from the centre, Root Length of contact line, Middle Length of contact line, Root Exponent & load on contact line, Tip & load on contact line, Root	[mm] : [mm] : [mm] : [mm] : [mm] : [mm] : [%] : [%] : [%] :	-3. 2. 9. 2. 1. 8. 83.	0000 4038 6082 1465	Distance from the center, Tip Distance from the center, Middle Distance from the center, Moot Length of contact line, Tip Length of contact line, Root Exponent Contact line, Fing + load on contact line, Middle + load on contact line, Root	[rum] : [rum] : [rum] : [rum] : [rum] : [rum] : [*] : [*] : [*] :	3.4 0.0 -3.4 9.1 2.6 1.5 8.4 8.4 8.4 8.4	000 038 465 082 000 581 839
Transverse load factor Face load factor Hidrsone factor Distinction factor Ulasticity factor Velocity factor Roughness factor Frodate Work hardening factor Life factor Berg gas factor	qrt (N/mm2)]	1.:	0000 9111 9115 9100 91754 0.9482 1.0856 1.0514 1.0000 0.9692 0.8500	Transvere Load factor Lengthwise curvature factor Face load factor Load having factor Bevel spiral angle factor Relative noth sensitivity factor Size factor Account of probad Bending moment arm Toobh por factor Stress correction factor Life factor	: : : : : : : : : : : : : : : : : : :	1 0 1 0 1 0 0 .6 0 .6 1 1 1 .1200 0 .9835 1 .0000 1 .8003 3 .7155 0 .8923 6 .8373 1 .26383 0 .5993	057 916 250 308
RESULTS - ISO10300		PINION	GEAR	RESULTS - ISO10300		PINION	GEAR
Torque \$1 Speed Amming Time Mominal contact stress Contact stress Contact stress Sufety factor for contact stress Safety factor for contact stress Pitting damage	[Nm] : [RPM] : [h] : [MPa] : [MPa] : [MPa] : [MPa] : [MPa] : :	5.0000 1000.0000 200.0000 646.1168 1036.1872 1219.0488 1172.3199 1373.1056 1.3252 0.0001	646.1168 1036.1872 1219.0438 1172.3199 1534.1438 1.4806 0.0000	Mominal tooth toot steess Tooth root steess Allowable steess number Permissible tooth root strees Safety factor for bending stress Bending damage	[Mpa] : [Mpa] : [Mpa] : [Mpa] : :	231.1995 591.2764 134.4720 288.1177 0.4873 524.7142	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 1867.2402 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 Permissible tooth root stress Safety factor for bending stress Bending damage	[Mpa] : [Mpa] : [Mpa] : [Mpa] :	554.8787 1194.7885 134.4720 306.1476 0.2562 10000000	181.6975 391.2388 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 Units : [mm] [da.mm.ss] Cutter Units : [in] Prepared by : Claude Gosseli Version : 4.0.405.80-461	1		16
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	[MPa] : [MPa] : [MPa] : [MPa] :	500.4799 806.0921 948.3437 1172.3199 1601.3555 1.9866 0.0000	500.4799 806.0921 948.9437 1172.3199 1789.1629 2.2196 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] :	357.8355 134.4720	45.4244 117.1748 134.4720 379.8610 3.2418 0.0000
Allowable Stress Number Permissible contact stress Safety factor for contact stress Pitting damage		0.0000					

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_m	6,4806.hyg - [主		
Blank Cutter Machine Hi Order	Other Operating Rim-Material	Bearings Arbor 4 >	🛫 B.Pattern Development - Gear Convex-IB	x
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	1
Offset	0.00000	0.00000	Free In Free In Free In 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	
Rate of Roll	4.390069	4.390069	○ Fixed 0.0400 [mm] ○ Fixed 0.0450 [mm]	
Cradle Angle	50.2296	48.4454		
			Backlash	
			© Free	
			e Fixed 0.161 [mm]	
				2
	Apply	OK Cancel	Apply < <back next="">> Reset Print OK Canc</back>	;el

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:

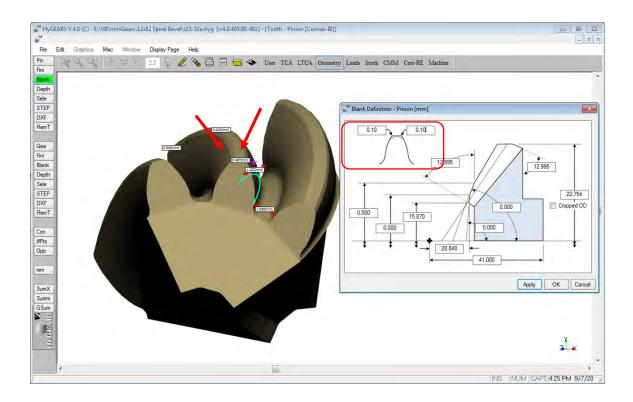
- at Toe,
- at Mid Facewidth,
- at Heel.

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.

