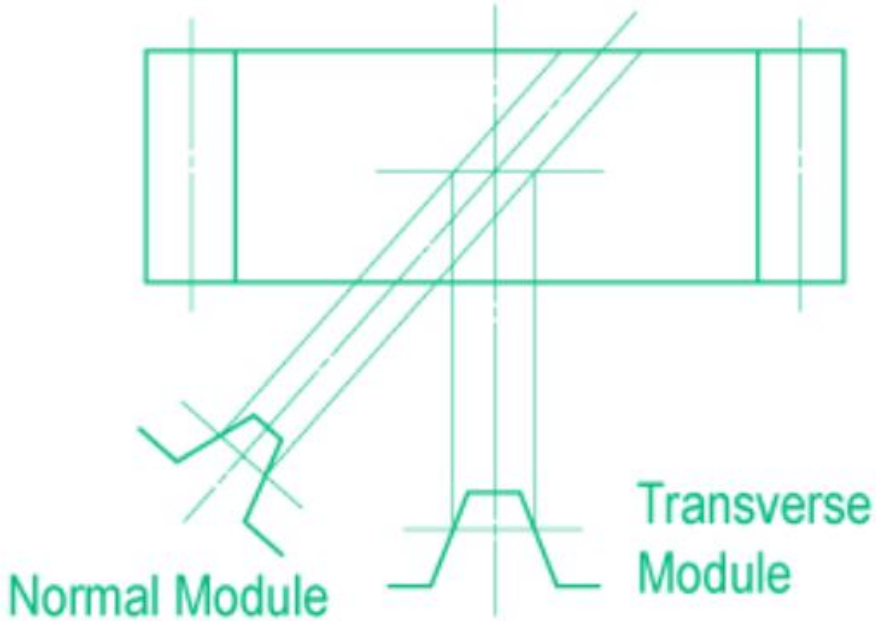
Transverse vs. Normal Module Helical Gear Tooth Profile in CATIA V5



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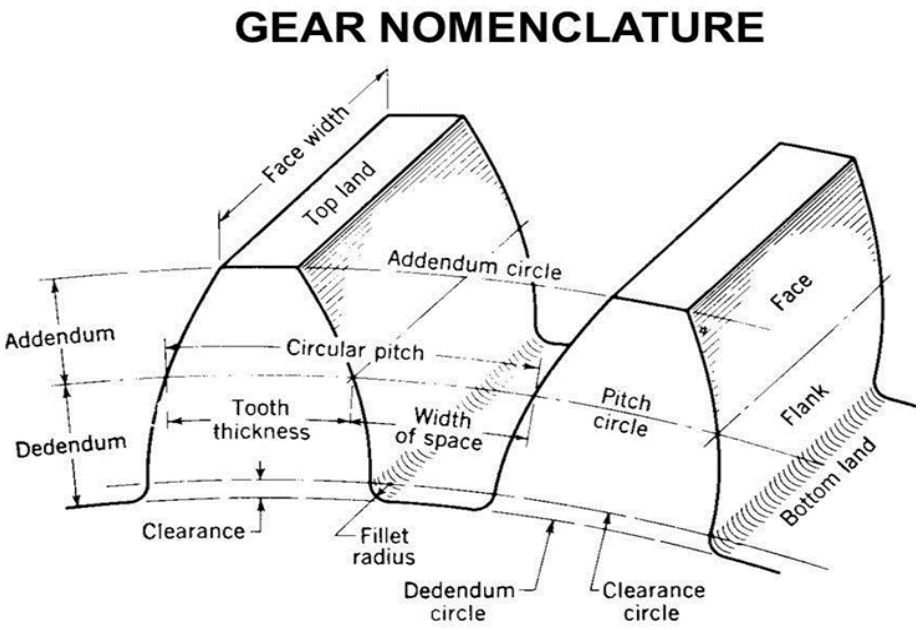
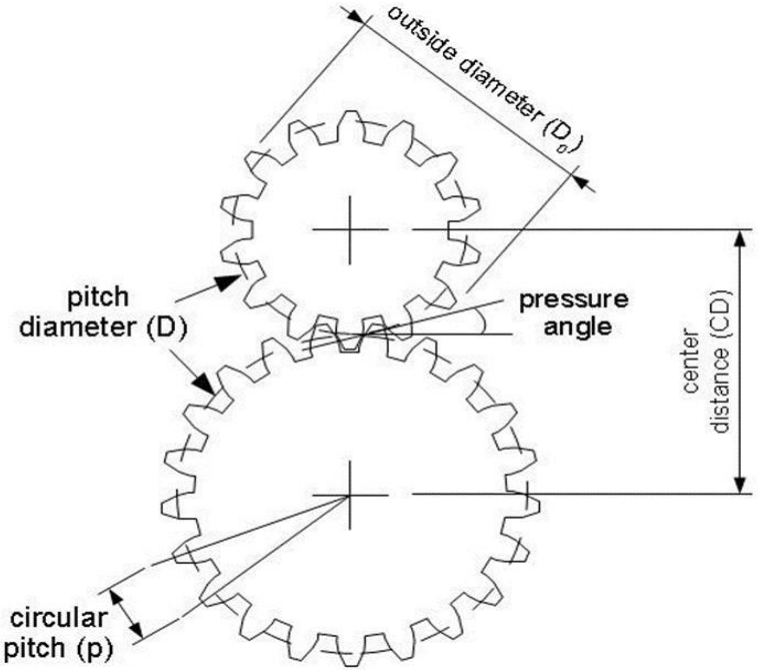
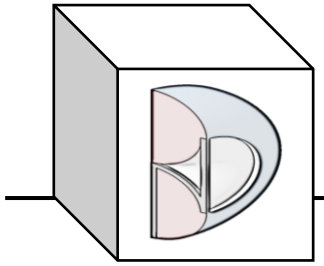
- This is an explanation of the difference between an Approximate and Involute gear tooth profile.
- This document assumes that you know basic gear geometry.







