Gears App

Modeling a Compound Geartrain
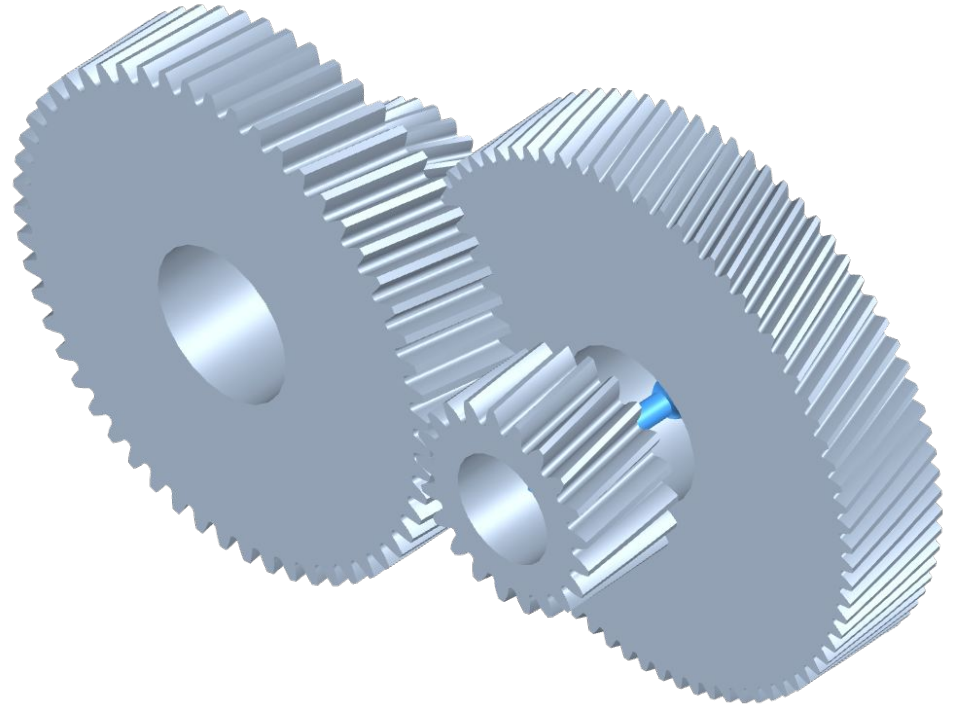
Overview

Learn how to model a 2-stage helical geartrain and simulate its powerflow.

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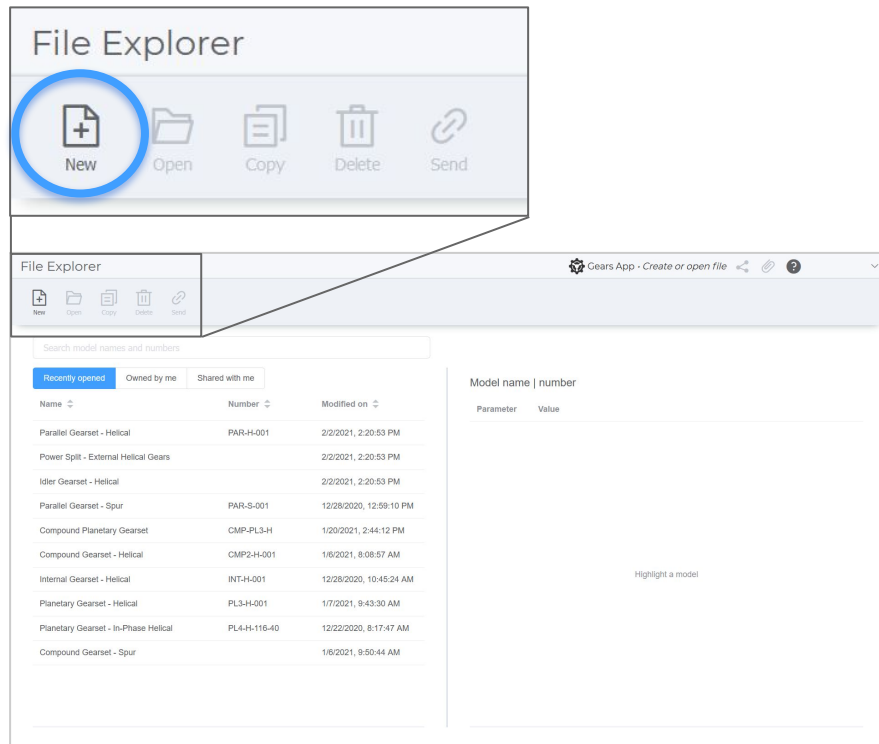
1. Modeling
2. Analyzing
3. Integrations

MODELING

Create Model

1. In a web browser, open [Gears App](#).

2. By default, the **File Explorer** will open to manage any existing models.

3. Create a new model by clicking the **New** ribbon button.

4. Once the new model opens, click the **Model Info** ribbon button to edit the model *name*.

**TIP:** Firefox or Chrome internet browser is recommended.

Create Gears

1. To create a new gear, from the **Model** ribbon tab, click the **External** button.

2. A new **Gear Modeler** tab opens.

3. Create the *Input Pinion* as defined on the next slide.

4. Repeat these steps for the *Input Wheel*, *Output Pinion*, and *Output Wheel*.

> **HINT:** Every gear created is automatically added to the Gear Library, an organization-wide collection of gears.

