Presenter: Linda Farral
Co-Presenter: Tommy Hayes
General Electric Energy
June 4th, 2008

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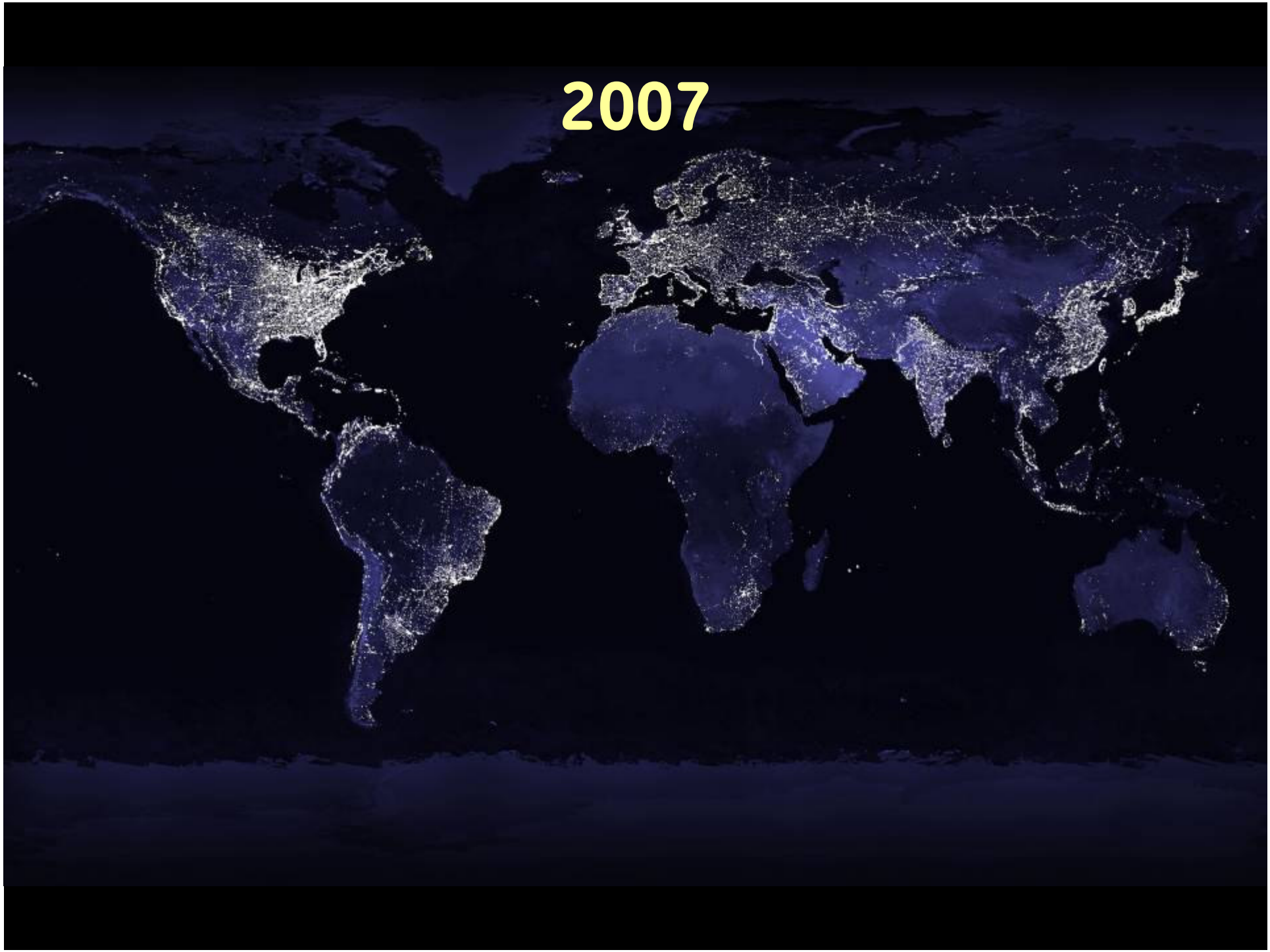
Achieving Design of Experiments (DoE) with Part Families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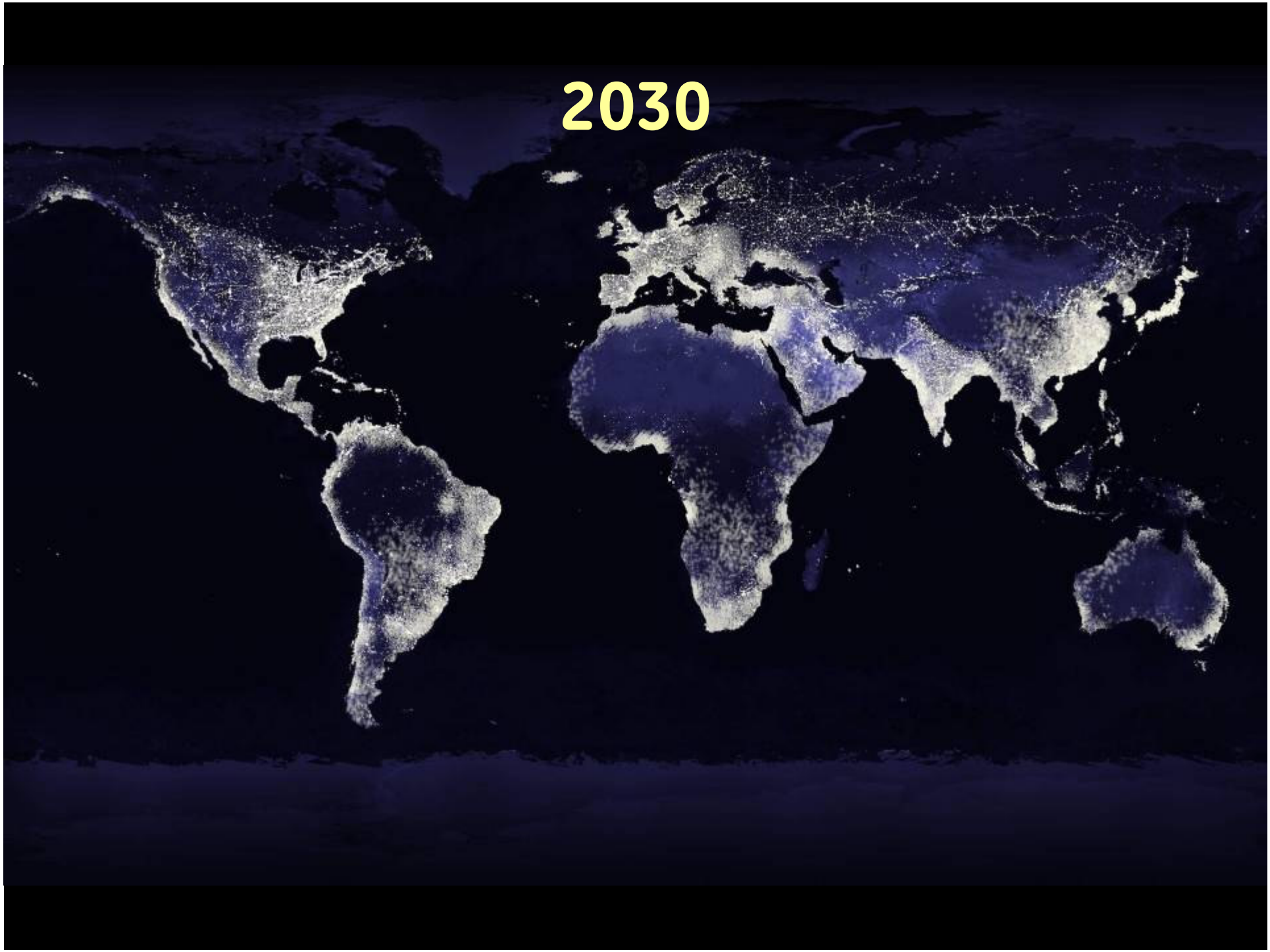
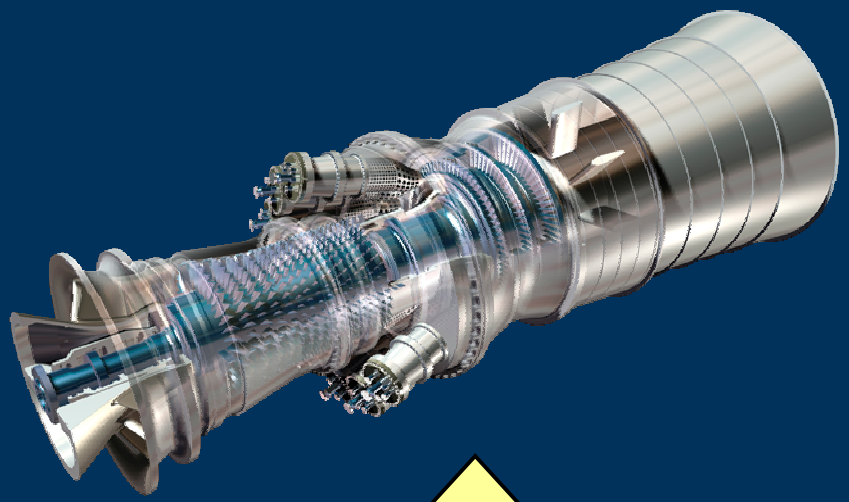

