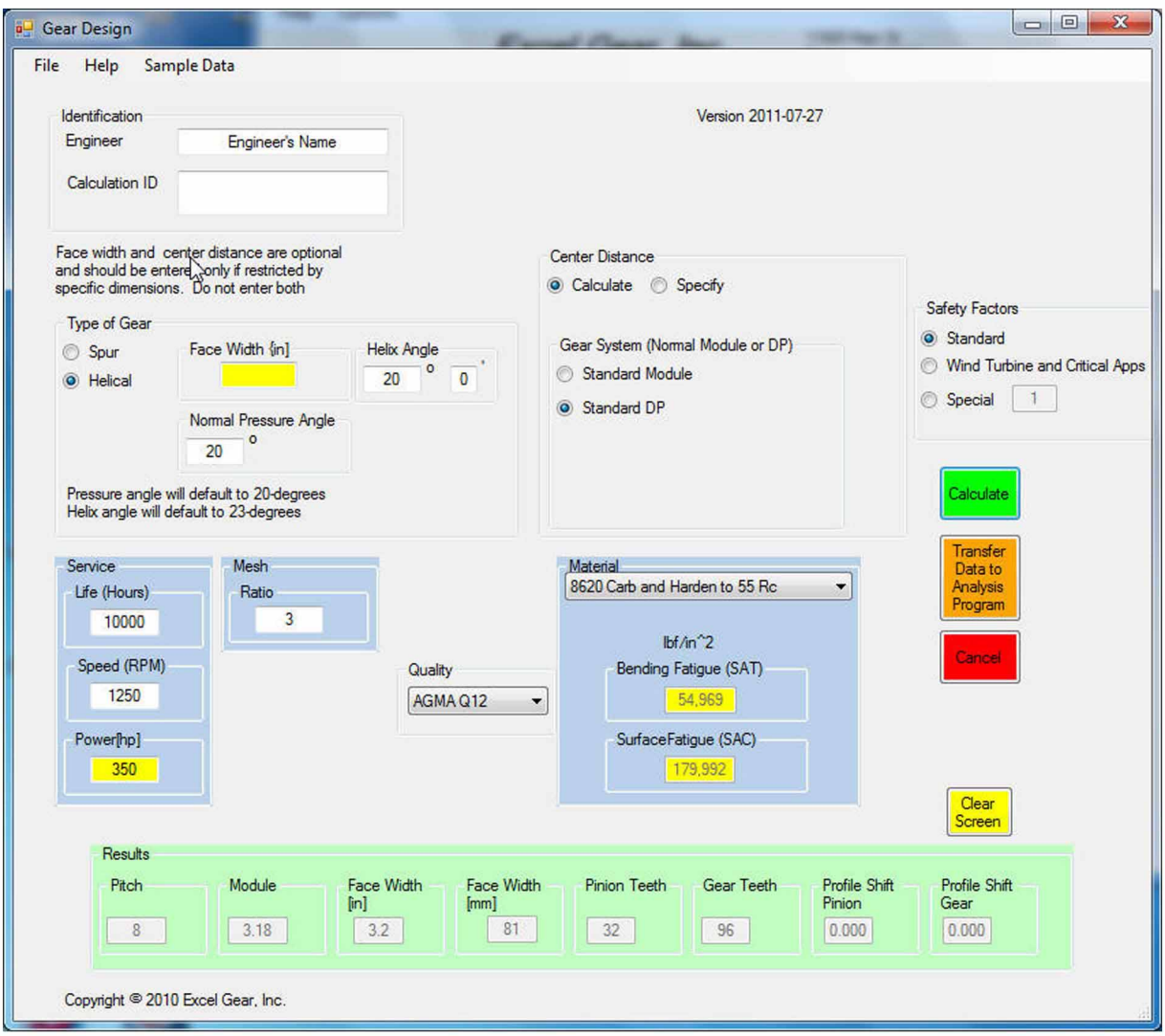
DESIGN: Example 1 - Minimal Input

Minimal Input will give a rough starting point for design. Rerunning after adding additional information is usual.

Task: Design a 3:1 reduction gear mesh to transmit 350 HP @ 1250 rpm for 10,000 hours of life.