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HELICAL GEARS – GENERAL INFORMATION

- Helical gears are one type of cylindrical gears with slanted tooth trace. Compared to spur gears, they have the larger contact ratio and excel in quietness and less vibration and able to transmit large force. A pair of helical gears has the same helix angle but the helix hand is opposite (right-hand & left-hand).

- When the reference section of the gear is in the normal plane, by tilting the hobbing tool, the spur gear hobbing machine and hobbing tool can be used to produce helical gears. Because of the twist of teeth, their manufacturing has the disadvantage of more difficult production.

- While spur gears do not generate axial thrust forces, because of the twist in the tooth trace, helical gears produce axial thrust force. Therefore, it is desirable to use thrust bearings to absorb this force. However, combining right hand and left hand helical gears making double helical gears will eliminate the thrust force.

- Helical gears are often used in automotive transmissions by replacing spur gears.

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TRANSVERSE MODULE vs. NORMAL MODULE

- Helical gears can be classified into two groups by the reference section of the gears being in the rotating plane (**transverse module**) and normal plane (**normal module**).
- If the reference section is in the rotating plane (*transverse module*), the center distance is identical to spur gears as long as they are the same module and number of teeth. This allows for *easy swapping with spur gears*. However, in this case, they require special hobbing cutters and grinding stones, leading to *higher production cost*.
- On the other hand, if the reference section is in the normal plane (*normal module*), it is possible to *use spur gear hobbing tools and grinding stones*. However, the same module and number of teeth in spur gears no longer match the center distance of helical gears, and *swapping becomes very difficult*. In addition, the center distance is usually not an integer.

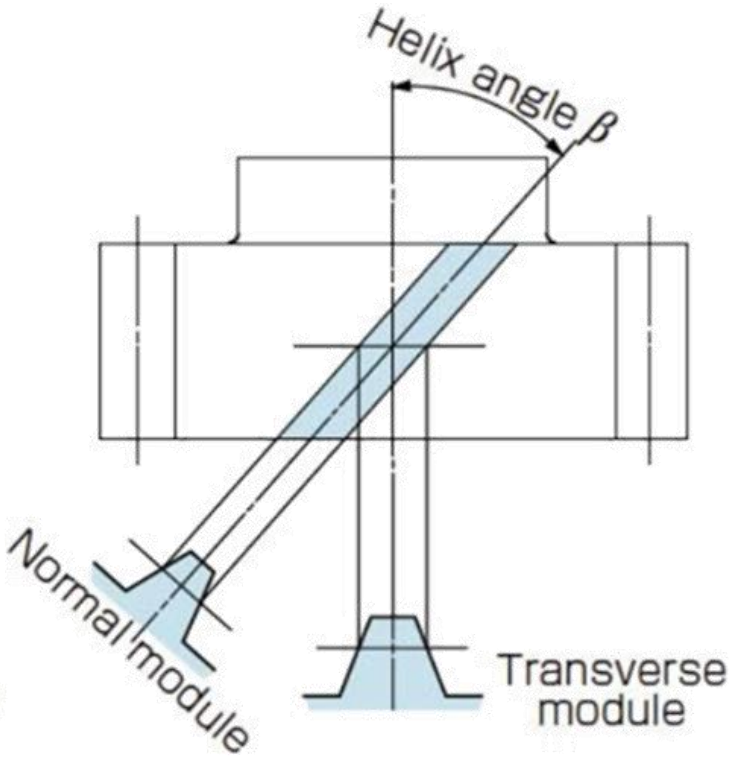
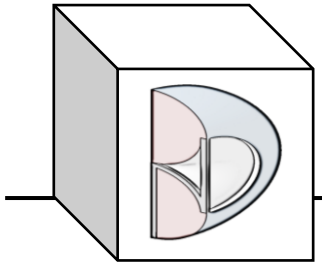


Fig. 2.9 Right-handed Helical Gear



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TRANSVERSE MODULE vs. NORMAL MODULE

Characteristics of Transverse Module and Normal Module		
Style	**Advantages**	**Disadvantages**
Transverse module	Replaces spur gears having the same module, number of teeth, and center distance.	Special gear cutting or grinding machines are required for processing each helix angle.
Normal module	Modifications of spur gears are made by gear cutting or grinding machines, even if they have different helix angles.	Have a center distance value different from that of a spur gear, although they have the same module size and the same number of gear teeth. The center distance value is rarely an integral number.

- Case for Transverse Module helical gears:
  - To reduce noise in an existing application, you want to swap the existing spur gears with helical gears.
  - Transverse module allows you to keep the existing center distances (same pitch diameters).
  - Higher cost to manufacture.

- Case for Normal Module helical gears:
  - In a new design where you have yet to establish center distances (larger pitch diameters).
  - Lower cost to manufacture.

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TRANSVERSE MODULE vs. NORMAL MODULE

- Pitch measured perpendicular to teeth is called normal pitch (p_n).
- In the axial view, the pitch on the reference is called the transverse pitch (p_t).

