Dontyne Systems

Gear Production Suite

Overview of Latest version 5.0-5.1-5.2

Presented by
Dr David Palmer & Dr Michael Fish

December 2015

BGA British Gear Association

American Gear Manufacturers Association

Dontyne Systems Limited is a company registered in England and Wales with company number 05973058.
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Dontyne Systems

Contents

Current Functionality

- V5.0
- V5.1 May 15
- V5.2 Dec 15

Under development (V5.3 Mar 16)

- Future release and modules under development

Dontyne Systems

Gearbox Concept Tool

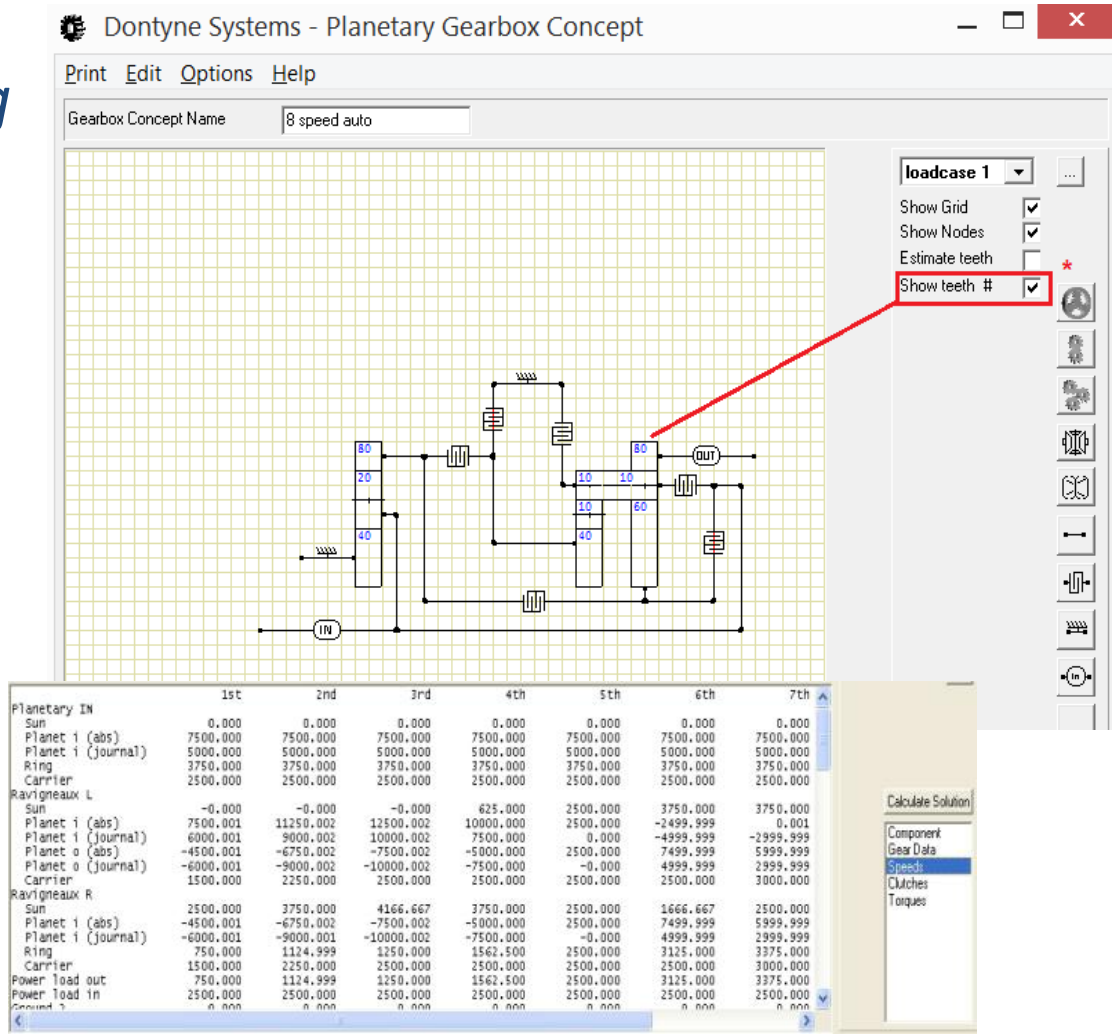
- *Rapid Layout And Testing of Planetary Type Gearbox*

Input

- *Drag & Drop Components and Connections*
- *Multiple Power Input/Output*
- *Estimated Ratio Sizing*
- *Live Testing of Power Flow*

Output

- *Speeds*
- *Torques*
- *Cycles*
- *Validity Check*



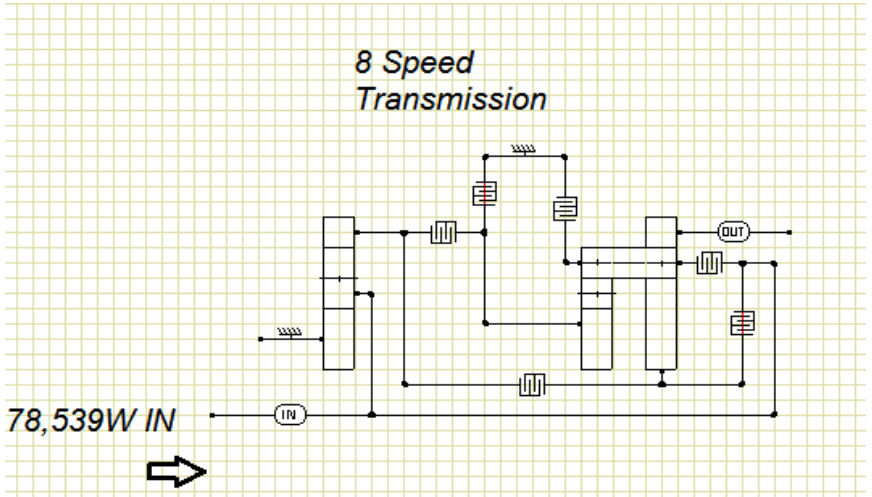
* New Feature V5.1 (show teeth on layout)

Dontyne Systems

Gearbox Concept Tool

- *Mesh power assessment for* ***ECO*** *design**

- *Shows mesh power inc. Recirculating Effect*
- *Allows designer to immediately recognise an inefficient arrangement*
- *Prevents mistakes in layout before progressing to detailed design stage*
- *Allows most Efficient Eco. Arrangement*

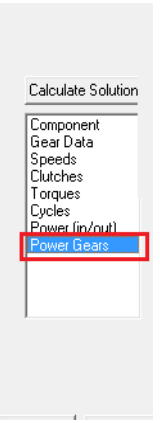


	1st	2nd	3rd	4th	5th	6th	7th	8th	rev
Planetary IN									
Sun to planet i	0.000	26179.938	0.000	47123.879	0.000	15707.963	20362.176	26179.938	0.000
Planet i to ring	0.000	26179.938	0.000	47123.879	0.000	15707.963	20362.176	26179.938	0.000
Ravigneaux L									
Sun to planet i	109955.773	109955.781	78539.828	0.000	0.000	15707.959	12217.303	0.004	0.000
Planet i to planet	109955.773	109955.781	78539.828	0.001	0.000	15707.959	12217.301	0.004	0.000
Ravigneaux R									
Sun to planet i	31415.930	31415.932	0.000	47123.883	0.002	0.000	3490.656	0.002	78539.820
Planet i to ring	78539.828	78539.844	78539.828	47123.887	0.002	15707.961	8726.643	0.004	78539.828
Total System Power	329867.312	382227.219	235619.484	188495.531	0.000	78539.805	77376.250	52359.887	157079.656
System Power/Power In	4.200	4.867	3.000	2.400	0.000	1.000	0.985	0.667	2.000

direct

4.2 x Input Power Transfered Across Gear Meshes

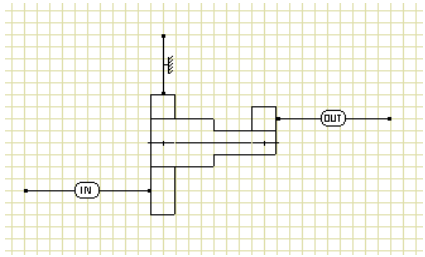
0.667 x Input Power Transferred Across Gear Meshes

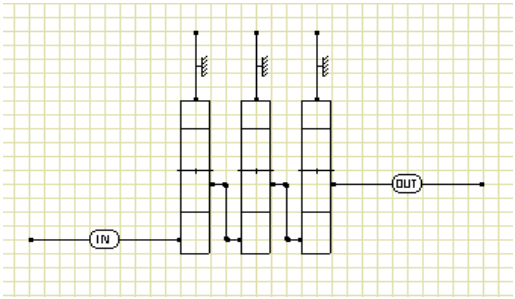


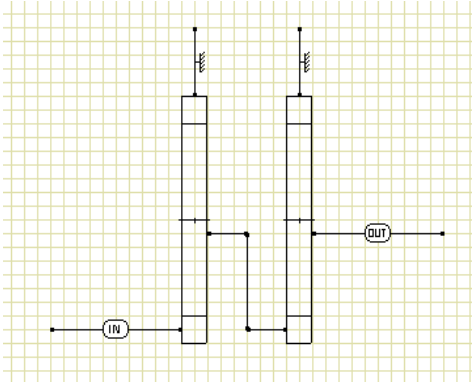
Gearbox Concept Tool

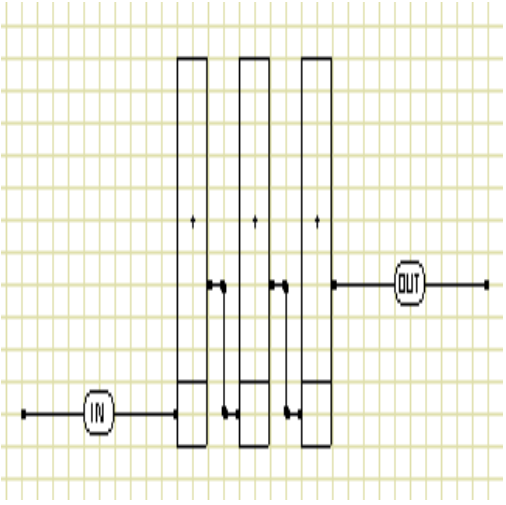
- Example ratio 80:1 Gearbox

[1]









System Power	26890	6277	4089	4080
Power/Power In	19.77	4.61	3.56	3.00

Compact but
Almost 20 x
Input Power due
to recirculating
Effect !

Compact and reasonable efficiency

Non Planetary,
Efficient in this case
but large size gearbox

Ref [1] AGMA 6123 B06 Section 8

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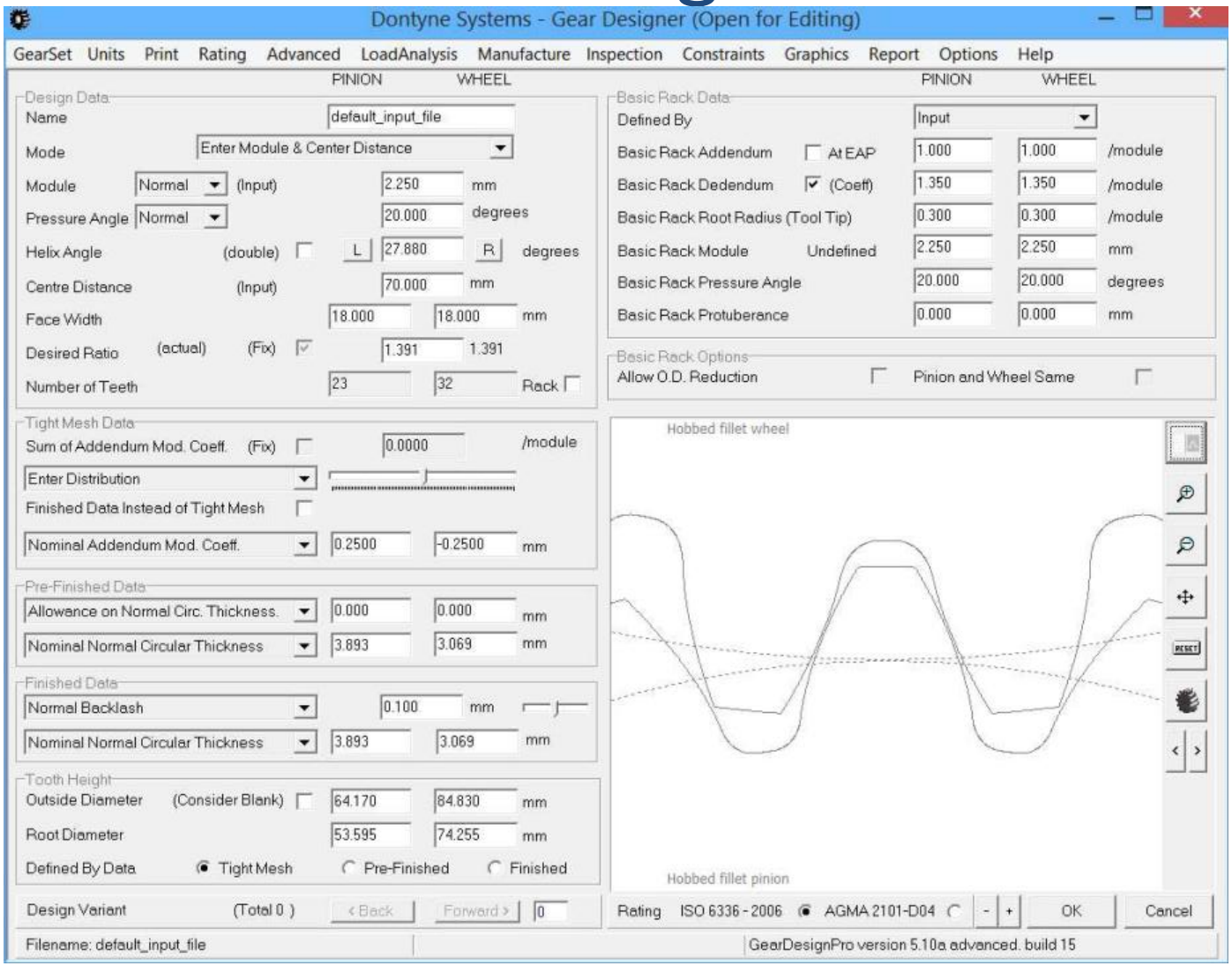
Gear Design Pro

Design and Rating to ISO and AGMA Standards



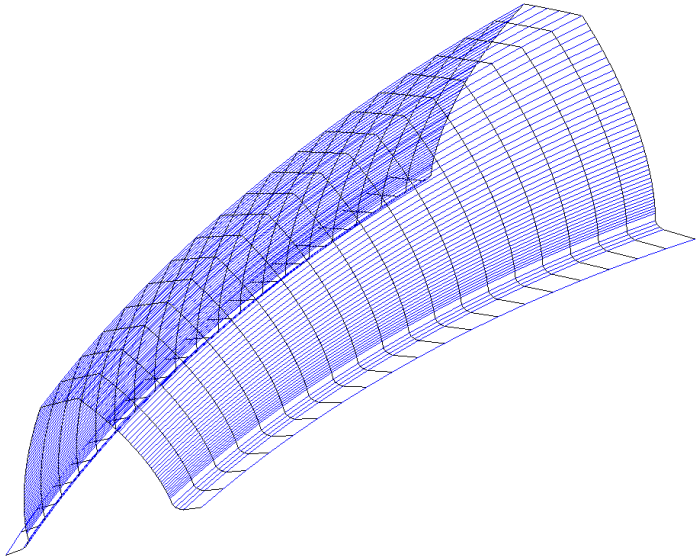
Gear Design Pro

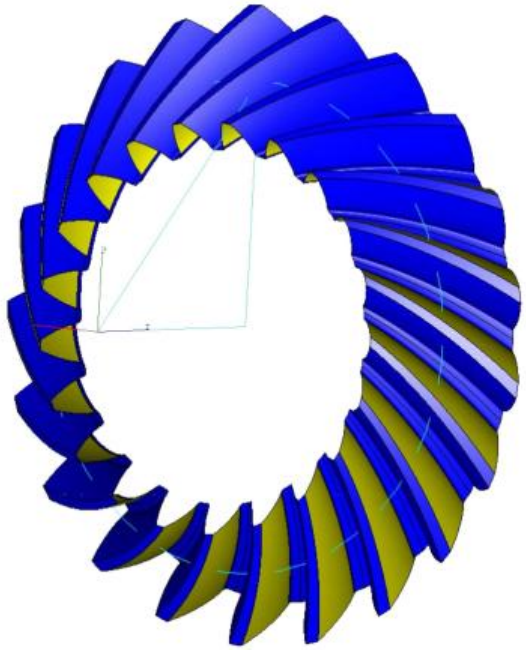
- Export Options

DXF 3D line grid

IGES B-Spline surface

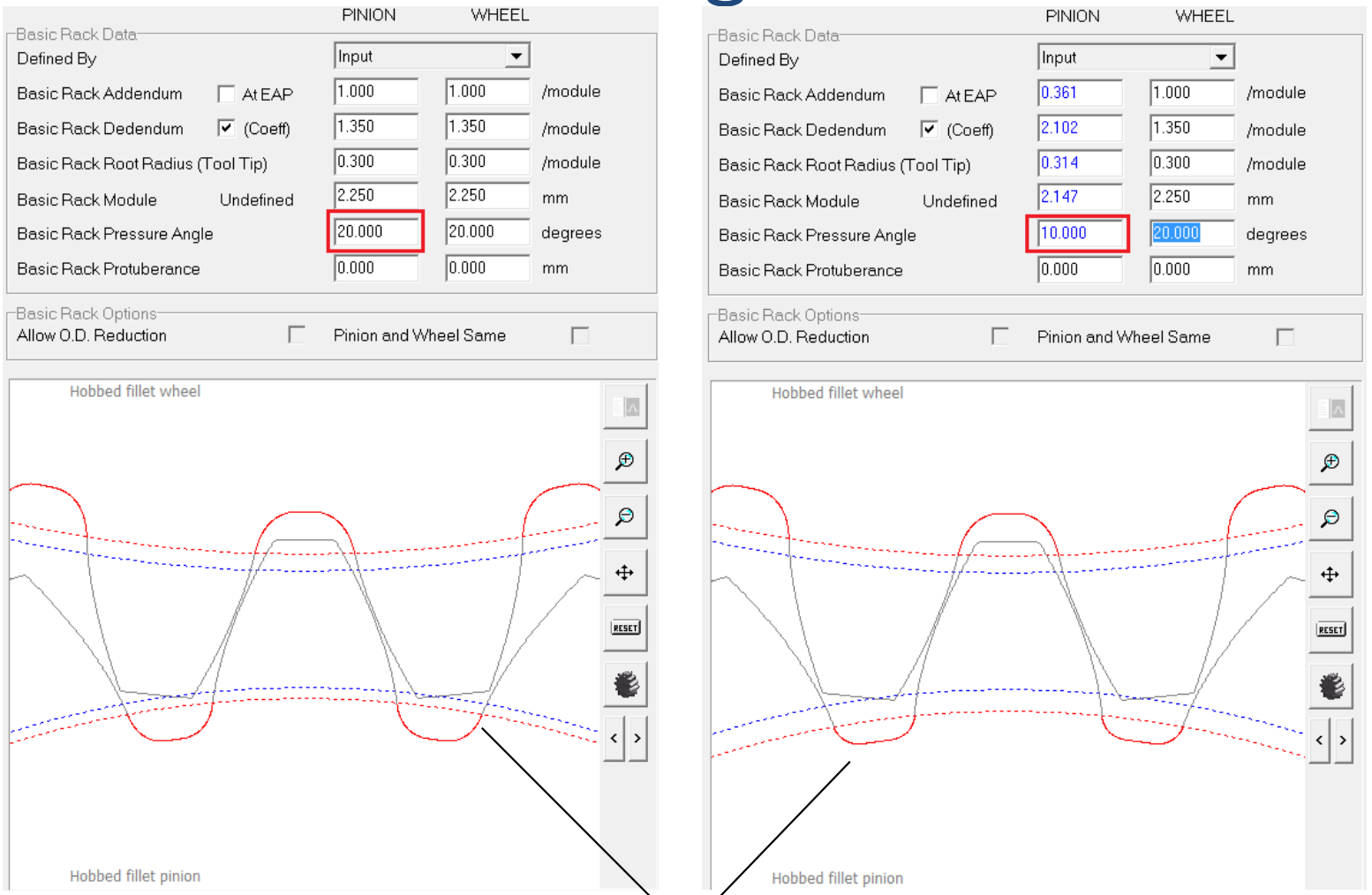
ASCII X,Y,Z Co-ordinates





Gear Design Pro

Consider tool pressure angle



Fillet Shape changes – Dontyne software considers effect on root strength

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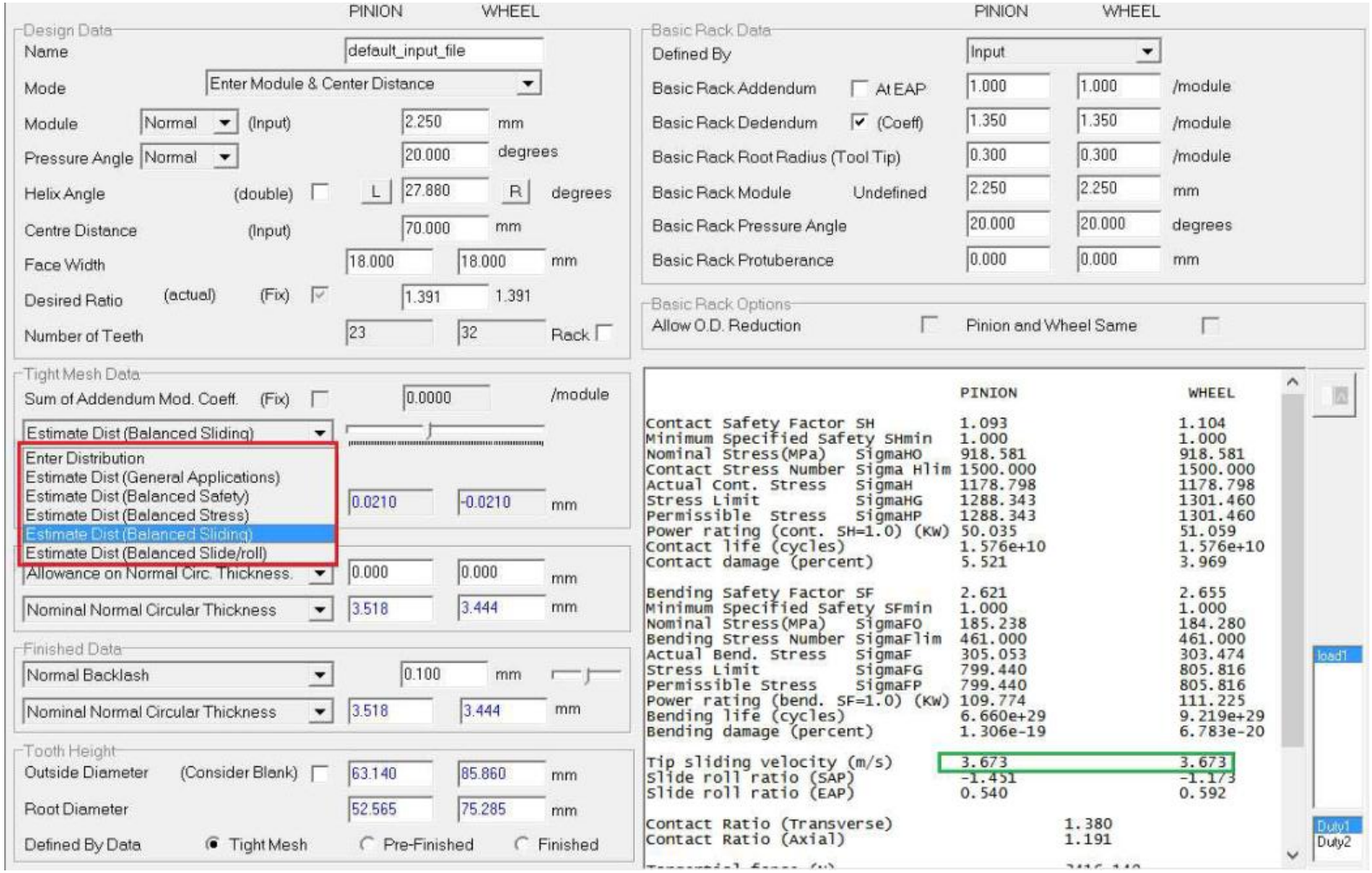
Gear Design Pro

