# HyGEARS®

**v4**

## HyGEARS THE GEAR PROCESSOR®

**Involute Simulation Softwares Inc.**

1139 des Laurentides
Québec  P.Québec
Canada  G1S-3C2

Web :   www.HyGEARS.com
Email : HyGEARS@HyGEARS.com

The information below lists a short general summary of the capabilities found in HyGEARS V 4.0.

## GEAR SIMULATION, DESIGN AND ANALYSIS

HyGEARS will allow you to design, analyze and create manufacturing Summaries for:
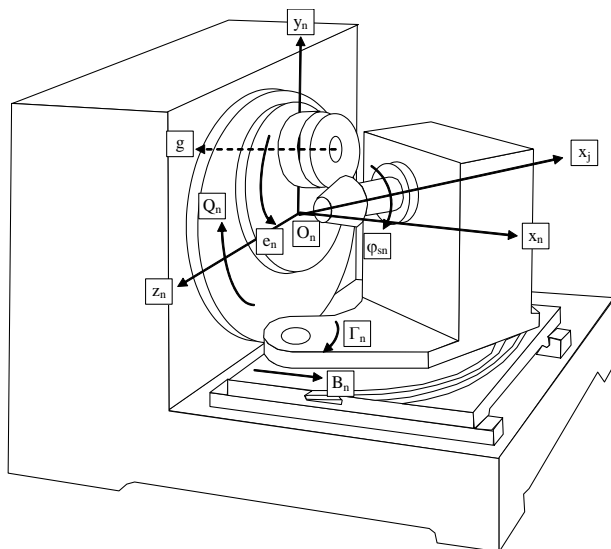
- Face milled (i.e. the Gleason process) spiral-bevel, Zerol and hypoid gears,
- Cyclo-Palloid spiral-bevel gears,
- Straight and Coniflex bevel gears,
- plus more conventional gears such as spur, helical, Herringbone and Beveloid.

The HyGEARS Face milled spiral-bevel and hypoid designs have been extensively tested in industry, and are on a par with those of the Gleason CAGE and Klingelnberg KIMoS softwares.

Because it is built on Vector Simulation, the HyGEARS tooth flank generator produces exactly the same tooth flank topography as the Gleason and Klingelnberg softwares when using the same cutters and machine settings.
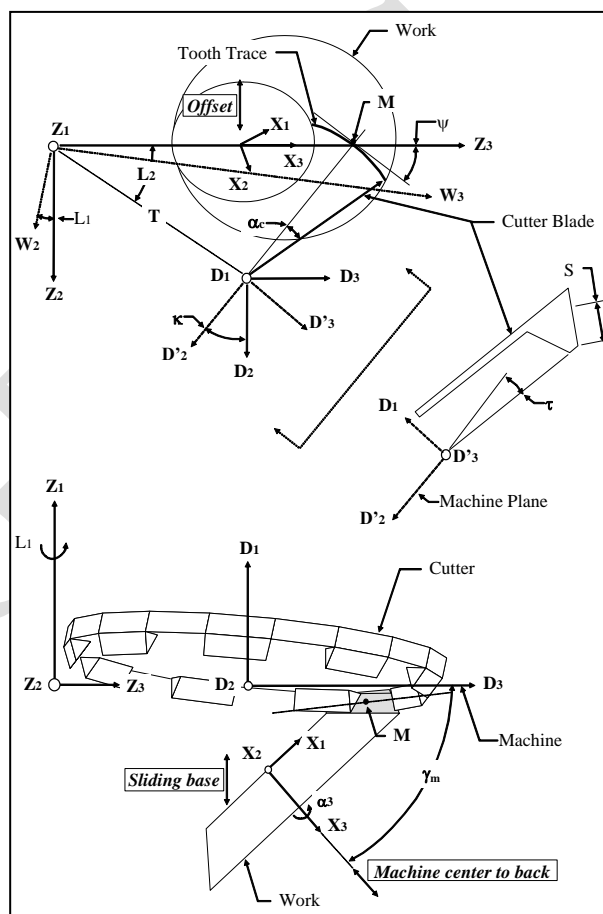
Gear sets designed by HyGEARS can be cut on most Gleason machines. HyGEARS will define the cutters and machine settings needed to produce the designed gears.