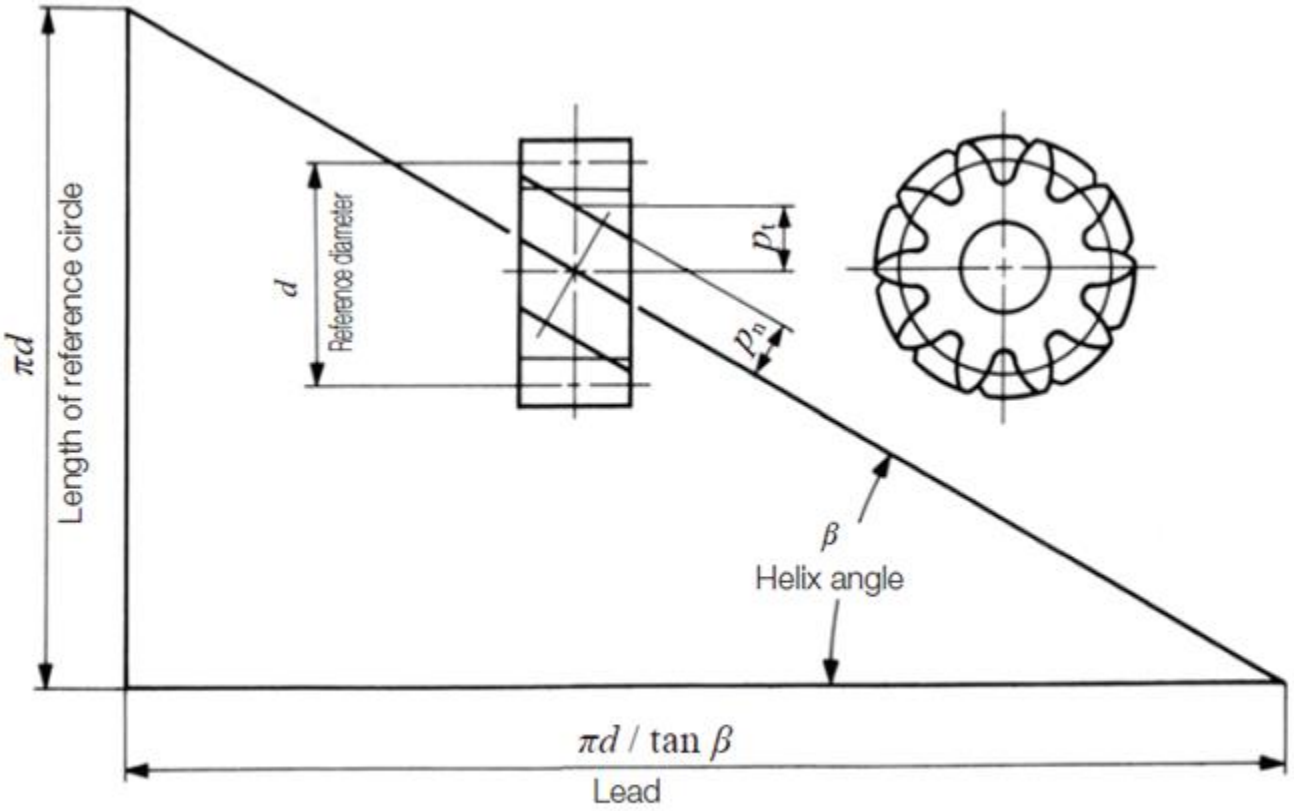

Fig.4.7 Fundamental relationship of a helical gear (Right-hand)

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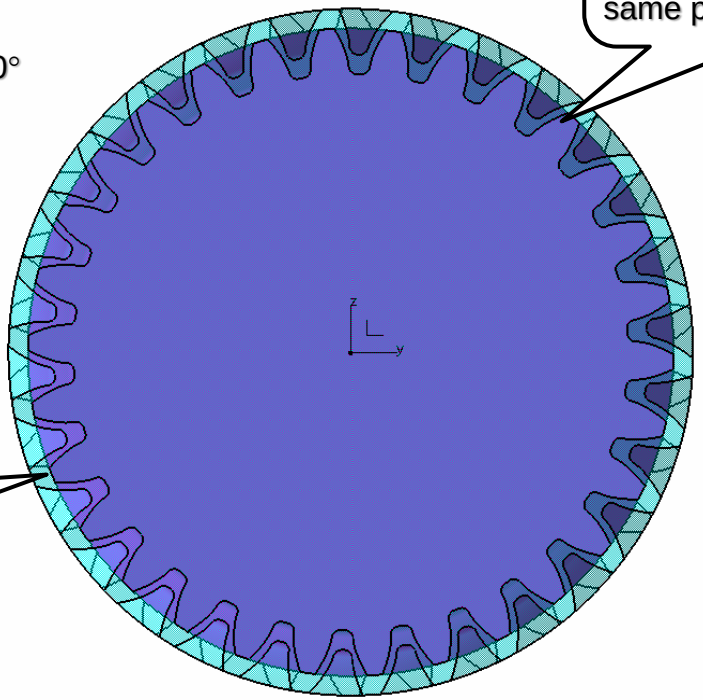
TRANSVERSE MODULE vs. NORMAL MODULE

- Here is an example of two helical gears; both with the same parameters:
  - Module: m = 8mm
  - Number of teeth: z = 30
  - Pressure Angle: Pa = 20°
  - Cylinder helix angle: Ca = 20°