Balance Options:- *

- Safety
- Stress
- Sliding
- Slide Roll

Balanced sliding or slide roll can lead to lower maximum sliding velocity and lower losses for ECO design

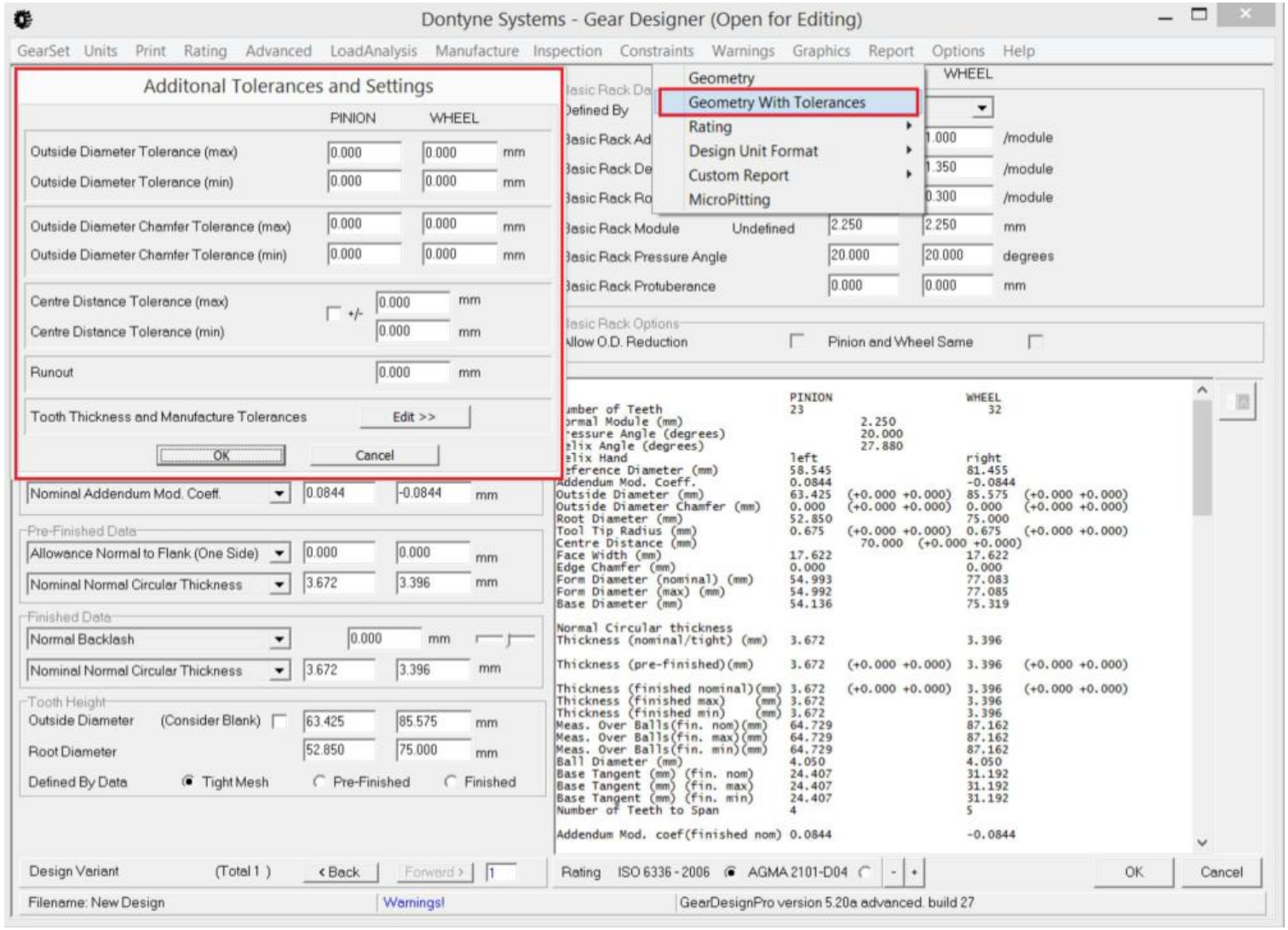


* New Feature V5.1

Gear Design Pro

- Geometry with tolerances:- *

Geometry calculations include the combined effect of tolerances

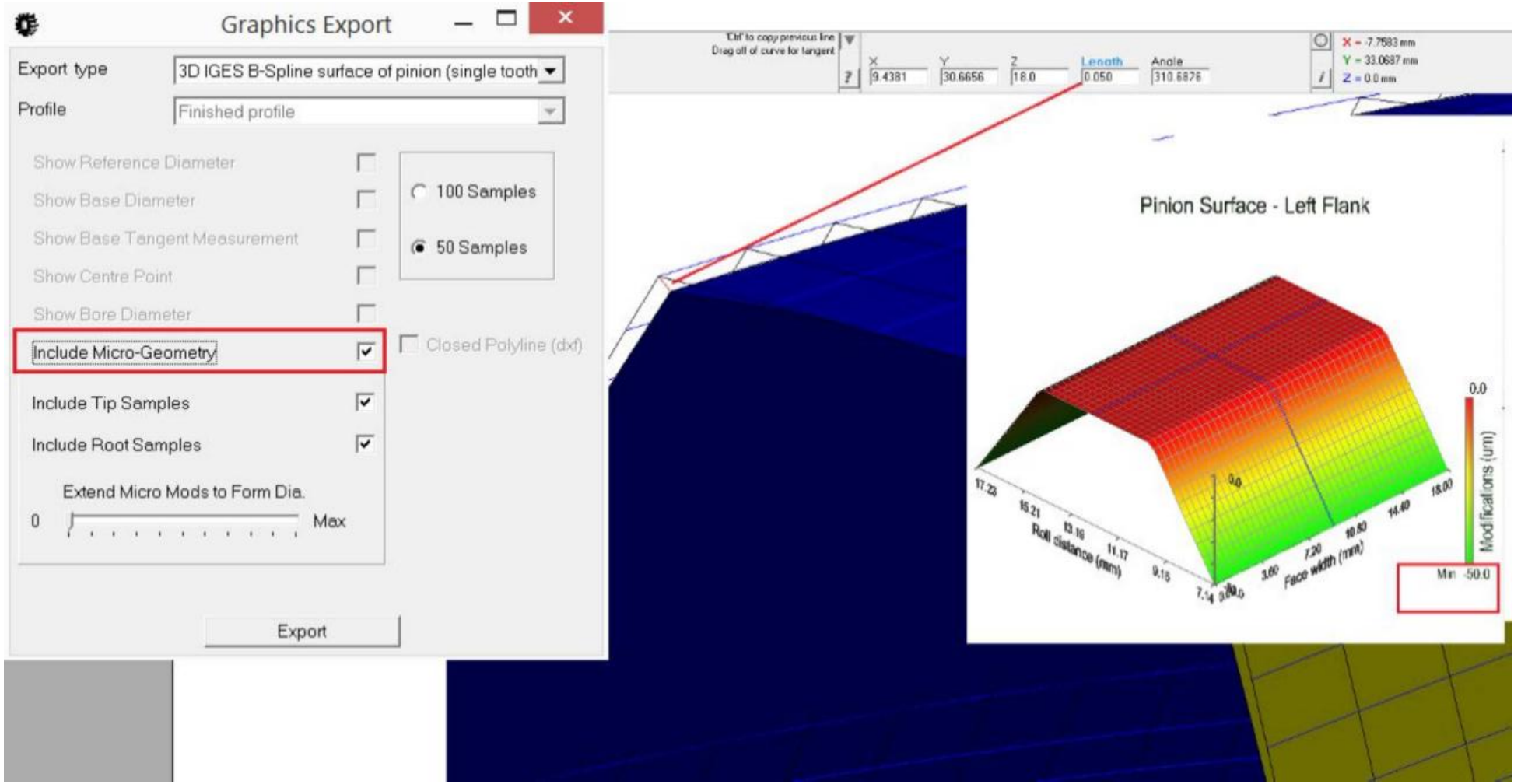


* New Feature V5.2

Dontyne Systems

Gear Design Pro

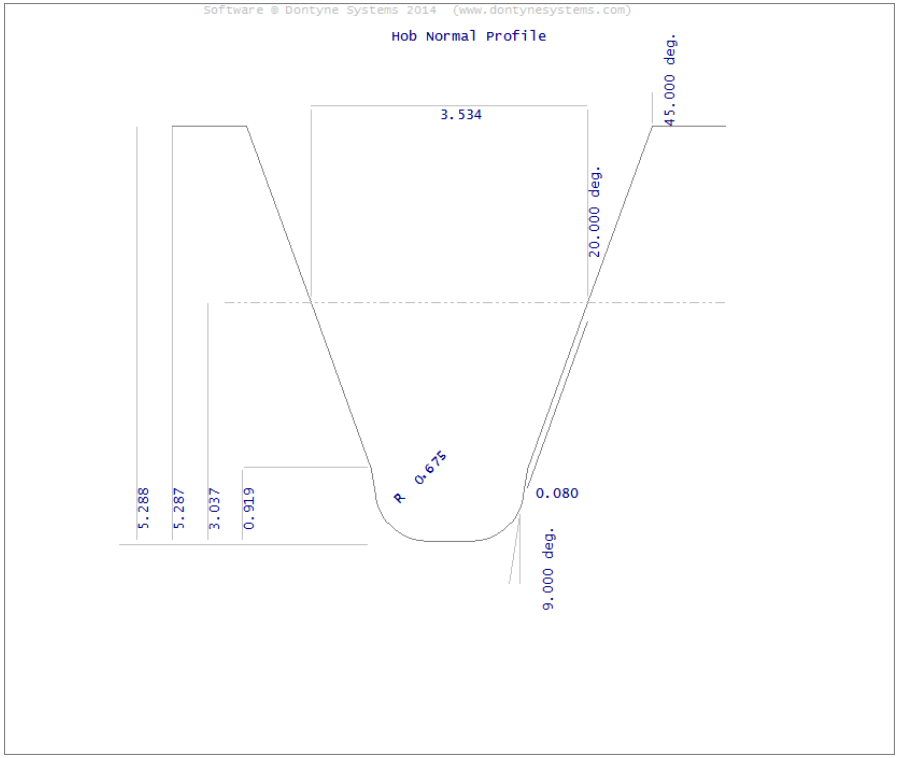
- Export IGES B-Spline Surface with Micro-Geometry Included:- *



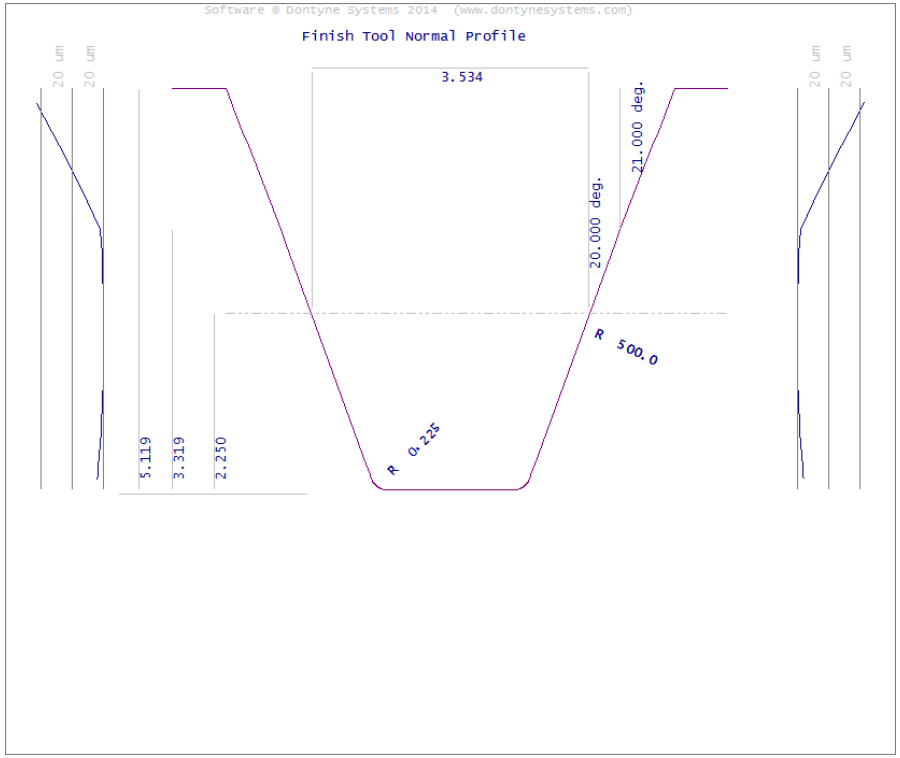
* New Feature V5.2

Gear Manufacture

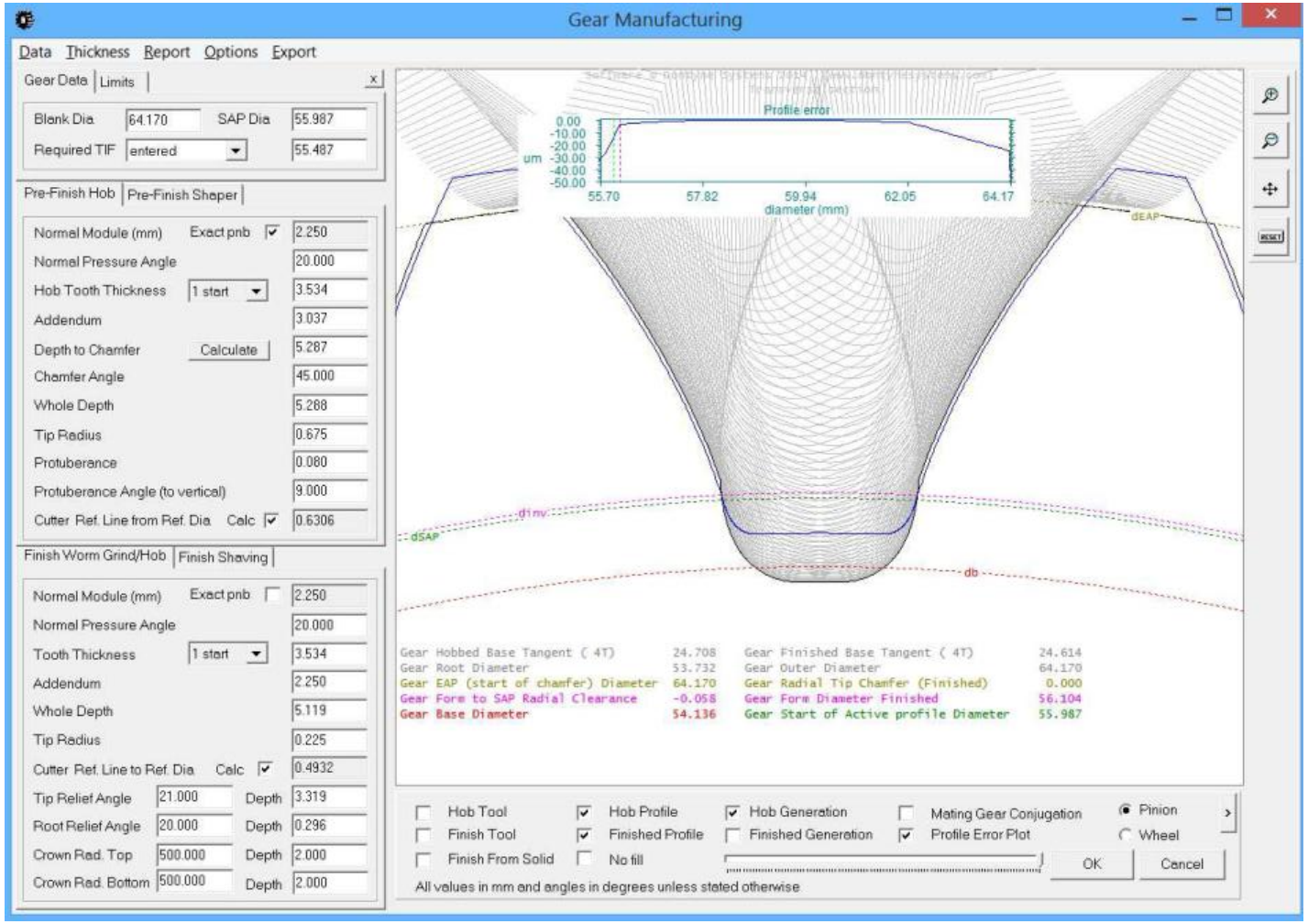
Define Hob



Define Finish Tool



Gear Manufacture



Generate the gear

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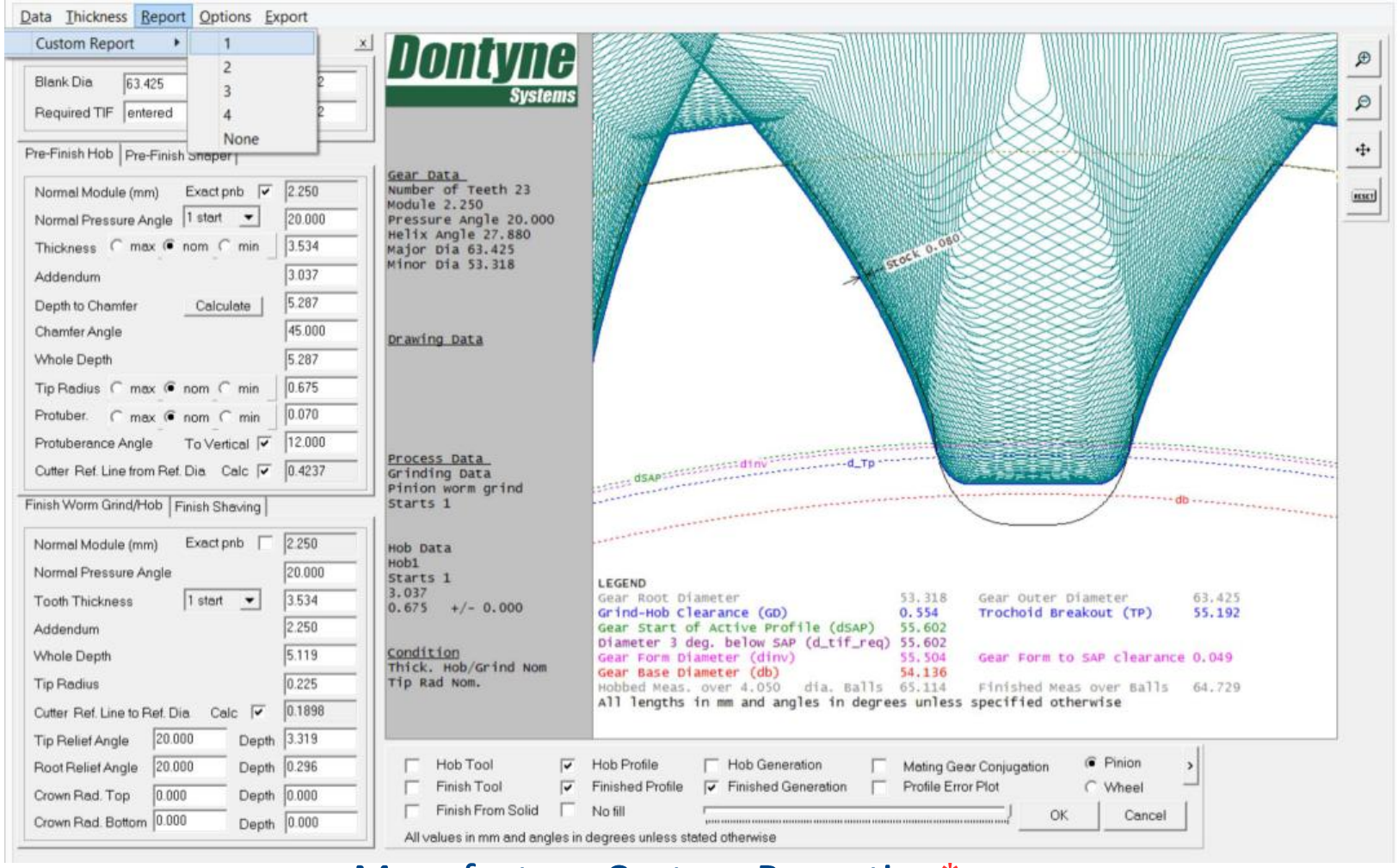
Machine Centre