In Vector Simulation, a theoretical gear generator is simulated by translations and rotations applied to reference frames that determine the relations between the cutting tool and work piece in the machine.
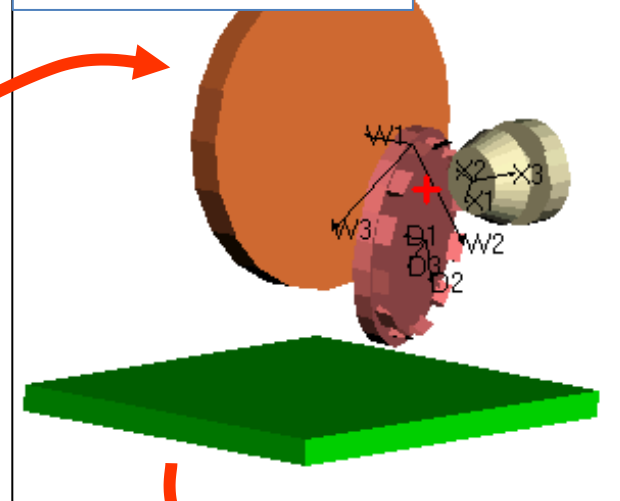


*3: A numerical machine is created from the Vector Model*

*1: A reference machine is discretized as a series of ref. frames*

*2: The Vector Model uses the ref. frames of the discretized machine*
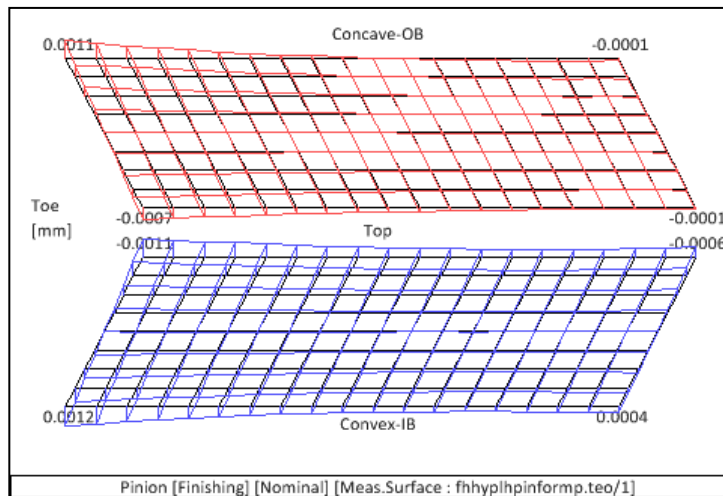
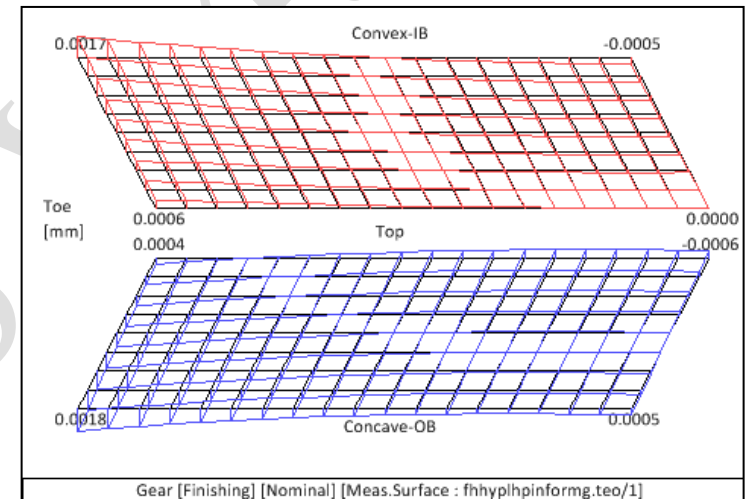*4: A numerical gear set is created with the Numerical machine.*
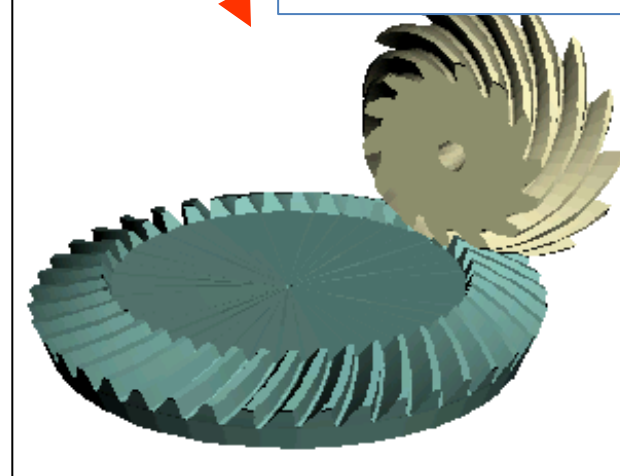
The 2 figures below compare the coordinates of the tooth flanks calculated by HyGEARS (black lines) to those calculated by the Gleason GAGE software for a 8x39 Face Hobbed gear set. Dimensions are [mm]. Differences are at the μm level.