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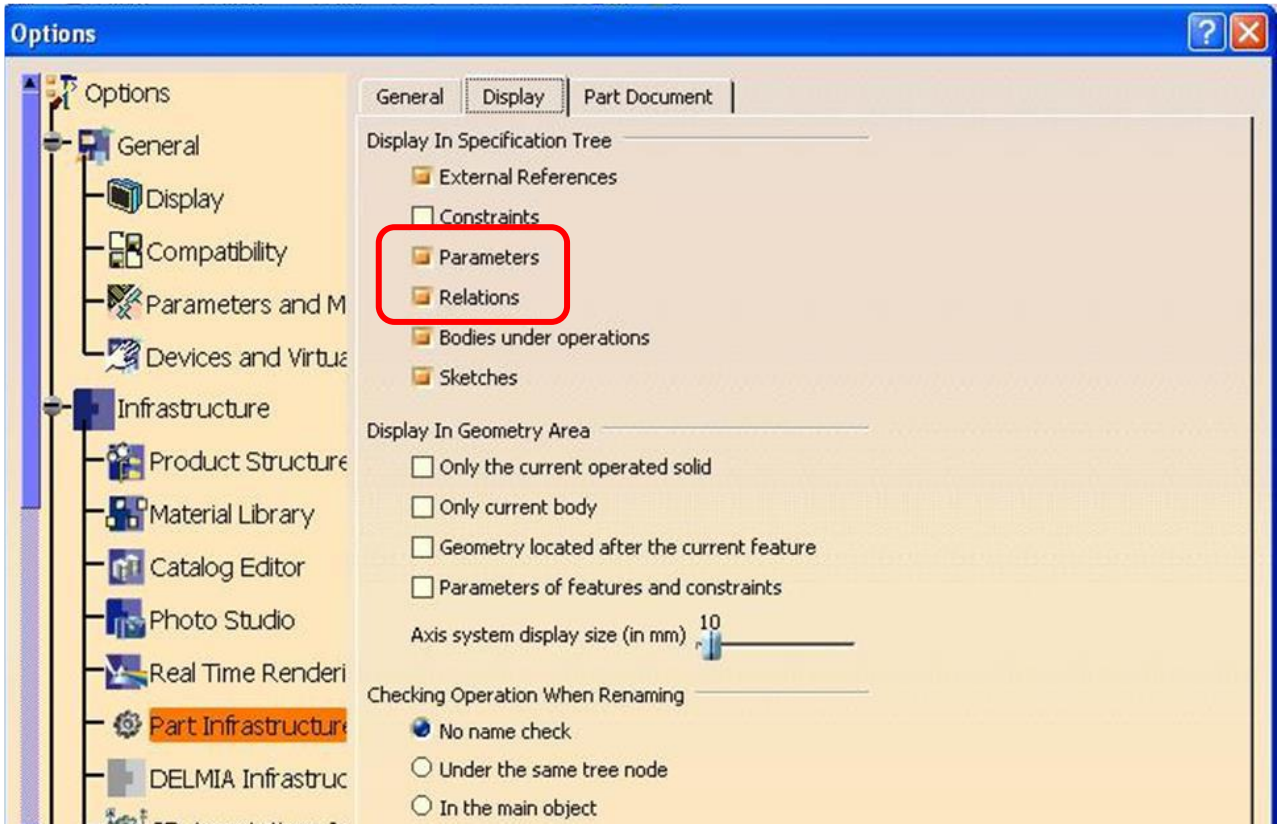
- When you start CATIA, go to TOOLS->OPTIONS->Infrastructure->
- Part Infrastructure and in Display select “Parameters” and “Relations”.



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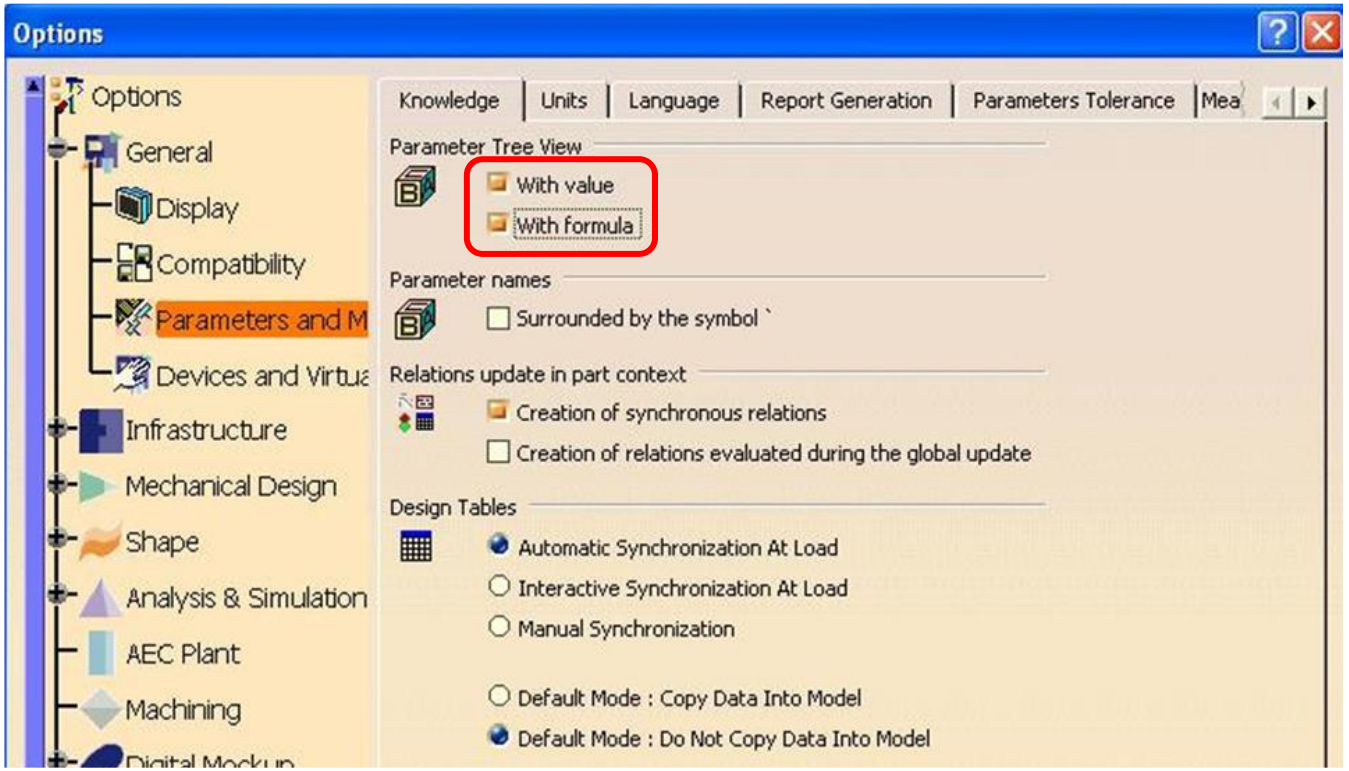
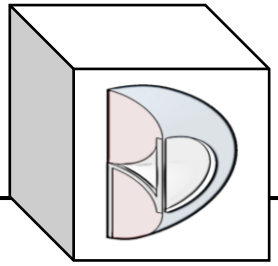
- Then in Options->General in Parameters and Measures select “With Value” and “With Formula” in Parameters Tree View.