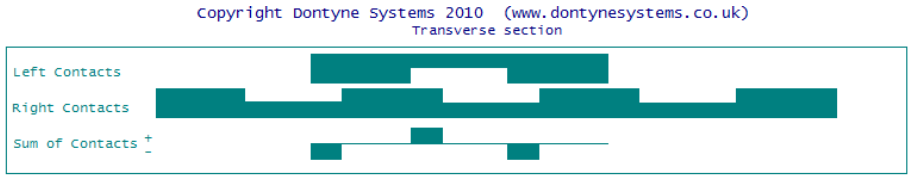


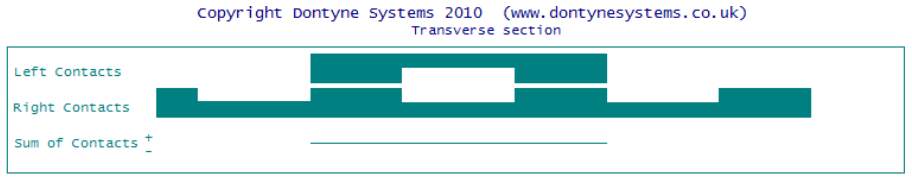
Manufacture Custom Reporting*

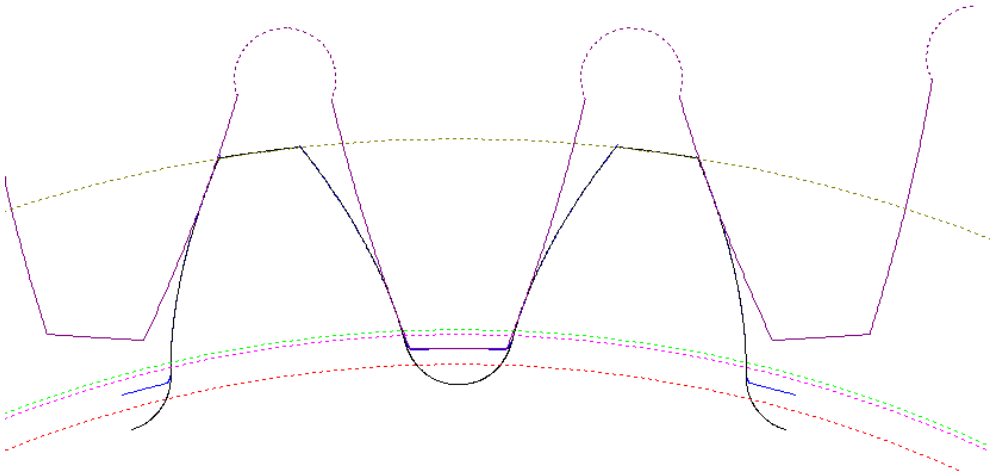
* New Feature V5.1

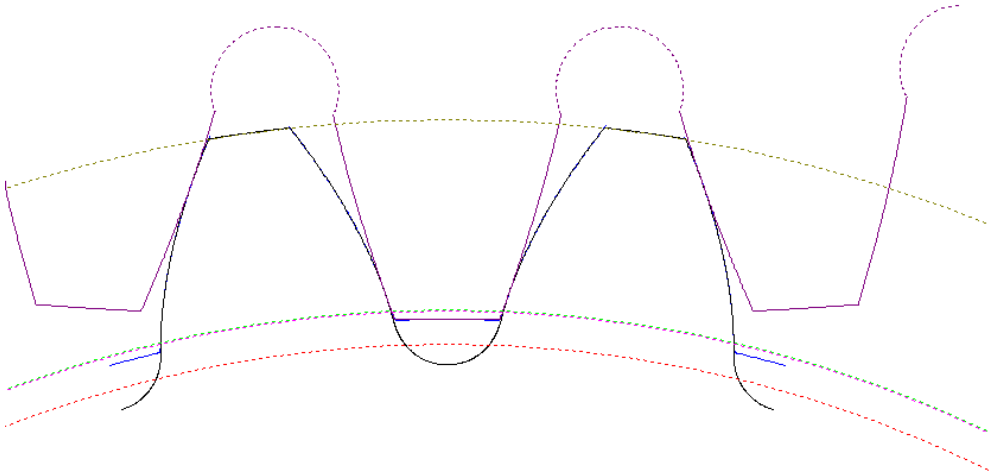
Machine Centre

Gear Shaving









Calculate balance of forces for optimum quality and tool life for resharpening

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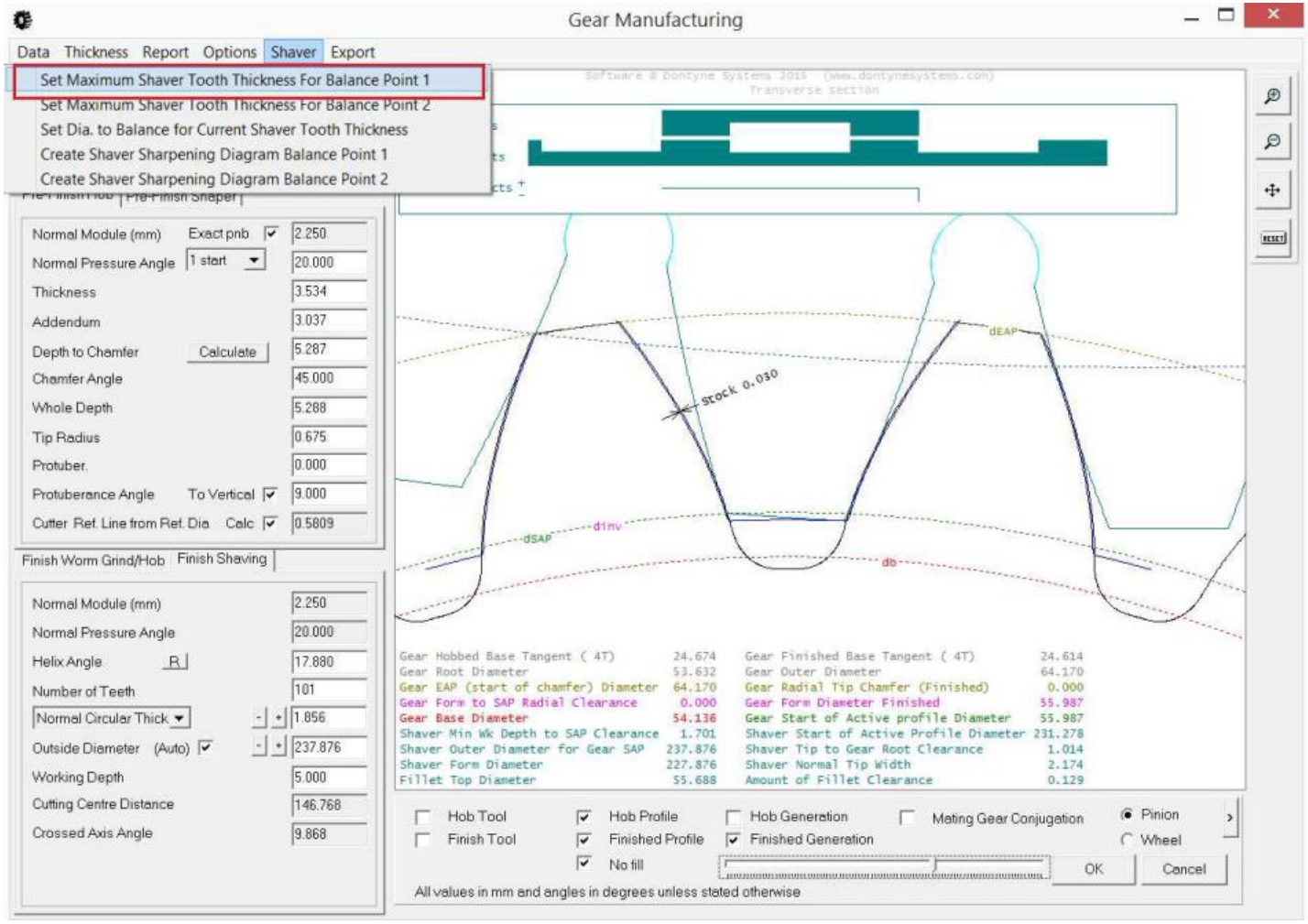
Machine Centre

Gear Shaving Automatically Find Balance Point*



* New Feature V5.2

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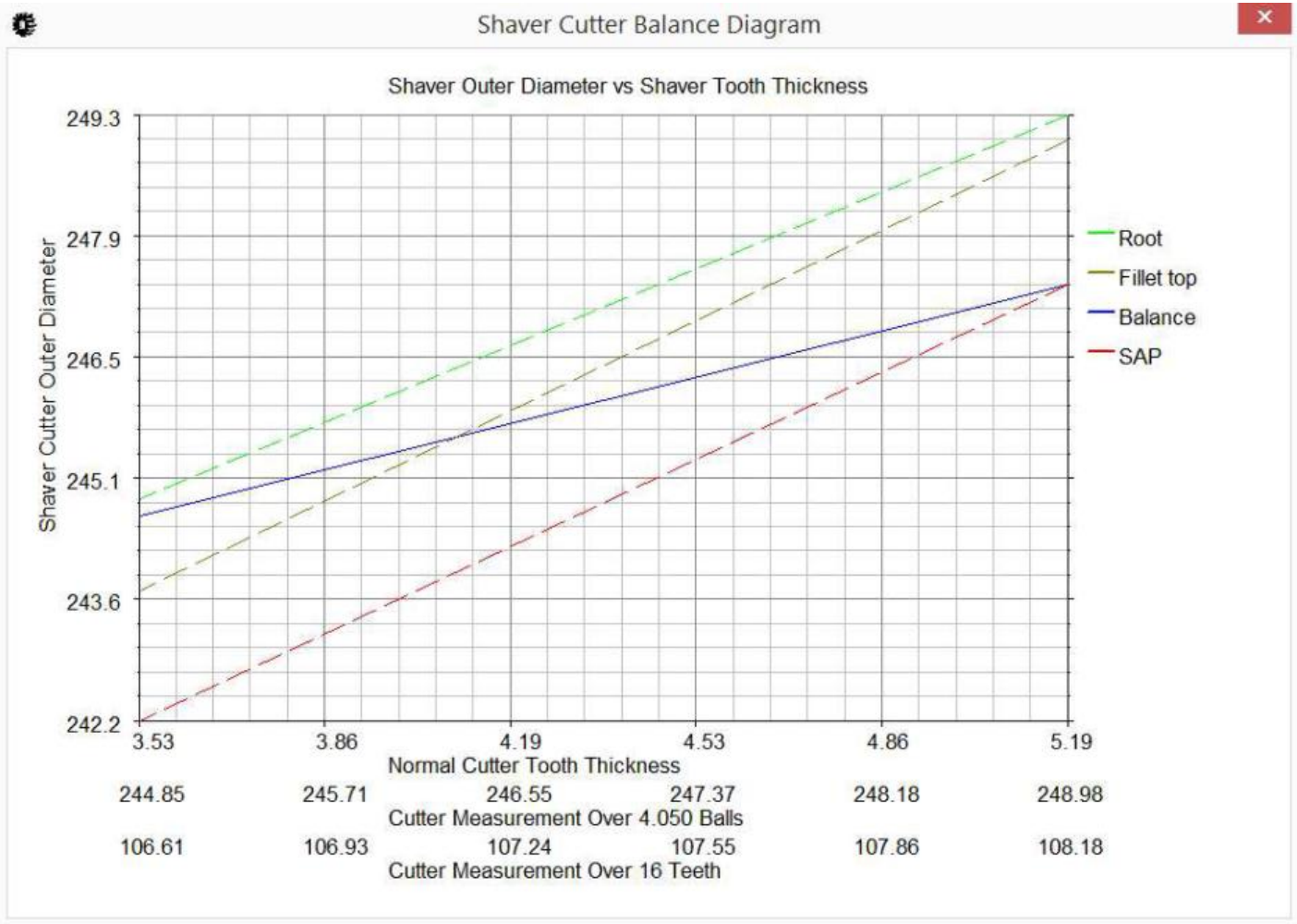
Machine Centre

Gear Shaving Balance Sharpening Diagram*



* New Feature V5.2

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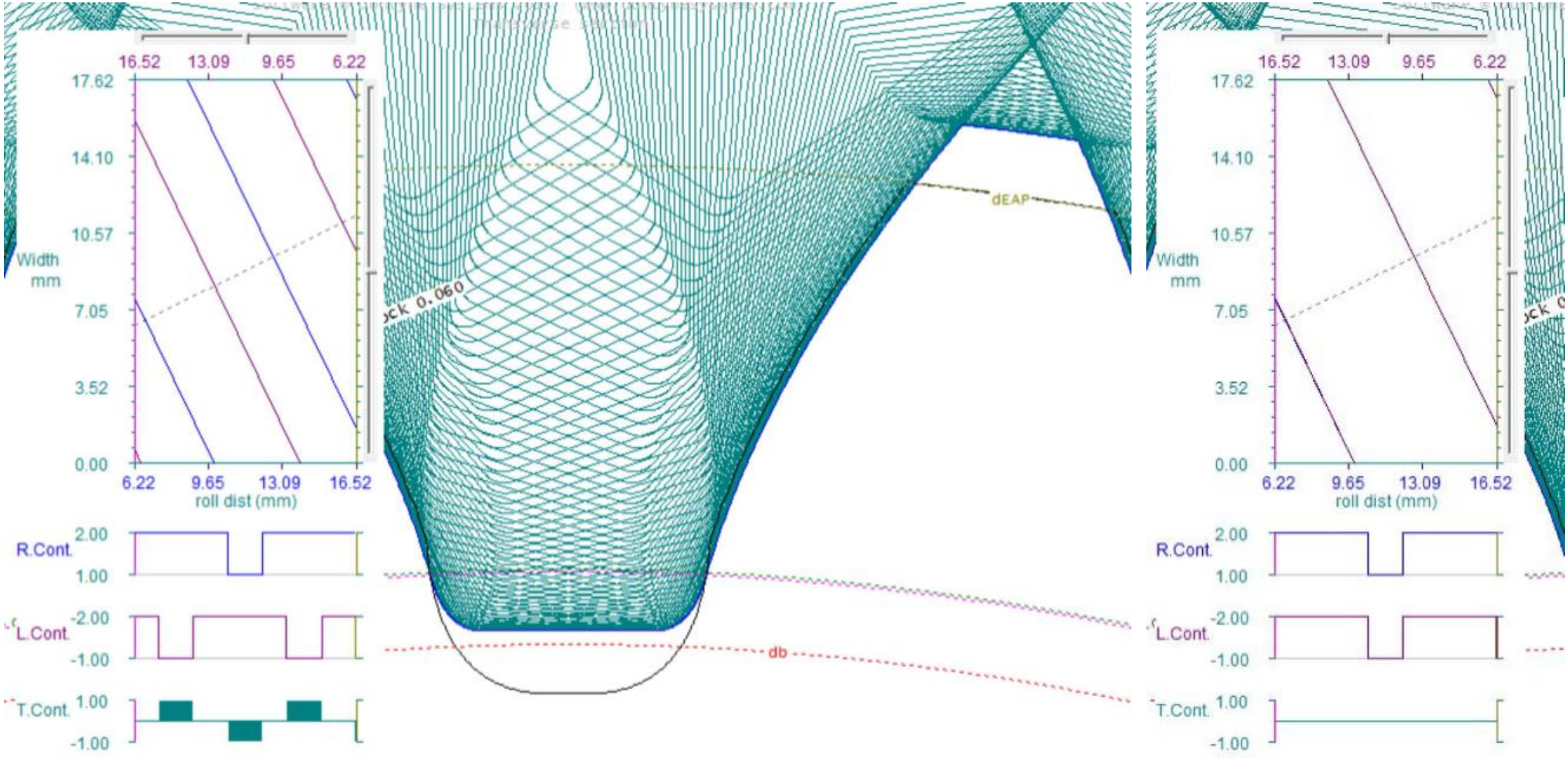
Gear Manufacture

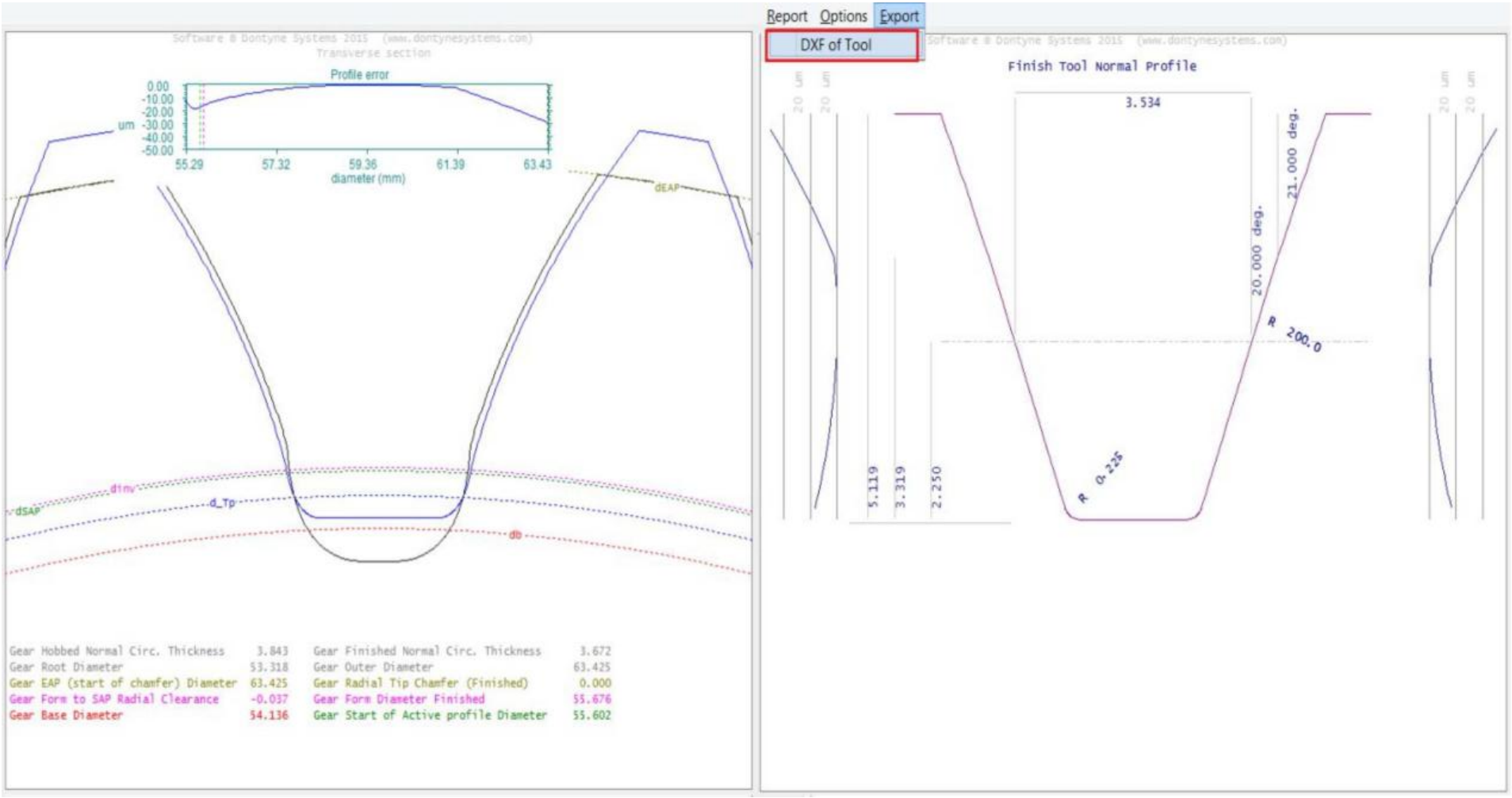
Find Balance Point Extended to Hobbing & Grinding Simulations*



* New Feature V5.2

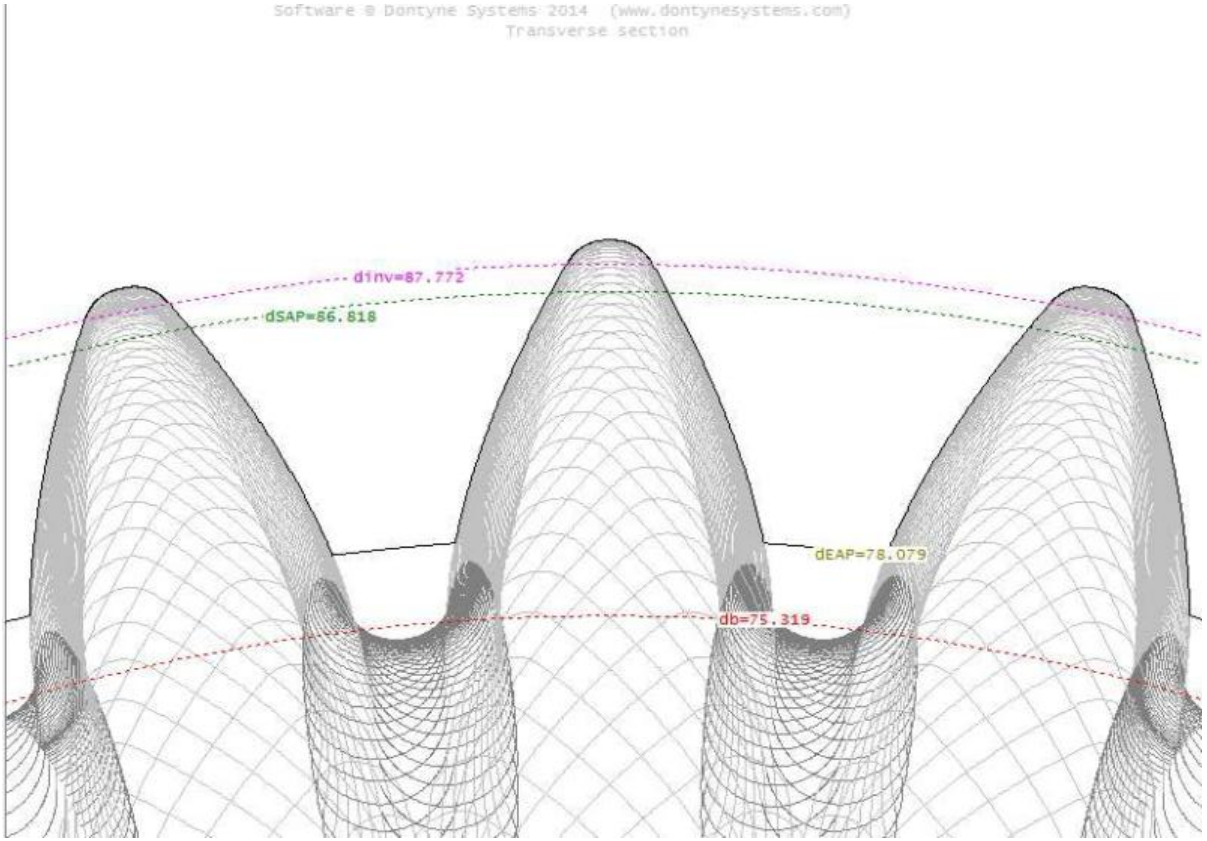
Gear Manufacture

Export Grind Wheel or Dressing Profile



Gear Manufacture

Gear Shaping

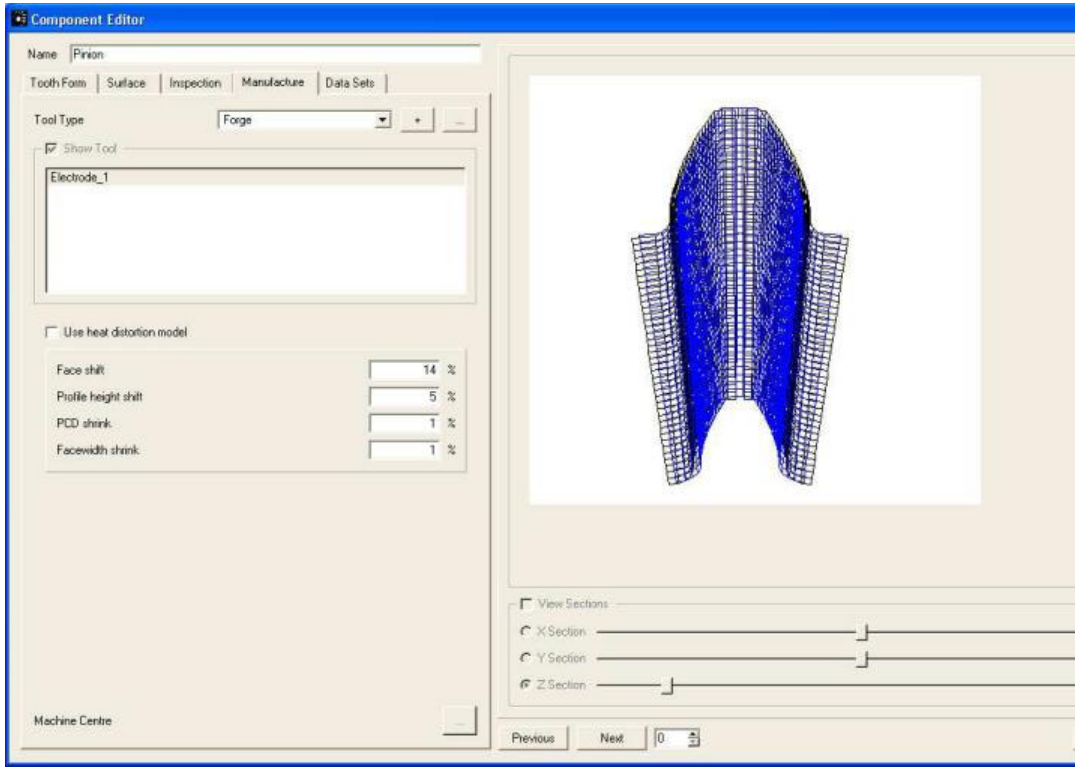


Machine Centre

Create die tool : modifying gear surface form

Different models for forging, sintering, or injection molding to compensate for heat distortion, elastic deformation, or shrinkage

Custom model can be created utilising customers knowledge base on the process for 'right first time' production



* New Feature V5.2

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Machine Centre

Model deformation for 'right first time' production

- Factors such as design parameters, material, force, and temperature will form model
- Model will be compared to existing data for validation (propose correct 50% as initial target)
- Considerable savings in time if avoidance of iteration to tool surface