> **TIP:** To insert a gear previously created, go to the Gear Library, find the gear, and click **Insert**.
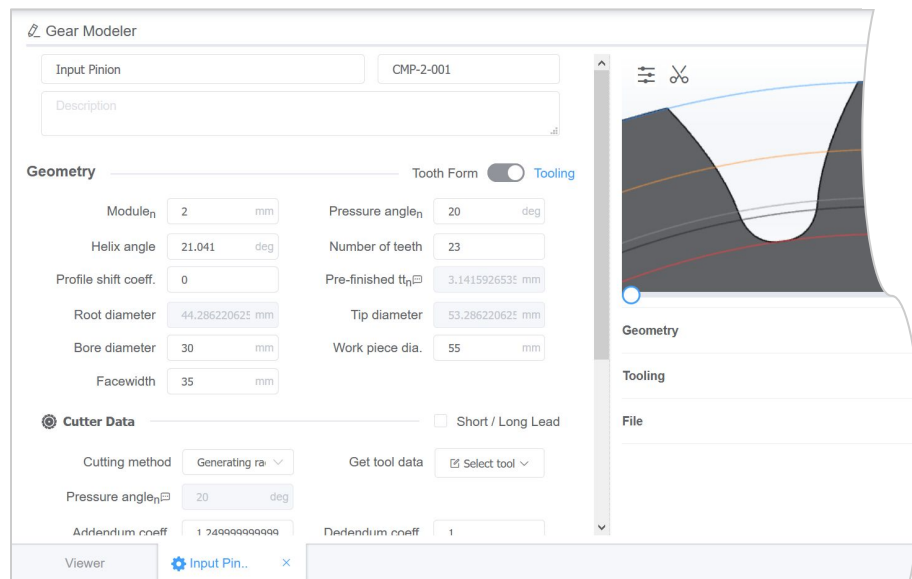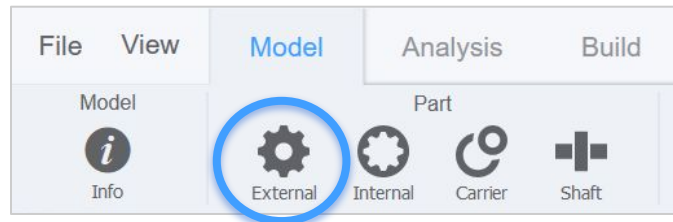
Gear Geometry

Name	Input Pinion	-
Module$_n$	2	mm
Pressure angle$_n$	20	deg
Helix angle	21.041	deg
Number of teeth	23	-
Profile shift coeff.	0.2	-
Bore diameter	30	mm
Work piece dia.	55	mm
Facewidth	35	mm

Cutter Data

Cutting method	Rack generation	-
Pressure angle$_n$	20	deg
Addendum coeff.	1.25	-
Dedendum coeff.	1.00	-
Protuberance size	0	mm
Protuberance angle	0	deg
Tip radius coeff.	0.38	mm

Name	Input Wheel	-
Module$_n$	2	mm
Pressure angle$_n$	20	deg
Helix angle	-21.041	deg
Number of teeth	79	-
Profile shift coeff.	-0.2	-
Bore diameter	50	mm
Work piece dia.	175	mm
Facewidth	35	mm

Cutter Data

Cutting method	Rack generation	-
Pressure angle$_n$	20	deg
Addendum coeff.	1.25	-
Dedendum coeff.	1.00	-
Protuberance size	0	mm
Protuberance angle	0	deg
Tip radius coeff.	0.38	mm

Gear Geometry

Name	Output Pinion	-
Module$_n$	2.87	mm
Pressure angle$_n$	20	deg
Helix angle	-9	deg
Number of teeth	21	-
Profile shift coeff.	0.1	-
Bore diameter	35	mm
Work piece dia.	70	mm
Facewidth	35	mm

Name	Output Wheel	-
Module$_n$	2.87	mm
Pressure angle$_n$	20	deg
Helix angle	9	deg
Number of teeth	55	-
Profile shift coeff.	-0.5	-
Bore diameter	50	mm
Work piece dia.	165	mm
Facewidth	35	mm

Cutter Data

Cutting method	Rack generation	-
Pressure angle$_n$	20	deg
Addendum coeff.	1.25	-
Dedendum coeff.	1.00	-
Protuberance size	0	mm
Protuberance angle	0	deg
Tip radius coeff.	0.38	mm

Cutter Data

Cutting method	Rack generation	-
Pressure angle$_n$	20	deg
Addendum coeff.	1.25	-
Dedendum coeff.	1.00	-
Protuberance size	0	mm
Protuberance angle	0	deg
Tip radius coeff.	0.38	mm

Create Shaft

1. To create a new shaft, from the **Model** ribbon tab, click the **Shaft** button.

2. A new shaft is added to the model, as shown in **Feature Tree** and **3D Viewer**.

3. For clarity, you may rename the shaft by right-clicking it in the **Feature Tree** and select **Rename**.

> **HINT:** Shafts are conceptual with no geometry to edit. A shaft origin is represented by a sphere in 3D Viewer.
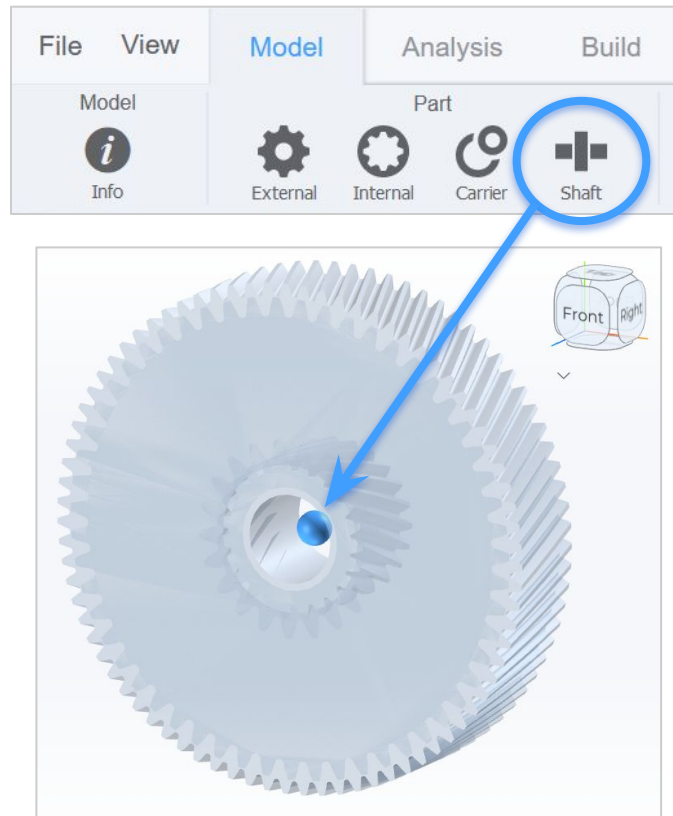
Create Subassembly