HyGEARS vs. Gleason - Pinion



HyGEARS vs. Gleason - Gear

Users define gear sets by their dimensions such as module, number of teeth, spiral or helix angle; when unknown, HyGEARS will provide default cutter dimensions, and will then proceed to calculate the machine settings.

Most traditional Gleason machines are supported. HyGEARS also has an integrated interface to the Gleason Phoenix machine.

For cylindrical gears, HyGEARS supports both rack and shaper cutters with both lengthwise crowning and profile modifications.
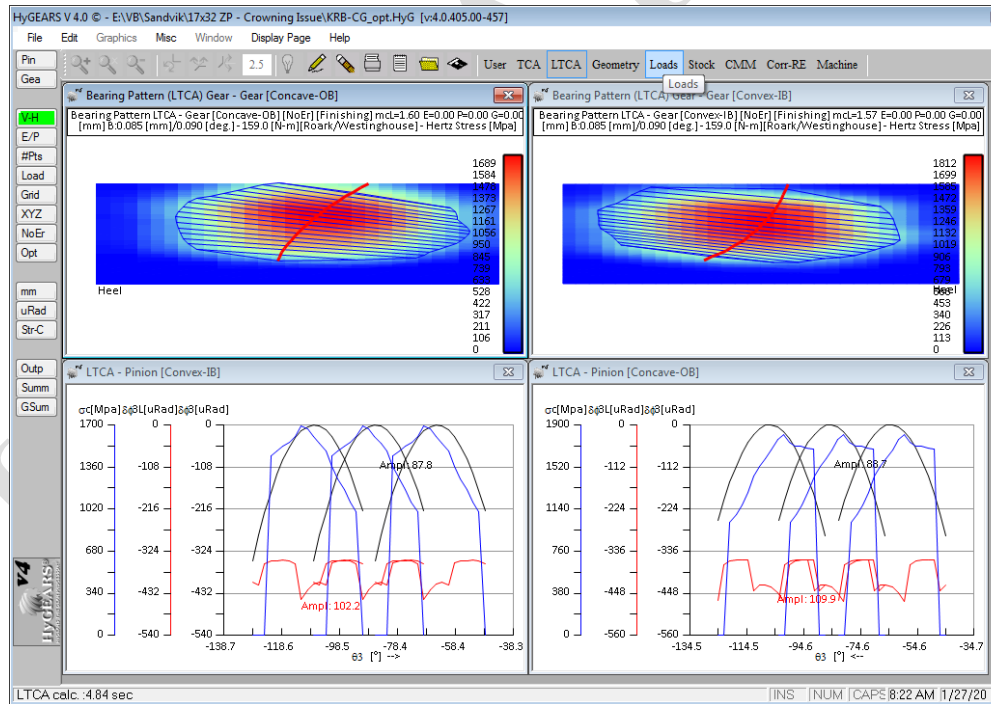
Gear sets can be analyzed for their unloaded kinematics, what is called Tooth Contact Analysis, or TCA.

Loaded Tooth Contact Analysis, or LTCA, is also offered to assess gear performance under load; results such as contact (or Hertz) stresses, bending stresses, transmission error, and efficiency, are calculated and displayed on the fly.