Required Input :

1. Choose spur or helical. In this case helical and enter 20- deg.
2. Enter pressure angle. If you do not enter the PA, 20- deg. will be assumed.
3. Enter ratio. For speed increasing drives enter output speed and reverse ratio (gear teeth /pinion teeth)
4. Select the manufacturing system you prefer, DP (Diametral Pitch) or module
5. Enter service factor, life, speed, and Horse Power (KW) required.
6. Choose a gear material - 8620 carb. and harden (or any other material from the table)
7. Press " Calculate" and the calculated sizes are shown at the bottom of this page and in output data sheet in the next page
8. Click "Transfer Data to Analysis" and follow instructions on the screen



Excel-lent Gear Design Version 2011-07-27

Calculation by: Engineer's Name 8/1/2011 3:12:48 PM
Gear Type is Helical
Gear System is Module
Pressure Angle is 20-deg
Helix Angle is 20-deg
Ratio is 3:1
Material is 8620
Heat Treatment Carb and Harden to 55 Rc

Quality Designation	AGMA Q12
Power	350.0 HP 260.99 kW
RPM	1250
Torque	17,640 In Lbf
Life is 10,000 Hours	

Center Distance not specified
Face Width Not Specified
Cycles = 750,000,000
Life Factor = 0.7787

Safety Factor = 1.0

%%% D =	4.051
%%% Face Width	3.038 in 77.18 mm
%%% DP/Module - Calculated	7.95 Normal DP 3.195 Normal Module
%%% DP/Module - Standard	8 Normal DP 3.175 Normal Module

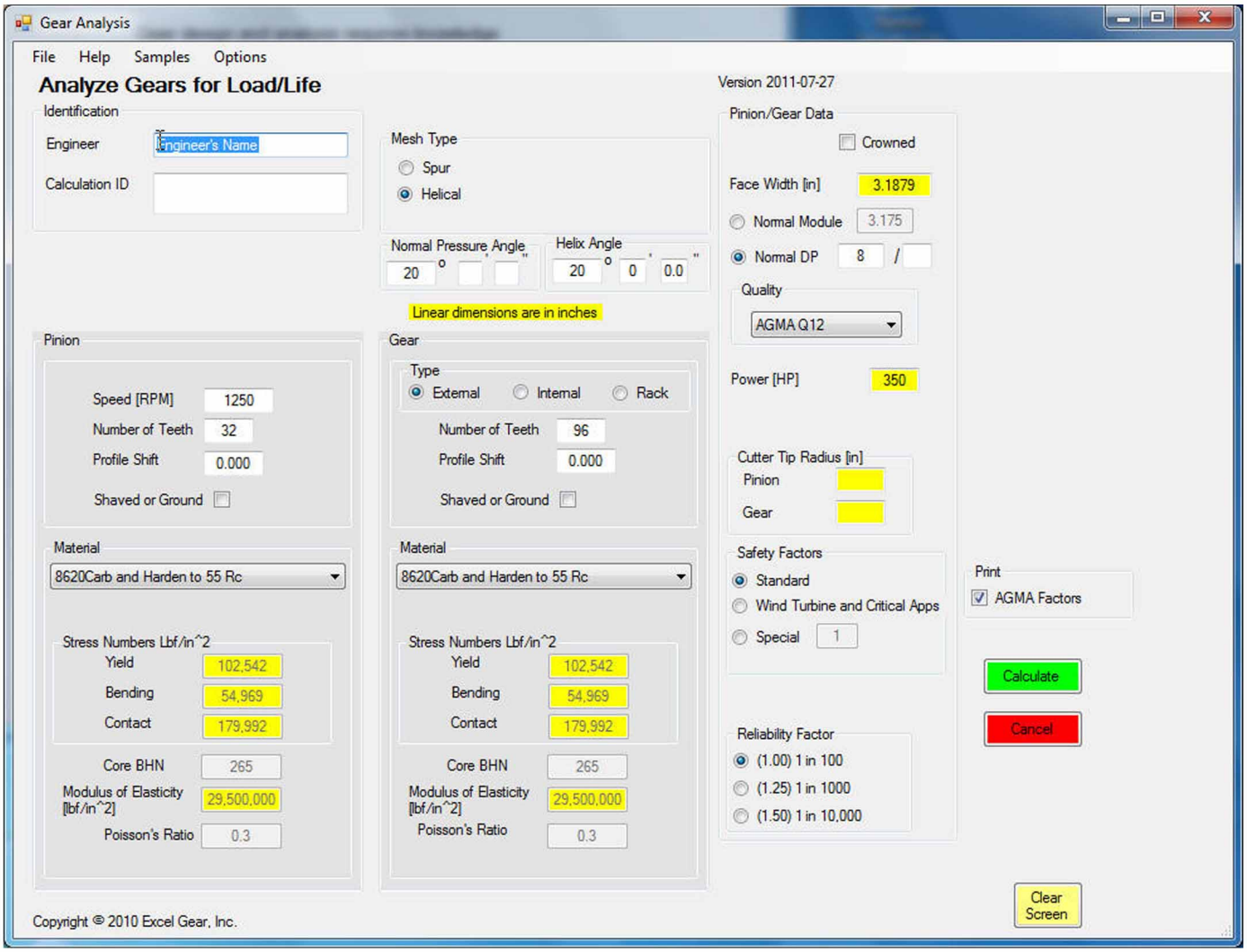
%%% Kv 1.10	
%%% Velocity	1306 ft/min 6.63 m/s
%%% D =	4.251
%%% Face Width	3.188 in 80.97 mm
%%% DP/Module - Calculated	7.956 Normal DP 3.193 Normal Module
%%% DP/Module - Standard	8 Normal DP 3.175 Normal Module