2030

Achieving DoE with Part Families

Presenter: Linda Farral
Co-Presenter: Tommy Hayes
GE Energy

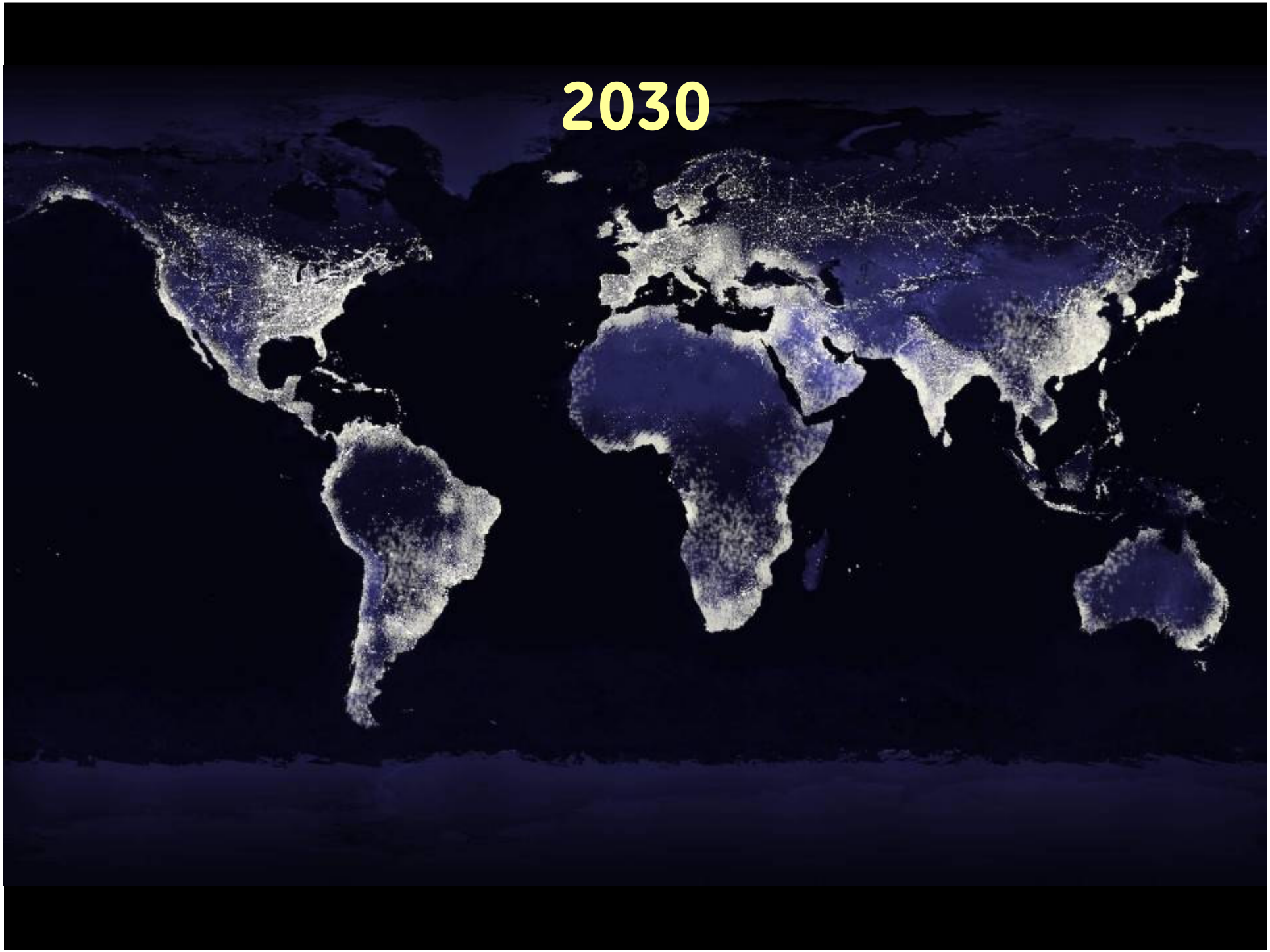
imagination at work

Achieving DoE with Part Families



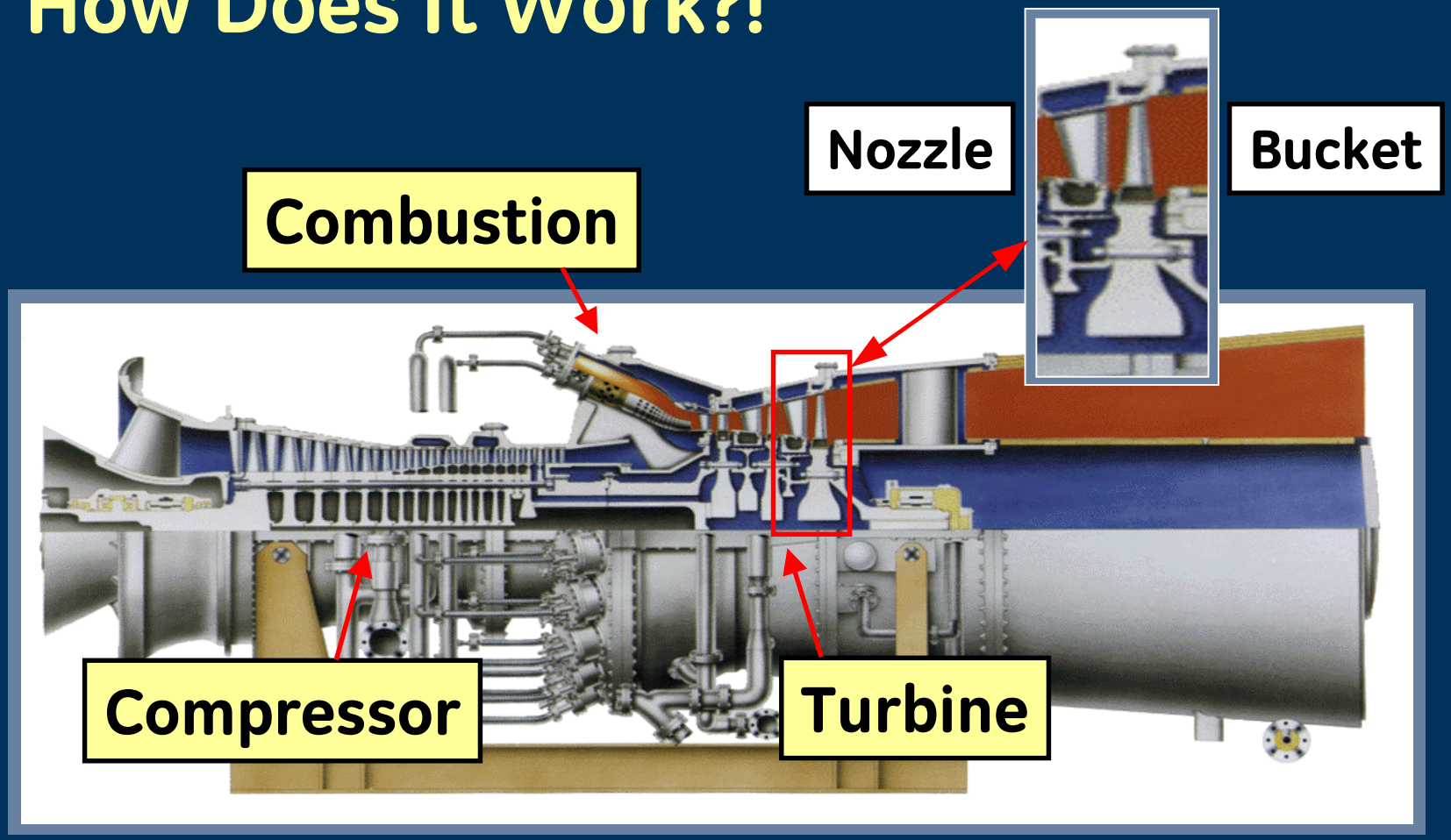
Powers ~500,000 Houses / Year!

1 Turbine = 5 Million MWh / Year!


2030

Achieving DoE with Part Families

How Does It Work?!



Achieving DoE with Part Families

Stage 3 Bucket
~25 lb Stationary
~300,000 lb Rotating

Hummer ~6400 lb

Achieving DoE with Part Families

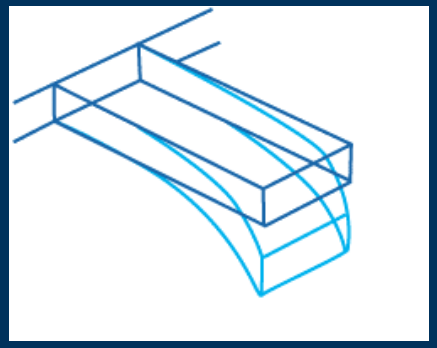
Stage 3 Bucket
1793 HP

Cadillac XLR-V
443 HP

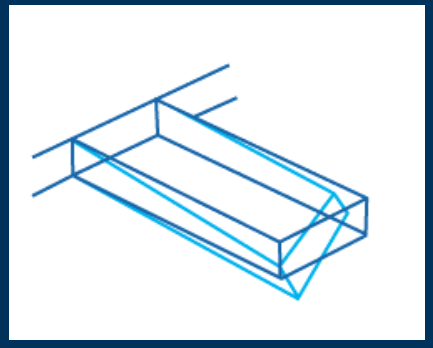
Achieving DoE with Part Families

What is the Purpose of a DoE?

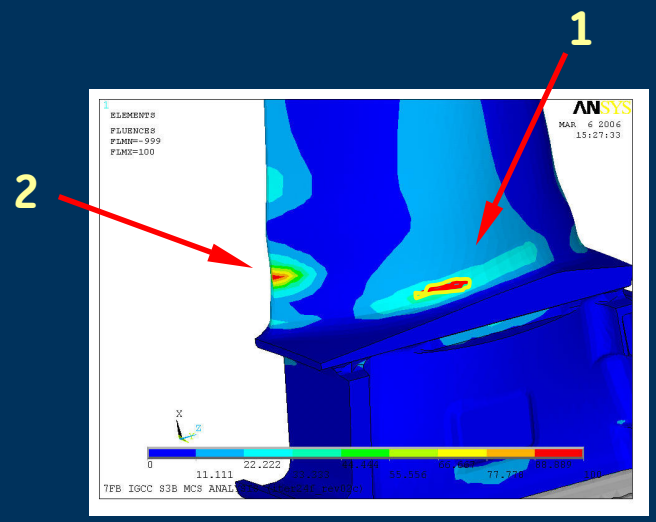
- **Reduce Failure Mode**



1) FLEX / BENDING



2) TORSION



Achieving DoE with Part Families

What is the Purpose of a DoE?

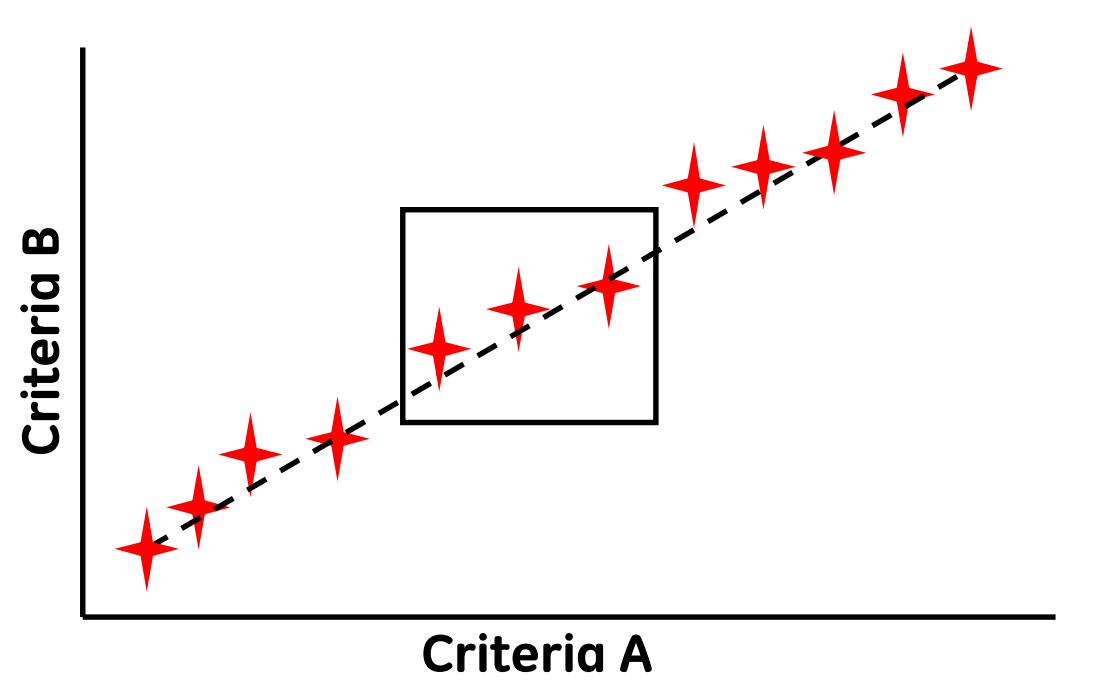
- Iteration and Optimization

	DOE_root_thickness	DOE_pitch_thickness	DOE_root_axial_chord	DOE_pitch_axial_chord	DOE_airfoil_twist	DOE_tip_stagger_angle
1	-0.15	-0.115	-0.4	-0.25	-7	-5
2	0.15	-0.115	-0.4	-0.25	-7	5
3	-0.15	0.115	-0.4	-0.25	-7	5
4	0.15	0.115	-0.4	-0.25	-7	-5
5	-0.15	-0.115	0.4	-0.25	-7	5
6	0.15	-0.115	0.4	-0.25	-7	-5
7	-0.15	0.115	0.4	-0.25	-7	-5
8	0.15	0.115	0.4	-0.25	-7	5
9	-0.15	-0.115	-0.4	0.25	-7	5
10	0.15	-0.115	-0.4	0.25	-7	-5

Achieving DoE with Part Families

What is the Purpose of a DoE?