4
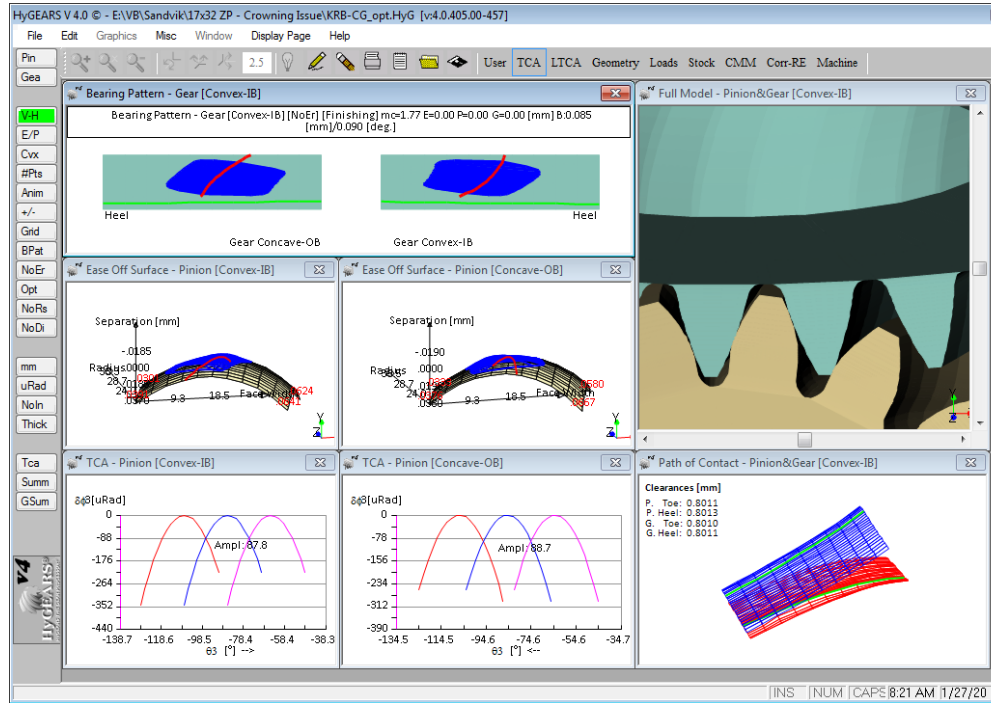
## TCA Display



## LTCA Display

## SUPPORTED SPIRAL-BEVEL GEAR CUTTING PROCESSES

Spiral-bevel, Zerol and hypoid gear cutting processes include:

- Fixed Setting,
- Spread Blade,
- Modified Roll,
- Duplex Helical,
- Semi-Completing,
- Formate,
- Face-Hobbing (generated and non-generated),
- Cyclo-Palloid.

## SUPPORTED GEAR CUTTING MACHINES

HyGEARS supports most Gleason machines, such as #16, 22, 26, 102, 106/108, 112, 116/118, 122, 606/607, 631, 641.

The Gleason Phoenix machines (HC or HG) are also supported in native mode, i.e. through machine settings keyed in at the controller keyboard.

If need be, it is also possible to generate the CNC code to drive directly the Phoenix machine, effectively bypassing Gleason's own software and maintaining only the CnC controller software.

## HYGEARS IMPORTS

HyGEARS can import Gleason SPA and Klingelnberg ND files for spiral-bevel, Zerol and hypoid gears, thereby saving time and possible errors when a user wants to use existing Gleason or Klingelnberg designs.

STEP, IGES and 3D Cad model files cannot be imported as they describe the resulting topography rather than the cutting process – HyGEARS is based on the cutting process.

Rather, the user creates a HyGEARS geometry using the parameters defining the desired gear set, such as tooth number, module, pressure and helix angle, etc. This is normally a one minute job at the end of which a HyGEARS geometry is created that can then be applied to all normal tasks such as Tooth Contact Analysis (TCA), Loaded Tooth Contact Analysis (LTCA), manufacturing on conventional or CnC machines, measurement and Closed Loop.

6

## HYGEARS EXPORTS

HyGEARS exports STEP files containing the solid models of the teeth; HyGEARS can also export tooth geometry to Klingelnberg and Becal Neutral Data files.

STEP files are a standard means to export geometry to and from CAD and CAM systems.


## TOOTH FLANK MEASUREMENT USING CMMS

HyGEARS currently supports 9 CMMs for measurement. Amongst the supported CMMs, we find:

- RAM/RFD
- Gleason's GAGE,
- Hoeffler,
- MdM,
- Klingelnberg P,
- Zeiss GearPro,
- Leitz, and more.

Closed Loop (or Corrective machine settings) and Reverse Engineering from the CMM output are integral, i.e. seamless, to HyGEARS. New CMMs, i.e. not already part of the supported CMMs, can be easily added once the input format for the Target file is known.


## 5AXIS CNC MACHINE MANUFACTURING

HyGEARS offers an integrated post-processor that generates machine-ready part programs to cut gears on multi-axis CnC machines.