Pinion Diameter	4.257 in 108.12 mm
Gear Diameter	12.770 in 324.36 mm
Diametral Pitch/Module	8 Normal DP 3.18 Normal Module
Face Width	3.19 in 81.0 mm
Number of teeth - Pinion	32
Number of teeth - Gear	96
Ratio - Specified	3
Ratio - Actual	3
Center Distance - Standard	8.513 in 216.241 mm

ANALYSIS: Example 1

DATA TRANSFERRED FROM DESIGN FOR LOAD / LIFE ANALYSIS.

NOTE: Our task is to come up with a gear design to transmit 350 HP @ 1250 rpm with no restriction of center distance and face width.



Click "Calculate" to run analysis. The results will be shown on page #4 . Gears are good for 350 HP for 10,000 hours of life as you will be on the next page. Capacity in surface fatigue and bending fatigue is also balanced.

Excel-lent Gear Analysis **Version 2011-07-27**

Calculation by: Excel-lent 8/8/2011 8:46:47 AM
External Helical Gear, Helix Angle 20

Normal Diametral Pitch	8	
Quality	AGMA Q12	
Face Width	3.188	in
Pinion Teeth	32	
Gear Teeth	96	
Normal Pressure angle 20:00:00	20	deg
Transverse pressure angle	21.173	deg
Helix angle	20	deg
Profile Shift - Pinion	0	
Profile Shift - Gear	0	
Pinion Speed	1250	RPM
Pinion Pitch Diameter	4.257	in
Center Distance - Standard	8.513	in
Cutter tip radius - Pinion	0.025	in
Cutter tip radius - Gear	0.025	in
Reference Power	350.00	HP
Safety Factor Bending	1.0	
Safety Factor Pitting	1.0	
Reliability Factor	1.0	

Pinion material - 8620 Carb and Harden to 55 Rc

Yield Strength	102542	Lbf/in^2
Bending strength	54969	Lbf/in^2
Surface strength	179992	Lbf/in^2
BHN	265	

Gear material - 8620 Carb and Harden to 55 Rc

Yield Strength	102542	Lbf/in^2
Bending strength	54969	Lbf/in^2
Surface strength	179992	Lbf/in^2
BHN	265	

Input

Hours of Life	Pinion Capacity [HP] Surface Fatigue	Pinion Capacity [HP] Bending Fatigue	Gear Capacity [Hp] Surface Fatigue	Gear Capacity [Hp] Bending Fatigue
100000	284.4	375.5	321.7	409.9
50000	307.4	380.2	347.6	415.0
25000	332.2	384.9	375.7	420.2
10000	368.1	391.2	416.3	427.1
5000	397.8	396.1	449.9	432.4
"Static"		774.5		829.0

Hours of Life	Torque [in-lbf] Pinion	Torque [in-lbf] Gear	Tangential Force [lbf] Pinion	Tangential Force [lbf] Gear
100,000	14,341	48,657	6,738	7,620
50,000	15,499	52,585	7,282	8,236
25,000	16,750	56,830	7,870	8,900
10,000	18,560	62,972	8,720	9,862
5,000	19,972	65,403	9,384	10,243
Static	39,050	125,402	18,347	19,640

Use 70% of the Bending Fatigue capacity values for idler gears and other gears where the teeth are completely reverse loaded on every cycle.