1. To create a subassembly, we will add gears to the shaft reference frame.

2. In the **Feature Tree**, drag-and-drop the *Input Wheel* onto the shaft.

3. Repeat above for the *Output Pinion*.

4. Right-click the shaft in **Feature Tree** and select **Position**.

5. Set relative x-coordinate as 109.5mm from *Input Pinion* and click **Apply**.
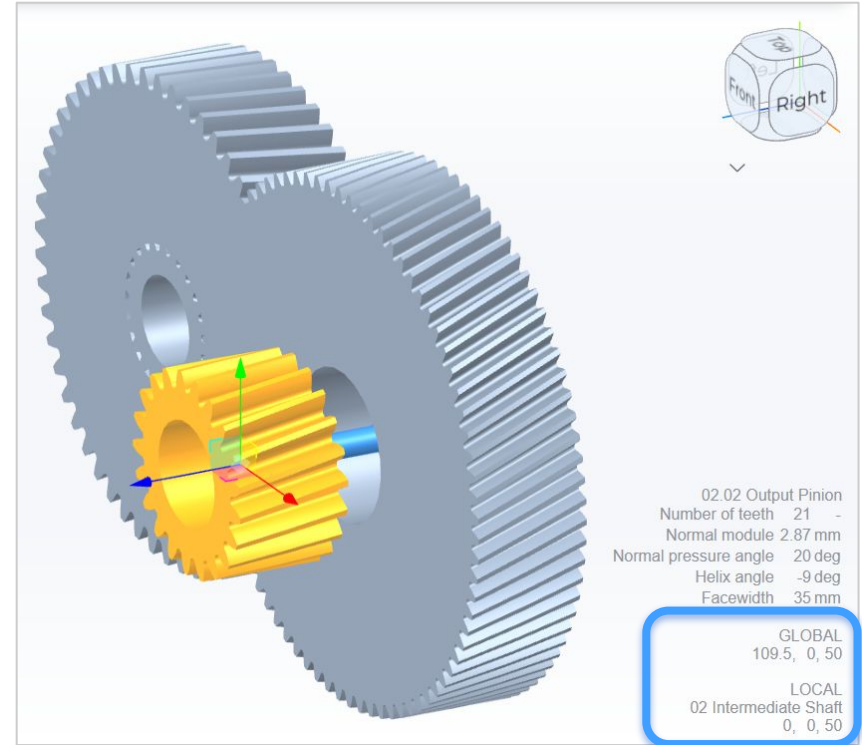
6. Exit the dialog.

HINT: By default, gears are positioned at the shaft origin.
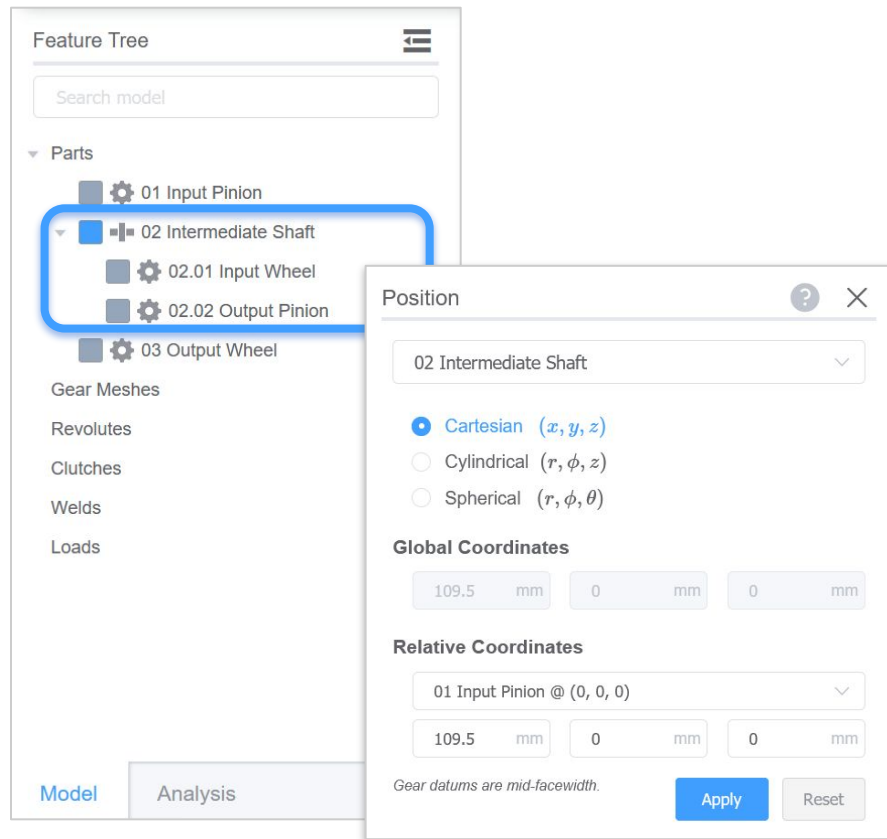
Position Gears

1. Right-click the *Output Pinion* in **3D Viewer**, and select **Move**.

2. A triad appears at the gear origin.

3. Drag its z-axis (blue) to 50mm per the display in lower right.

4. Press Esc to exit the move tool.

> **HINT:** The *Move* tool uses increments of 0.5mm to interactively position a part in the *3D Viewer*.

02.02 Output Pinion
Number of teeth   21   -
Normal module 2.87 mm
Normal pressure angle   20 deg
Helix angle   -9 deg
Facewidth   35 mm

GLOBAL
109.5, 0, 50

LOCAL
02 Intermediate Shaft
0, 0, 50

Position Gears

1. Click the *Output Wheel* in **3D Viewer**, and notice the display in lower right.

2. Select the GLOBAL z-coordinate field and set its value to 50mm.

3. Press Enter to accept the value and observe the updated 3D view.
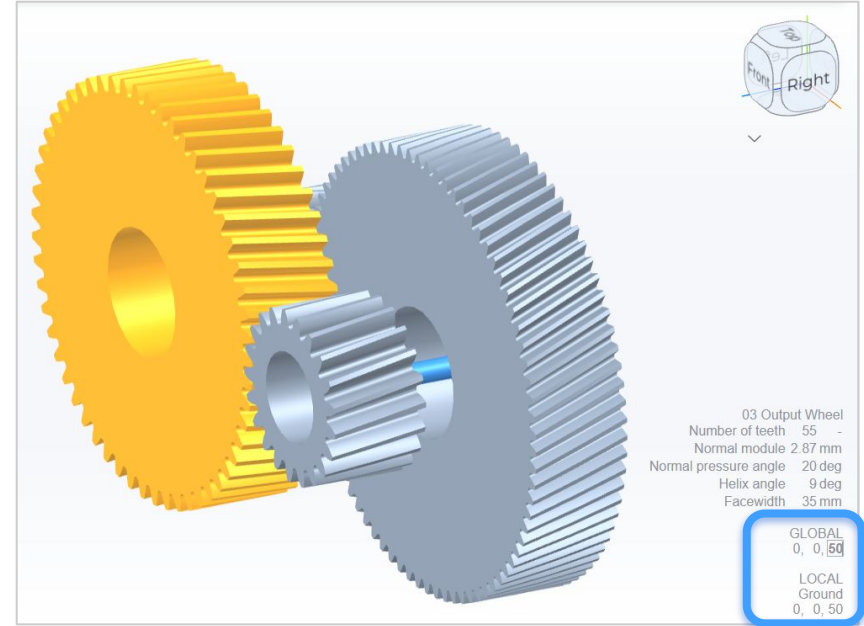
TIP: Ctrl + click two gears in 3D Viewer to see valuable information in the bottom right, including if the gears are "meshable" and the center distance for no backlash.