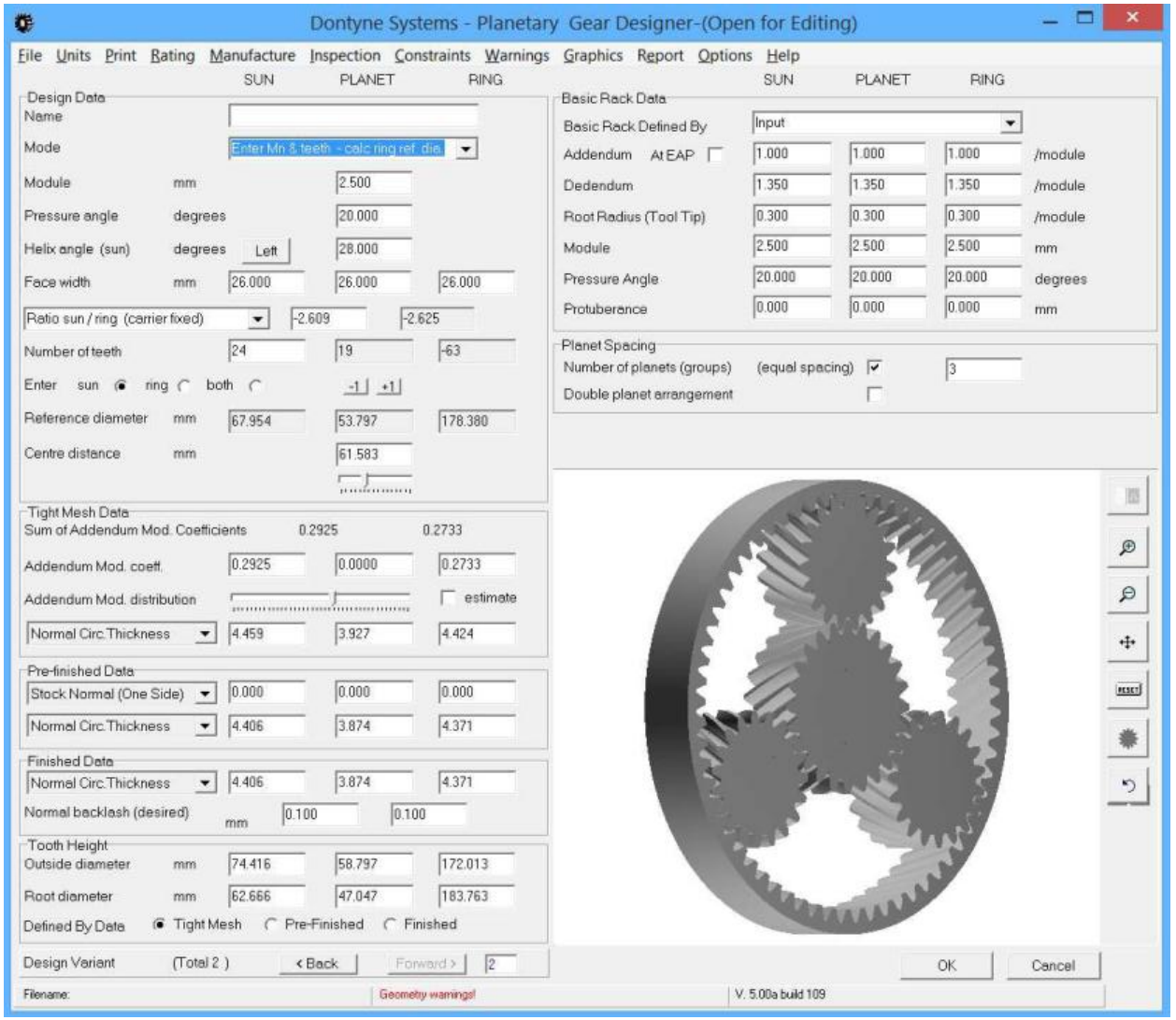
* New Feature V5.2

Dontyne Systems

Gear Design Pro - Planetary Gears

Features:-

- Assembly Check
- Tip Clearance Checks
- Multi planet Design
- Phasing calculations
- ISO Rating

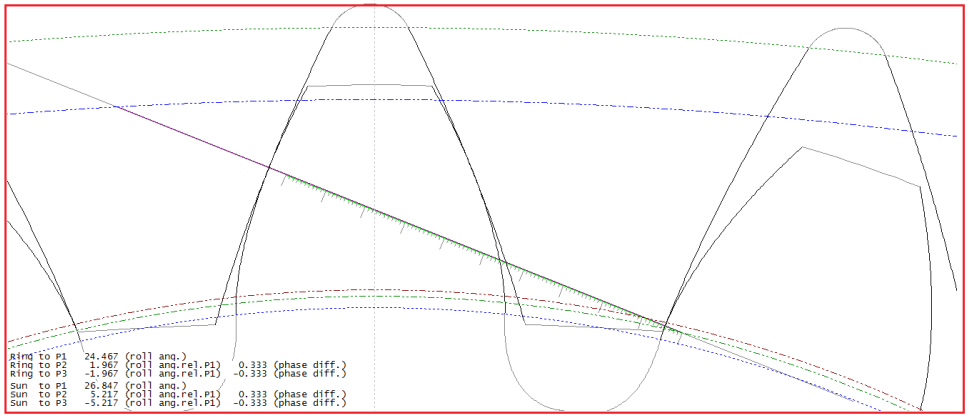


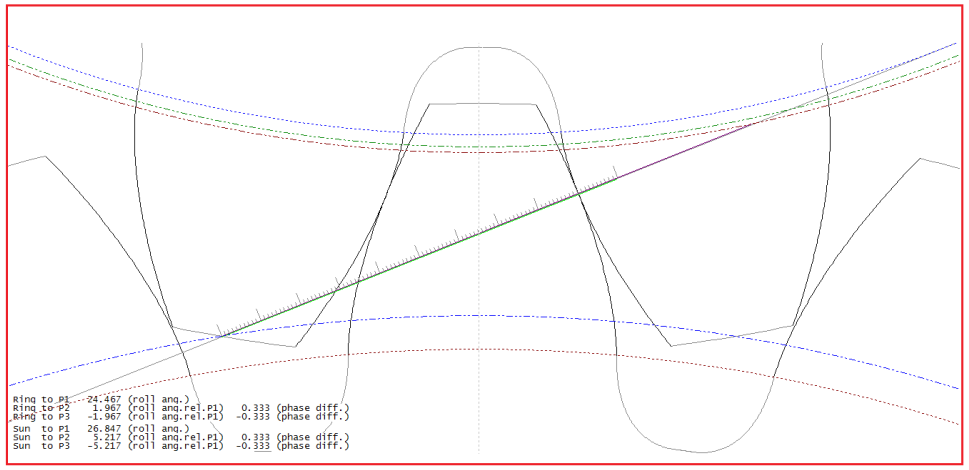
Dontyne Systems

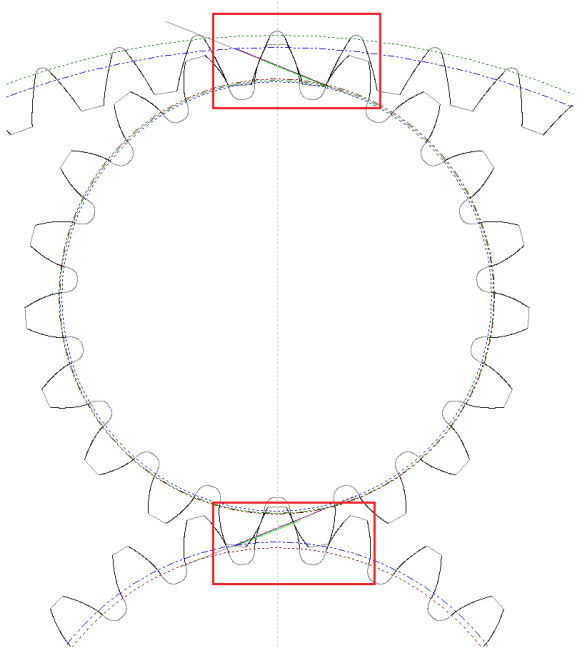
Load Analysis Model - Planetary Gear *

Features:-

- Phasing
- Load Sharing
- Transmission Error



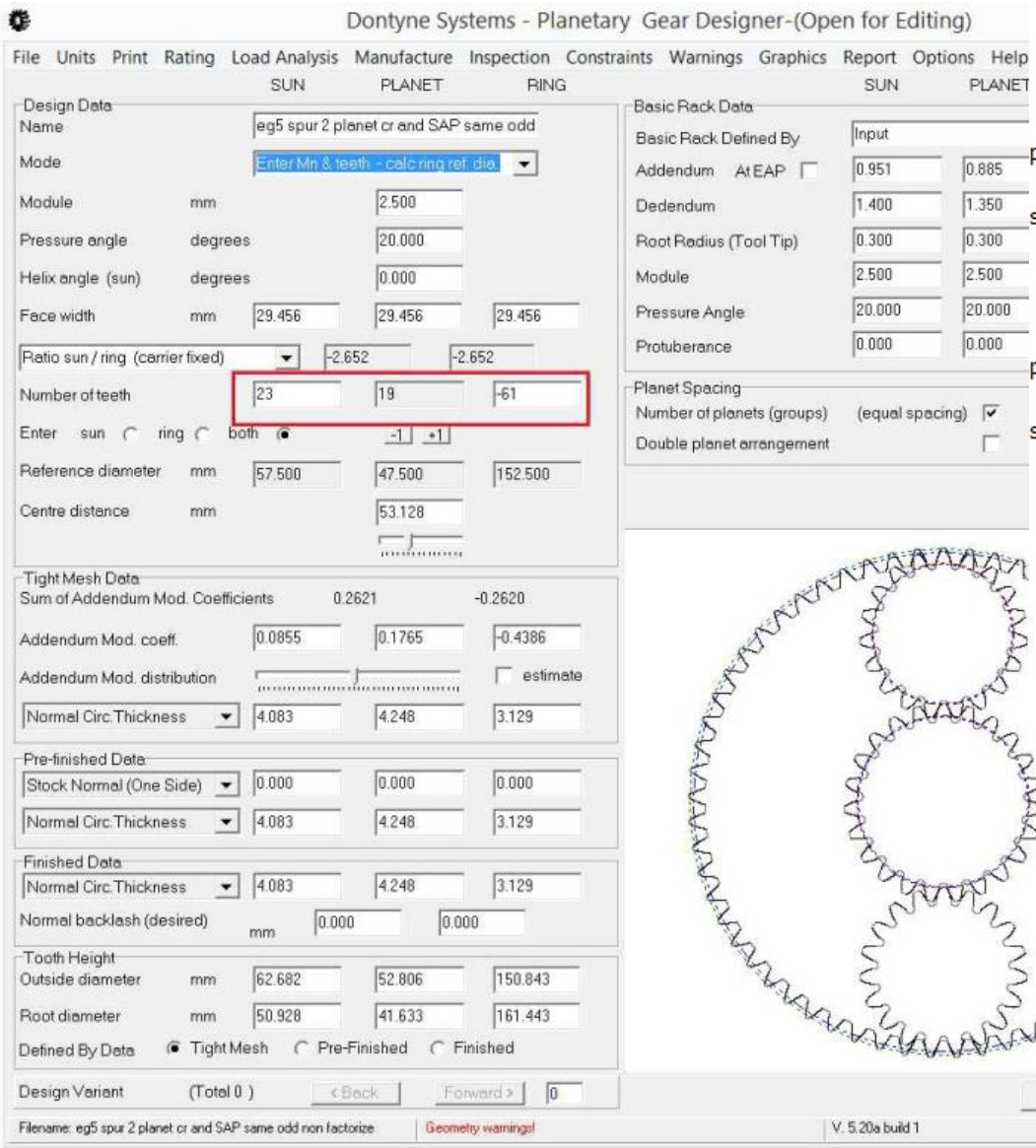


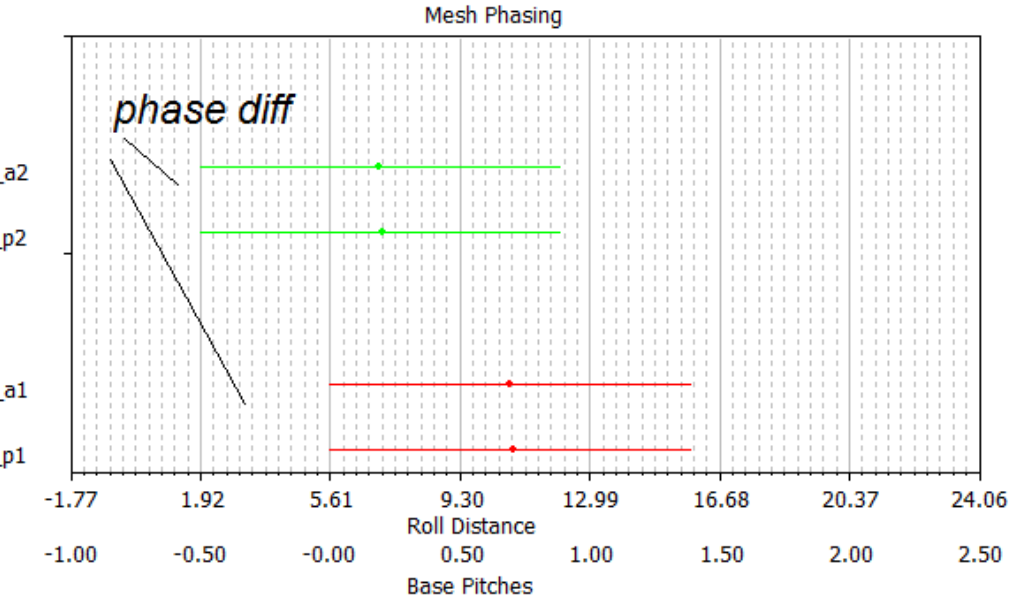


* New Feature V5.2

Dontyne Systems

Load Analysis Model - Planetary Gear





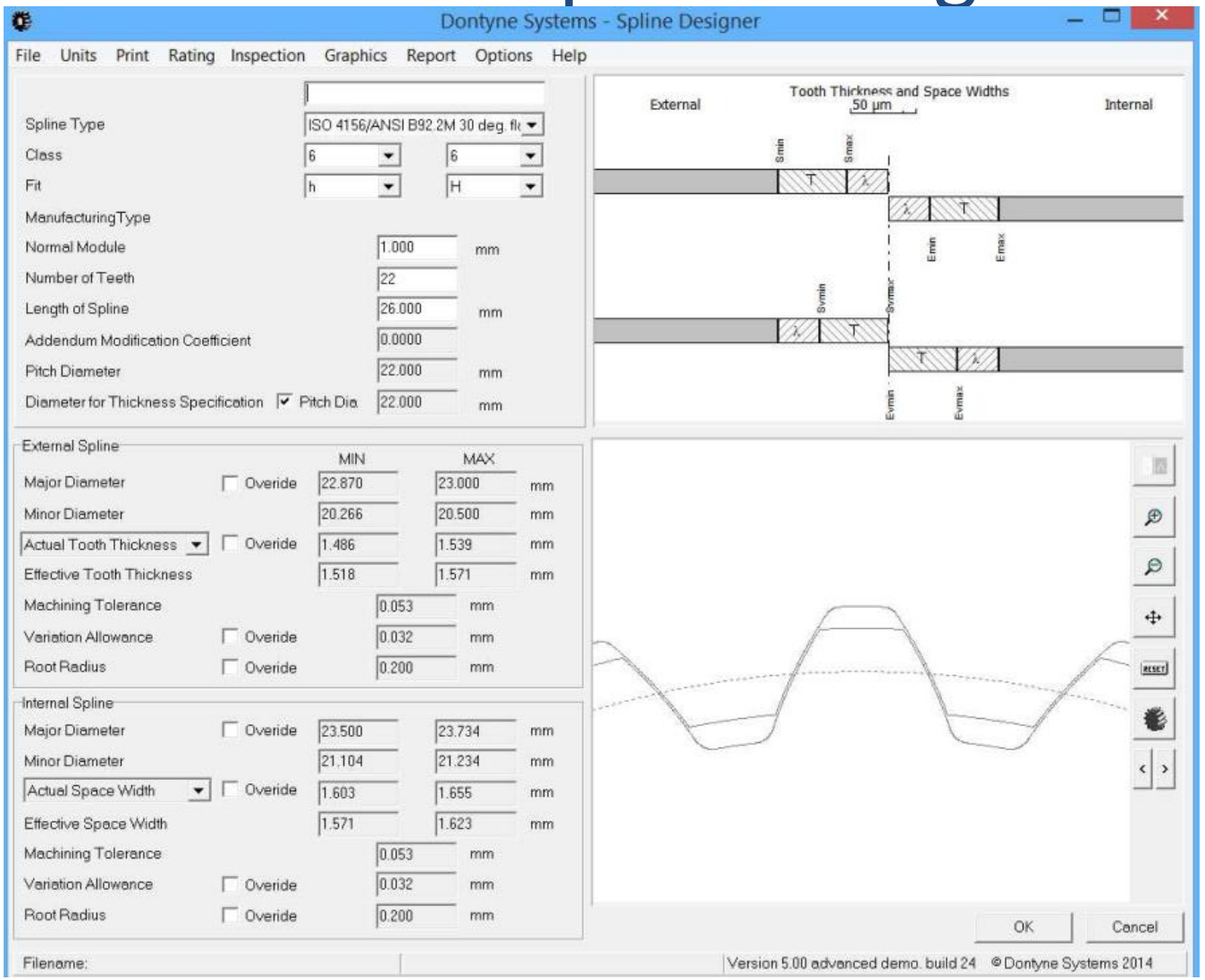
	SUN-PLANET	PLANET-RING
Relative roll distance positions		
Transverse base pitch	7.3803	
Path of contact length	10.2778	10.2778
Start of active profile (act)	5.6087	3.8300
End of active profile (act)	15.8865	14.1079
phase diff sun-planet planet-ring	-0.0000	
Phase difference planet1-planet1	0.0000	0.0000
Phase difference planet1-planet2	-3.6902	-3.6902
Start of active profile (adjusted)	0.0000	-0.0000
Start of active profile (adjusted)	-3.6902	-3.6902
Normalized roll distance positions		
Normalized phase planet1-planet1	0.0000	0.0000
Normalized phase planet1-planet2	-0.5000	-0.5000
Start of active profile (normalized)	0.0000	-0.0000
Start of active profile (normalized)	-0.5000	-0.5000

* New Feature V5.2

Connections - Spline Design

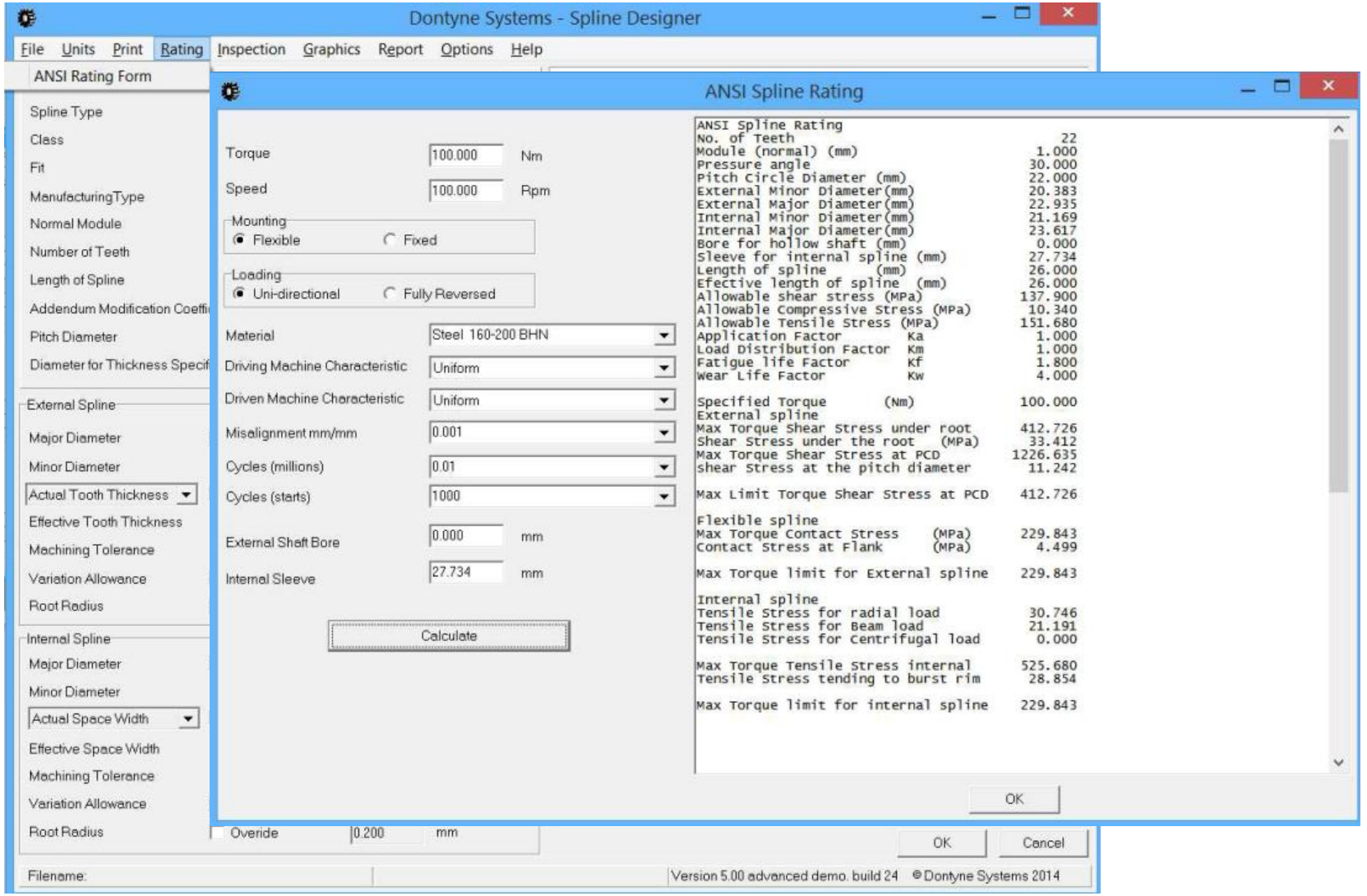
Standards

- *ISO*
- *ANSI*
- *DIN*



Connections - Spline Design

ANSI Strength Calculation *



* New Feature V5.0

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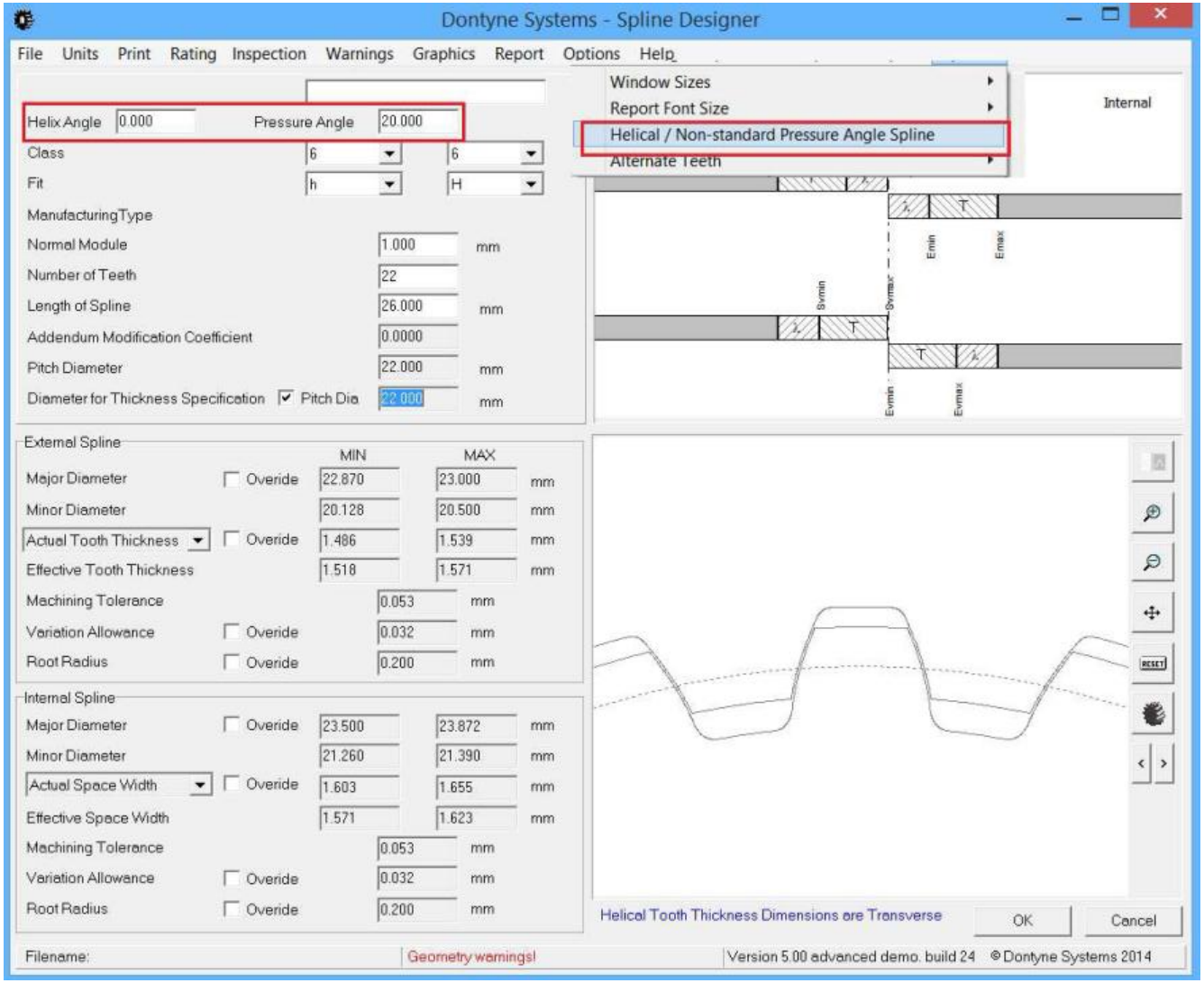
Spline Design