Design Differences between Transverse & Normal module helical gears



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- For Transverse Module, there are the following Eleven formulae:
  - Known:
    - Fw // length parameter [**Face width: Fw** =100mm]
    - m // length parameter [**Module: m** = 8mm]
    - z // real parameter [**Number of teeth: z** = 30]
    - Tpa // angle parameter [**Transverse pressure angle: Tpa** = 20 deg]
    - Ca // angle parameter [**Cylinder helix angle: Ca** = 20deg]
  - Resultant:
    - s // angle parameter [**Symmetry angle: s** = 90deg/z]
    - Pd // length parameter [**Pitch diameter: Pd** = z*m]
    - Bd // length parameter [**Base diameter: Bd** = Pd * cos(Tpa*1rad)]
    - Ad // length parameter [**Addendum diameter: Ad** = Pd+(2*m)]
    - Dd // length parameter [**Dedendum diameter: Dd** = Pd-(2.5*m)]
    - tr // length parameter [**tooth radius at dedendum circle: tr** = 0.38*m]

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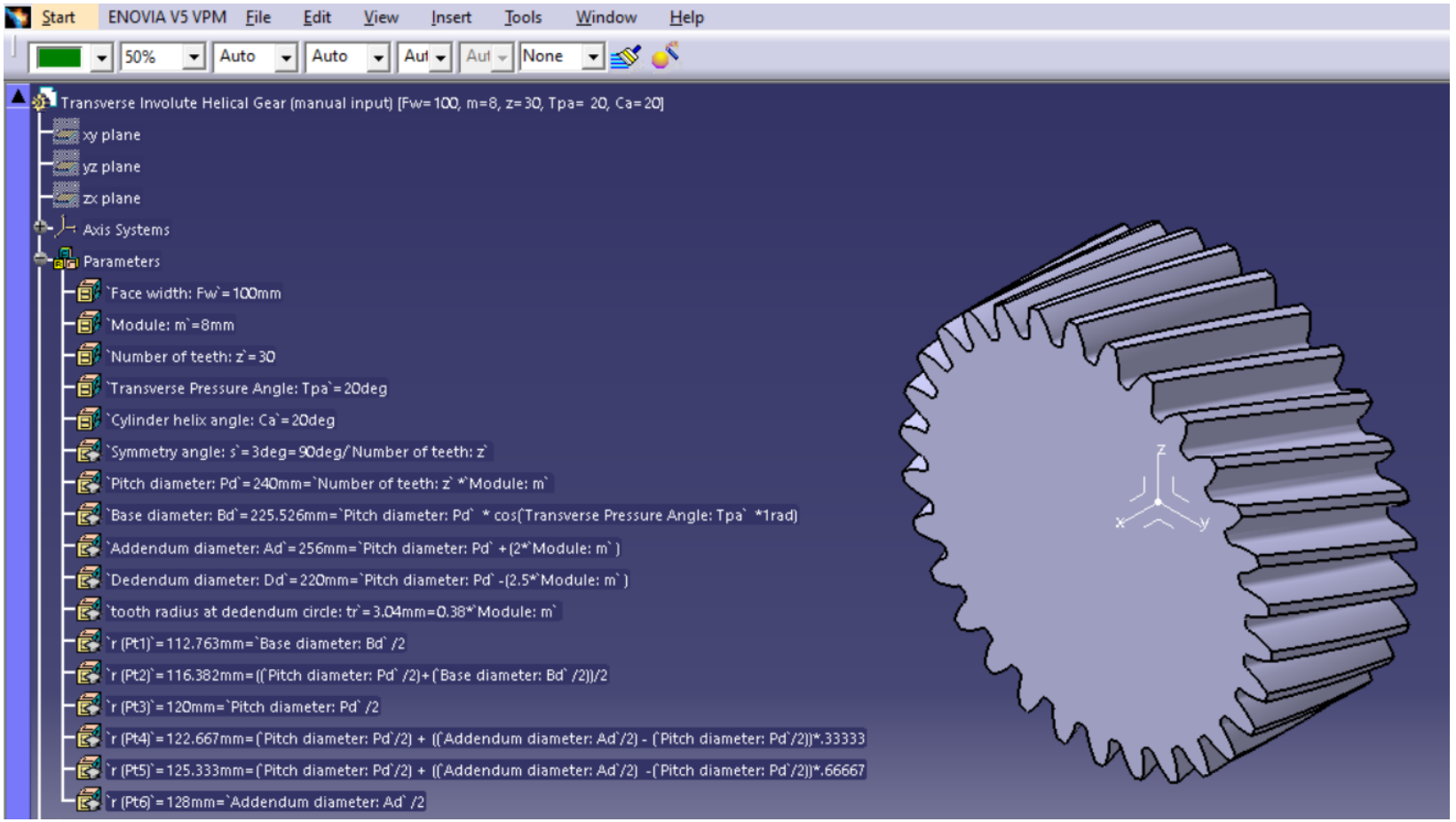
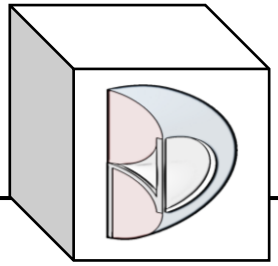
- Transverse module helical gear parameters.





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- For Normal Module, there are the following Twelve formulae:
  - Known:
    - Fw // length parameter [**Face width: Fw** =100mm]
    - m // length parameter [**Module: m** = 8mm]
    - z // real parameter [**Number of teeth: z** = 30]
    - Npa // angle parameter [**Normal Pressure Angle: Npa** = 20 deg]
    - Ca // angle parameter [**Cylinder helix angle: Ca** = 20deg]
  - Resultant:
    - Tpa // angle parameter [**Transverse pressure angle: Tpa** = atan(tan(Npa)/cos(Ca))]
    - s // angle parameter [**Symmetry angle: s** = 90deg/z]
    - Pd // length parameter [**Pitch diameter: Pd** = (z*m)/cos(Ca*1rad)]
    - Bd // length parameter [**Base diameter: Bd** = Pd * cos(Tpa*1rad)]
    - Ad // length parameter [**Addendum diameter: Ad** = Pd+(2*m)]
    - Dd // length parameter [**Dedendum diameter: Dd** = Pd-(2.5*m)]
    - tr // length parameter [**tooth radius at dedendum circle: tr** = 0.38*m]