Constrain Gears

1. From the **Model** ribbon tab, click the **Constrain** button to open dialog.

2. Click the **Mesh Search** button to automatically identify gears to mesh.

3. Confirm the selected gears to mesh, then click **Add Meshes**.

4. Exit the dialog.

> **TIP:** Ctrl + click two gears in 3D Viewer, then right-click to see options to constrain them.

> **HINT:** Every component is considered to be rotationally unconstrained unless specified otherwise.
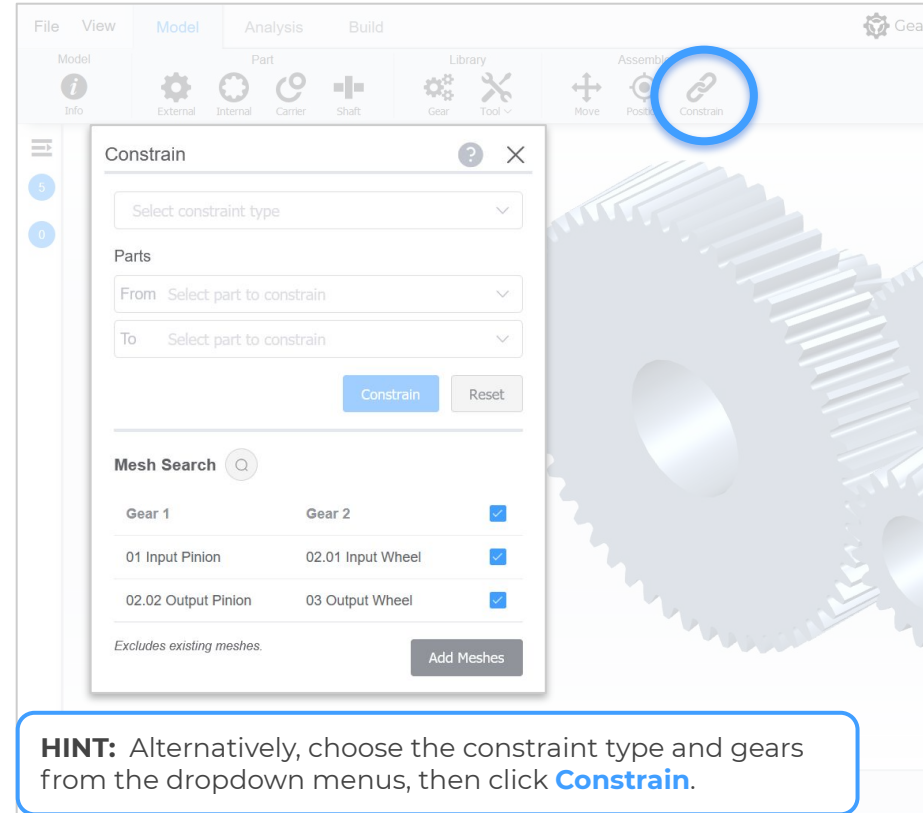

> **HINT:** Alternatively, choose the constraint type and gears from the dropdown menus, then click **Constrain**.

Constrain Gears

1. Since each gear is rotationally free, we need to add *Weld* constraints between the shaft and its gears.

2. From the **3D Viewer**, Ctrl + click the *Shaft* and *Input Wheel*, then right-click for constraint options, and select **Weld**.

3. Repeat for *Shaft* and *Output Pinion*.
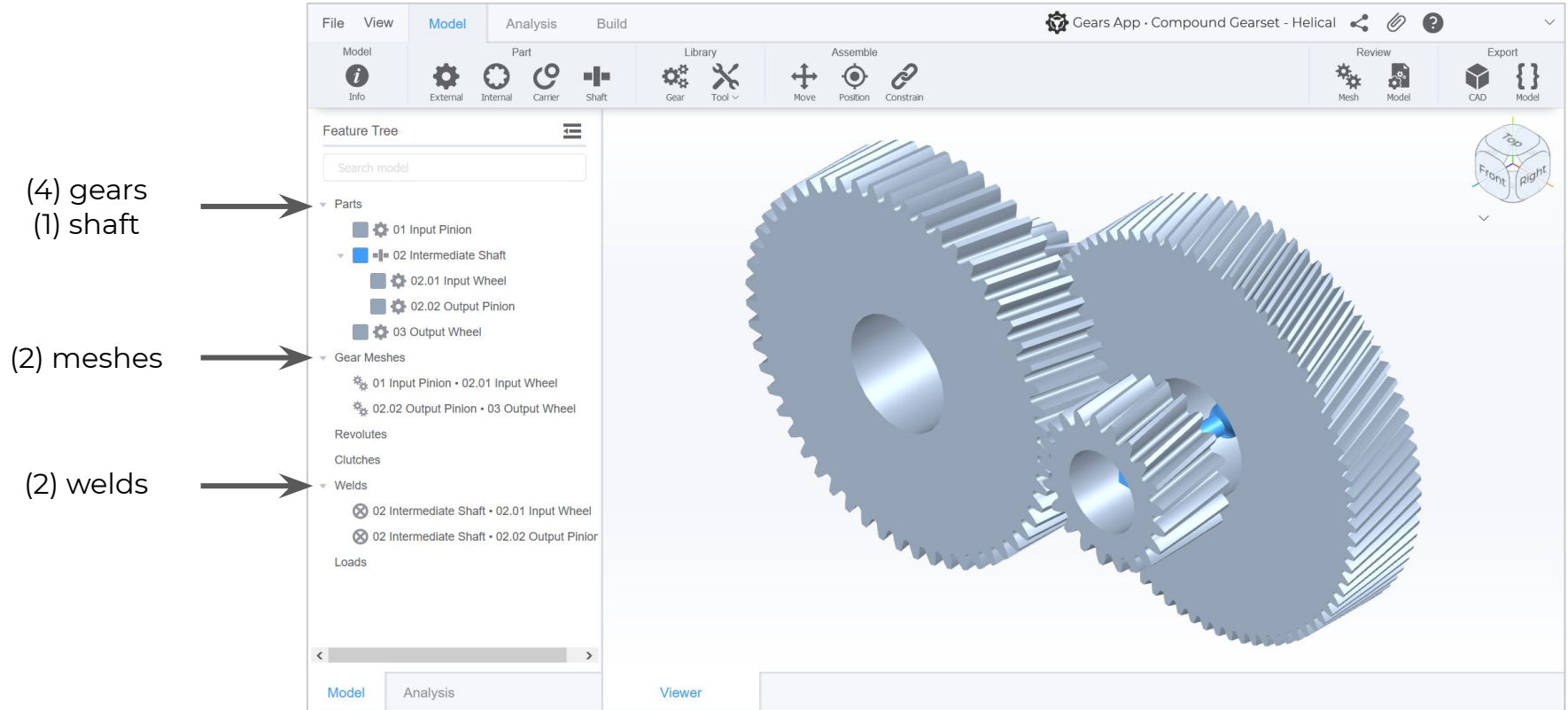
4. No other constraints are required.

