

Gear Generator

Prepared by Cristina Şipoş, 10th September 2023

Introduction

This report describes the relationship between certain fields in the Gear Generator application, such as the Number of teeth, Pitch diameter, Diametral pitch, and Pressure Angle. The report also lists the application details and the discoveries made during the testing process.

This report was made in response to a testing learning challenge given to me by James Bach.

Product Description

Gear Generator is a tool for creating involute spur gears. The Gear Generator may compose full gear layouts with connected gears to design multiple gears system with control of the input/output ratio and rotation speed. Gears can be animated at various speeds to demonstrate working mechanisms. Gear Generator can be accessed [here](#).

Product Observations

When opening the application, the Gear Generator by default shows four gears, starting the numbering with #0 as the first gear. The application displays the gear properties such as:

- Number of teeth (N)
- Pitch diameter (D)
- Diametral pitch (P)
- Pressure Angle (PA)

Each displayed gear, besides gear #0, has a parent gear.

Multiple gears can be added; however, the added gears can be removed one by one or cleared from the Clear button.

By default, all gears are external gears, however, they also can be selected as internal gears.

Gears can be animated from the Start/Stop, Freeze, Reset, and Speed buttons. Gears also can be displayed on different scales.

Analysis of Fields

I was not given any specifications, nor could I find any documentation. I had no access to the developer. Therefore, I had to rely on open exploration to discover the limits of the fields.

I performed extreme input exploration on these fields and noticed that the application rejected inputs that were higher or lower than certain values. I have also noticed that during my exploration, when I press on SHIFT+ENTER the values can violate these limits.

Each property listed above has minimum and maximum limits.

Find below the minimum and maximum limits of the Number of teeth (N), the Pitch diameter(D), the Diametral pitch (P), and the Pressure Angle (PA).

Limits	No. of teeth (N)	Pitch diameter (D)	Diametral pitch (P)	Pressure Angle (PA)
minimum	4	0.013333333	0.5	12
maximum	400	800	300	35

However, when combining the limits of the Number of teeth (N) and Diametral pitch (P), I found out that Pitch diameter (D) also has other limits in relationship with N and P.

Fields	Limits	Values
No. of teeth (N)	minimum	4
Pitch diameter (D)	minimum	0.013333333
Diametral pitch (P)	maximum	300
No. of teeth (N)	maximum	400
Pitch diameter (D)	minimum	1.333333333
Diametral pitch (P)	maximum	300
No. of teeth (N)	minimum	4
Pitch diameter (D)	maximum	8
Diametral pitch (P)	minimum	0.5
No. of teeth (N)	maximum	400
Pitch diameter (D)	maximum	800
Diametral pitch (P)	minimum	0.5

The limits can be confirmed using the procedures below:

Title	Gear Generator Extreme Values Testing
Summary	This set of test cases explores the effect of using extreme values in the gear specification fields.
Setup	<p>Start by clearing all the existing gears and creating a connected set of at least four gears that have the following maximal parameters:</p> <p>Gear 0: 4 teeth, diametral pitch = 300 Gear 1: 400 teeth, diametral pitch = 300 Gear 2: 4 teeth, diametral pitch = 0.5 Gear 3: 400 teeth, diametral pitch = 0.5</p> <p>These are chosen to create an extreme situation that may cause trouble for the app. If you want, you can add more gears.</p> <p>Choose one of the gears to select. Try different ones every time you run this procedure.</p>
Notes	<p>As you go through this procedure, don't just focus on the number fields.</p> <p>Look at the graphics to see that the gears look right and are animating properly.</p>

SUMMARY	TEST STEPS	ORACLE NOTES
Test the minimum input for the "Number of teeth" (N) field	<ol style="list-style-type: none"> 1. Enter a number larger than the minimum and less than the maximum into the N field. (Example: 7) 2. Click on the "-" button repeatedly until the number stops decrementing 3. Enter a number larger than the minimum and less than the maximum into the N field. (Example: 7) 4. Enter a 0 or some other number less than 4 into the N field. 	<p>Check the number of teeth in the diagram matches your input.</p> <p>VERIFY that the N = 4 Check the number of teeth in the diagram is 4.</p> <p>Check the number of teeth in the diagram matches your input.</p> <p>VERIFY that the N = 4 Check the number of teeth in the diagram is 4.</p>