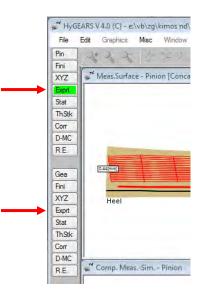
eral Cutter Units	
Geometry Name	Test-1-Spiral-Bevel
Directory	
Geometry Source File	E:\VB\
Geometry Source File	SpirBevI.lst
Types	
Geometry Type	Spiral-Bevel
Material	Beveloid
Pinion Tooth Hand	Coniflex CurFace
Tooth Taper	Ext. Spur-Helical
Tooli Taper	Face Clutch Face Gear
Misc	Herringbone
Power [Kw] / Torque [N-m]	Hypoid Int. Spur-Helical
Pinion Speed (RPM)	Involute Spline
Number of Teeth [Pinion - Gear]	Spiral-Bevel Spurved
Module/Pitch Diameter	Straight Bevel (Generated)
Gear Tooth Face Width	Worm Gear Zerol
Shaft Angle	90.00.00
Depth Factor (Gear)	3 530 AGMA / ISO
Addendum Factor (Gear)	0.103 AGMA
Clearance Factor	0.103 0.125
	0.125

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	
Geometry Source File	E:\VB\
Geometry Source File	Facegear.lst
Types	
Geometry Type	Face Gear 🗸 👻
Material	AISI 4140 -
Pinion Tooth Hand	Left
Power [Kw] / Torque [N-m]	375.00 2237.09
Power [Kw] / Torque [N-m] Pinion Speed (RPM)	375.00 2237.09 1600.00
Pinion Speed (RPM) Number of Teeth [Pinion - Gear]	
Pinion Speed (RPM)	1600.00
Pinion Speed (RPM) Number of Teeth [Pinion - Gear] Module/Pitch Diameter Gear Tooth Face Width	1600.00 17 1.647 28
Pinion Speed (RPM) Number of Teeth [Pinion - Gear] Module/Pitch Diameter	1600.00 28 17 1.647 28 10.000000 / 279.9999

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.

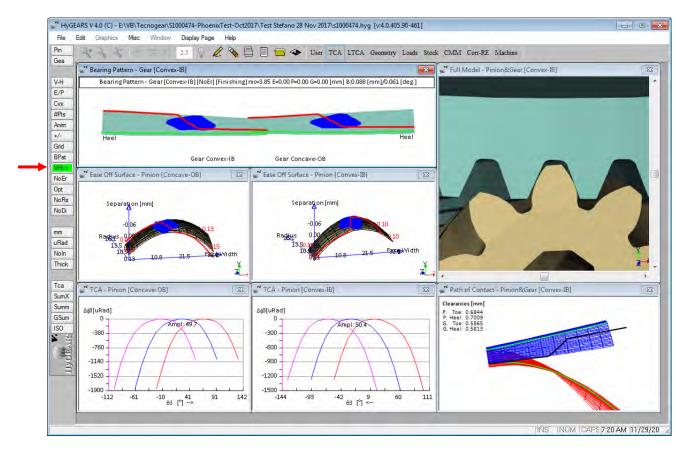


The *"Exprt"* button calls the CMM Nominal Format window, figure below, where one can select the format in which the currently loaded CMM file will be exported (can be a Nominal or an actual CMM output file).

HyG	EARS V 4.0 (C) - e:\vb\zg\kimo	s nd\hygears_ex1	5 - fm - lh - hy	poid\kimos_nd_
File	Edit Graphics Misc Win	dow Display Pa	ige Help	
Pin	2+22 5=	1 2.5	2 NE	
Fini			~ • -	
XYZ	Meas.Surface - Pinion [C	oncave-OB]		
Exprt •				
Stat	CMM Format Pinion			
ThStk	Se Civily romat Philon			
Corr D-MC	🔘 Ram 300 🛛 🔘	Hoeffler ZP350	C Leitz	
R.E.	🔘 Gear Bevel (Ux) 🔘	MdM Metrosoft		
[N.L .	🔘 Klingelnberg P 🔘	CDS		55
Gea	GAGE 🔘	Zeiss GPro		
Fini	ŧ.		OK	Cancel
XYZ	Heel			
Exprt				
Stat				
ThStk				
Corr				
D-MC	M Come Many Circ. Dial			
R.E.	Comp. MeasSim Pini	011		
	0.0001		Concave-OB	

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.

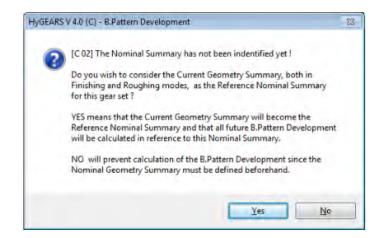
At the manufacturing stage of a gear set, it is common practice to use surface measurement to quantify the difference between the theoretical tooth surfaces and those produced on actual machines, which requires the use of a Coordinate Measurement Machine, or CMM.

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] - H	ypoid 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
0	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.