HINT: Alternatively, use the Constrain dialog to choose the constraint type and parts from the dropdown menus.
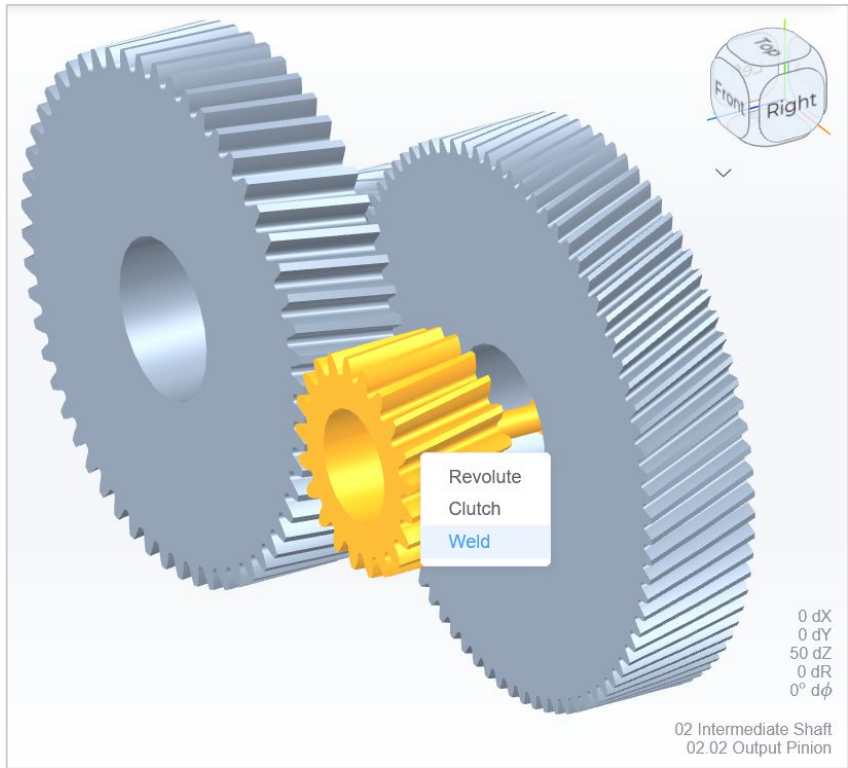
**TIP:** To deselect any selected parts, press Esc.

Review Model

Your model should look like the one below, possibly with different part names.

(4) gears
(1) shaft

(2) meshes

(2) welds

Review Mesh

1. From the **Model** ribbon tab, click the **Mesh** button to open tab.

2. Select a *gear mesh* from the dropdown to examine it.

3. Select a *plot type* from dropdown.

4. Interactively review gear mesh and plot by **scrolling with mouse** in the gear or plot areas.

5. Notice the gear mesh parameters available in the lower right quadrant.

> **TIP:** Right click a gear mesh from the Feature Tree and select Review Mesh to achieve the first two steps above.
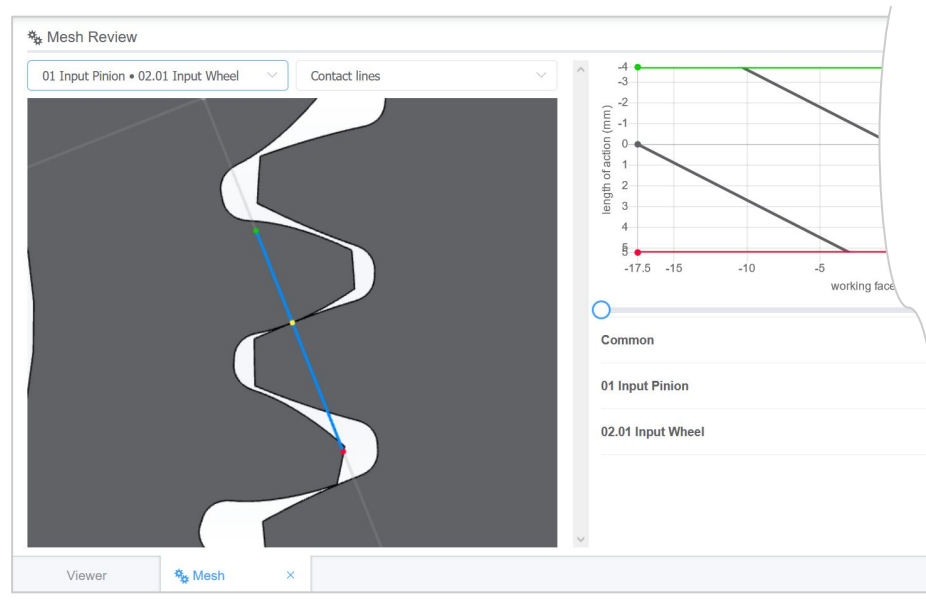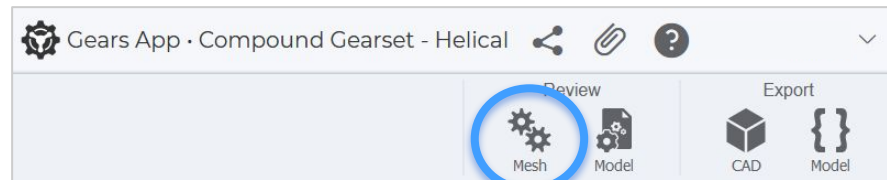
Reporting