Results

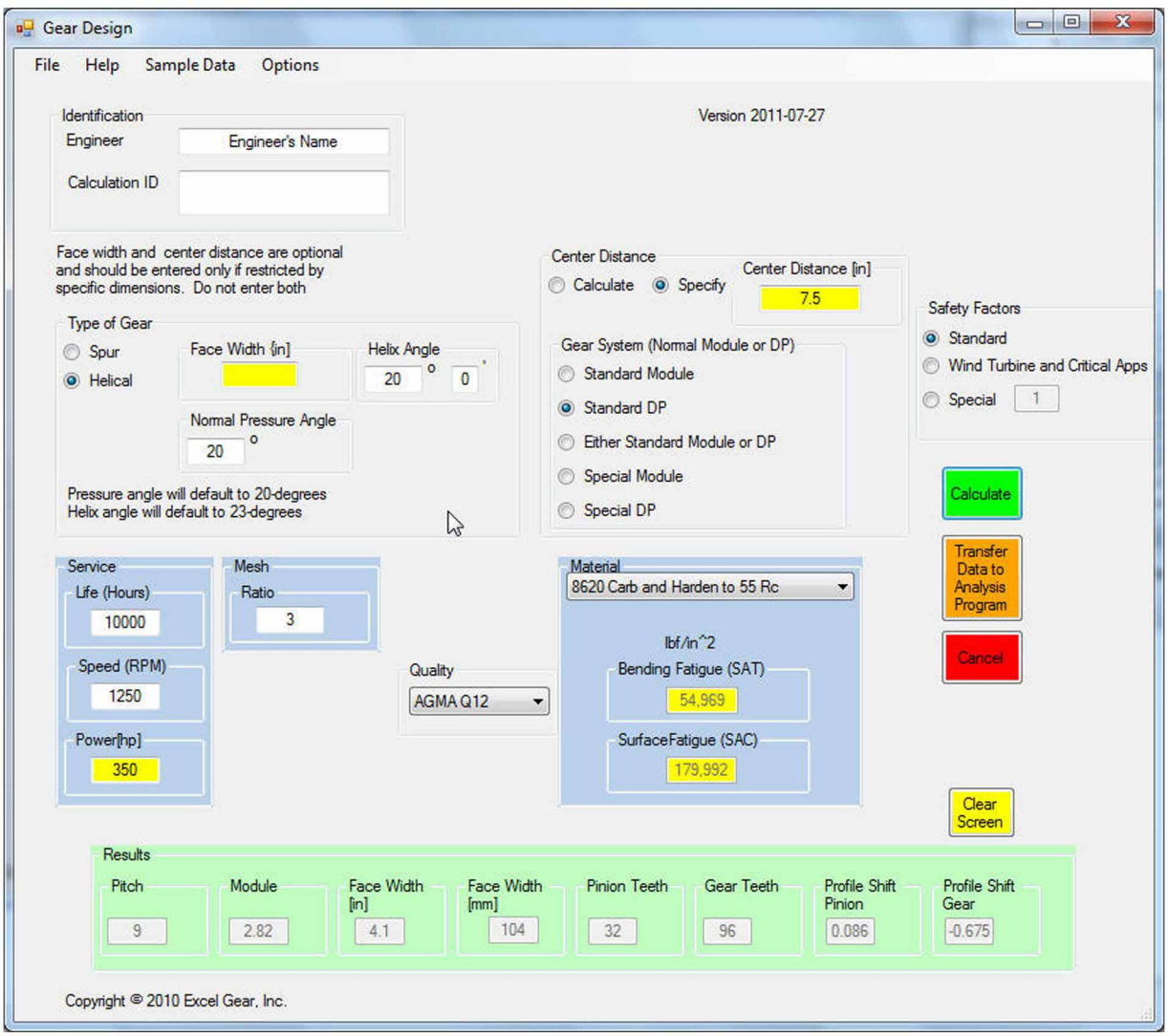
DESIGN: Example 2 - Minimal Input

Minimal Input will give a rough starting point for design. Rerunning after adding additional information is usual.

Task: Design a 3:1 reduction gear mesh to transmit 350 HP @ 1250 rpm for 10,000 hours of life, as in example 1 except center distance is restricted to 7.500"

Required Input : Same as in example 1 except center distance is 7.500"

1. Choose helical and enter 20 deg.
2. Enter pressure angle. If you do not enter the PA, 20- deg. will be assumed.
3. Enter ratio. For speed increasing drives enter output speed and reverse ratio (gear teeth /pinion teeth)
4. Select the manufacturing system you prefer, DP (Diametral Pitch) or module
5. Enter service factor, life, speed, and Horse Power (KW) required.
6. Highlight "Specify Center distance" and enter 7.500".
7. Choose a gear material - 8620 carb. and harden (or any other material from the table)
8. Press " Calculate" and the calculated sizes are shown at the bottom of this page and in output data sheet in the next page
9. Click "Transfer Data to Analysis" and follow instructions on the screen