Thus, no external CAM software such as EdgeCAM, MasterCAM or GibbsCAM is needed: the part programs generated by HyGEARS are downloaded directly to the CnC machine without any need for further intervention, i.e. they can be executed "as is".

Any gear type supported by HyGEARS can be cut on any 3, 4, and 5Axis CnC machine.

3Axis machines are derived from non-simultaneous 5Axis machines; the 4Axis machines have 4 simultaneous axes, i.e. one of the X, Y, Z coordinates, tool tilt or work rotation, is step wise, while the other four are simultaneous. The non-simultaneous axis can be any of the normal 5 axes.

HyGEARS offers an easy interface to create 3, 4, and 5Axis CnC machines for a given architecture, be it AB, AC, BA or BC.
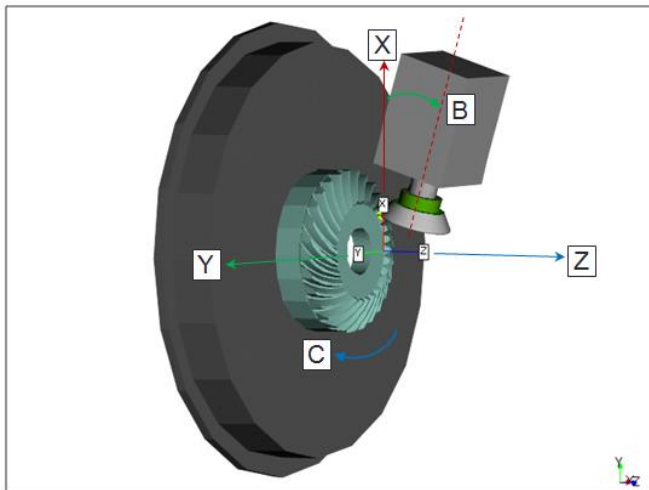
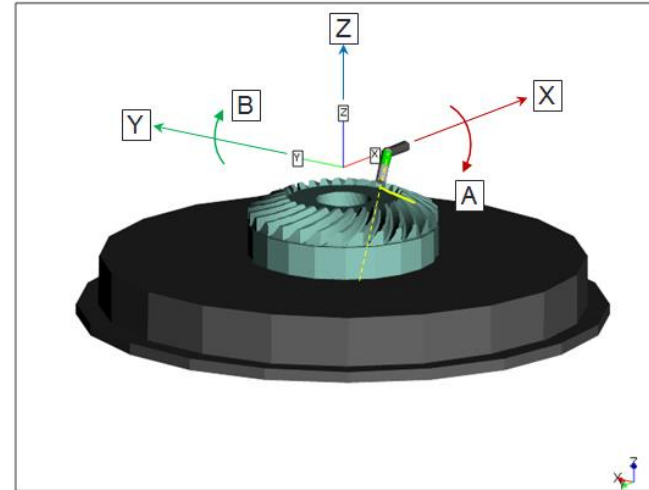AC Type: rotating and tilting turntable
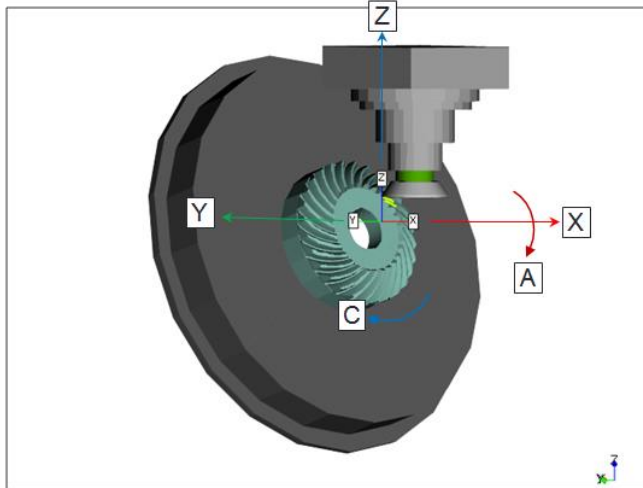
AB Type: rotating and tilting turntable
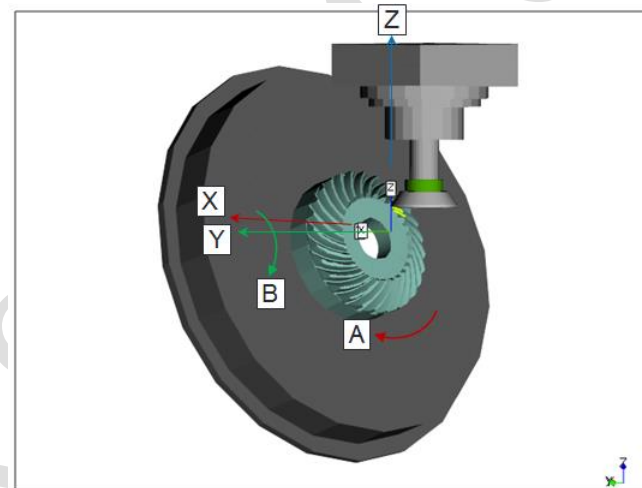
BC Type: rotating turntable, tilting tool