Non-standard pressure angle of helical splines *

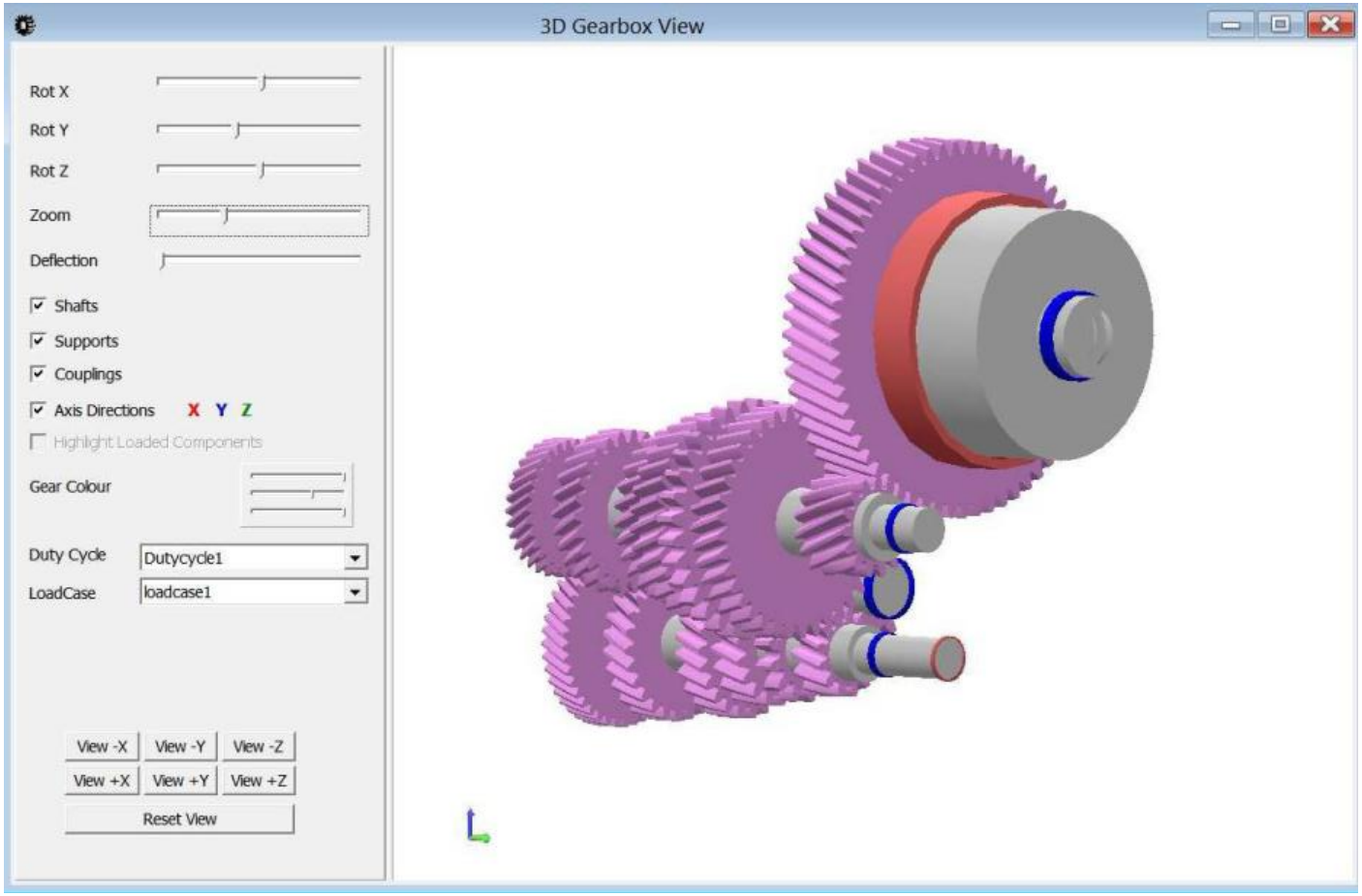


* New Feature V5.0

Gearbox Modeller*

Features :-

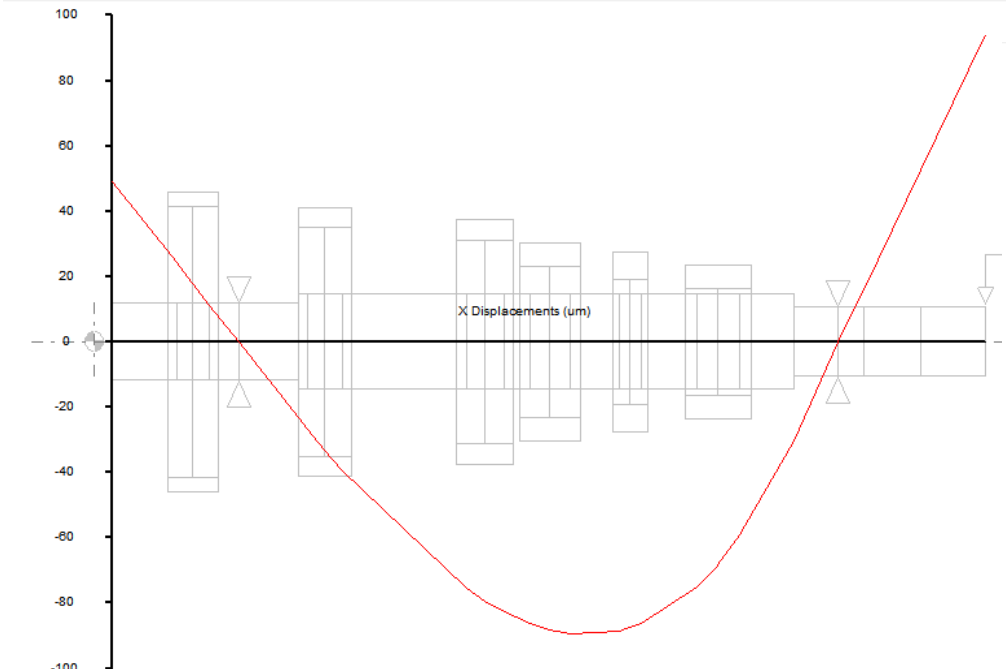
- *Power flow*
- *Gear Misalignments*
- *Shaft deflections and stresses*
- *Links directly to Gear Load Analysis model*



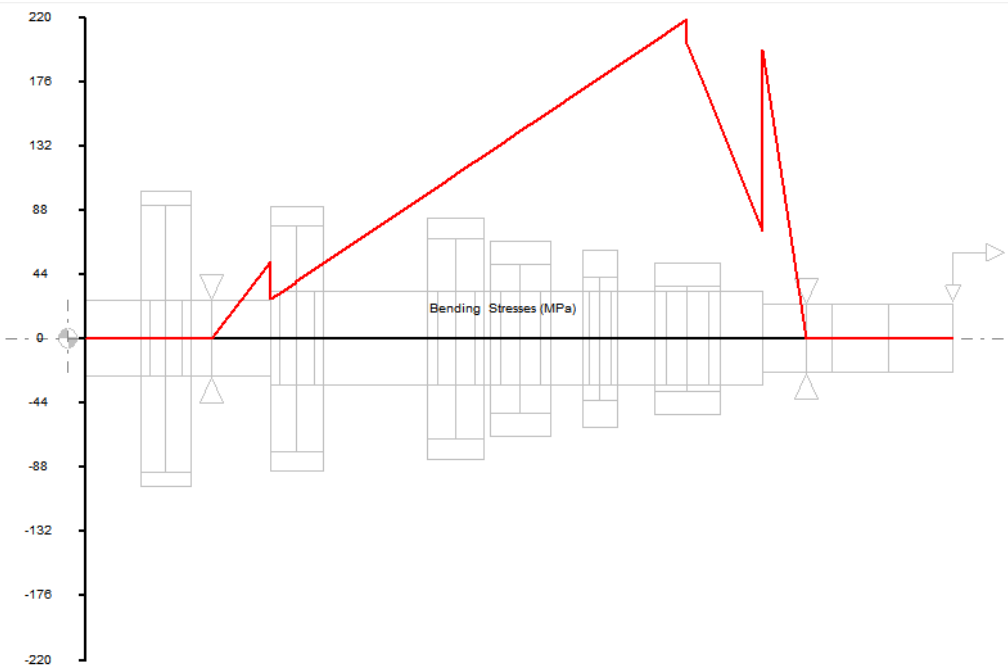
* New Feature V5.0

Gearbox Modeller

Shaft Deflections

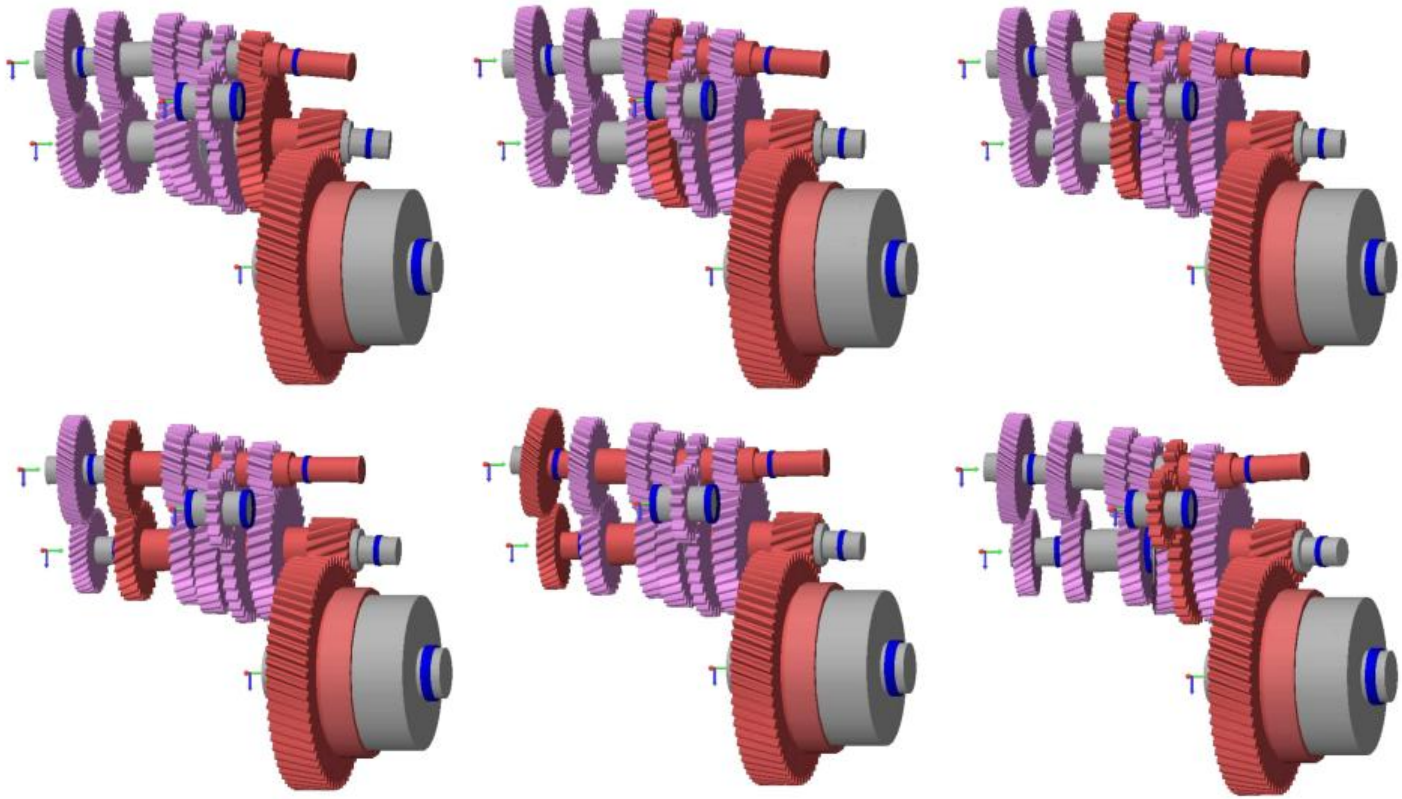


Shaft Stresses



Gearbox Modeller

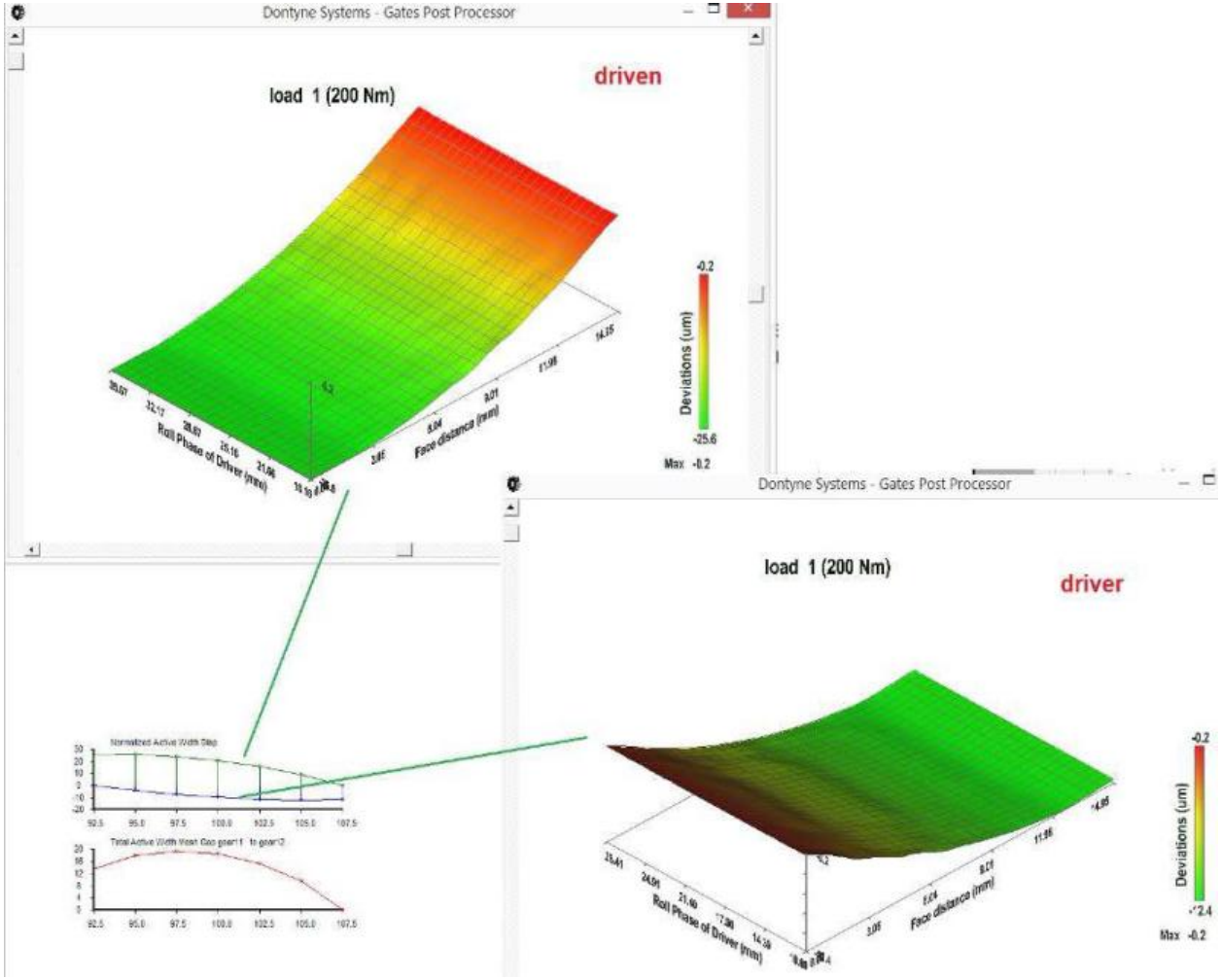
Powerflow diagrams



Dontyne Systems

Gearbox Modeller

Gear Misalignment Form Deviations



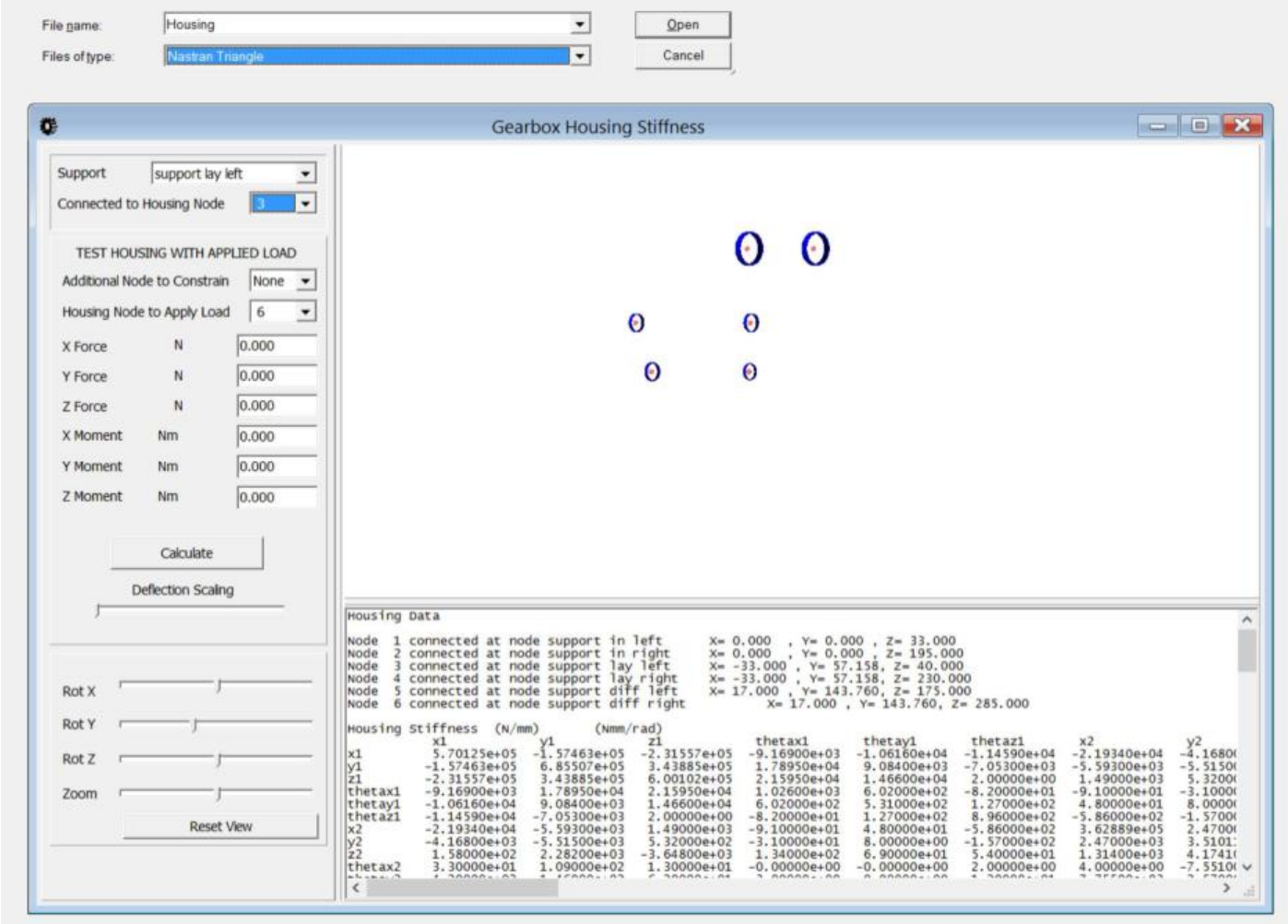
Full form deviations across tooth passed to LAM *

* New Feature V5.2

Dontyne Systems

Gearbox Modeller

Import NASTRAN file formats for Housing Stiffness



* New Feature V5.2

Dontyne Systems

Load Analysis Model Surface Optimization*

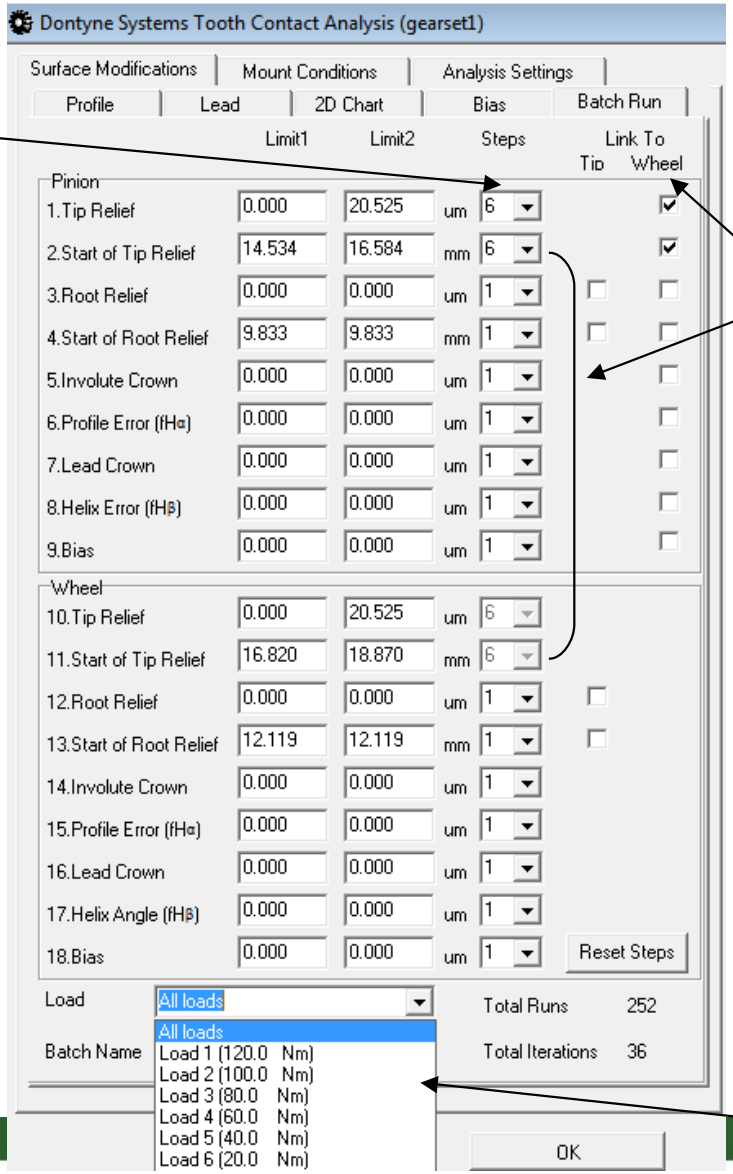
- Batch running option available release 5.0
- Many cases can be analyzed and the desired surface chosen from up to 20,000 variants
- Surface modifications include tip relief, crowning, bias and helix corrections for multiple loads
- Plots of results links directly to existing 3D graphics in the GATES program