- Trade Study – Optimal Combinations



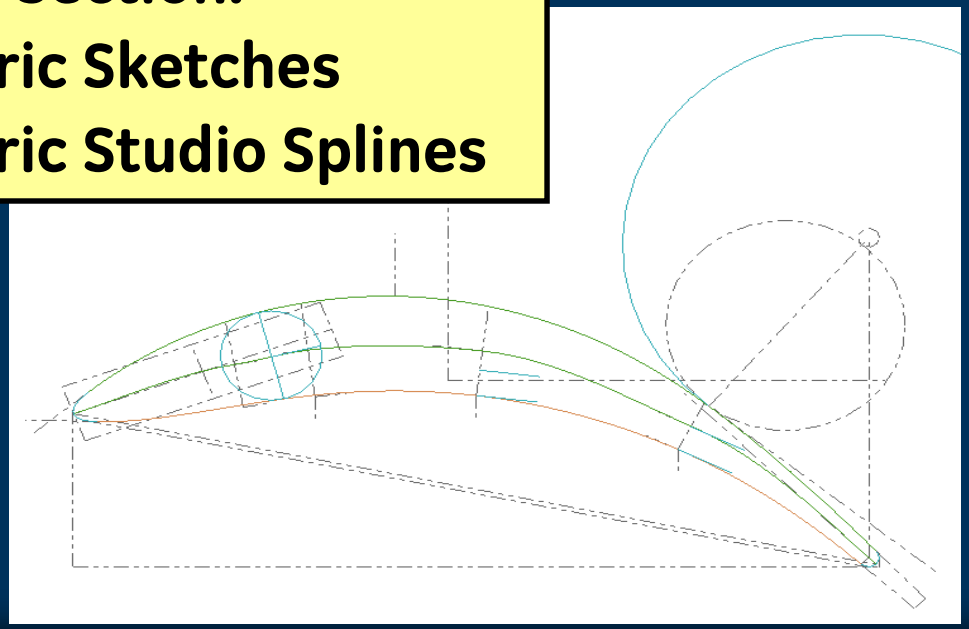
Achieving DoE with Part Families

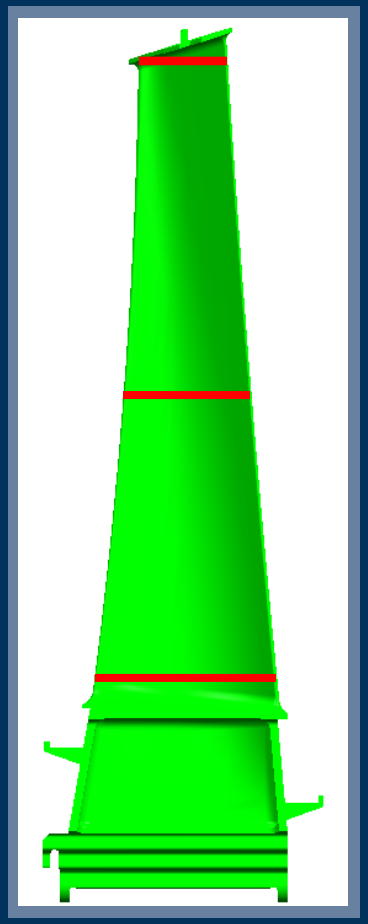
Benefits of Unigraphics for DoE?

- Multiple Sketches When Designing to Extremes

Contents of Section:

- 4 Parametric Sketches
- 3 Parametric Studio Splines

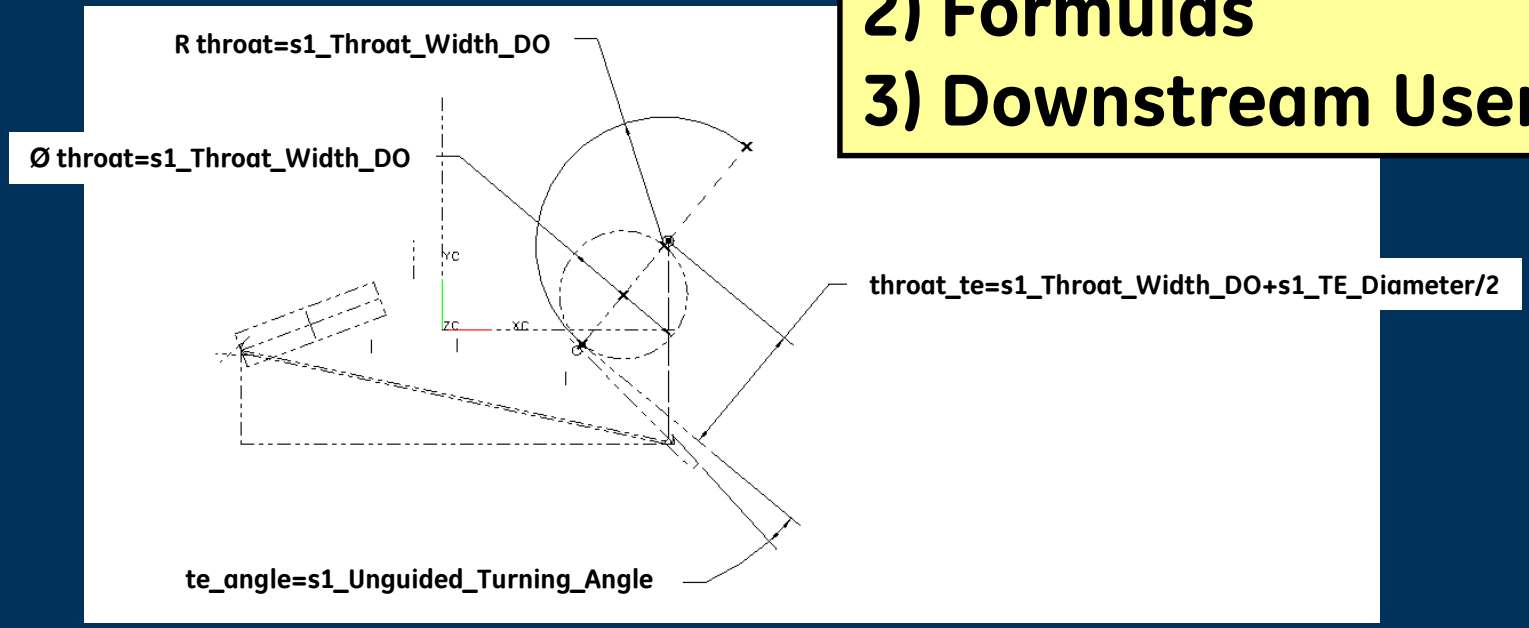




Benefits of Unigraphics for DoE?

- Ability to Name Expressions

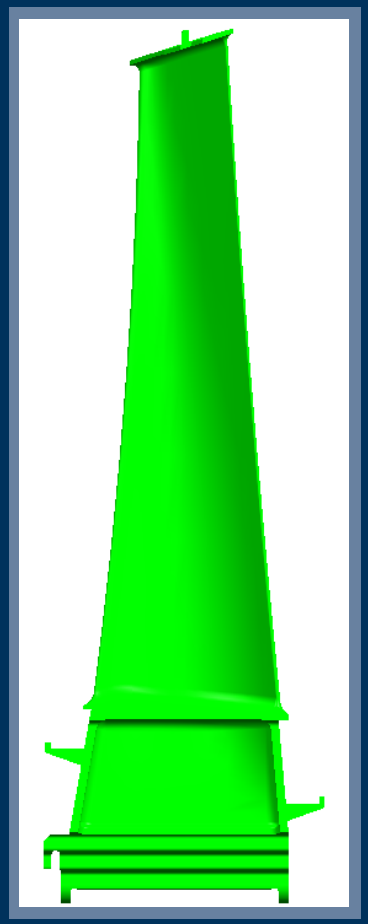
1) Visual
2) Formulas
3) Downstream Users



Achieving DoE with Part Families

Benefits of Unigraphics for DoE?

- CAD is the Virtual Part



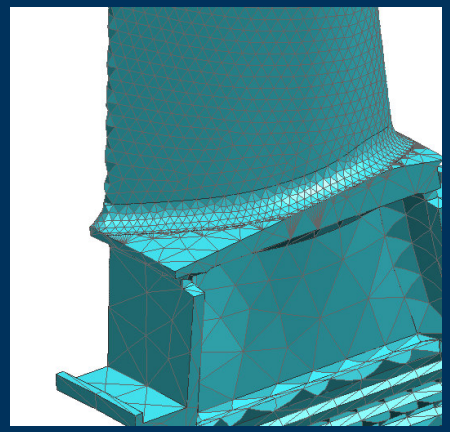
Changing Airfoil Parameters Affects Entire Bucket Tip to Shank, and Vice Versa

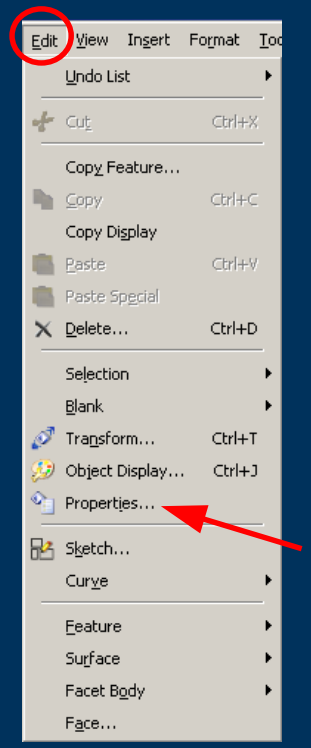
Part Family Master

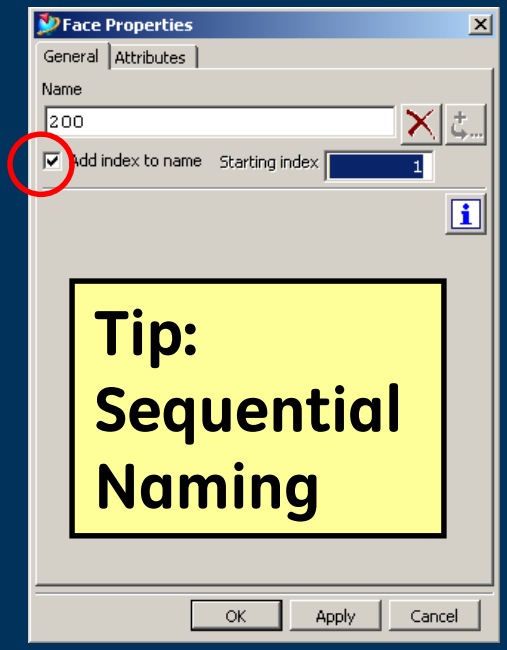
Achieving DoE with Part Families

Benefits of Unigraphics for DoE?