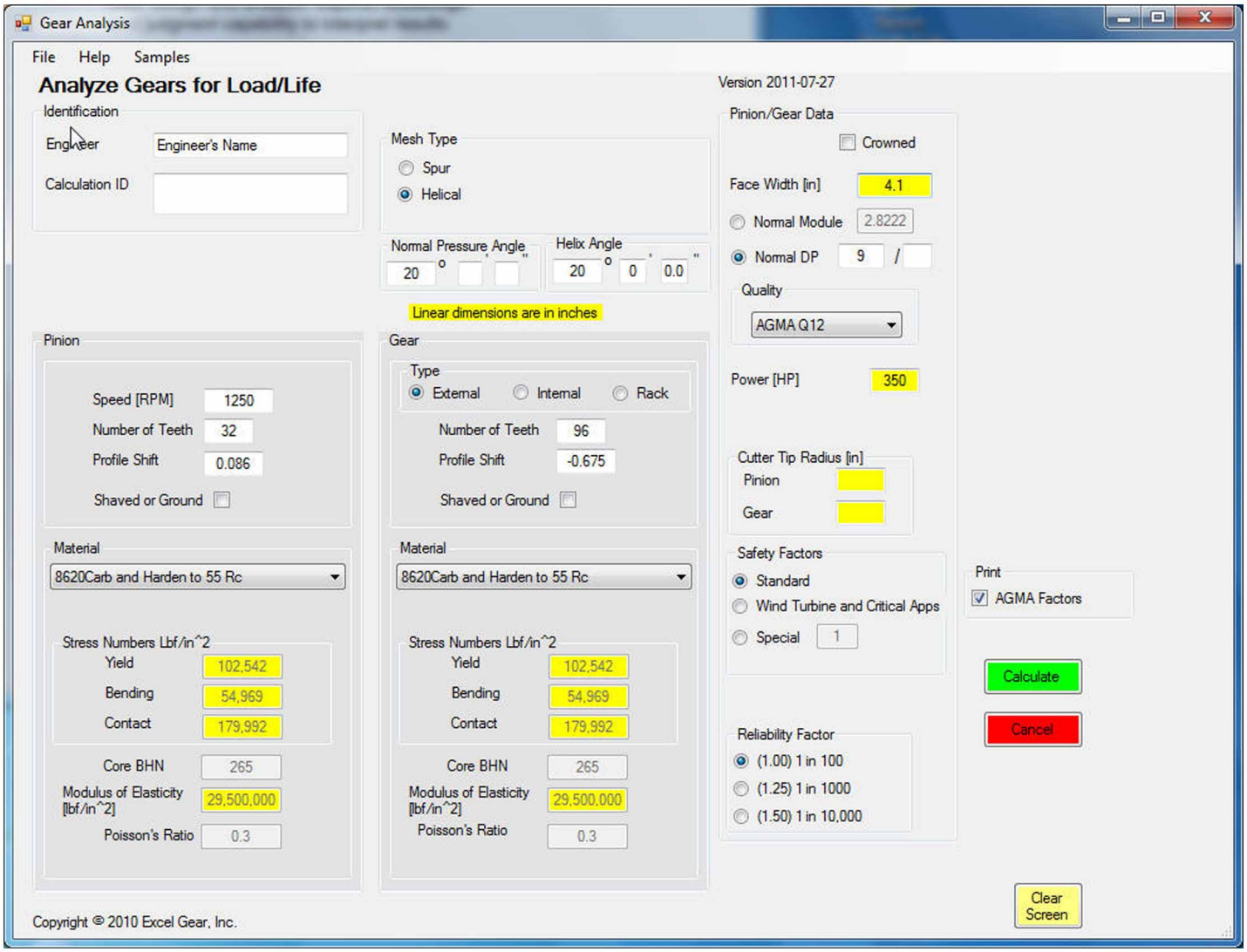
```
Calculation by: Excel-lent  8/8/2011 9:12:22 AM
Gear Type is Helical
Gear System is Diametral Pitch
Pressure Angle is 20-deg
Helix Angle is 20-deg
Ratio is 3:1
Material is 8620
Heat Treatment Carb and Harden to 55 Rc

Quality Designation                    AGMA Q12
Power                                  350.0 HP      260.99 kW
RPM                                    1250
Torque                                 17,640 In Lbf
Life is 10,000 Hours

Center Distance Specified              7.500 in    190.50 mm
Face Width Not Specified
Cycles = 750,000,000
Life Factor = 0.7787

Safety Factor = 1.0
%%% DP/Module - Calculated             8.589 Normal DP 2.957 Normal Module
%%% DP/Module - Standard               9 Normal DP  2.822 Normal Module
%%% DP/Module - Zero Profile Shift     9.081 Normal DP 2.797 Normal Module

%%% Sum of Profile Shifts              -0.589
%%% Transverse Operating Pressure Angle 19.799

%%% Kv 1.10
%%% Velocity                           1227 ft/min   6.23 m/s
%%% DP/Module - Calculated             9.018 Normal DP 2.817 Normal Module
%%% DP/Module - Standard               9 Normal DP  2.822 Normal Module
%%% DP/Module - Zero Profile Shift     9.081 Normal DP 2.797 Normal Module

%%% Sum of Profile Shifts              -0.589
%%% Transverse Operating Pressure Angle 19.799

Pinion Diameter                        3.750 in     95.25 mm
Gear Diameter                          11.250 in   285.75 mm
Diametral Pitch/Module                 9 Normal DP   2.82 Normal Module
Face Width                             4.10 in      104.0 mm
Number of teeth - Pinion               32
Number of teeth - Gear                 96
Ratio - Specified                      3
Ratio - Actual                         3
Profile Shift - Pinion                 0.086
Profile Shift - Gear                   -0.675
Center Distance - Standard             7.567 in    192.214 mm
Center Distance - Actual               7.502 in    190.552 mm
```