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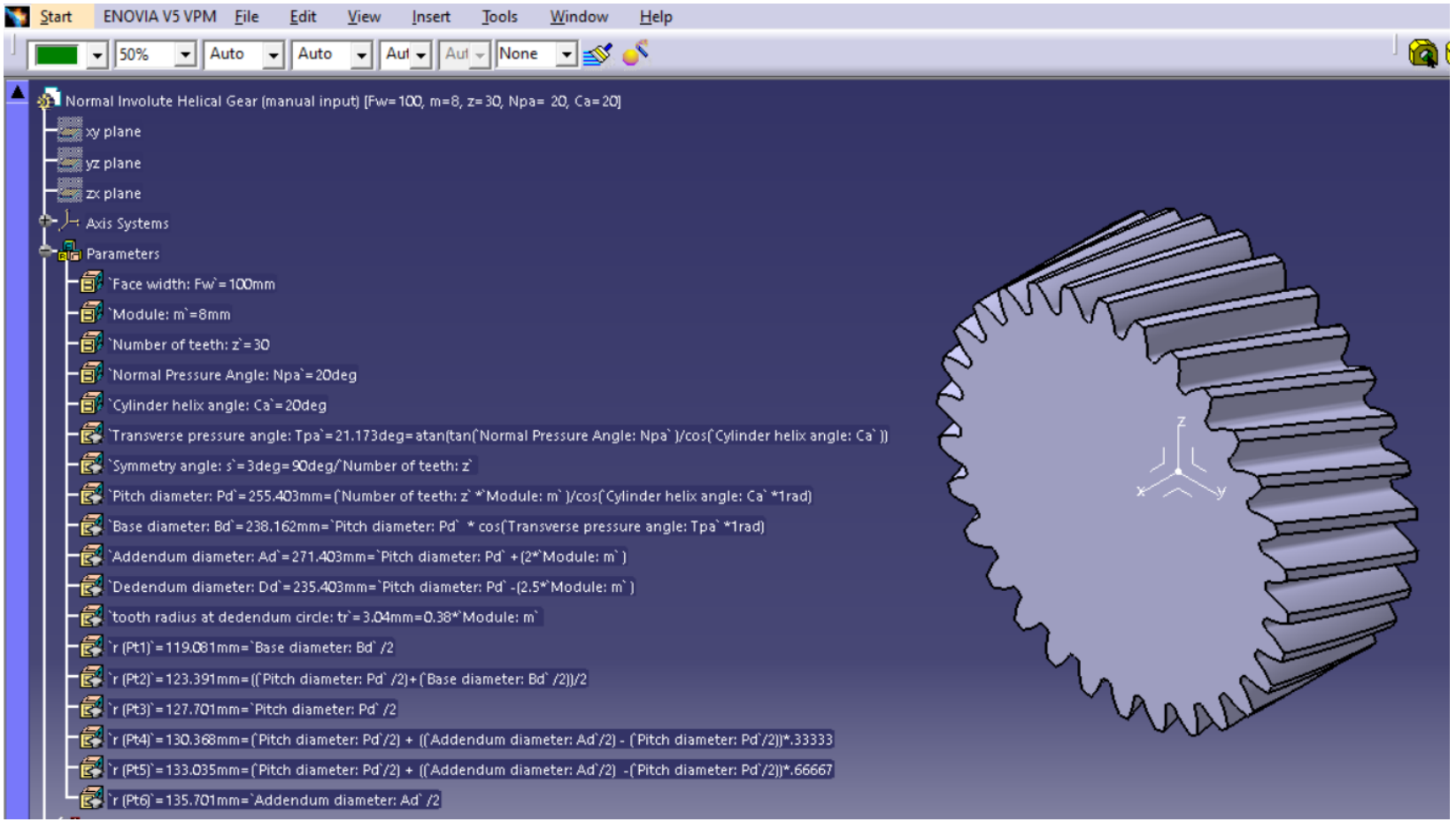
- Normal module helical gear parameters.



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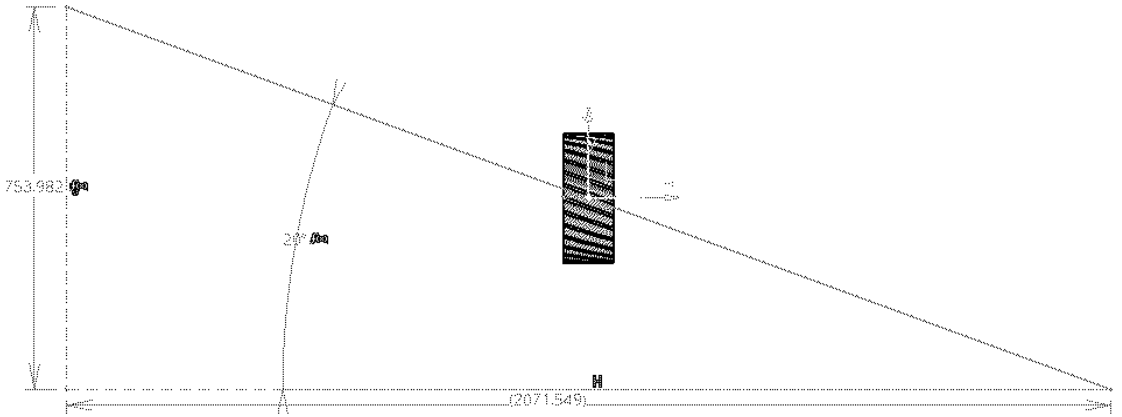
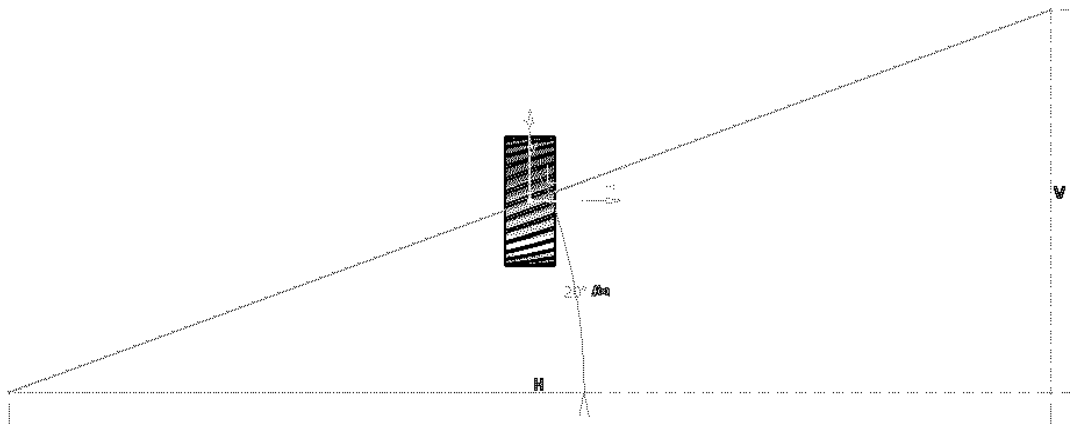
- Both transverse and normal module gears require Right and Left hand sketches.