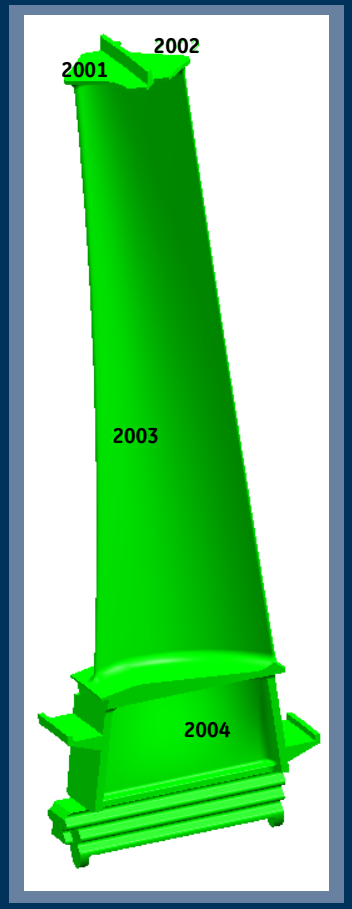
- Tagging Faces for FEA Repeatability







Tip: Sequential Naming

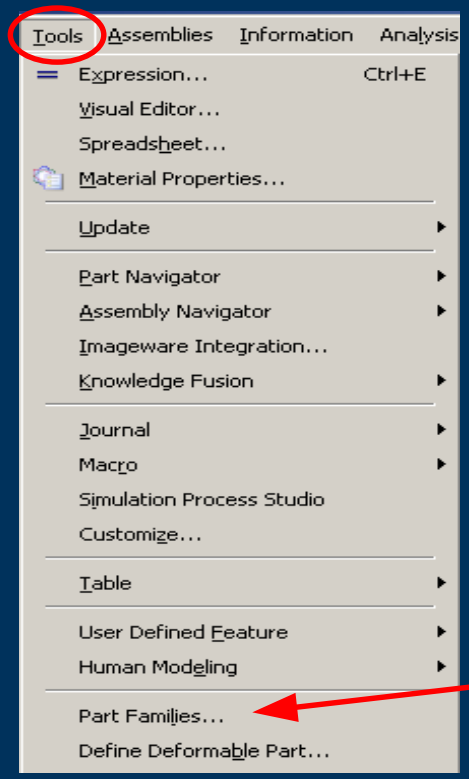


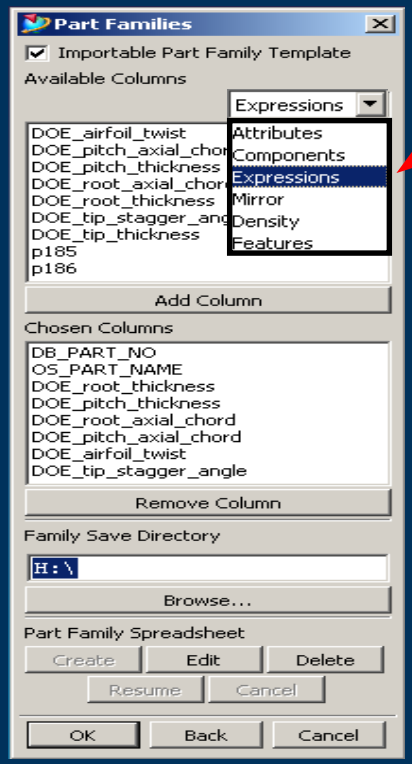
Add Tagging to Part Family Master

Achieving DoE with Part Families

Benefits of Unigraphics for DoE?

- Part Families is the Money Maker of a DoE





Tip:
Mix and Match for Optimization

Part Families Aren't Just for Standard Parts

Achieving DoE with Part Families

Part Families Output

Microsoft Excel - Worksheet in Part Family - S3B_DOE4_PARTFAMILY_MASTER

PartFamily

Verify Part
Apply Values
Update Parts
Create Parts
Save Family
Cancel

	A	B	C		E	F	G	H
1	DB_PART_NO	OS_PART_NAME	DOE_root_thick	ickness	DOE_root_axial_chord	DOE_pitch_axial_chord	DOE_airfoil_twist	DOE_tip_stagger_angle
2	doe4_run1	doe4_run1	-0.15		-0.4	-0.25	-7	-5
3	doe4_run2	doe4_run2	0.15		-0.4	-0.25	-7	5
4	doe4_run3	doe4_run3	-0.15		-0.4	-0.25	-7	5
5	doe4_run4	doe4_run4	0.15		-0.4	-0.25	-7	-5
6	doe4_run5	doe4_run5	-0.15		0.4	-0.25	-7	5
7	doe4_run6	doe4_run6	0.15	-0.115	0.4	-0.25	-7	-5
8	doe4_run7	doe4_run7	-0.15	0.115	0.4	-0.25	-7	-5
9	doe4_run8	doe4_run8	0.15	0.115	0.4	-0.25	-7	5
10	doe4_run9	doe4_run9	-0.15	-0.115	-0.4	0.25	-7	5
11	doe4_run10	doe4_run10	0.15	-0.115	-0.4	0.25	-7	-5
12	doe4_run11	doe4_run11	-0.15	0.115	-0.4	0.25	-7	-5
13	doe4_run12	doe4_run12	0.15	0.115	-0.4	0.25	-7	5
14	doe4_run13	doe4_run13	-0.15	-0.115	0.4	0.25	-7	-5
15	doe4_run14	doe4_run14	0.15	-0.115	0.4	0.25	-7	5
16	doe4_run15	doe4_run15	-0.15	0.115	0.4	0.25	-7	5
17	doe4_run16	doe4_run16	0.15	0.115	0.4	0.25	-7	-5
18	doe4_run17	doe4_run17	-0.15	-0.115	-0.4	-0.25	7	5
19	doe4_run18	doe4_run18	0.15	-0.115	-0.4	-0.25	7	-5
20	doe4_run19	doe4_run19	-0.15	0.115	-0.4	-0.25	7	-5
21	doe4_run20	doe4_run20	0.15	0.115	-0.4	-0.25	7	5
22	doe4_run21	doe4_run21	-0.15	-0.115	0.4	-0.25	7	-5
23	doe4_run22	doe4_run22	0.15	-0.115	0.4	-0.25	7	5
24	doe4_run23	doe4_run23	-0.15	0.115	0.4	-0.25	7	5
25	doe4_run24	doe4_run24	0.15	0.115	0.4	-0.25	7	-5
26	doe4_run25	doe4_run25	-0.15	-0.115	-0.4	0.25	7	-5
27	doe4_run26	doe4_run26	0.15	-0.115	-0.4	0.25	7	5
28	doe4_run27	doe4_run27	-0.15	0.115	-0.4	0.25	7	5
29	doe4_run28	doe4_run28	0.15	0.115	-0.4	0.25	7	-5
30	doe4_run29	doe4_run29	-0.15	-0.115	0.4	0.25	7	5
31	doe4_run30	doe4_run30	0.15	-0.115	0.4	0.25	7	-5
32	doe4_run31	doe4_run31	-0.15	0.115	0.4	0.25	7	-5
33	doe4_run32	doe4_run32	0.15	0.115	0.4	0.25	7	5
34	doe4_run33	doe4_run33	0.15	0	0	0	0	0
35	doe4_run34	doe4_run34	0	0.115	0	0	0	0
36	doe4_run35	doe4_run35	0	0	0.4	0	0	0
37	doe4_run36	doe4_run36	0	0	0	0.25	0	0
38	doe4_run37	doe4_run37	0	0	0	0	7	0
39	doe4_run38	doe4_run38	0	0	0	0	0	5
40	doe4_run39	doe4_run39	-0.15	0	0	0	0	0

Sheet1

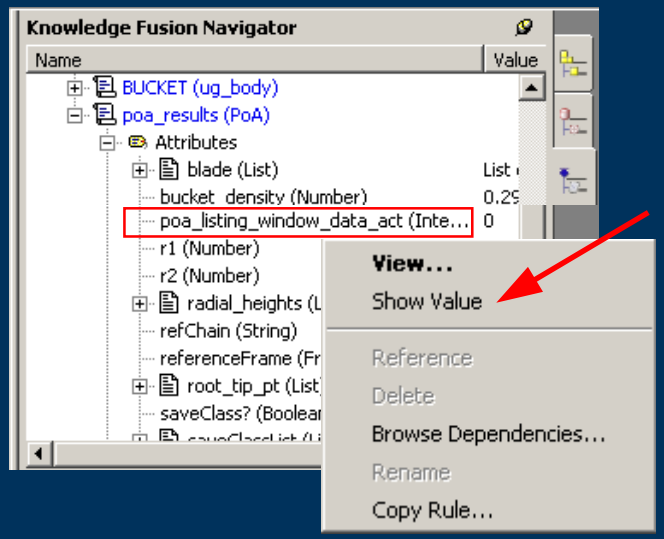
Family Initialized

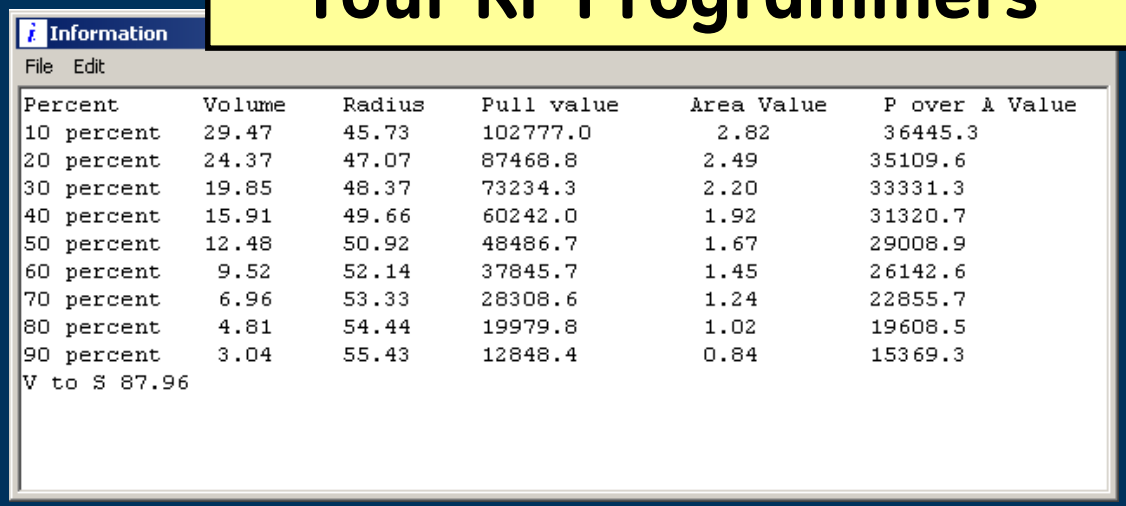
Achieving DoE with Part Families

Benefits of Unigraphics for DoE?