* New Feature V5.0

Load Analysis Model Surface Optimization

Up to 10 increments for each parameter

Available surface Modifications



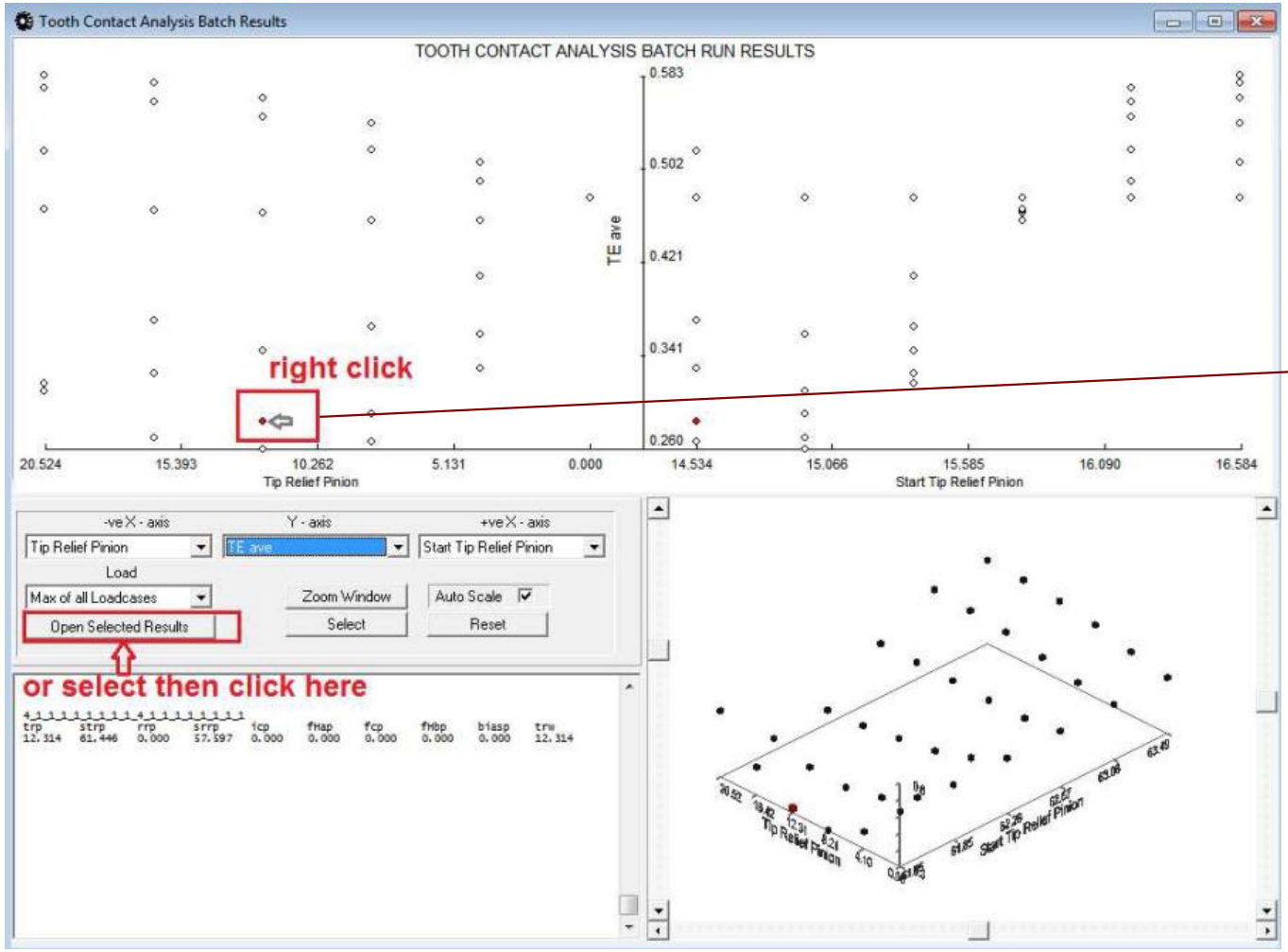
Pinion and wheel can be linked so that steps change together

Up to 9 loads for each modification

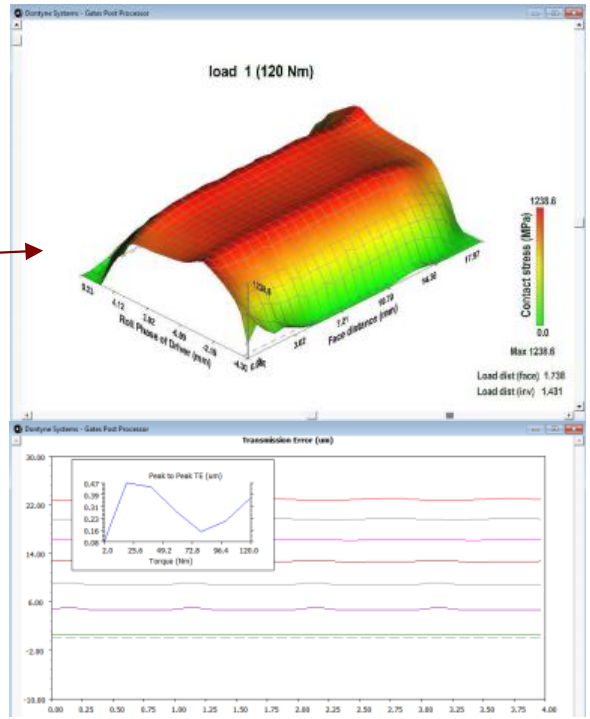
Dontyne Systems

Load Analysis Model Surface Optimization

Graphical display allows user to select a particular design



Tooth surface stress

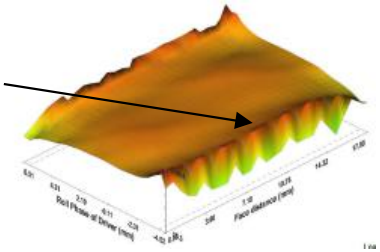


Transmission Error (TE)

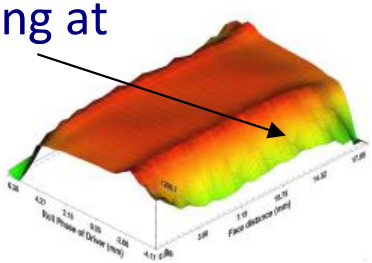
Load Analysis Model Surface Optimization

What is optimum amount of tip relief?

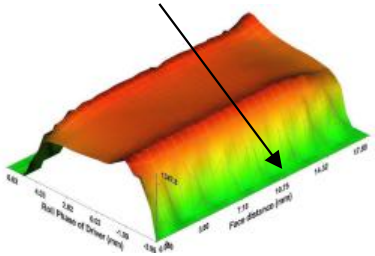
High stress at tip

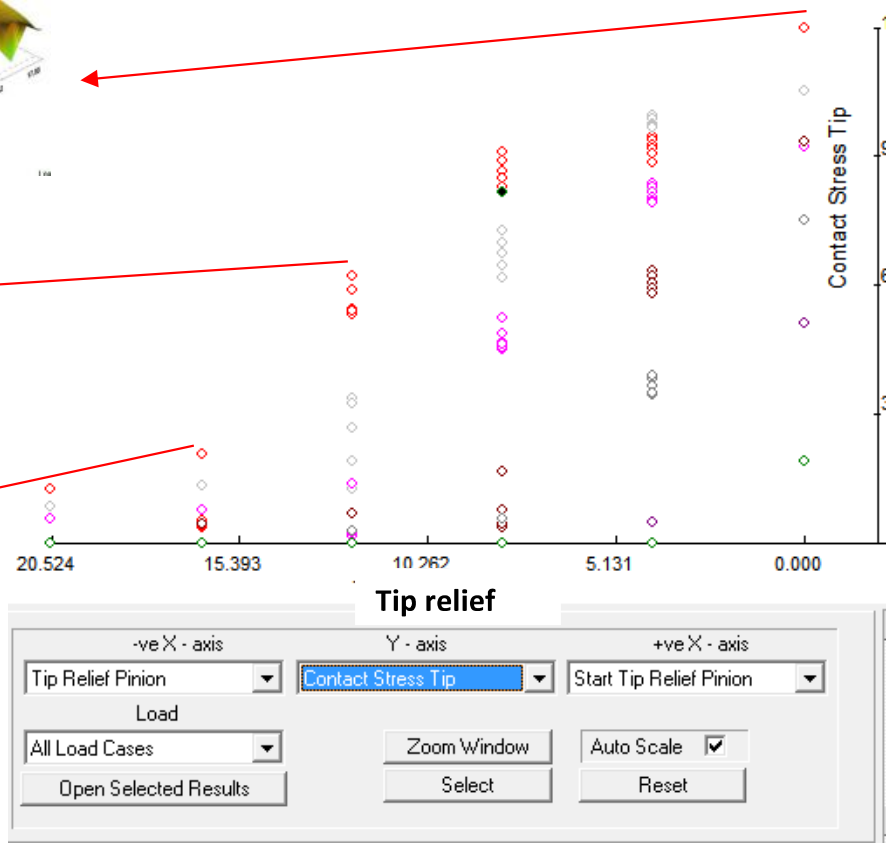


Stress reducing at tip at tip



Low stress at tip



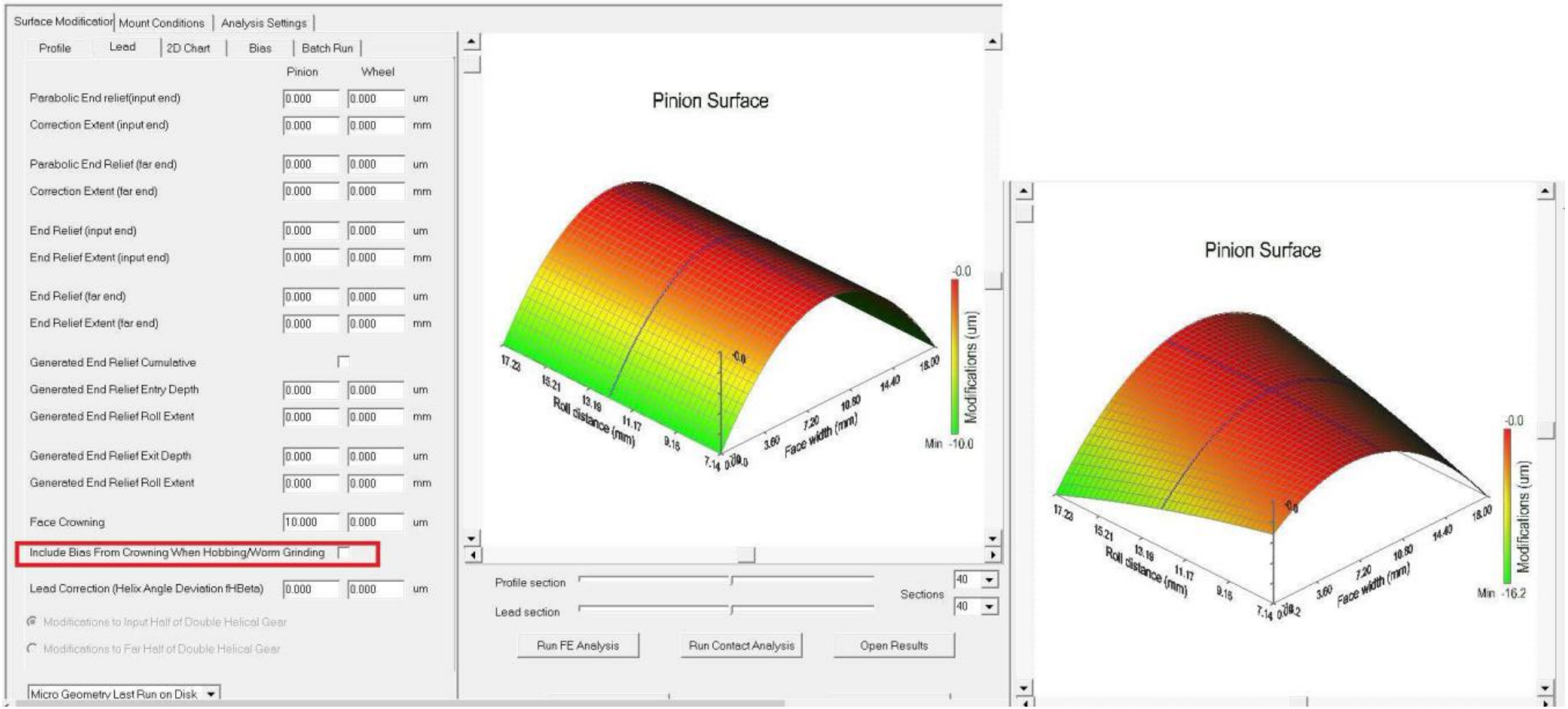


Contact stress at tip

Dontyne Systems

Load Analysis Model Bias From Crowning*

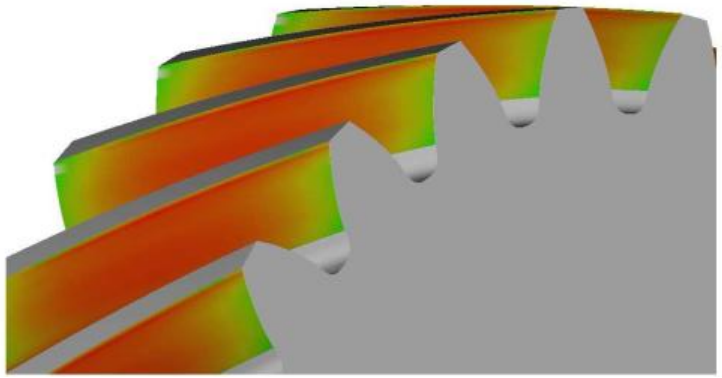
The twisting of the surface due to manufacturing effect of crown

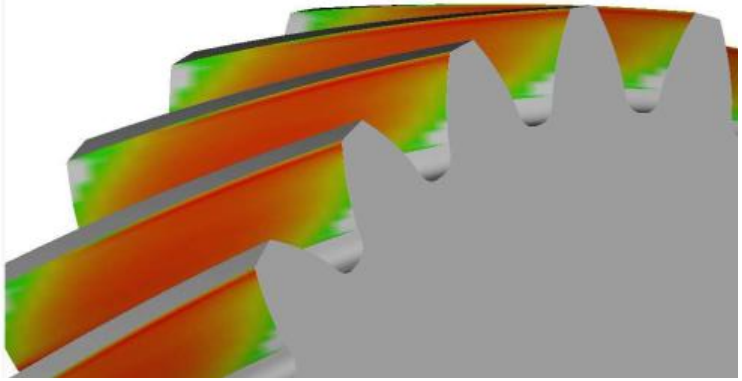


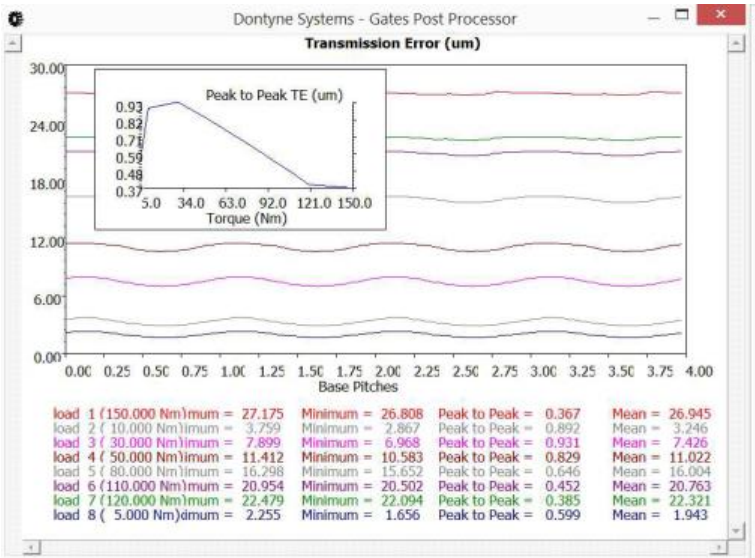
* New Feature V5.1

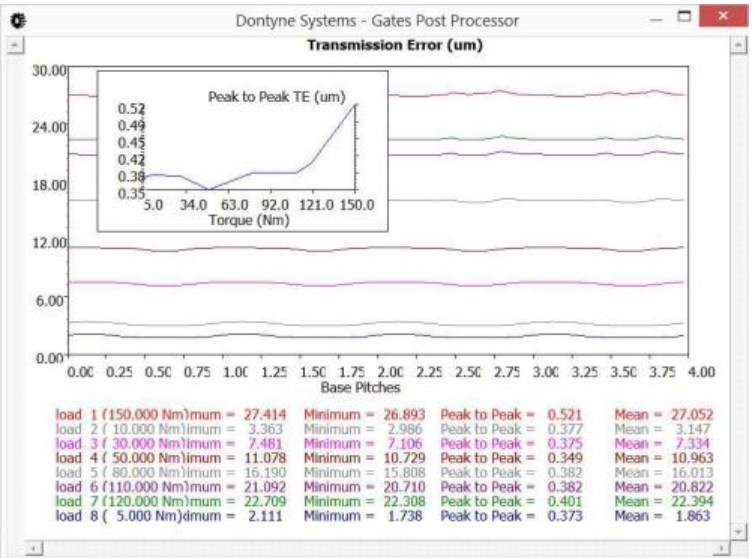
Load Analysis Model Bias From Crowning

The twisting of the surface due to manufacturing effect of crown



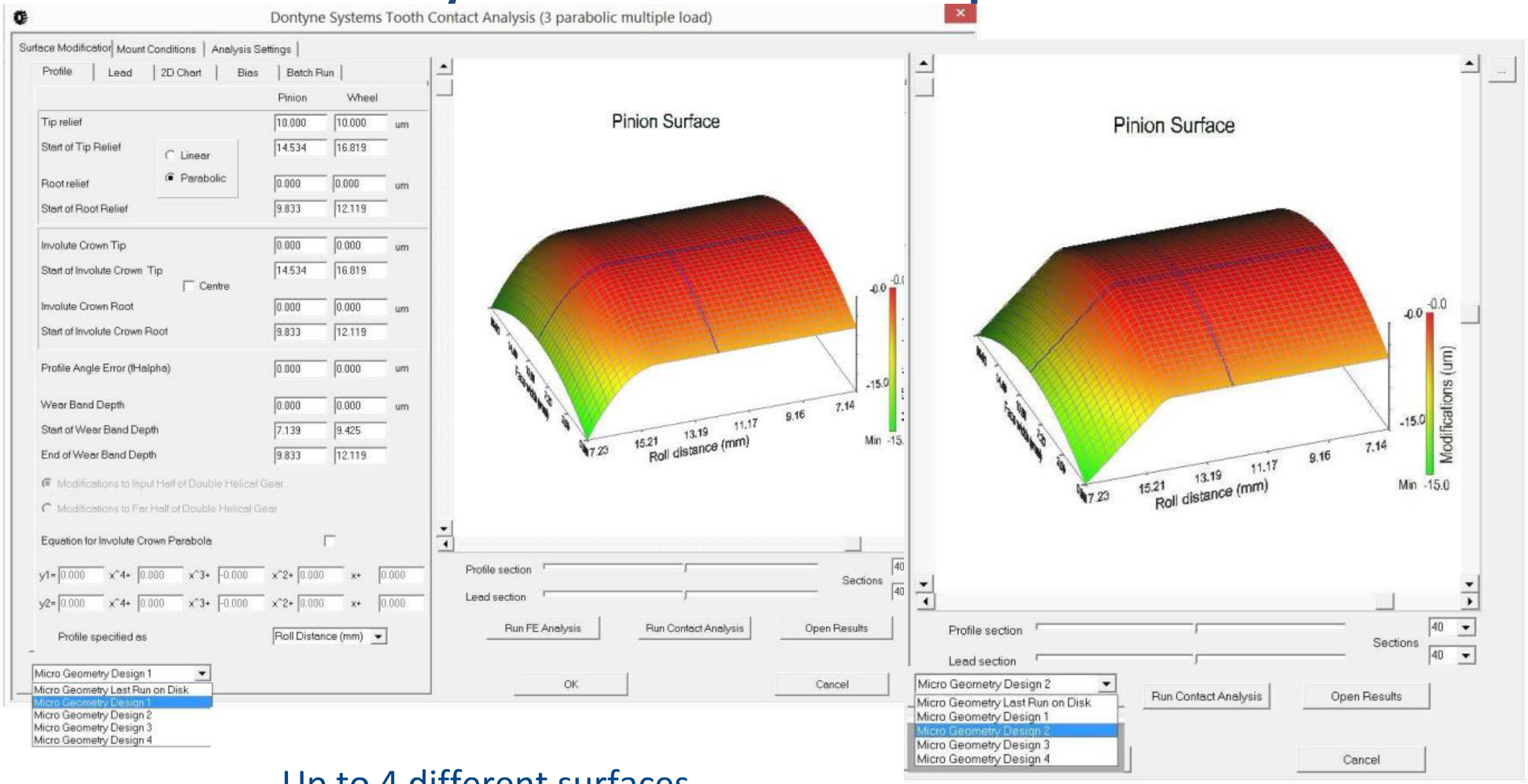






Dontyne Systems

Load Analysis Model Multiple-Surfaces*



Up to 4 different surfaces

* New Feature V5.2

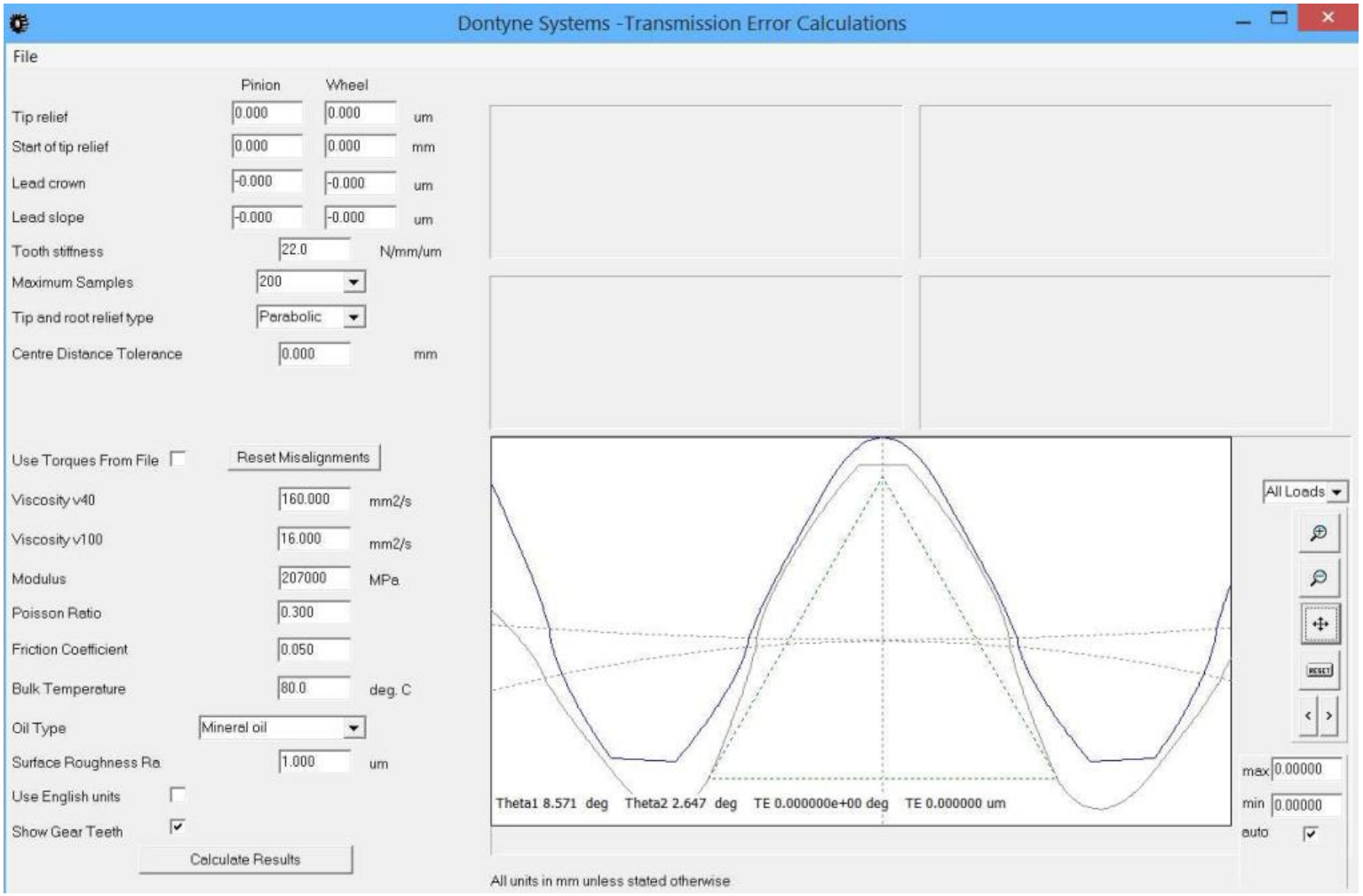
Dontyne Systems

Non-Involute Load Analysis Model*

- The Dontyne Generic load analysis model allows non-involute spur or helical gear profiles to be analysed
- This profile could be involute, cycloidal, Convoloid® or any new customer specific gear shape
- Results are provided for transmission error, load, stress and powerloss etc.