Data to be transfered to Analysis.

ANALYSIS: Example 2

DATA TRANSFERRED FROM DESIGN FOR LOAD / LIFE ANALYSIS.

NOTE: Our task is to come up with a gear design to transmit 350 HP @ 1250 rpm with a preferred center distance of 7.500"



Click "Calculate" to run analysis. The results will be shown on page # 8. Gears are good for 350 HP for 10,000 hours of life as you will be on the next page. Capacity in surface fatigue and bending fatigue is also balanced.

Excel-lent Gear Analysis Version 2011-07-27

Calculation by: Engineer's Name 8/1/2011 3:08:10 PM
External Helical Gear, Helix Angle 20

Normal Diametral Pitch	9	
Quality	AGMA Q12	
Face Width	4.1	in
Pinion Teeth	32	
Gear Teeth	96	
Normal Pressure angle 20:00:00	20	deg
Transverse pressure angle	21.173	deg
Helix angle	20	deg
Profile Shift - Pinion	0.086	
Profile Shift - Gear	-0.675	
Pinion Speed	1250	RPM
Pinion Pitch Diameter	3.784	in
Pinion Pitch Diameter - Operating	3.751	in
Center Distance - Standard	7.567	in
Center Distance - Operating	7.502	in
Cutter tip radius - Pinion	0.022	in
Cutter tip radius - Gear	0.022	in
Reference Power	350.00	HP
Safety Factor Bending	1.0	
Safety Factor Pitting	1.0	
Reliability Factor	1.0	

Pinion material - 8620 Carb and Harden to 55 Rc

Yield Strength	102542	Lbf/in^2
Bending strength	54969	Lbf/in^2
Surface strength	179992	Lbf/in^2
BHN	265	

Gear material - 8620 Carb and Harden to 55 Rc

Yield Strength	102542	Lbf/in^2
Bending strength	54969	Lbf/in^2
Surface strength	179992	Lbf/in^2
BHN	265	

	Pinion Capacity [HP]		Gear Capacity [Hp]	
Hours of Life	Surface Fatigue	Bending Fatigue	Surface Fatigue	Bending Fatigue
100000	287.2	390.2	324.8	376.9
50000	310.4	395.0	351.0	381.5
25000	335.4	399.9	379.3	386.3
10000	371.7	406.5	420.3	392.6
5000	401.7	411.6	454.2	397.5
"Static"		804.7		762.2

Hours	Torque [in-lbf]		Tangential Force [lbf]	
of Life	Pinion	Gear	Pinion	Gear
100,000	14,479	49,125	7,720	8,731
50,000	15,648	53,090	8,343	9,436
25,000	16,911	57,376	9,017	10,197
10,000	18,739	59,389	9,991	10,555
5,000	20,252	60,126	10,798	10,686
Static	40,574	115,285	21,633	20,490