<p>Test the maximum input for the "Number of teeth" (N) field</p>	<ol style="list-style-type: none"> 1. Enter a number larger than the minimum and less than the maximum into the N field. (Example: 395) 2. Click on the "-" button repeatedly until the number stops decrementing 3. Enter a number larger than the minimum and less than the maximum into the N field. (Example: 7) 4. Enter a 0 or some other number less than 4 into the N field 	<p>Check the number of teeth in the diagram matches your input.</p> <p>VERIFY that the N = 4 Check the number of teeth in the diagram is 4.</p> <p>Check the number of teeth in the diagram matches your input.</p> <p>VERIFY that the N = 4 Check the number of teeth in the diagram is 4.</p>
<p>Test the "Number of teeth" (N) with bad data</p>	<ol style="list-style-type: none"> 1. Enter a number with decimals into the N field. (Example: 4.2) 2. Click ENTER 3. Enter a number larger than the minimum and less than the maximum in the N field (Example: 40) 4. Enter alphabetical and special characters into the N field (Example: abcd\$%(*&^!) 5. Click ENTER 	<p>Check the number of teeth in the diagram matches your input. VERIFY that N= 4.2</p> <p>Check the number of teeth in the diagram matches your input.</p> <p>Check that alphabetical and special characters are displayed in the field.</p> <p>VERIFY that the value of N returns to 40.</p>
<p>Test the minimum input for the "Diametral pitch" (P) field</p>	<ol style="list-style-type: none"> 1. Enter a number less than the minimum into the P field (Example: 0.1) 2. Click ENTER 	<p>Check that the inserted number is displayed in the field</p> <p>VERIFY that the P=0.5</p>
<p>Test the maximum input for the "Diametral pitch" (P) field</p>	<ol style="list-style-type: none"> 1. Enter a number larger than the maximum into the P field (Example: 400) 2. Click ENTER 	<p>Check that the inserted number is displayed in the field</p> <p>VERIFY that the P=0.5</p>

<p>Test that the value of the Diametral pitch modifies when clicking on SHIFT+ENTER</p>	<ol style="list-style-type: none"> 1. Enter a number in the Number of teeth field and into Pitch diameter (N=350, D=400) 2. Click SHIFT+ENTER while the cursor is in the Pitch diameter field 3. Enter a number in the Number of teeth field and into Pitch diameter (N=300, D=800) 4. Click SHIFT+ENTER while the cursor is in the Number of teeth field 	<p>Check that the inserted values are displayed in the fields</p> <p>VERIFY that the P=0.875</p> <p>Check that the inserted values are displayed in the fields</p> <p>VERIFY that the P=0.375</p>
<p>Test that the value of the Diametral pitch modifies when clicking on SHIFT+ENTER</p>	<ol style="list-style-type: none"> 1. Enter the minimum Number of teeth and the maximum value of Diametral pitch (N=4, P=300) 2. Click ENTER 3. Enter the maximum Number of teeth and the maximum value of Diametral pitch (N=400, P=300) 4. Click ENTER 5. Enter the minimum Number of teeth and the minimum value of Diametral pitch (N=4, P=0.5) 6. Click ENTER 7. Enter the maximum Number of teeth and the minimum value of Diametral pitch (N=400, P=0.5) 8. Click ENTER 	<p>Check that the inserted values are displayed in the fields</p> <p>VERIFY that the D=0.013333333</p> <p>Check that the inserted values are displayed in the fields</p> <p>VERIFY that the D=1.333333333</p> <p>Check that the inserted values are displayed in the fields</p> <p>VERIFY that the D=8</p> <p>Check that the inserted values are displayed in the fields</p> <p>VERIFY that the D=800</p>

		Pitch diameter (D)			
		0.01333333	1.33333333	8	800
No. of teeth (N)	4	✓	N/A	N/A	N/A
Diametral pitch (P)	300		N/A	N/A	N/A
No. of teeth (N)	400	N/A	✓	N/A	N/A
Diametral pitch (P)	300	N/A		N/A	N/A
No. of teeth (N)	4	N/A	N/A	✓	N/A
Diametral pitch (P)	0.5	N/A	N/A		N/A
No. of teeth (N)	400	N/A	N/A	N/A	✓
Diametral pitch (P)	0.5	N/A	N/A	N/A	

Table: Field testing coverage matrix

Also, these limits are related to each other mathematically. This means that if I change one input, the other inputs will change as well based on the mathematical relationship. Below is the formula for each property:

PITCH DIAMETER (D) = N (Number of teeth) / P (Diametral Pitch)

DIAMETRAL PITCH (P) = N (Number of teeth) / D (Pitch Diameter)

NUMBER OF TEETH (N) = D (Pitch Diameter) * P (Diametral Pitch)

N	P	D=N/P
4	0.5	8
4	300	0.01333333
400	0.5	800
400	300	1.33333333

N	D	P=N/D
4	8	0.5
4	0.01333333	300
400	800	0.5
400	1.33333333	300

D	P	N=D*P
8	0.5	4
0.01333333	300	4
800	0.5	400
1.33333333	300	400

The value of PA does not change the relationship between N, P, and D.