- Knowledge Fusion for Automation

1) Be Picky on What is KF
2) Choose Key People to be Your KF Programmers



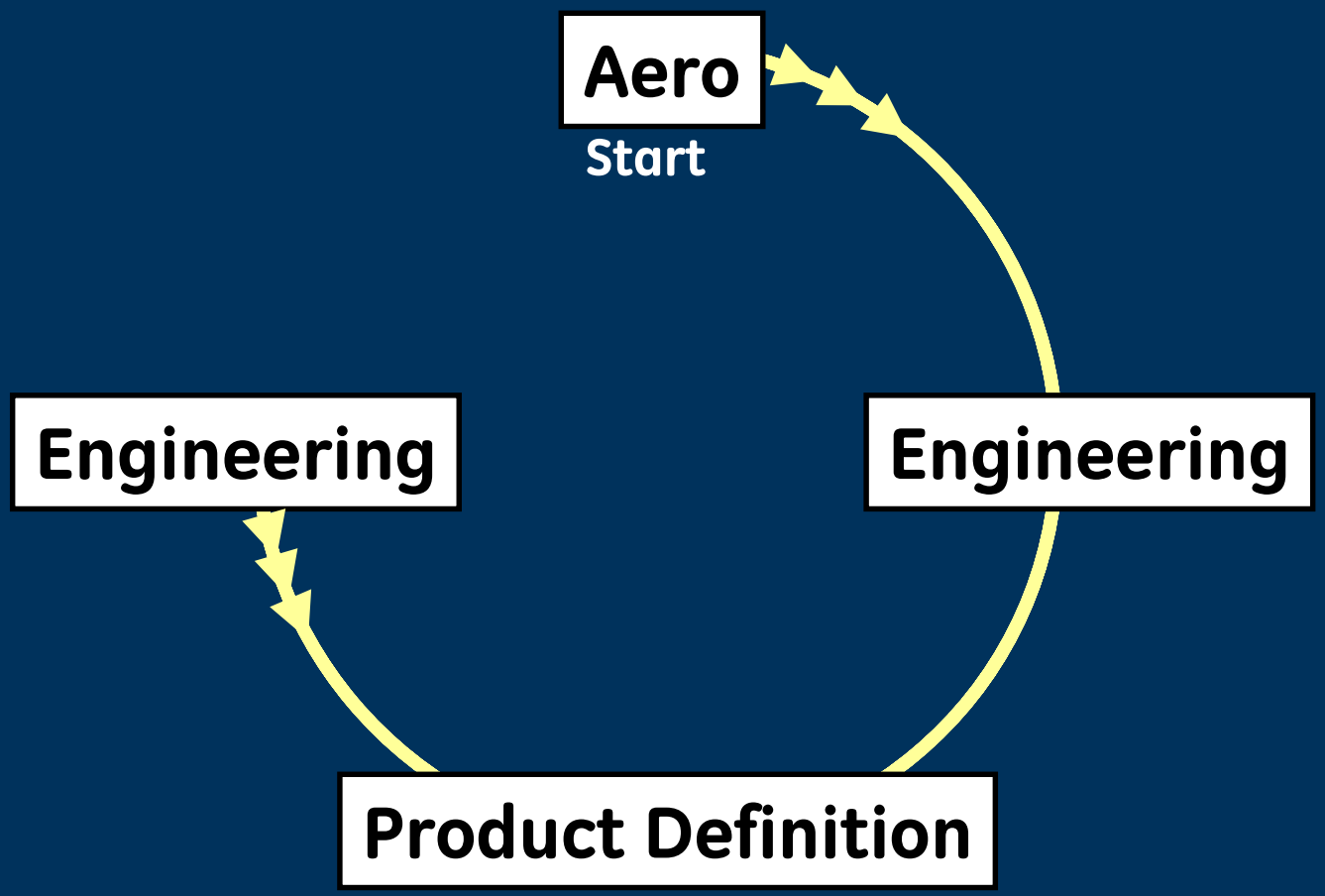


Percent	Volume	Radius	Pull value	Area Value	P over A Value
10 percent	29.47	45.73	102777.0	2.82	36445.3
20 percent	24.37	47.07	87468.8	2.49	35109.6
30 percent	19.85	48.37	73234.3	2.20	33331.3
40 percent	15.91	49.66	60242.0	1.92	31320.7
50 percent	12.48	50.92	48486.7	1.67	29008.9
60 percent	9.52	52.14	37845.7	1.45	26142.6
70 percent	6.96	53.33	28308.6	1.24	22855.7
80 percent	4.81	54.44	19979.8	1.02	19608.5
90 percent	3.04	55.43	12848.4	0.84	15369.3

V to S 87.96

Achieving DoE with Part Families

Life Cycle of a DoE – Forward and Back



Achieving DoE with Part Families

Fully Parametric Part Family Method Saved 6 Months – 9 Months on This Particular DoE

Time Savings = Money Savings

Achieving DoE with Part Families

Demo Will Include… Also See Appendix

- Part Families => Live DoE Run
- KF Program => List Results
- Basic Sketcher => Define Requirements
- Tagging UG Faces => FEA Mesh
- Copy / Paste Feature => Quick Duplication
- Sectioning => Visual Comparison

Achieving DoE with Part Families

Demo

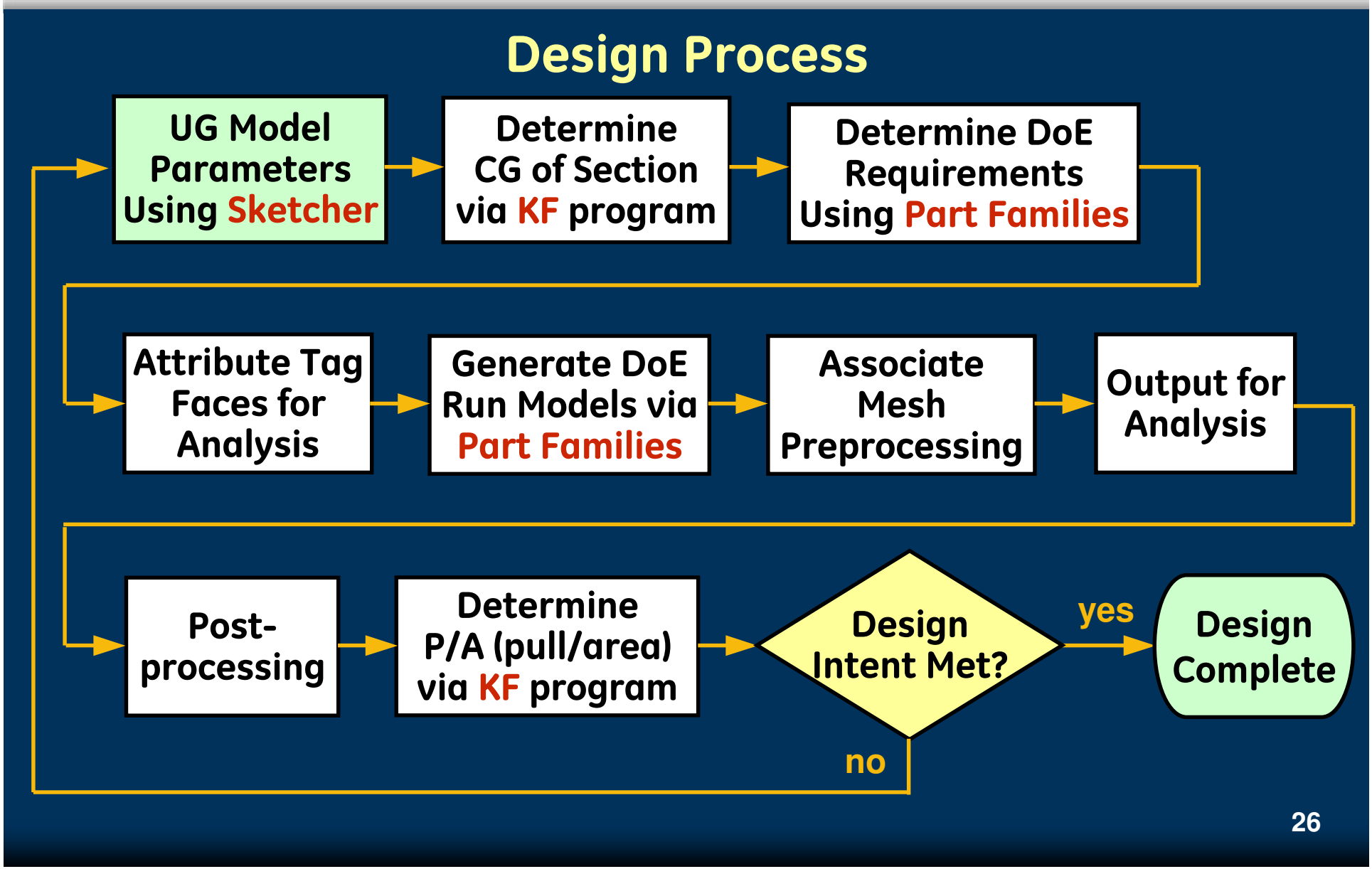
Appendix

Achieving DoE with Part Families

Table of Contents:

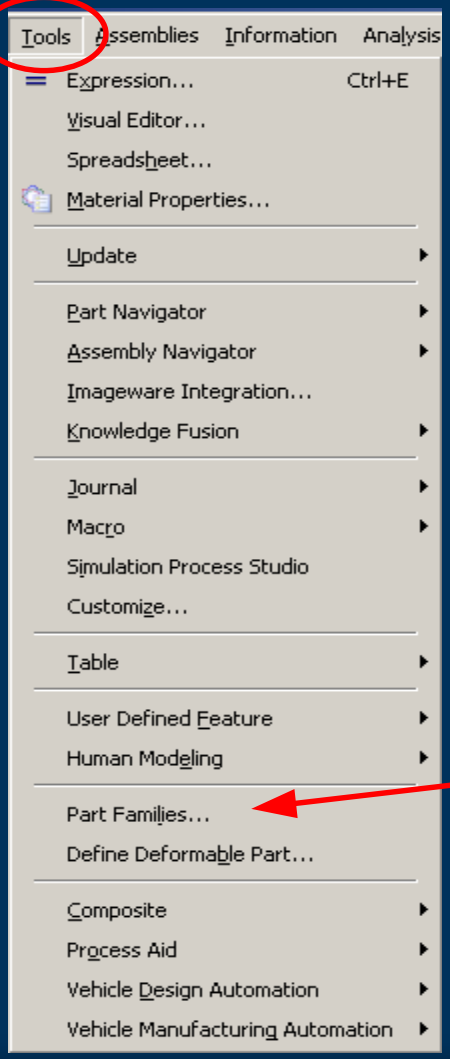
Design Process 26
Part Families 27
Knowledge Fusion (KF) 30
Tagging for FEA 34
Expressions 37
Copy / Paste Feature 38
Model Sectioning 40