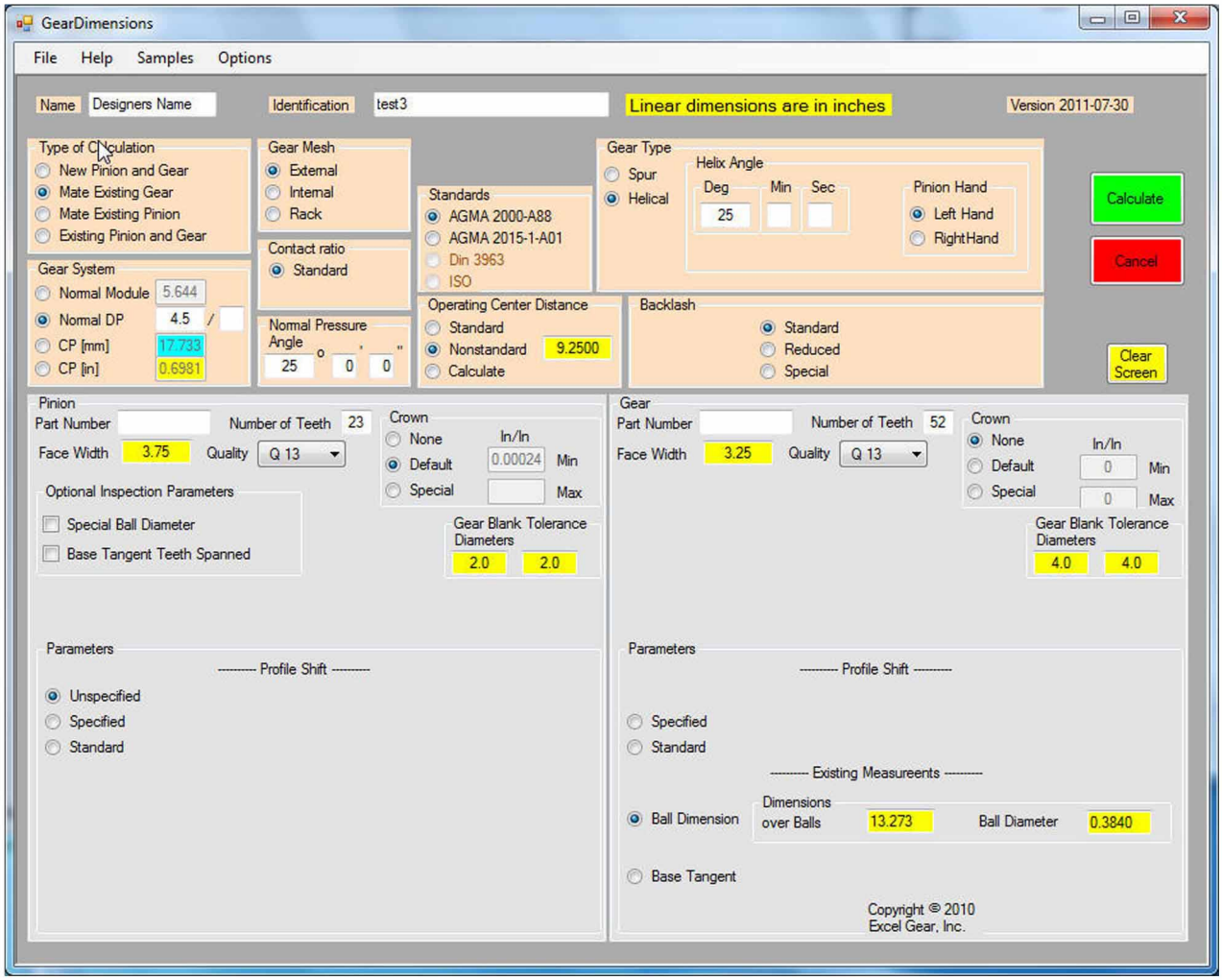
Use 70% of the Bending Fatigue capacity values for idler gears and other gears where the teeth are completely reverse loaded on every cycle.

DIMENSION: Example #3

Task: Calculate dimension for 23T pinion to mesh with an existing gear at 9 250" center distance

Existing gear data: 52T, 4.5 DP, 25 deg. pressure angle, 25 deg. helix angle, RH, DOP: 13.273" over 0.3840" diameter pins, & 3.25" FW.

Input sheet below shows data entered. In this case we have added gear blank shaft and bore sizes for the program to calculate required gear blank tolerances.



Click "Calculate" and the results will be shown in pages 10 and 11.