* New Feature V5.0

Non-Involute Load Analysis Model



Dontyne Systems

Bevel Gear Surface Design for 5-Axis Milling*

- The Dontyne Generic Spiral bevel gear program can produce the mathematically complex gear tooth surface data
- The co-ordinates can be exported in ASCII (x,y,z) format or DXF and IGES 3D grid forms.
- The gears can be roll checked to visualize the correct conjugation of the gear pair

* New Feature V5.0

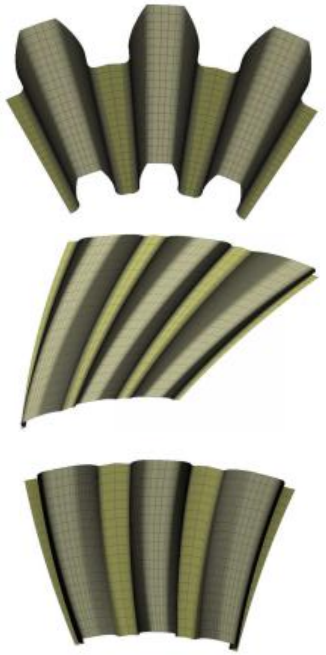
Bevel Gear Surface Design for 5-Axis Milling

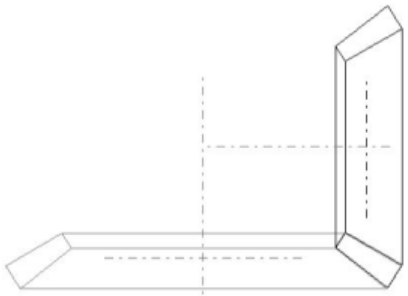
Is the Gear an Approximate Virtual Gear?

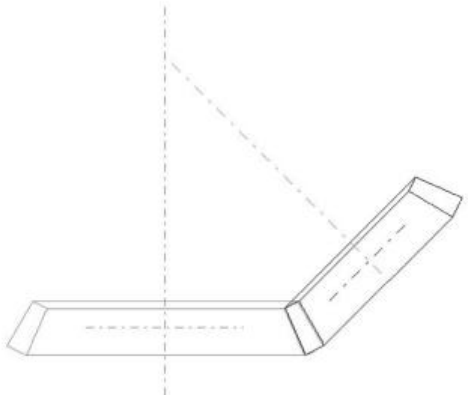
- Some programs employ “Tredgold's” approximation which substitutes a conical surface that is tangential to the actual spherical surface
- This surface in the back cone is an approximation to the exact spherical surface
- The Dontyne program uses the exact spherical involute with no approximation or virtual spur gear in the back cone

Bevel Gear Surface Design for 5-Axis Milling

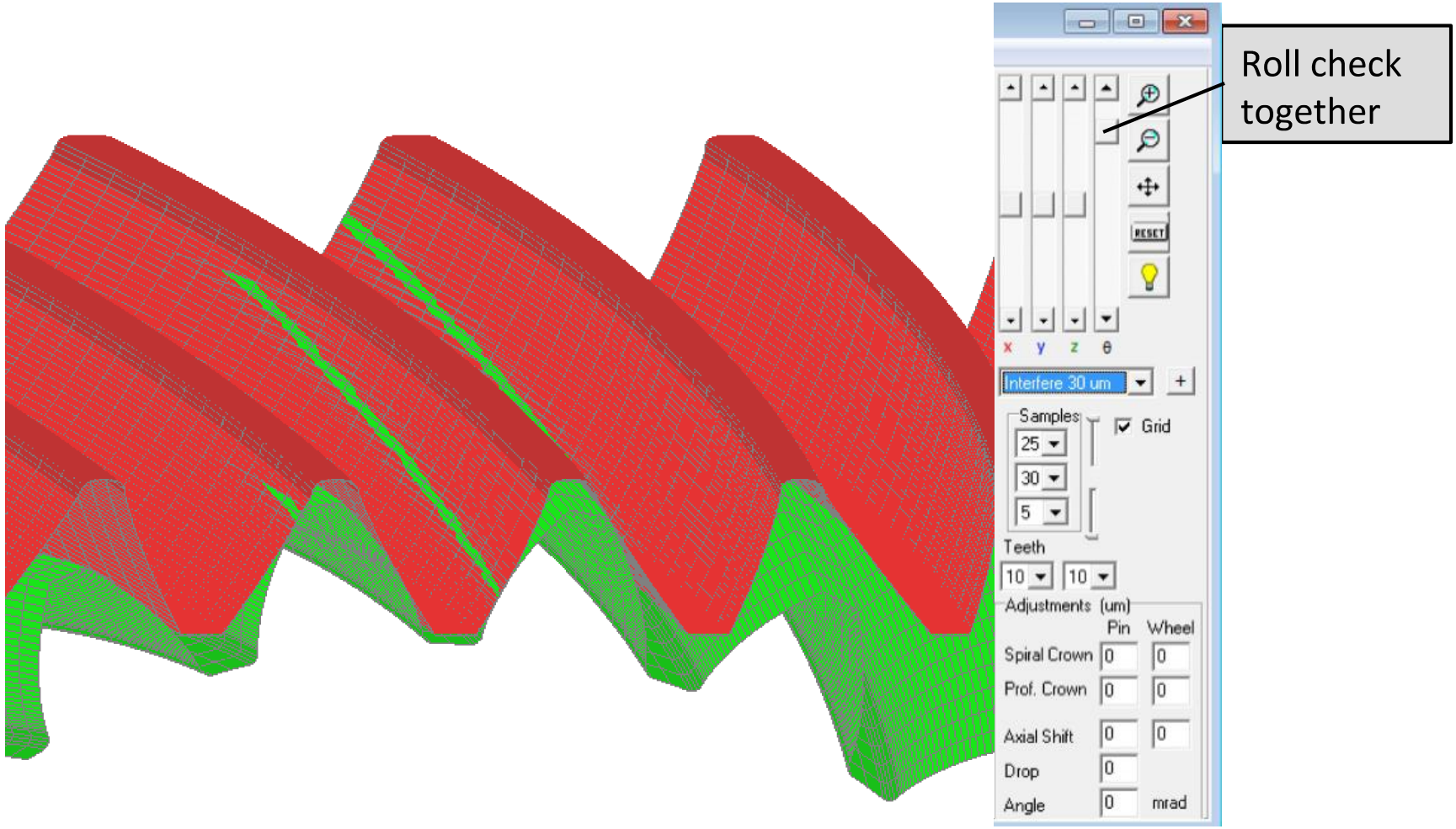
- Straight bevel
- Spiral Bevel
- Zerol Bevel
- 90 degree or other





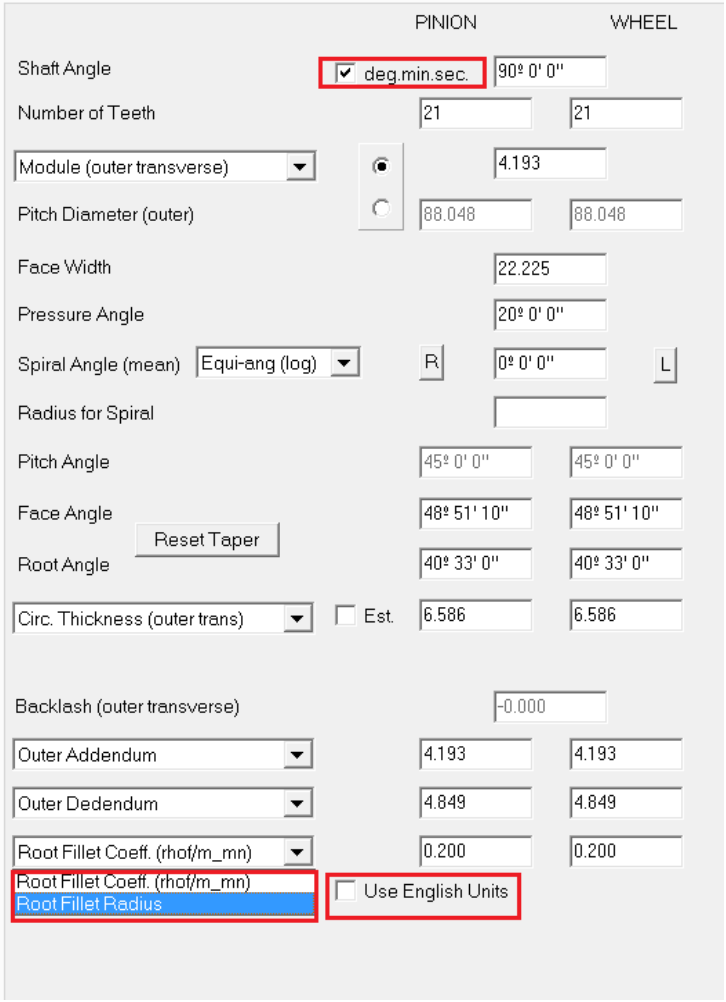


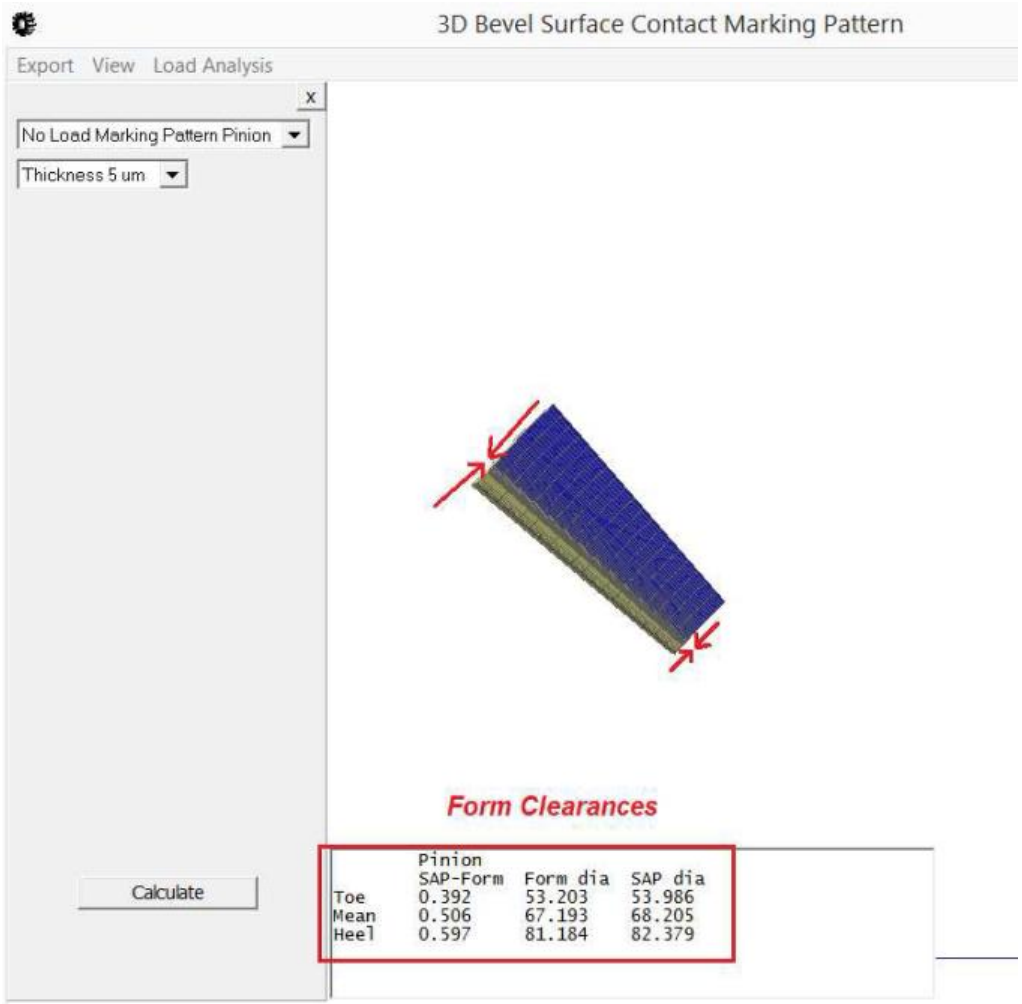
Bevel Gear Surface Design for 5-Axis Milling



Dontyne Systems

Bevel Gear Interface Additions



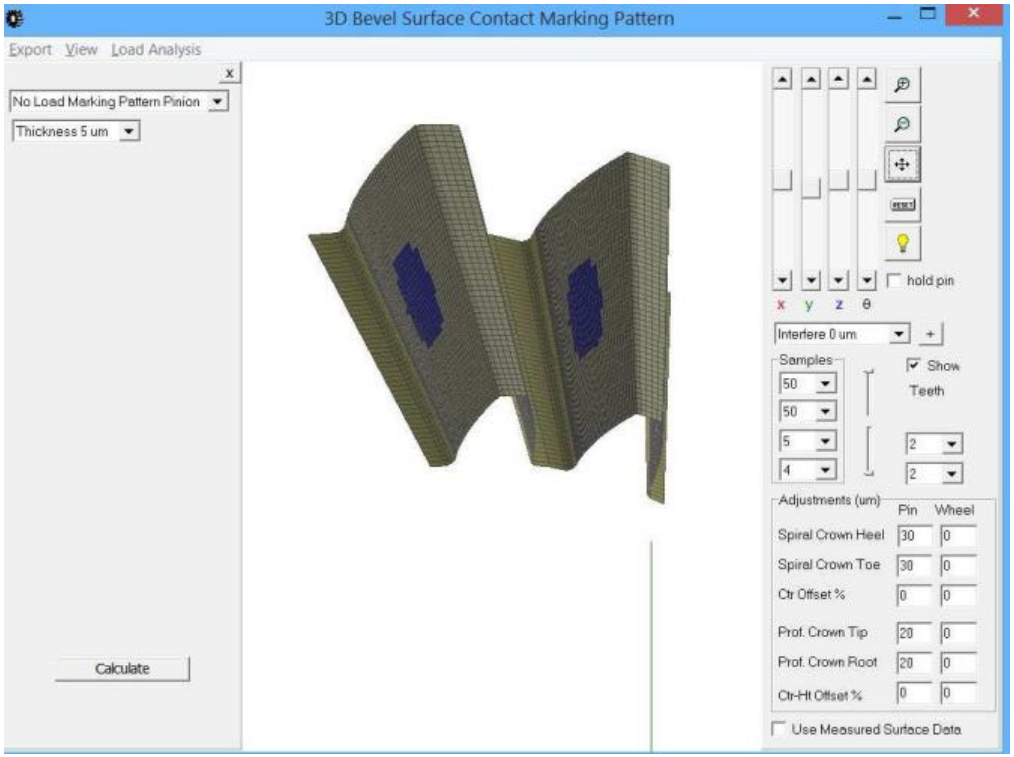


* New Features V5.1

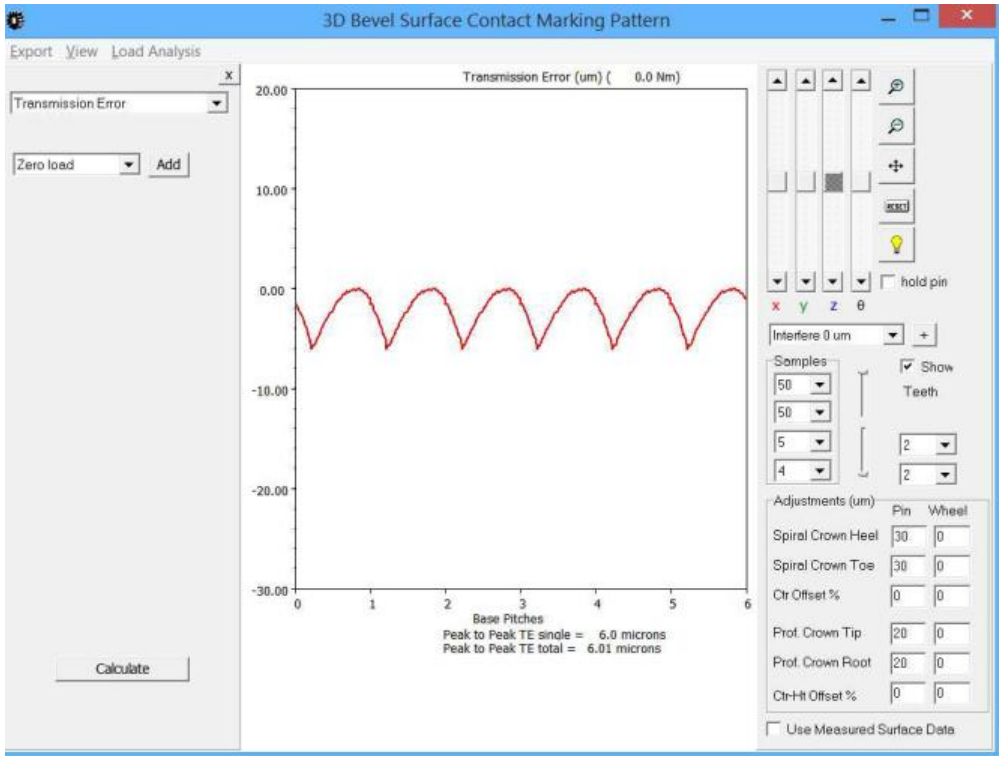
Dontyne Systems

Bevel Gear – No Load Analysis

Marking Pattern*



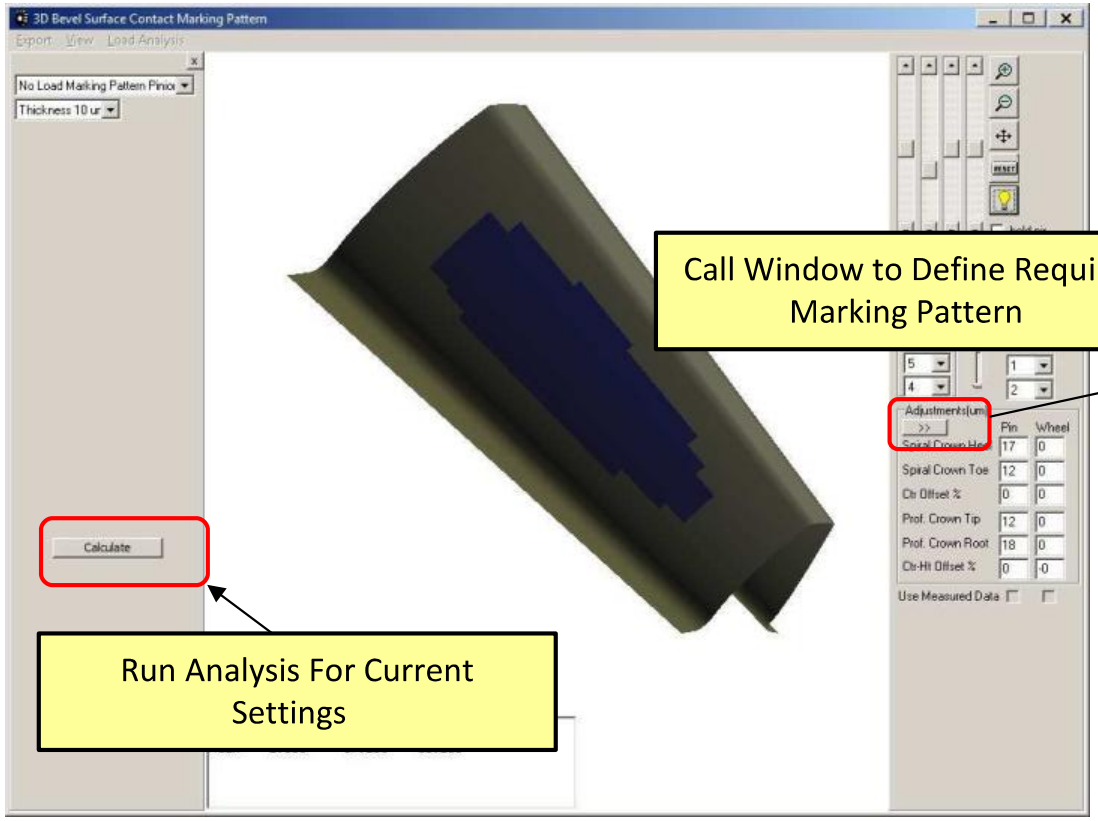
Transmission Error*



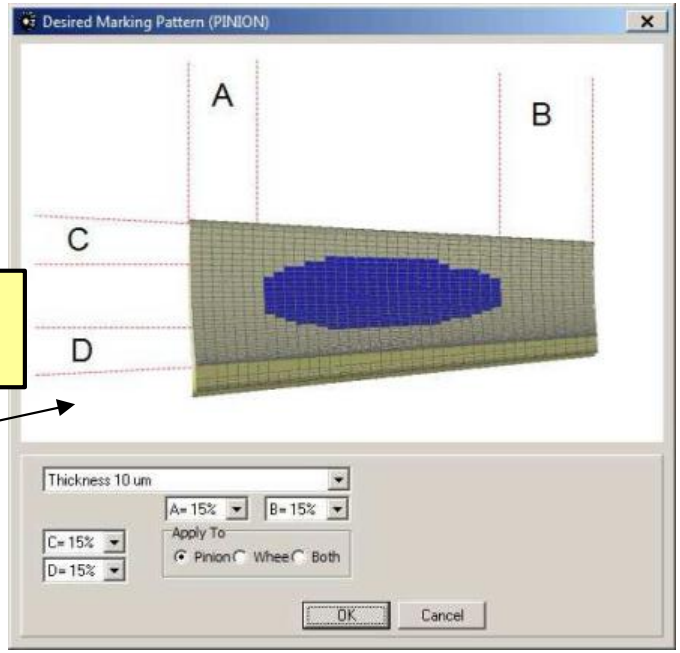
* New Feature V5.1

Dontyne Systems

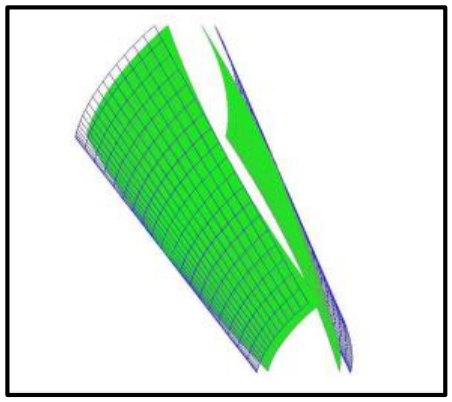
Bevel Gear Definition of Micro Geometry



Call Window to Define Required Marking Pattern



Run Analysis For Current Settings



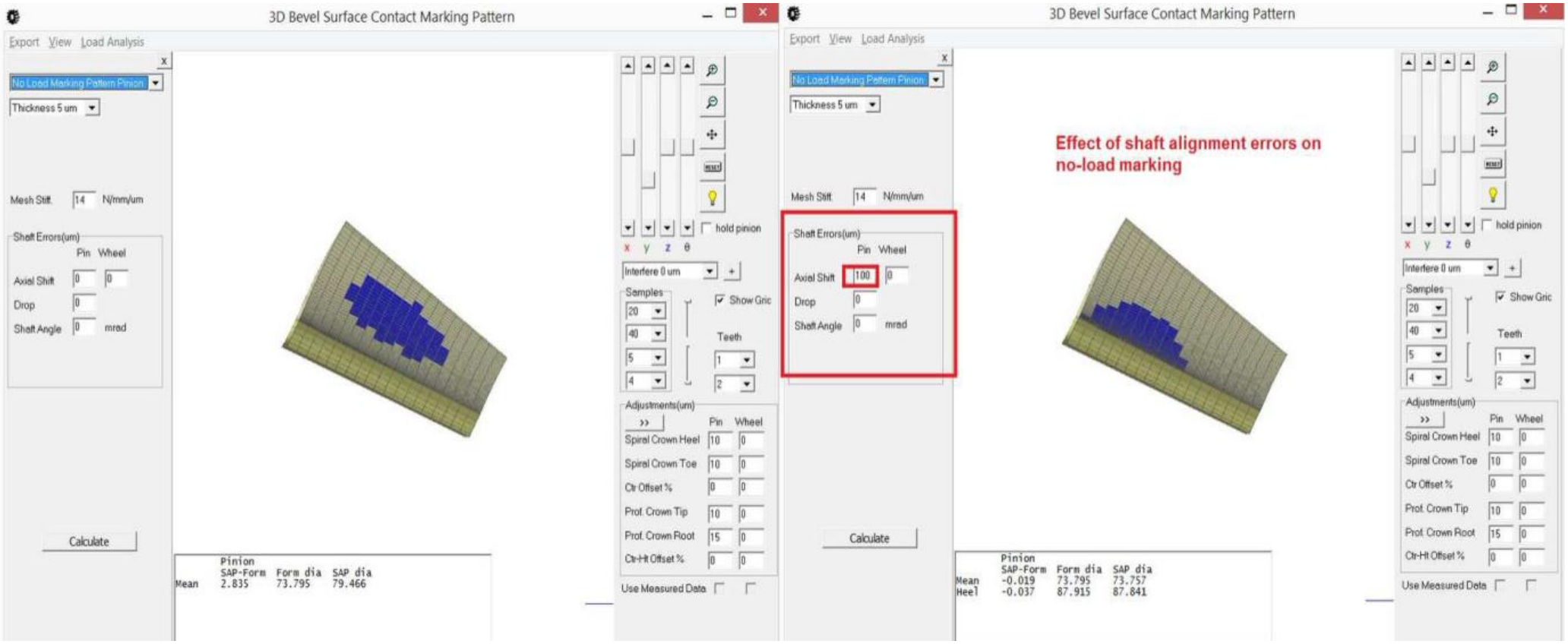
Modification can be viewed relative to the theoretical surface