Right-hand





Left-hand

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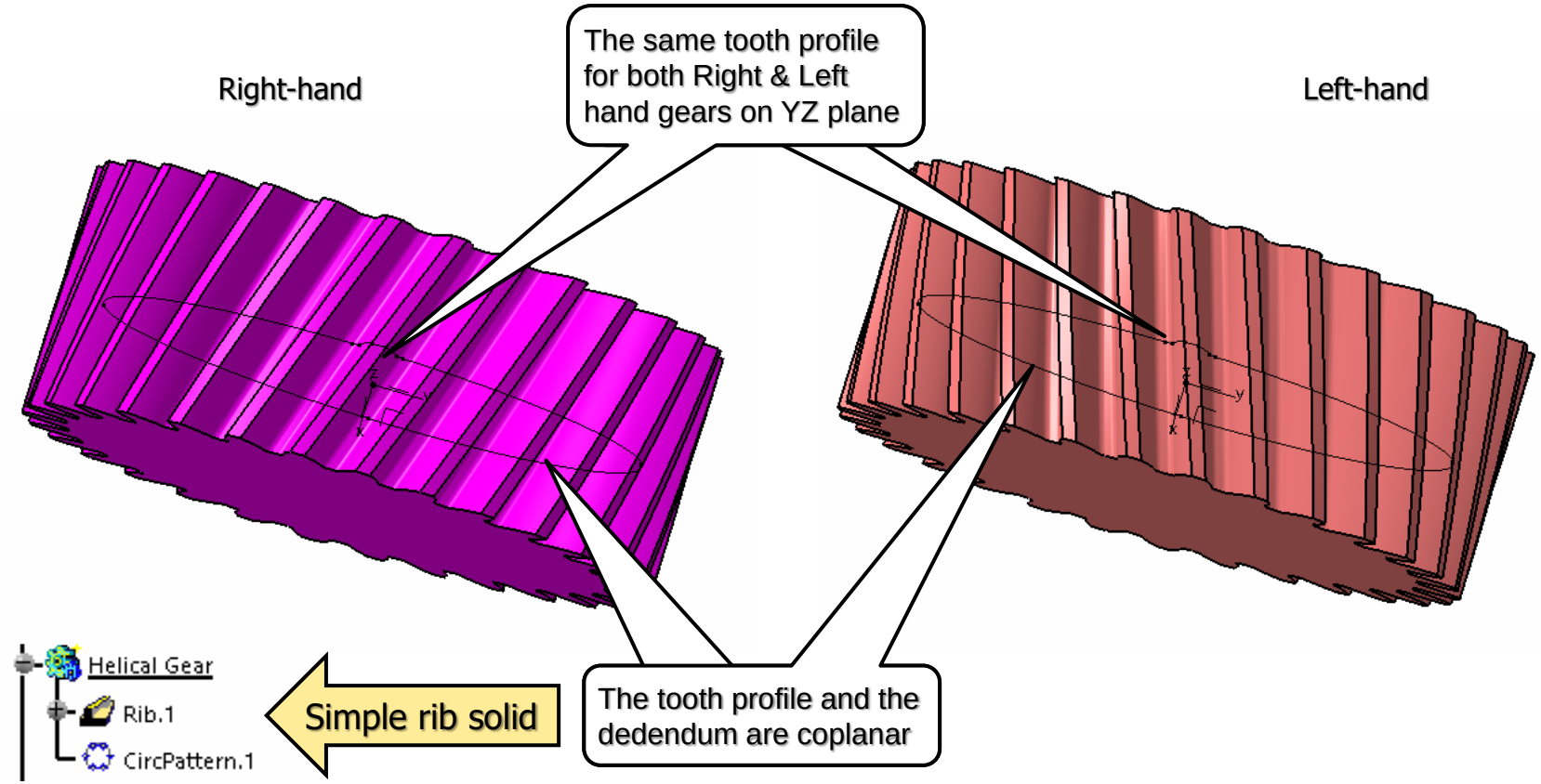
- Transverse module helical gear tooth profile Right and Left hand.