1. From the **Model** ribbon tab, click the **Model** button to open a report tab.

2. Modeling report is auto-generated.

3. Review data for each part, including assembly, constraints, and geometry.

4. Review data for each gear mesh, including common and individual gear parameters.

> **HINT:** Alternatively, click the File dropdown and choose Model Report to auto-generate the report.
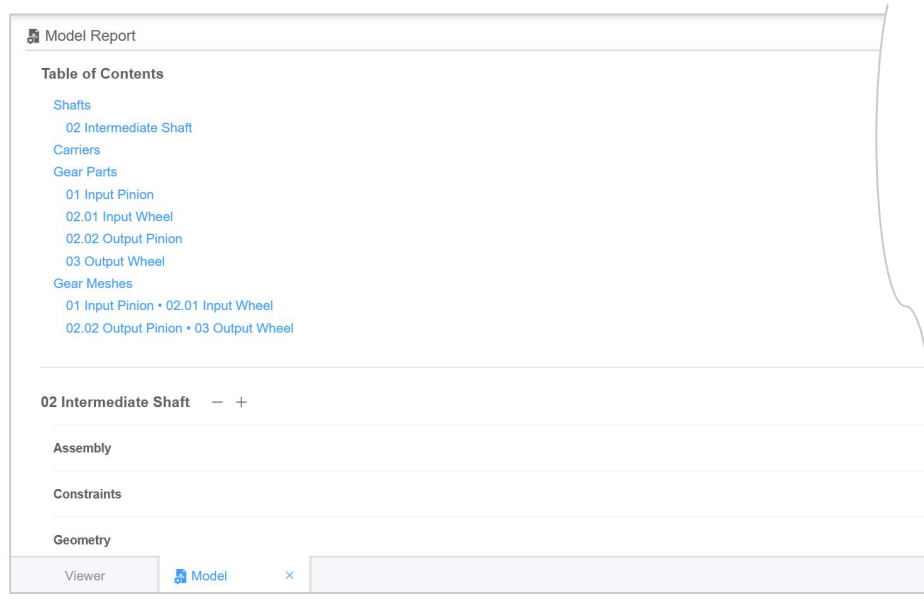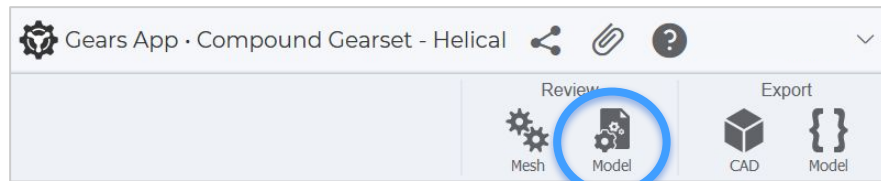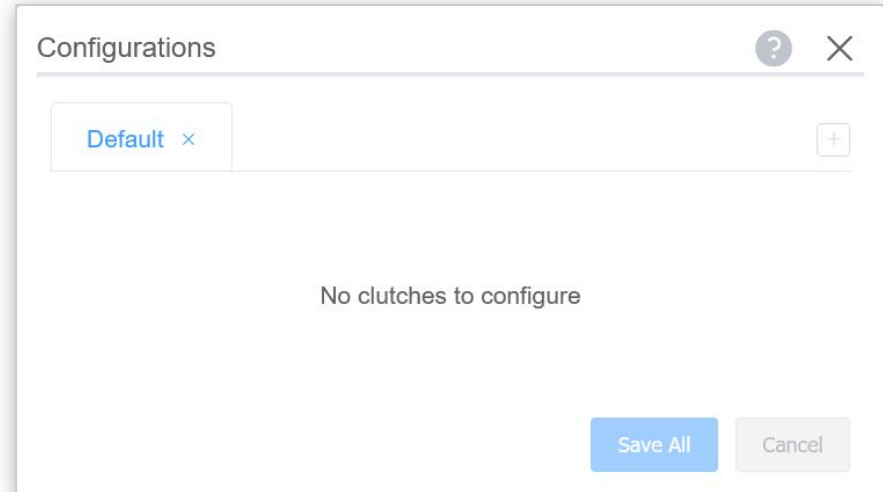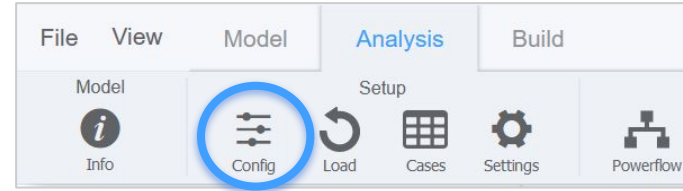
ANALYZING

Configurations

1. From the **Analysis** ribbon tab, click the **Config** button to open dialog.

2. A **Default** configuration is added automatically.

3. Our model does not have clutches, so nothing else needs to be done.

HINT: To define a load case, as shown later, a configuration must be defined even if no clutches exist.

System Loads

1. To torsionally constrain the model, we must define the system loads.

2. From the **Analysis** ribbon, click the **Load** button.

3. Per the notification message, select a part in the **3D Viewer**.

4. Click the *Input Pinion* to add a load.

5. Repeat for the *Output Wheel*. Notice the loads shown in **Feature Tree**.
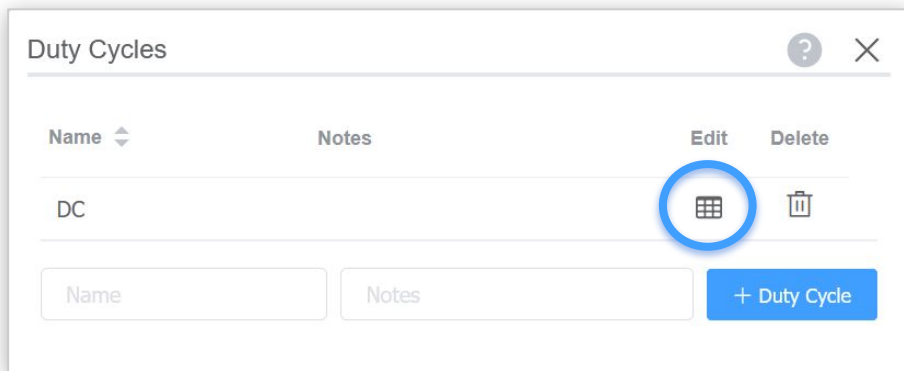
> **HINT:** To cancel the creation of a load, press Esc.