* New Feature V5.2

Dontyne Systems

Bevel Gear – No Load Analysis

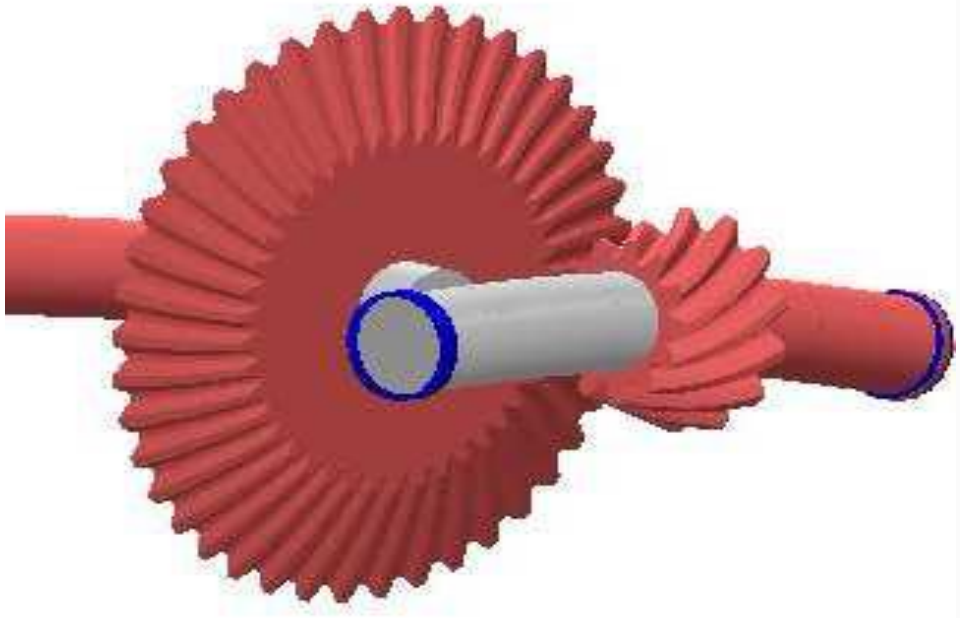
Effect of Alignment Error*

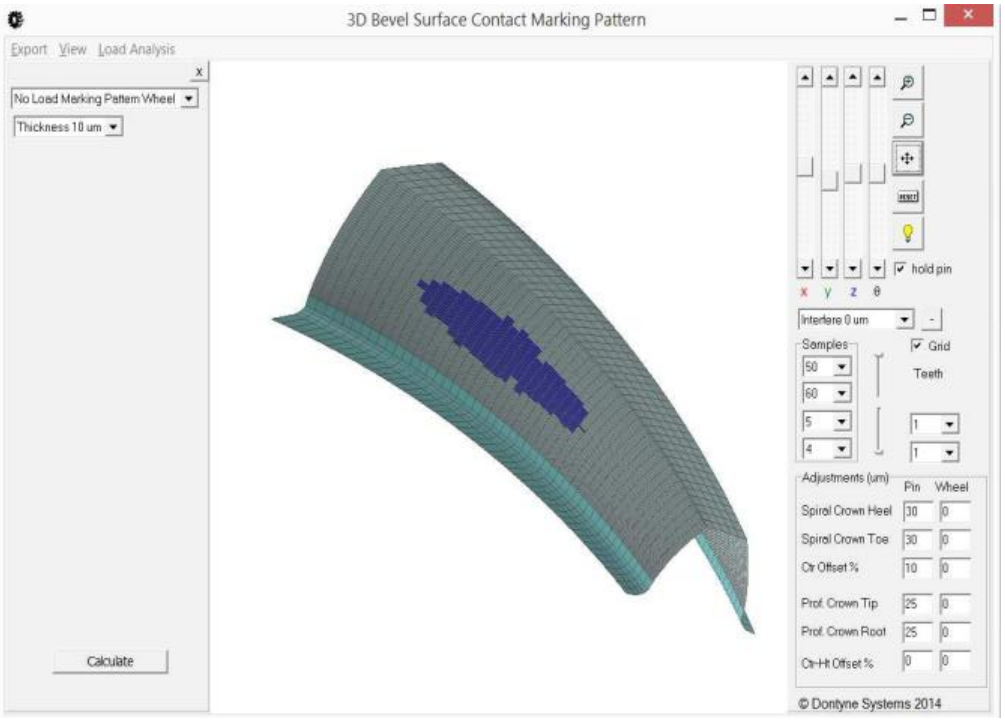


* New Feature V5.2

Dontyne Systems

Bevel Gear – Load Analysis Model



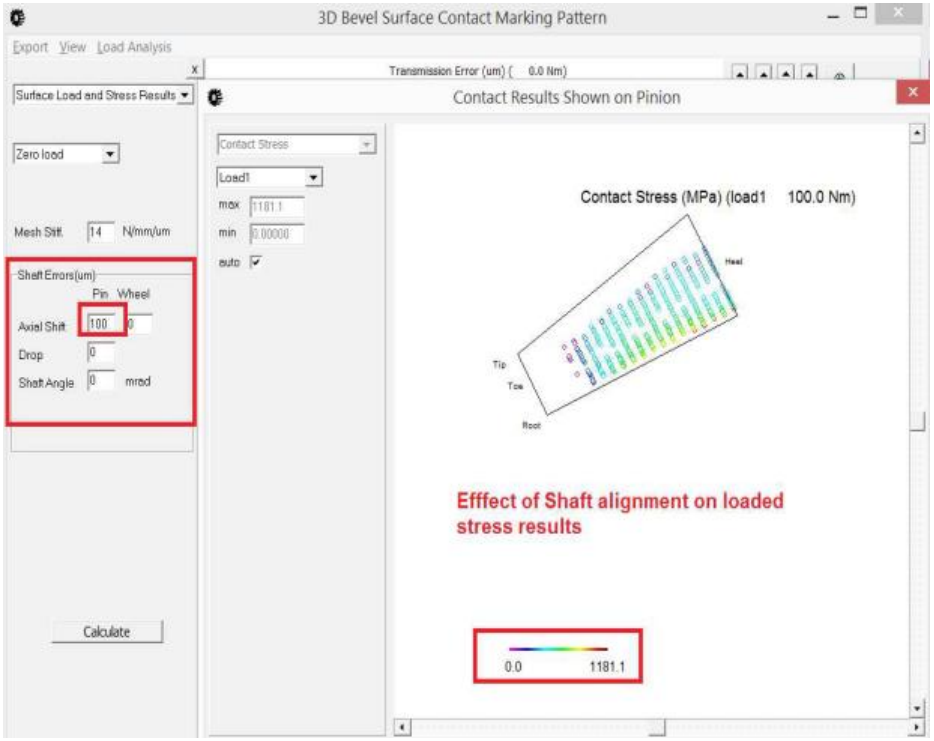


* New Feature V5.2

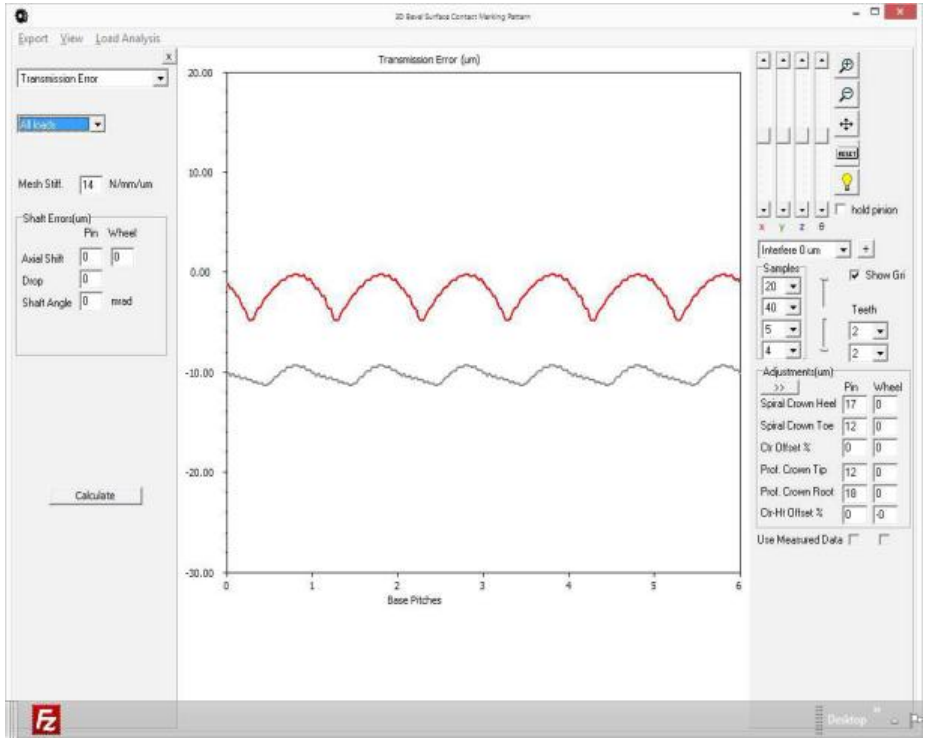
Dontyne Systems

Bevel Gear – Load Analysis Model

Contact Stress Pattern*



Harris Map - Transmission Error*



* New Feature V5.2

Dontyne Systems

Links To Inspection

Gear Checking Machine
OSK

CMM
Wenzel

Gauging devices
Equator (Renishaw)

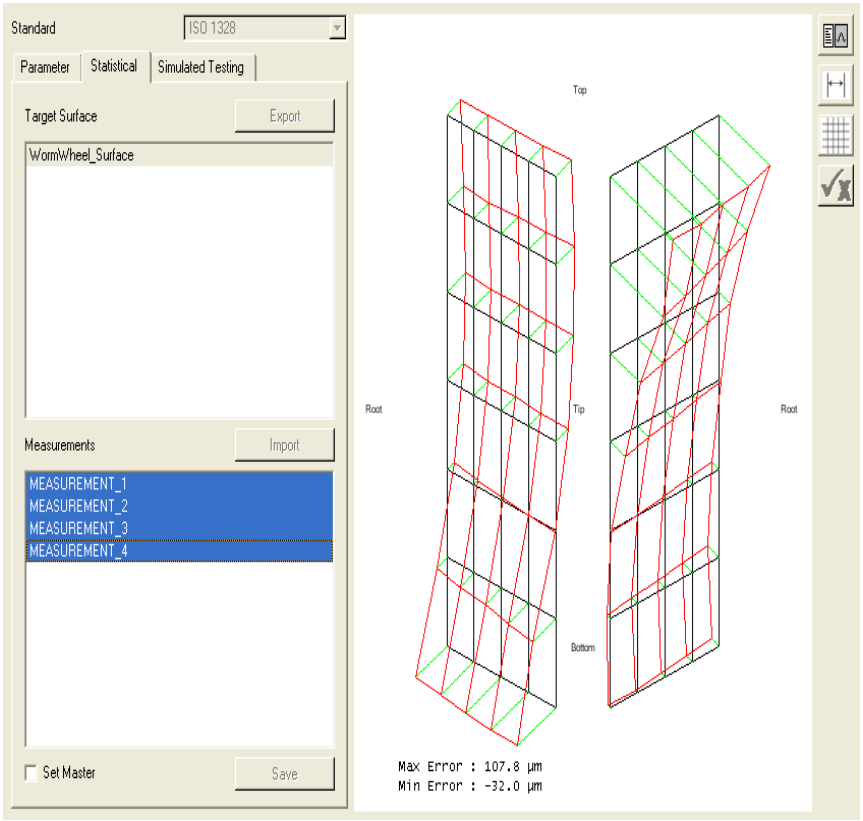
The Gear Production Suite has links to many measuring devices some of which embed Dontyne Systems software in their own applications

* New Feature V5.2

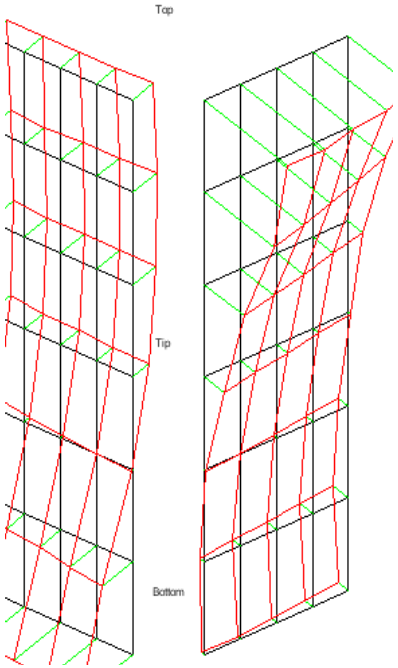
Links To Inspection

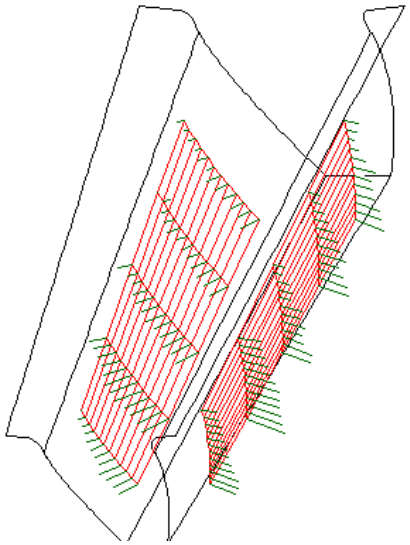
Tooth surface measured data can be imported and evaluations used for

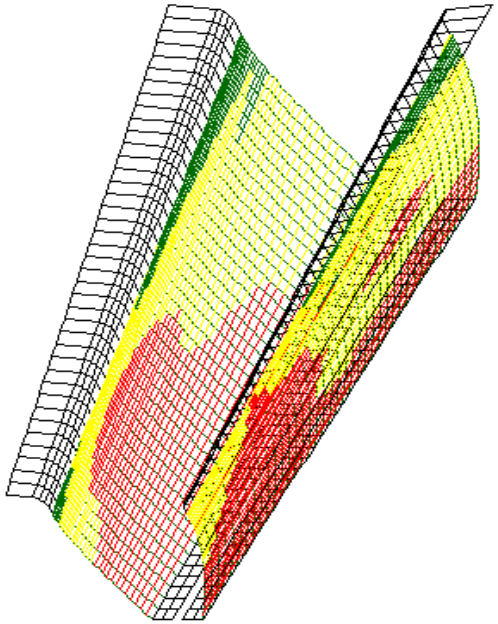
Statistical analysis of several teeth
Creating master tooth form
Tooth contact analysis



Links To Inspection



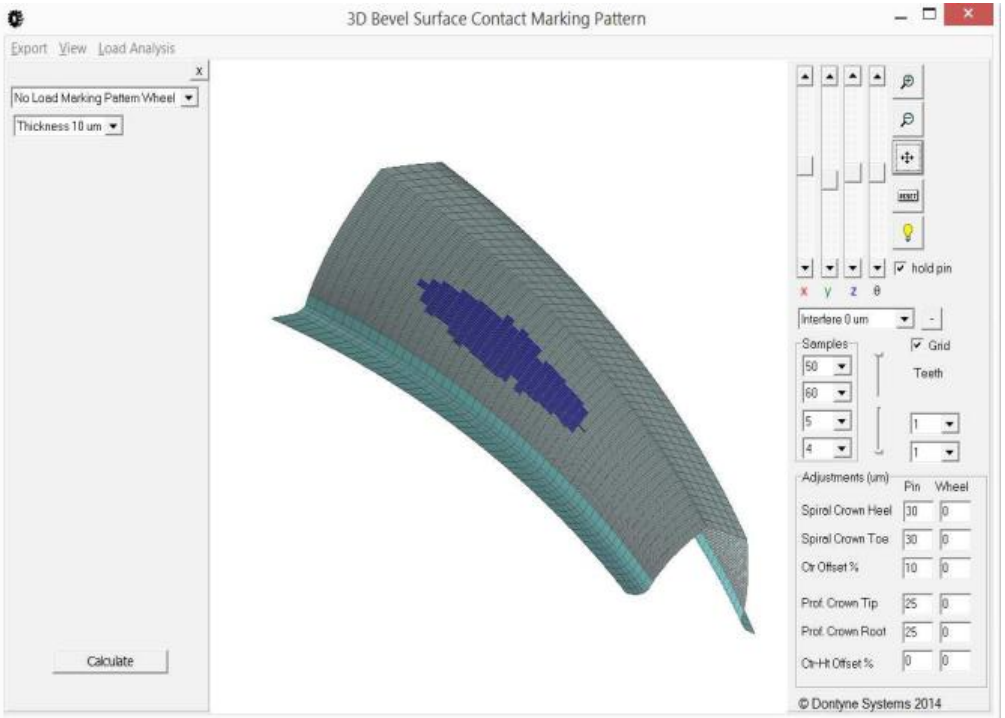


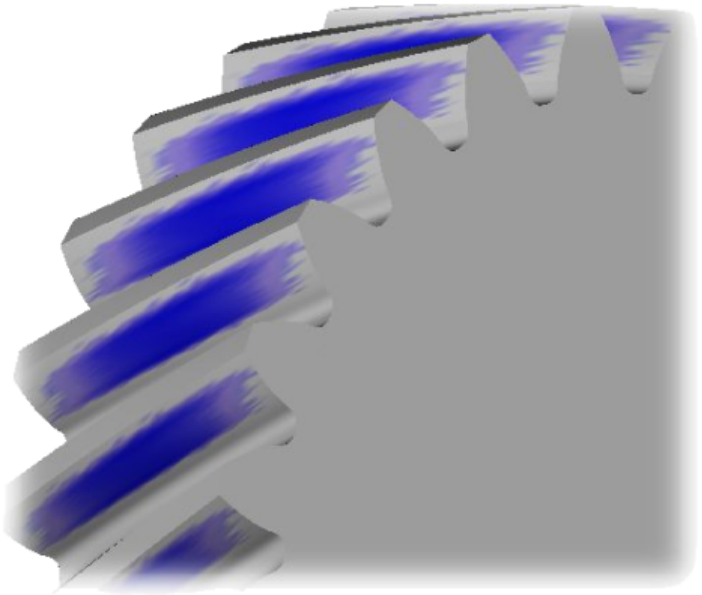


Various formats available to illustrate error on whole tooth or flanks only

* New Feature V5.2

Links To Inspection

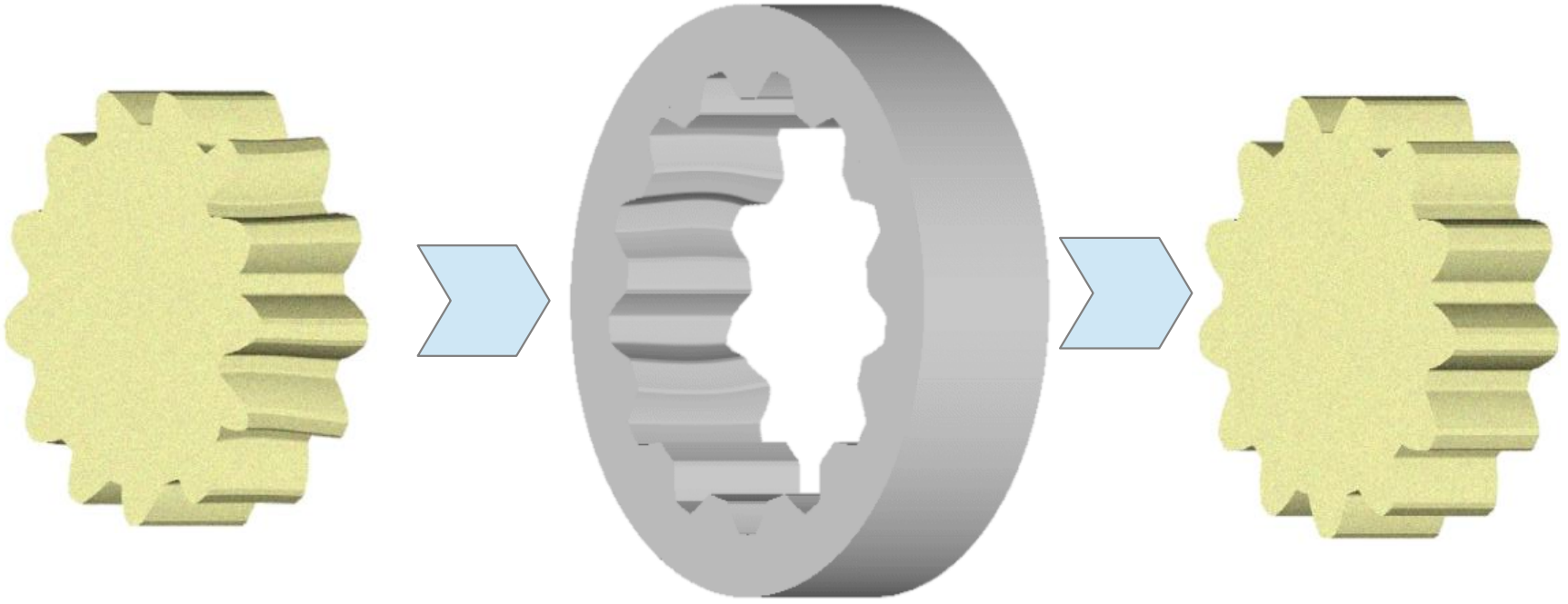




Tooth surface measurement data can be used to simulate no-load bearing/marking pattern and transmission error

Optimal

Tooth surface measured data can be used to make correction to tool/process



Measure error in gear (e.g. due to shrinkage)

Invert errors on tool/machine

Improved quality gear

* New Feature V5.2

Current Development

Manufacturing

- Shaper cutter with protuberance
- Form Grinding
- Advanced surface effects from reduced diameter continuous grinding wheel diameter

Current Development

Bevel Gear Module

- Gleason Face Milling Surface in addition to Spherical Involute
- Face milled Hypoid gears
- G-code output for CNC manufacture

Current Development

Gearbox Designer

- Include ISO 281 bearing calculations in System Model
- Bearing database direct access from System model