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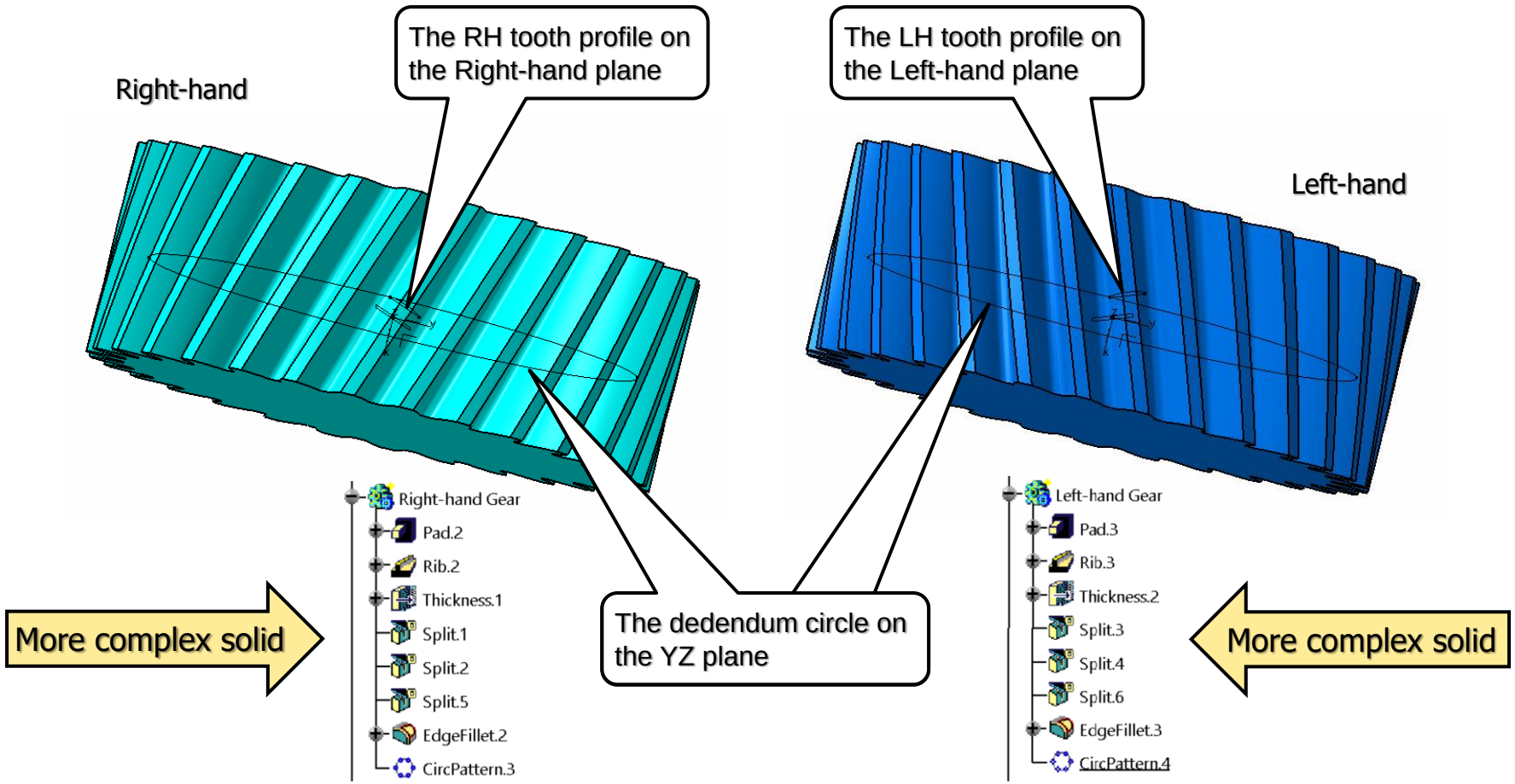
- Normal module helical gear tooth profile Right and Left hand.



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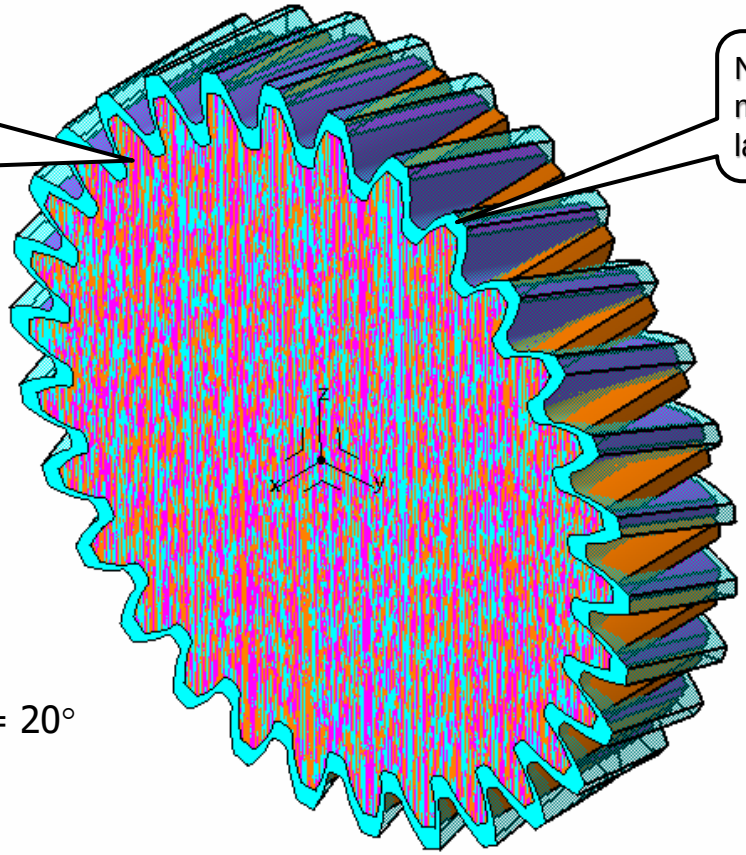
- Section through the YZ plane.

Notice the Spur gear and the Transverse module gear have exactly the same section.



Notice the Normal module gear has a larger section.

Module: m = 8mm
Number of teeth: z = 30
Pressure Angle: Pa = 20°
Cylinder helix angle: Ca = 20°

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- We can now see the differences between Transverse vs. Normal Module Helical Gear Tooth Profile in CATIA V5.
- Understanding these differences is important as we continue with our segment on Involute Helical Gears.
- Next we will look at Designing Transverse Involute Helical Gears in CATIA V5 (manual input).

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- Conclusion:

  This has been an explanation of Transverse vs. Normal Module Helical Gear Tooth Profile in CATIA V5.

  We hope this will help those who need this type of simulation.

  As always, we are open to any discussions this may bring.

  Please ***subscribe*** to our YouTube channel!