BA Type: tilting and swiveling tool

8

Other CnC machine architectures are also supported using workpiece coordinates or Traori (Siemens), TCP (Fanuc), TCPM (Heidenhain) or TCPC (Okuma) - all integral to HyGEARS - where the tool axis orientation is given with the usual X Y Z coordinates, rather than the turntable and tool angles.

CnC gear manufacturing can be done using:

- Face Mill cutters (for spiral-bevel, hypoid and Zerol type gears),
- Dish type cutters (for Coniflex straight-bevel type gears),
- Conical Side Milling Tools (or CoSIMT, like Sandvik's InvoMill and UpGear tools) for all gear types,
- End Mill cutters, for all gear types,
- Ball Mill cutters, for all gear types.



Using any tool will produce exactly the same tooth surface; for example, for a spiral-bevel gear, using a Face-mill cutter, a CoSIMT, an End Mill or a Ball Mill cutter, one gets exactly the same tooth flank topography; only the time to cut will be different.

Therefore, HyGEARS offers a totally general manufacturing capability using conventional and multi-axis CnC machines.

## CLOSED LOOP

Corrective Machine Settings (Closed Loop) is seamless with conventional and CnC machines, which allows for effective corrections using the CMM output. Either in situ or CMM measurement can be used.

## MULTI-AXIS CNC MACHINES

HyGEARS offers many pre-defined machines from manufacturers such as:

- DMG
- Heller
- Depo
- Fanuc
- GroB
- Fryer
- Haas
- Hermle
- Juaristi
- Mazak
- Matec
- GF Mikron
- Mori-Seiki
- Okuma
- Breton

Any CnC machine, not already in the list, can be defined in HyGEARS. Defining a CnC machine requires just a few steps best done on-site with the help of an operator.

## SUPPORTED CNC CONTROLLERS

The currently supported CnC controllers are:
- GCodes,
- Siemens,
- Heidenhain,
- Fanuc,
- Okuma,
- Mazak

Other controllers can be added once their language details are known. Any machine can have any controller; and one machine can be defined for 2 controllers by simply cloning the desired machine and changing the controller, a 1 minute job.

## ON BOARD MEASUREMENT

The Probe (CMM) tool, coupled to a Renishaw type probing head, can be used to measure the tooth flanks in-situ on any CnC machine, which results in saved time and money by immediate assessment of the quality of a part.



## TRIAL PERIOD

A Trial version of HyGEARS is available at no cost for up to 2 months, but Training is necessary before the software is released for Trial.

Training, which usually lasts 3 to 4 days on-site, i.e. at the customer's location, ensures that the Trial user understands the philosophy behind HyGEARS to guarantee a valuable experience. It also creates a direct contact with the prospective customer and often allows the addition of functions which are specific to the trial user.

Training travelling expenses (flight economy class, hotel) are covered by the trial user.

## IN SUMMARY

HyGEARS is the <u>only software on the market</u> allowing the manufacture of spiral-bevel, Zerol, hypoid, spur, helical, Herringbone, Beveloid, straight bevel and Coniflex gears with a variety of tools such as Face Mill, Conical Side Milling (i.e. InvoMill, UpGear), End Mill and Ball Mill tools where exactly the same tooth surfaces are obtained, no matter the tool or the machine (conventional, i.e. dedicated or multi-axis CnC) used.

HyGEARS is also the <u>only software on the market with integrated Closed Loop</u> (i.e. Corrective Machine Settings) for straight bevel, Coniflex, spiral bevel, Zerol and hypoid gears, for conventional (dedicated) machines <u>and</u> multi-axis CnC machines.

Claude Gosselin, ing., Ph.D.
Involute Simulation Softwares Inc.
1139 ave des Laurentides
Quebec, QC, G1S-3C2, Canada