Achieving DoE with Part Families



Achieving DoE with Part Families

Part Families Input



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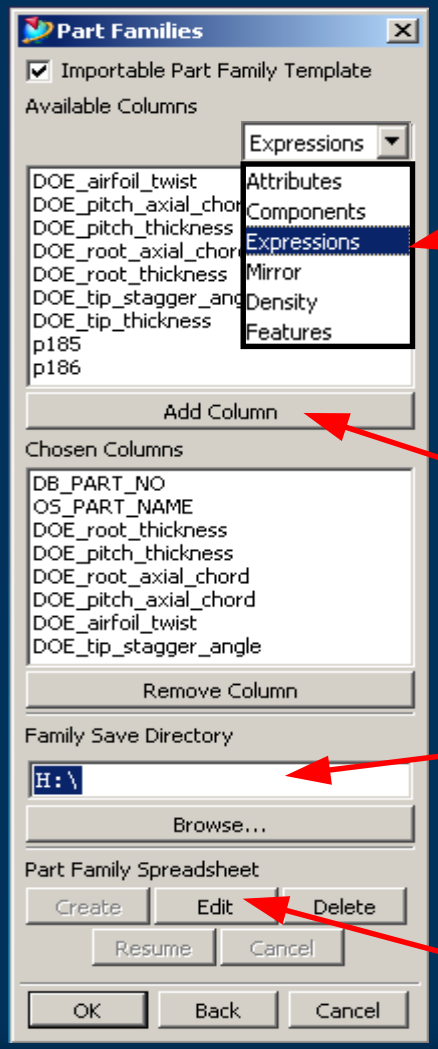


Tip: Mix and Match for Optimization

2) Choose Needed Expressions then Add Column

Tip: Save to Native UG

3

Achieving DoE with Part Families

Part Families Output

4

Microsoft Excel - Worksheet in Part Family - S3B_DOE4_PARTFAMILY_MASTER

File Edit View Insert Format Tools Data Window Help PartFamily

A1 = DB_PART_NO

	A	B	C	D	E	F	G	H
1	DB_PART_NO	OS_PART_NAME	DOE_root_thickness	DOE_pitch_thickness	DOE_root_axial_chord	DOE_pitch_axial_chord	DOE_airfoil_twist	DOE_tip_stagger_angle
2	doe4_run1	doe4_run1	-0.15	-0.115	-0.4	-0.25	-7	-5
3	doe4_run2	doe4_run2	0.15	-0.115	-0.4	-0.25	-7	5
4	doe4_run3	doe4_run3	-0.15	0.115	-0.4	-0.25	-7	5
5	doe4_run4	doe4_run4	0.15	0.115	-0.4	-0.25	-7	-5
6	doe4_run5	doe4_run5	-0.15	-0.115	0.4	-0.25	-7	5
7	doe4_run6	doe4_run6	0.15	-0.115	0.4	-0.25	-7	-5
8	doe4_run7	doe4_run7	-0.15	0.115	0.4	-0.25	-7	-5
9	doe4_run8	doe4_run8	0.15	0.115	0.4	-0.25	-7	5
10	doe4_run9	doe4_run9	-0.15	-0.115	-0.4	0.25	-7	5
11	doe4_run10	doe4_run10	0.15				-7	-5
12	doe4_run11	doe4_run11	-0.15				-7	-5
13	doe4_run12	doe4_run12	0.15				-7	5
14	doe4_run13	doe4_run13	-0.15				-7	-5
15	doe4_run14	doe4_run14	0.15				-7	5
16	doe4_run15	doe4_run15	-0.15				-7	5
17	doe4_run16	doe4_run16	0.15				-7	-5
18	doe4_run17	doe4_run17	-0.15				7	5
19	doe4_run18	doe4_run18	0.15				7	-5
20	doe4_run19	doe4_run19	-0.15				7	-5
21	doe4_run20	doe4_run20	0.15				7	5
22	doe4_run21	doe4_run21	-0.15				7	-5
23	doe4_run22	doe4_run22	0.15	-0.115	0.4	-0.25	7	5
24	doe4_run23	doe4_run23	-0.15	0.115	0.4	-0.25	7	5
25	doe4_run24	doe4_run24	0.15	0.115	0.4	-0.25	7	-5
26	doe4_run25	doe4_run25	-0.15	-0.115	-0.4	0.25	7	-5
27	doe4_run26	doe4_run26	0.15	-0.115	-0.4	0.25	7	5
28	doe4_run27	doe4_run27	-0.15	0.115	-0.4	0.25	7	5
29	doe4_run28	doe4_run28	0.15	0.115	-0.4	0.25	7	-5
30	doe4_run29	doe4_run29	-0.15	-0.115	0.4	0.25	7	5
31	doe4_run30	doe4_run30	0.15	-0.115	0.4	0.25	7	-5
32	doe4_run31	doe4_run31	-0.15	0.115	0.4	0.25	7	-5
33	doe4_run32	doe4_run32	0.15	0.115	0.4	0.25	7	5
34	doe4_run33	doe4_run33	0.15	0	0	0	0	0
35	doe4_run34	doe4_run34	0	0.115	0	0	0	0
36	doe4_run35	doe4_run35	0	0	0.4	0	0	0
37	doe4_run36	doe4_run36	0	0	0	0.25	0	0
38	doe4_run37	doe4_run37	0	0	0	0	7	0
39	doe4_run38	doe4_run38	0	0	0	0	0	5
40	doe4_run39	doe4_run39	-0.15	0	0	0	0	0

- **Headers will Show in Row #1**
- **Add Part Variables in Rows #2-40**

Sheet1

Family Initialized

NUM

Achieving DoE with Part Families

Part Families Output

Microsoft Excel - Worksheet in Part Family - S3B_DOE4_PARTFAMILY_MASTER

File Edit View Insert Format Tools Data Window Help

PartFamily

Verify Part
Apply Values
Update Parts
Create Parts
Save Family
Cancel

A1 = DB_PART_NO

	A	B	C		E	F	G	H
1	DB_PART_NO	OS_PART_NAME	DOE_root_thic	ickness	DOE_root_axial_chord	DOE_pitch_axial_chord	DOE_airfoil_twist	DOE_tip_stagger_angle
2	doe4_run1	doe4_run1	-0.15		-0.4	-0.25	-7	-5
3	doe4_run2	doe4_run2	0.15		-0.4	-0.25	-7	5
4	doe4_run3	doe4_run3	-0.15		-0.4	-0.25	-7	5
5	doe4_run4	doe4_run4	0.15		-0.4	-0.25	-7	-5
6	doe4_run5	doe4_run5	-0.15		0.4	-0.25	-7	5
7	doe4_run6	doe4_run6	0.15	-0.115	0.4	-0.25	-7	-5
8	doe4_run7	doe4_run7	-0.15	0.115				-5
9	doe4_run8	doe4_run8	0.15	0.115				5
10	doe4_run9	doe4_run9	-0.15	-0.115				5
11	doe4_run10	doe4_run10	0.15	-0.115				-5
12	doe4_run11	doe4_run11	-0.15	0.115				-5
13	doe4_run12	doe4_run12	0.15	0.115				5
14	doe4_run13	doe4_run13	-0.15	-0.115				-5
15	doe4_run14	doe4_run14	0.15	-0.115				5
16	doe4_run15	doe4_run15	-0.15	0.115				5
17	doe4_run16	doe4_run16	0.15	0.115				-5
18	doe4_run17	doe4_run17	-0.15	-0.115	-0.4	-0.25	7	5
19	doe4_run18	doe4_run18	0.15	-0.115	-0.4	-0.25	7	-5
20	doe4_run19	doe4_run19	-0.15	0.115	-0.4	-0.25	7	-5
21	doe4_run20	doe4_run20	0.15	0.115	-0.4	-0.25	7	5
22	doe4_run21	doe4_run21	-0.15	-0.115	0.4	-0.25	7	-5
23	doe4_run22	doe4_run22	0.15	-0.115	0.4	-0.25	7	5
24	doe4_run23	doe4_run23	-0.15	0.115	0.4	-0.25	7	5
25	doe4_run24	doe4_run24	0.15	0.115	0.4	-0.25	7	-5
26	doe4_run25	doe4_run25	-0.15	-0.115	-0.4	0.25	7	-5
27	doe4_run26	doe4_run26	0.15	-0.115	-0.4	0.25	7	5
28	doe4_run27	doe4_run27	-0.15	0.115	-0.4	0.25	7	5
29	doe4_run28	doe4_run28	0.15	0.115	-0.4	0.25	7	-5
30	doe4_run29	doe4_run29	-0.15	-0.115	0.4	0.25	7	5
31	doe4_run30	doe4_run30	0.15	-0.115	0.4	0.25	7	-5
32	doe4_run31	doe4_run31	-0.15	0.115	0.4	0.25	7	-5
33	doe4_run32	doe4_run32	0.15	0.115	0.4	0.25	7	5
34	doe4_run33	doe4_run33	0.15	0	0	0	0	0
35	doe4_run34	doe4_run34	0	0.115	0	0	0	0
36	doe4_run35	doe4_run35	0	0	0.4	0	0	0
37	doe4_run36	doe4_run36	0	0	0	0.25	0	0
38	doe4_run37	doe4_run37	0	0	0	0	7	0
39	doe4_run38	doe4_run38	0	0	0	0	0	5
40	doe4_run39	doe4_run39	-0.15	0	0	0	0	0

Sheet1

Family Initialized

- **Highlight Desired Rows then Select *Create Part* from Pull Down**

Achieving DoE with Part Families

Tip Shroud KF Program

Shroud/Cutter | Z-Form | Scallop Cuts

☑ Create Base Model

Axis Length

1.00

.05 — 2.00

Shroud Base Parameters

Shroud Thickness	0.1250
Extension of Base	1.0000
Start Angle	-10.0000
End Angle	10.0000

Cutter Parameters

Number of Cutter Teeth	1
B - Top of Cutter Width	0.1800
C - Height of Cutter	0.4000
D. Tooth offset (+Upstream)	-0.1000
Draft Angle	3.0000

<<<<<RESULTS>>>>

dx (+Upstream) = -0.020
dy (+Left) = -0.004
dz (+Larger Rad) = 0.000

OK | Apply | Cancel

Shroud/Cutter | Z-Form | Scallop Cuts

>>>> Pressure Face(Load Face) <<<<

Dist. LE Pierce	0.8000
Angle	55.0000
Length	0.4000

>>>>>> FWD Adjacent Face <<<<<<<

Angle	-45.0000
length	0.6000

>>>>> AFT Adjacent Face <<<<<<

Length	0.5000
Bucket Count	92.0000

OK | Apply | Cancel

Shroud/Cutter | Z-Form | Scallop Cuts

>>>> PRESSURE SIDE <<<<<<

LE Offset	0.3000
PS Point Dist from LE	1.5000
PS Offset Length	0.8000
Leading Edge % Spacing	0.0100
Angle to Zcut for Tangency	90.0000
Tangency Vector Magnitude	0.5000