I performed these operations manually at first, then worked with James to create automation. The script is designed to automate and validate the process of configuring different varieties of gear configurations. I created a JSON file with the limits of the gear and a JSON file with different gear configurations. Each test consists of an ID and an array of gear objects, where each gear object represents a gear with specific parameters. The parameters include:

- N: Number of teeth
- P: Diametral pitch
- PA: Pressure angle

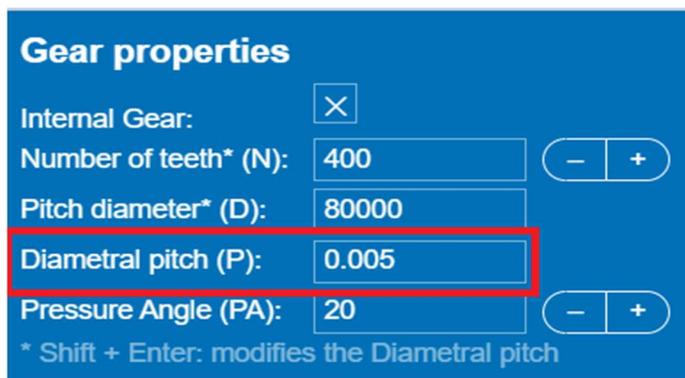
Each test case evaluates the Gear Generator functionality, and data accuracy using various combinations of these parameters. For example, “test number 1” evaluates four different gear configurations, while the rest of the test cases evaluate three configurations.

The automation code and the JSON files have been uploaded to the [GitHub repository](#).

Test Results

The application appears to be stable and functional. The interface is intuitive and easy to navigate. I did find some bugs, however.

When using certain data inputs for N and D fields, I found out that when clicking on **Shift + Enter** the Diametral pitch (P) goes under its limit.



Gear properties

Internal Gear:

Number of teeth* (N):

Pitch diameter* (D):

Diametral pitch (P):

Pressure Angle (PA):

* Shift + Enter: modifies the Diametral pitch

Gear properties

Internal Gear:

Number of teeth* (N):

Pitch diameter* (D):

Diametral pitch (P):

Pressure Angle (PA):

* Shift + Enter: modifies the Diametral pitch

Gear properties

Internal Gear:

Number of teeth* (N):

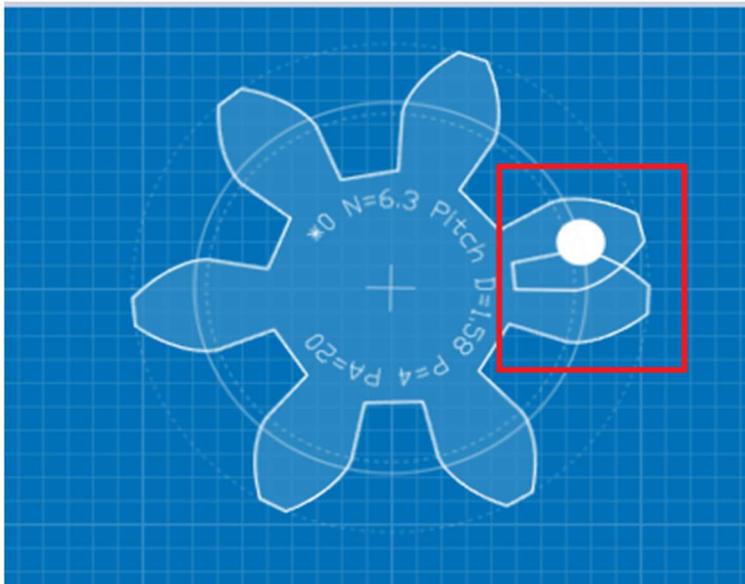
Pitch diameter* (D):

Diametral pitch (P):

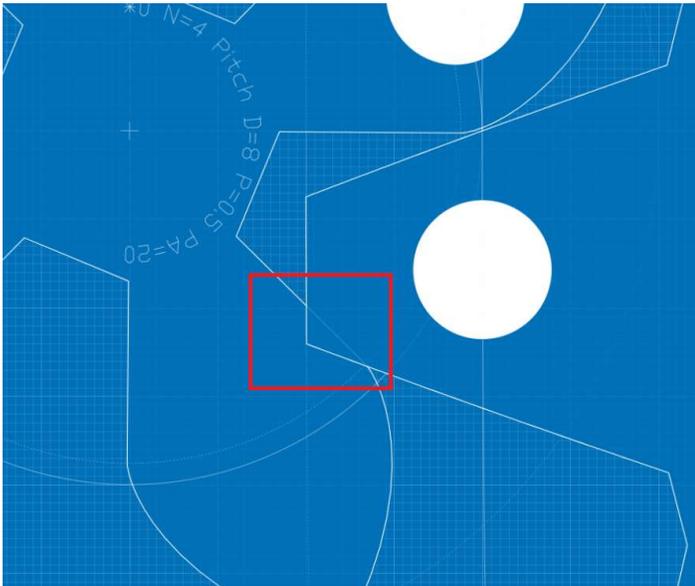
Pressure Angle (PA):

* Shift + Enter: modifies the Diametral pitch

The Number of teeth field accepts **numbers with decimals** and the gear displays asymmetrical teeth.



When analyzing one of the screenshots taken while performing test automation, I observed that **one of the teeth of the gear overlaps the other teeth.**



When multiple gears, with a large number of teeth (eg. Gear #0: 30 teeth, Gear #1: 40 teeth), are added, the bottom and the right-side scroll bars do not work properly, **causing the gears to be truncated.** Even at the smallest scale, the entire gear remains partially obscured.