> **HINT:** Both the *input* and *output* loads must be defined to torsionally constrain the system with balanced powerflow.
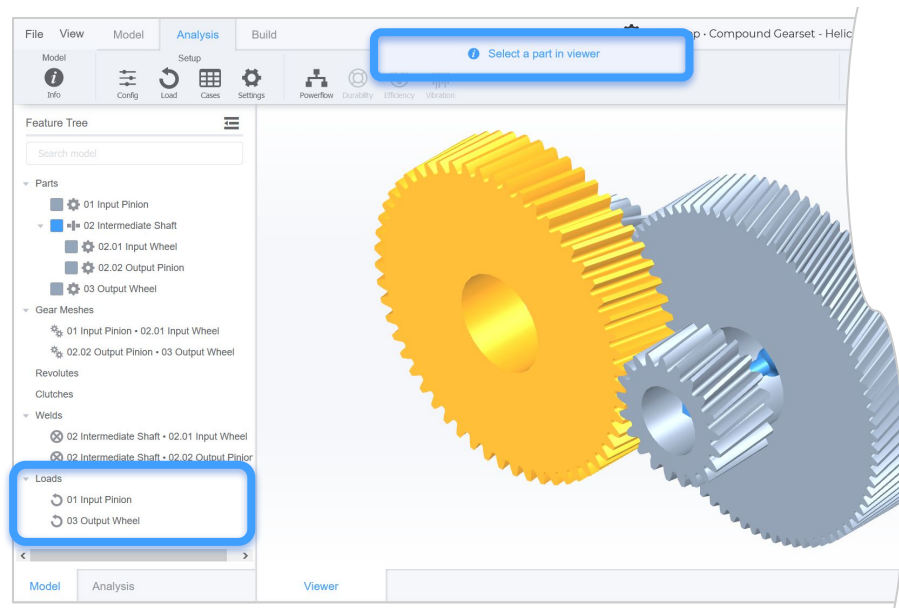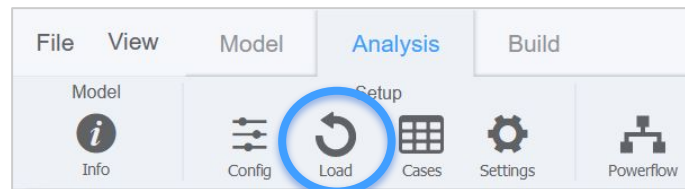
Duty Cycle

1. From the **Analysis** ribbon tab, click the **Cases** button to open dialog.

2. Specify a duty cycle with name *DC* and click **+ Duty Cycle** button.

3. To add load cases to the duty cycle, click its **Edit** ⊞ button.
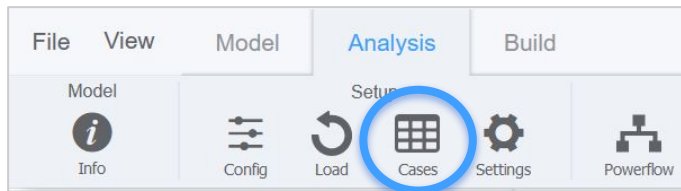
HINT: A *duty cycle* is a collection of *load cases*, i.e. discrete loads, preferably binned from real-world time series data.

Load Cases

1. Click the **Add Case** button to add a load case. Add two cases.

2. Edit the table of cases to define the load conditions for the model.

3. On completion, exit the dialog.

Name	Config	Hrs	Input Pinion			Output Wheel		
			rpm	Nm	kW	rpm	Nm	kW
LC1	Default	10	5000	5				
LC2	Default	1	-1000	-5				

> **TIP:** To edit the load cases of a duty cycle, double click the duty cycle in the Feature Tree on Analysis tab.

Load Cases | DC

|	Name ⇕	Config ⇕	Hours	01 Input	
				Speed (rpm)	Torque
☐	LC1	Default ⌄	10	5000	5
☐	LC2	Default ⌄	1	-1000	-5

Delete

Run Powerflows

1. From the **Analysis** ribbon tab, click the **Powerflow** button to open dialog.

2. Click the **Run** ▶ button next to the duty cycle to simulate.

3. If the model has been properly defined, it will successfully solve.

4. If it failed to solve, review the prior steps in this tutorial.
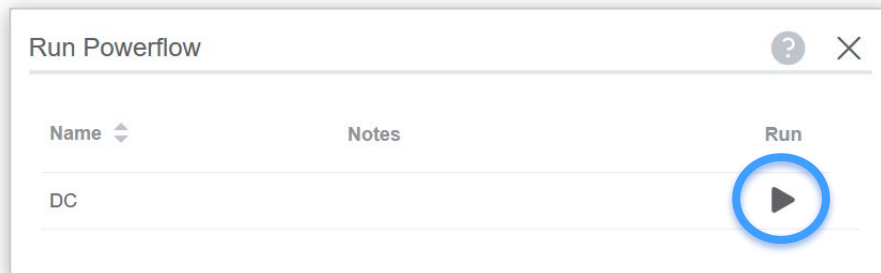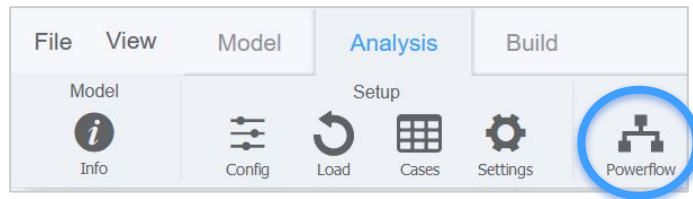
TIP: Run a duty cycle or load case from the Feature Tree by right clicking it in the *Powerflows* tree and clicking **Run**.