Excel-lent Gear Dimensions Version 2011-07-30

Calculation by: Designers Name 8/5/2011 7:53:39 PM
* Pinion * AGMA Diametral Pitch Long Addendum Helical Gear
All Dimensions are in inches

Normal Diametral Pitch	4.5	
Number of Teeth	23	
Helix angle	25:00:00 LH	25.000 Deg
Pressure Angle (Normal)	25:00:00	25.000 Deg
Operating Pressure Angle	25.62	
Pitch Diameter (Ref.)		5.6395
Profile Shift	0.271	
Quality Designation	AGMA Q 13	
Total Backlash - Standard		0.0067/0.0100
Tooth Thickness Reduction		0.0033/0.0050
Crown		0.0009/0.0011
Face Width		3.7500
Addendum Diameter		6.205/6.193
Mating Gear		
Part Number		Ctr. Dist 9.2500
Number of teeth	52	

Manufacturing and Inspection data

Ball/Pin Diameter		0.3840
Dimension over Balls		
Pre-Grind		6.2900/6.2872
Finish		6.2642/6.2614
Dimension over One Ball		
Finish		3.1390/3.1376
Base Tangent over 5 Teeth		
Pre-Grind		3.0924/3.0907
Finish		3.0771/3.0754
Base Circle Diameter		5.0147
Base Helix angle	22:31:16 22.521 (Deg)	
Whole Depth (Ref Only)		0.5000
Roll Angles	21:44:52 41:31:46	
	21.7478 41.5295 (Deg)	
Form Diameter		5.3705
Tolerance Data		
Profile Tolerance - FF		0.00028
Pitch tolerance - FP		0.00018
Accumulated Pitch Tolerance - FPA		0.00113
run-out Tolerance - FR		0.00080
Lead - FB		0.00044
Total Composite		0.00112
Tooth to Tooth Composite		0.00033

Note: The following gear blank tolerances are the maximum allowable to manufacture the gears to the specific quality. Closer tolerances may be required for other reasons(e.g. bearing fit).

		Bore	Shaft
Reference Diameter	2.0		
Size & Form Tolerance		0.00049	0.00049
Run-out Tolerance		0.00027	
Reference Diameter	2.0	Bore	Shaft
Size & Form Tolerance		0.00049	0.00049
Run-out Tolerance		0.00027	
O.D. Radial Run-out and Axial run-out tolerance		0.00030	

Excel-lent Gear Dimensions Version 2011-07-30

Calculation by: Designers Name 8/5/2011 7:53:39 PM
* External Gear * AGMA Diametral Pitch Short Addendum Helical Gear
All Dimensions are in inches

Normal Diametral Pitch	4.5	
Number of Teeth	52	
Helix angle	25:00:00 RH	25.000 Deg
Pressure Angle (Normal)	25:00:00	25.000 Deg
Operating Pressure Angle	25.62	
Pitch Diameter (Ref.)		12.7501
Profile Shift	-0.023	
Quality Designation	Q 13	
Total Backlash - Standard		0.0067/0.0100
Tooth Thickness Reduction		0.0033/0.0050
No Crown Specified		
Face Width		3.2500
Addendum Diameter		13.184/13.170
Mating Gear		
Part Number	Ctr. Dist	9.2500
Number of teeth	23	

Manufacturing and Inspection data

Ball/Pin Diameter		0.3840
Dimension over Balls		
Pre-Grind		13.3032/13.3001
Finish		13.2746/13.2715
Base Tangent over 10 Teeth		
Pre-Grind		6.4303/6.4287
Finish		6.4150/6.4133
Base Circle Diameter		11.3375
Base Helix angle	22:31:16 22.521 (Deg)	
Whole Depth (Ref Only)		0.5000
Roll Angles	25:07:02 33:52:01	
	25.1173 33.8669 (Deg)	
Form Diameter		12.3904
Tolerance Data		
Profile Tolerance - FF		0.00031
Pitch tolerance - FP		0.00021
Accumulated Pitch Tolerance - FPA		0.00137
run-out Tolerance - FR		0.00098
Lead - FB		0.00039
Total Composite		0.00131
Tooth to Tooth Composite		0.00032

Note: The following gear blank tolerances are the maximum allowable to manufacture the gears to the specific quality. Closer tolerances may be required for other reasons(e.g. bearing fit).

Reference Diameter	4.0	Bore	Shaft
Size & Form Tolerance		0.00062	0.00062
Run-out Tolerance		0.00029	
Reference Diameter	4.0	Bore	Shaft
Size & Form Tolerance		0.00062	0.00062
Run-out Tolerance		0.00029	
O.D. Radial Run-out and Axial run-out tolerance		0.00037	