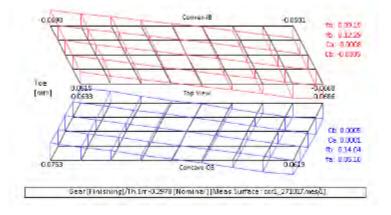
Each machine setting modification is then added to the latest Summary version in the history of the considered pinion. It is therefore imperative that the geometry data file be saved on disk after VH>> machine settings changes have been calculated and applied. HyGEARS automatically proposes to do so.

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.

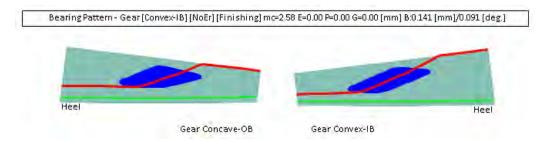
Up to 7 VH>> machine settings changes steps are currently allowed in HyGEARS, which should be sufficient for most applications.

Example:

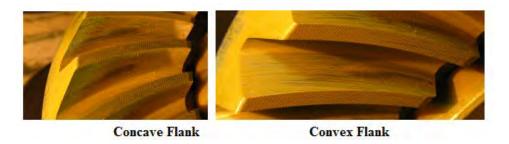
A 9x37 RH spiral bevel gear set is being developed. The gear member is already cut - but differs from the original design as shown below - and the pinion needs to be cut to mesh correctly with the gear.



The target contact patterns appear below:

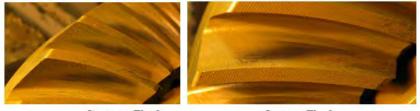


Upon running the gear set on the VH tester with the design MD (mounting distance), the contact patterns came out as show below, i.e Toe heavy on the gear convex flank, and a bit towards Heel on the gear concave flank:



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:

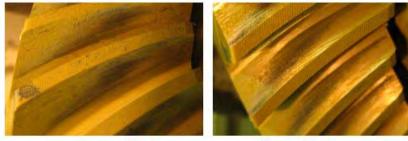
- E: -0.62 mm
- P: +0.70 mm
- G: -0.35 mm



Concave Flank

Convex Flank

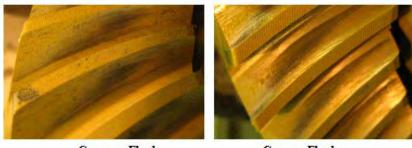
Using the VH>> function, the above values were entered in HyGEARS, a new pinion Summary was obtained and used to cut the pinion, and the following contact patterns were obtained on the gear:



Concave Flank

Convex Flank

Clearly, the contact patterns went where desired by the developer at the 1st 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 2nd iteration yielded the following result:



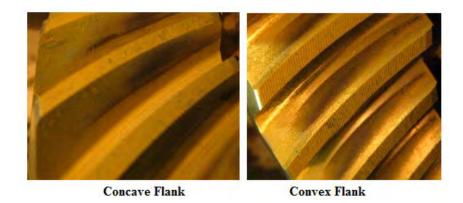
Concave Flank



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.

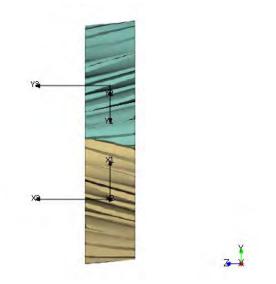
From Build 405.90, figure below, the *Plunging Tool* option is also offered where the axis of the work is installed in the machine as if cutting a spur gear, but the tool plunges progressively as the tool advances along the face width: in effect, the *Profile Shift* factor changes continuously as the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

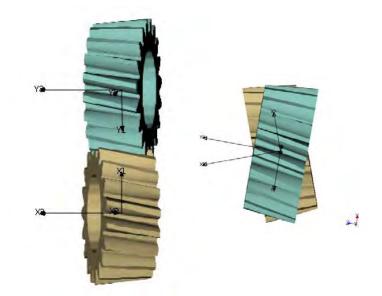
Plunging Tool, the helix and blades angles of the pinion are adjusted in order to center the Contact Pattern.

W New Geometry Definition - [mm]	(dd.mm.ss)				
Names Geometry Name	Test-1-Beveloid [Ext]				
Directory	C:\HyGEARS40Data\				
Geometry Source File	Beveloid.lst				
Types Geometry Type	Beveloid [Ext]				
Material	AISI 4140 -				
Pinion Tooth Hand	Left 🗸				
Cutting Method	Pivoted Work				
Misc	Plunging Tool				
Power [Kw] / Torque [N-m]	26.19 249.98				
Pinion Speed (RPM) Number of Teeth [Pinion - Gear]	1000.00				
Module/Pitch Diameter	1.750000 / 33.250				
Gear Tooth Face Width	15.000 Input Plane				
Number of Planets Backlash	0 Normal Plane 0.0020 Transv. Plane				
Shaft Angle	0.0000				
Pitch Angle [Pinion - Gear]	6.0000 -6.0000				
Offset	0.0000				
	Import < <back next="">> Cance</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.