HINT: If the model is modified, outdated results will automatically update when accessing results.
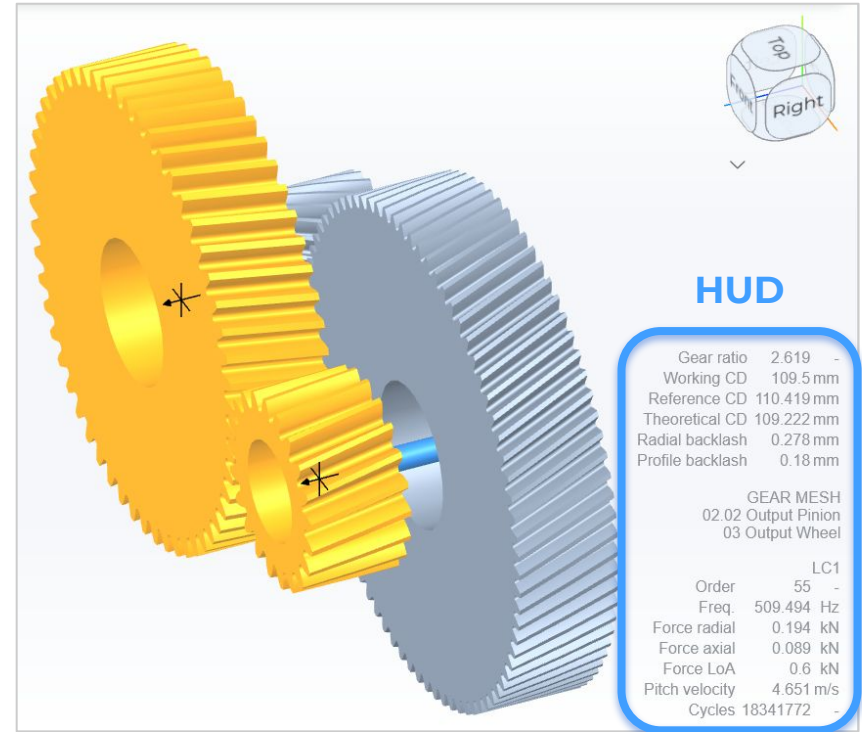
HINT: Notice the load cases in the Feature Tree show ✕ when unsolved and ⛁ when solved.

Results & Animation

1. To interactively review powerflow results, a load case must be *set*.

2. From the **Analysis** tab of **Feature Tree**, double click a load case in the *Powerflows* tree to *set* it.

3. Select a gear or gear mesh in **Feature Tree** to display certain results in HUD.

4. From the **Analysis** ribbon tab, click the **Animate** button to start animation.

TIP: Animate a load case from the Feature Tree by right clicking it in the *Powerflows* tree and clicking **Animate**.

TIP: With a load case set, view results for a gear by selecting it in the 3D Viewer.

HUD

Gear ratio	2.619	-
Working CD	109.5	mm
Reference CD	110.419	mm
Theoretical CD	109.222	mm
Radial backlash	0.278	mm
Profile backlash	0.18	mm

GEAR MESH
02.02 Output Pinion
03 Output Wheel

|		
	LC1	-
Order	55	-
Freq.	509.494	Hz
Force radial	0.194	kN
Force axial	0.089	kN
Force LoA	0.6	kN
Pitch velocity	4.651	m/s
Cycles	18341772	

HINT: Gear or gear mesh *order*, as shown in HUD, is based on the reference part in Settings, from the Analysis ribbon.

Reporting

1. From the **Analysis** ribbon tab, click the **Analysis** button to open a report tab.

2. Analysis report is auto-generated.

3. Review load case results for the gears and gear meshes, including angular velocities, torques, forces, and frequencies.

> **HINT:** Alternatively, click the File dropdown and choose Analysis Report to auto-generate the report.
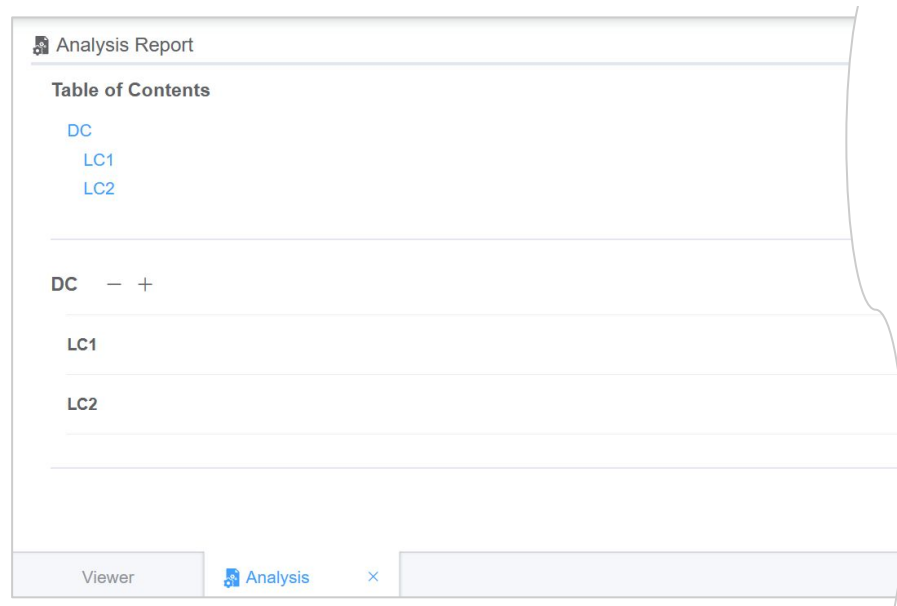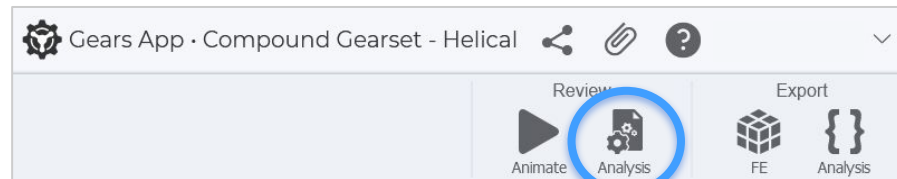
INTEGRATIONS

EXPORTS, CONSULTING, & MANUFACTURING

Export Data

Need to evaluate your gears in other software?

Learn how to export data to work with CAD, FE, and other software. Leverage the fully web-based ecosystem of the Gears App to streamline your gear design development.

See tutorial: *Model Data and Exports*

Design Review

Need an expert to review your design?

Learn how to request services to conduct a design review with independent consultants from our global network at Drivetrain Hub.

See tutorial: *Consulting and Manufacturing*

Manufacturing

Need to build your gear system?

Learn how to create mockups with our additive manufacturing service, and efficiently communicate with qualified global manufacturers to prototype and mass produce your gears.

See tutorial: *Consulting and Manufacturing*

What Next?

➔   Sign up and start using [Gears App](#).

➔   Keep learning with the [Tutorial Series](#).