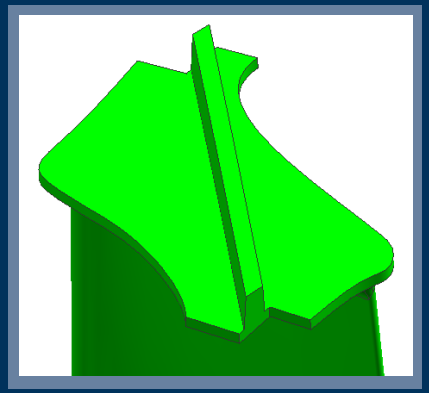
>>>> SUCTION SIDE <<<<

TE Offset	0.1500
SS Point Dist from TE	0.3000
SS Offset Length	0.2500
Trailing Edge % Spacing	0.0050
Angle to Zcut for Tangency	70.0000
Tangency Vector Magnitude	0.7500

☐ Use 2 lines for SS Scallop Control

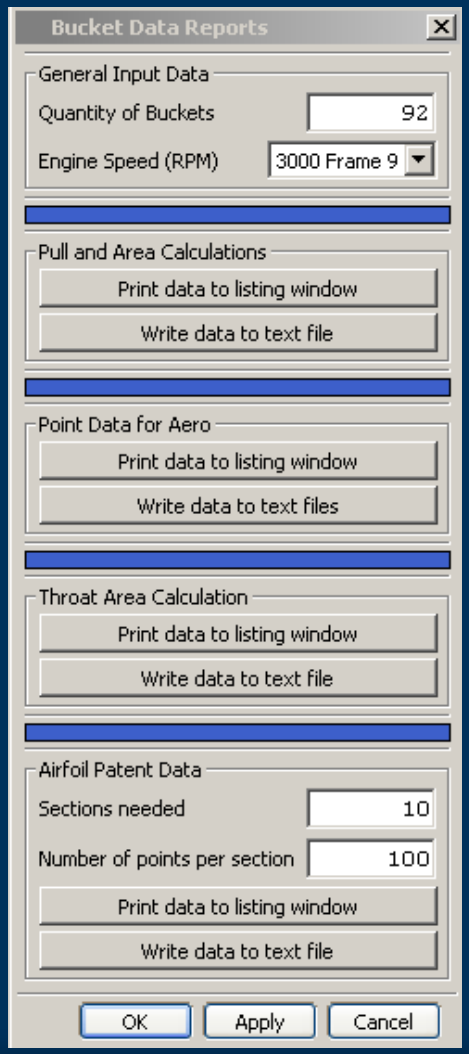
☑ Make Solid Cuts

OK | Apply | Cancel



Achieving DoE with Part Families

Pull over Area (PoA) KF Program



Dialog Identifiers:

Quantity of Buckets – **QTY_OF_BUCKETS**

Engine Speed (RPM) - **ENG_RPM**

PoA Listing Window – **POA_LISTING_WINDOW_DATA**

PoA Data File – **WRITE_FILE_FOR_POA_FILE**

Aero Listing Window – **AERO_LISTING_WINDOW_DATA**

Aero Data Files – **AERO_WRITE_AERO_FILES**

Throat Sections needed – **NUMBER_OF_THROAT_SECTIONS**

Throat Listing Window – **THROAT_LISTING_WINDOW_DATA**

Throat Data File – **WRITE_FILE_FOR_THROAT_FILE**

Sections Needed – **NUMBER_OF_PATENT_SECTIONS**

Number of points per section – **NUMBER_OF_PATENT_POINTS**

Patent Listing Window – **PATENT_LISTING_WINDOW_DATA**

Patent Date File - **WRITE_FILE_FOR_PATENT_FILE**

Achieving DoE with Part Families

KF Program Code to Write Data to File

TextPad - [\\ngw-204017267p\7fb_s3b_igcc\User_Conference\PoA.dfa]

File Edit Search View Tools Macros Configure Window Help

PoA.dfa

```
##########################################################

# PUT outputs into text file
(string parameter modifiable) write_file_for_poa_file: "c:\poa_data.txt";

(list) write_file_for_poa_file_act:
@{
        # if the file does not exist, then create it
        $confirmfile << IF (Access(write_file_for_poa_file:,Exists)) THEN doNothing ELSE closeFile(openFile(
        write_file_for_poa_file:,Write));
        $op << openFile( write_file_for_poa_file:; writeappend );
        $filename3 << first(SplitString(ug_askCurrentWorkPart( ), "."));
        $wr1 << write( $filename3 + "~n" +
        "Percent     Volume    Radius    Pull value     Area Value    P over A Value~n", $op);

        $wr2 << loop
        {
            for $a from 1 to number_of_sections:;
            do write( format("%2.0f",$a*10) + " percent   " + format("%5.2f",nth($a,bucket_volumes:)) + "     " +
            format("%5.2f",nth($a,bucket_z_centroids:)) + "     " + format("%6.1f",nth($a,bucket_pull:)) + "       " +
            format("%5.2f",nth($a,bucket_trimmed_surface_area:)) + "        " + format("%6.1f",nth($a,
            bucket_pull_over_area:)) + "~n",$op);
          return is 0;
        };

        $wr3 << write("V to S " + format("%5.2f",body_full:Volume:) + "  " + "~n~n",$op );

        $cl << closeFile( $op );

        {$op,$wr1,$cl};
};
```

ANSI Characters

33	!
34	"
35	#
36	$
37	%
38	&
39	'
40	(
41	)
42	*
43	+
44	,
45	-
46	.
47	/
48	0
49	1

168 253 Read Ovr Block Sync Rec Caps

Achieving DoE with Part Families

KF Program Code to Print Data to Listing Window

TextPad - [\\ngw-204017267p\7fb_s3b_igcc\User_Conference\PoA.dfa]

File Edit Search View Tools Macros Configure Window Help

PoA.dfa

```
(Integer parameter uncached) poa_listing_window_data_act:
@{

    $p0 << ug_printValues({"Percent     Volume    Radius    Pull value     Area Value    P over A Value"} );
    $p1 << loop
    {
        for $a from 1 to number_of_sections:;
        do  ug_printValues({ format("%2.0f",$a*10) + " percent    " + format("%5.2f",nth($a,bucket_volumes:)) + "     "
        + format("%5.2f",nth($a,bucket_z_centroids:)) + "     " + format("%6.1f",nth($a,bucket_pull:)) + "        " +
        format("%5.2f",nth($a,bucket_trimmed_surface_area:)) + "        " + format("%6.1f",nth($a,
        bucket_pull_over_area:)) });
        return is 0;
    };

    $p10 << ug_printValues({"V to S " +  format("%5.2f",body_full:Volume:) } );

};
```

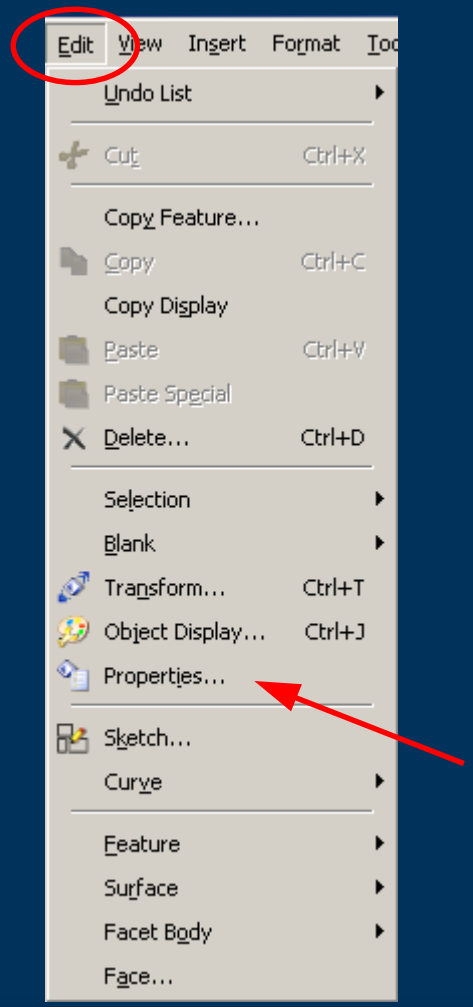
ANSI Characters

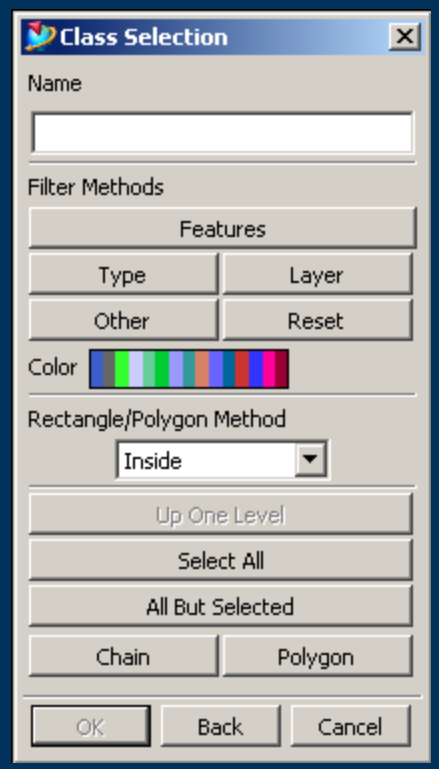
33 !
34 "
35 #
36 $
37 %
38 &
39 '
40 (
41)
42 *

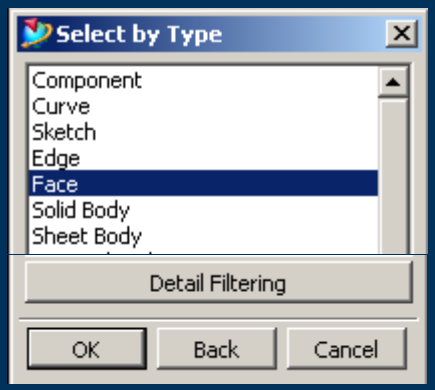
168 253 Read Ovr Block Sync Rec Caps

Achieving DoE with Part Families

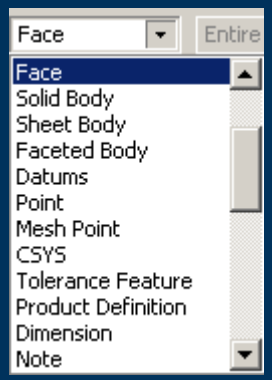
Tagging Faces for FEA







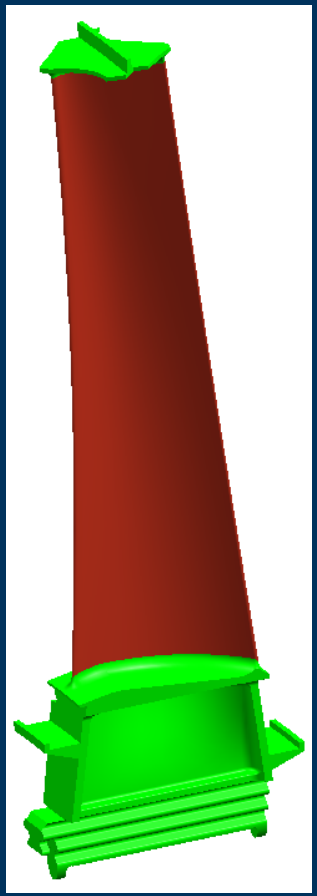
Long Method

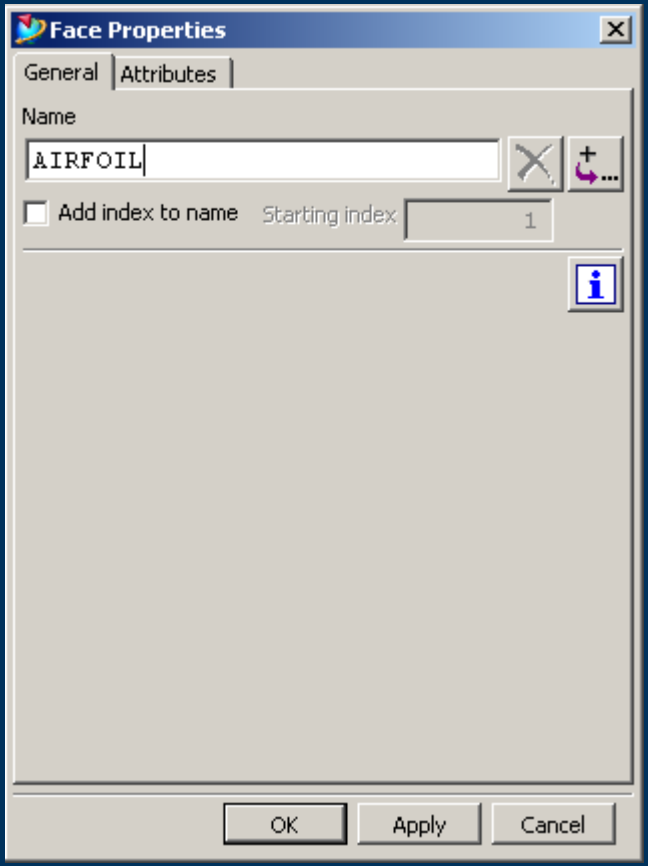


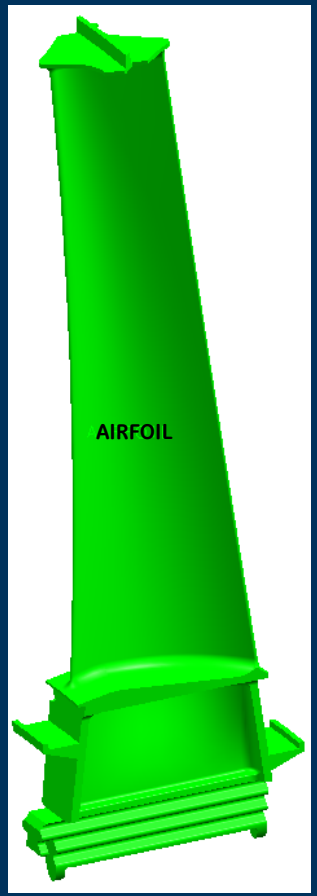
Preferred Method

Achieving DoE with Part Families

Tagging Faces for FEA



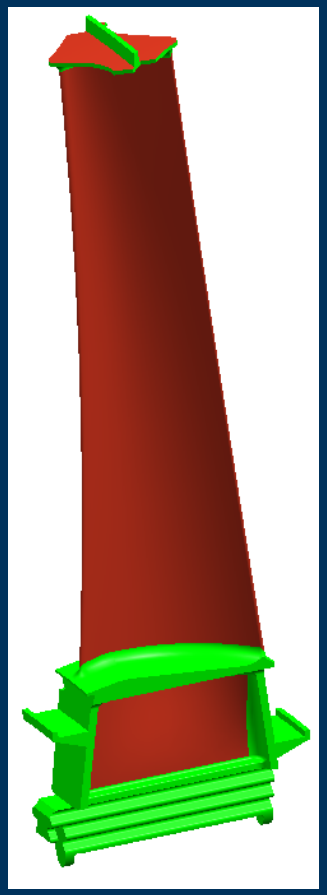


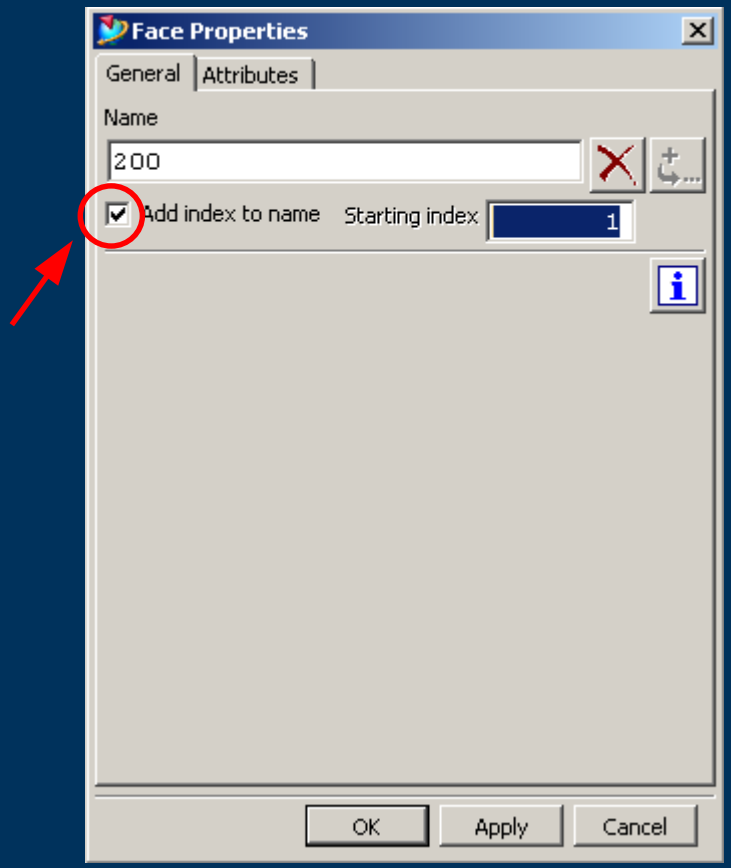


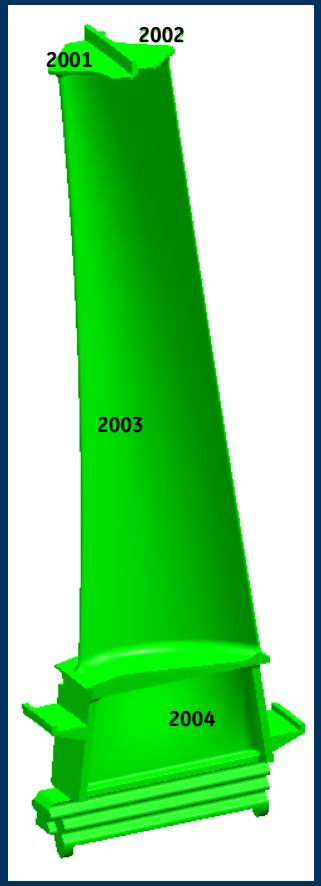
Option 1 – single name

Achieving DoE with Part Families

Tagging Faces for FEA







Option 2 – Sequential

Achieving DoE with Part Families

Expression Naming and Filtering

Filter by Formula

- User Defined
- Named
- Filter by Name
- Filter by Value
- Filter by Formula
- Unused Expressions
- Object Parameters
- Measurements
- All

Expressions

Listed Expressions: Filter by Formula | *DOE*

Name	Formula	Value	Un
DOE_airfoil_Twist	s3b_doe4_partfamily_master::DOE_airfoil_twist	0	
DOE_pitch_chord	s3b_doe4_partfamily_master::DOE_pitch_axial_chord	0	
DOE_pitch_Tmax	s3b_doe4_partfamily_master::DOE_pitch_thickness	0	
DOE_root_chord	s3b_doe4_partfamily_master::DOE_root_axial_chord	0	
DOE_root_Tmax	s3b_doe4_partfamily_master::DOE_root_thickness	0	
DOE_tip_stagger_angle	s3b_doe4_partfamily_master::DOE_tip_stagger_angle	0	
DOE_tip_Tmax	s3b_doe4_partfamily_master::DOE_tip_thickness	0	
p222 (LE_AND_TE_RADII_SECTION_1:Sketch(5) Horizontal Dimension between Line174 and Line174)	s1_Meridional_Chord+DOE_root_chord	5.5362	
p288 (LE_AND_TE_RADII_SECTION_2:Sketch(13) Horizontal Dimension between Line174_0 and Line174_0)	s2_Meridional_Chord+DOE_pitch_chord	3.7237	
p358 (S1_TMAX:Sketch(11) Diameter Dimension on Arc23)	s1_Tmax+DOE_root_Tmax	0.7	
p361 (LE_AND_TE_RADII_SECTION_1:Sketch(5) Positioning Dimension Angle To Edge...)	90-(DOE_airfoil_Twist/2)	90	
p364 (LE_AND_TE_RADII_SECTION_3:Sketch(22) Positioning Dimension Angle To Edge...)	90+(DOE_airfoil_Twist/2)+DOE_tip_stagger_angle	90	
p366 (S2_TMAX:Sketch(19) Diameter Dimension on Arc24)	s2_Tmax+DOE_pitch_Tmax	0.594	
p370 (S3_TMAX:Sketch(28) Diameter Dimension on Arc25)	s3_Tmax+DOE_tip_Tmax	0.23	
p379 (S1_TMAX:Sketch(11) Perpendicular Dimension between Line219 and Line197)	if(DOE_root_Tmax<=0)(.00001)else(DOE_root_Tmax*.75)	1e-005	
p381 (S1_TMAX:Sketch(11) Perpendicular Dimension between Line220 and Line201)	if(DOE_root_Tmax<=0)(.00001)else(DOE_root_Tmax*.25)	1e-005	
p382 (S2_TMAX:Sketch(19) Perpendicular Dimension between Line221 and Line198_0)	if(DOE_pitch_Tmax<=0)(.00001)else(DOE_pitch_Tmax*.75)	1e-005	
p383 (S2_TMAX:Sketch(19) Perpendicular Dimension between Line222 and Line201_0)	if(DOE_pitch_Tmax<=0)(.00001)else(DOE_pitch_Tmax*.25)	1e-005	
p384 (S3_TMAX:Sketch(28) Perpendicular Dimension between Line223 and Line198_0_0)	if(DOE_tip_Tmax<=0)(.00001)else(DOE_tip_Tmax*.75)	1e-005	
p385 (S3_TMAX:Sketch(28) Perpendicular Dimension between Line224 and Line201_0_0)	if(DOE_tip_Tmax<=0)(.00001)else(DOE_tip_Tmax*.25)	1e-005	

Length

Name

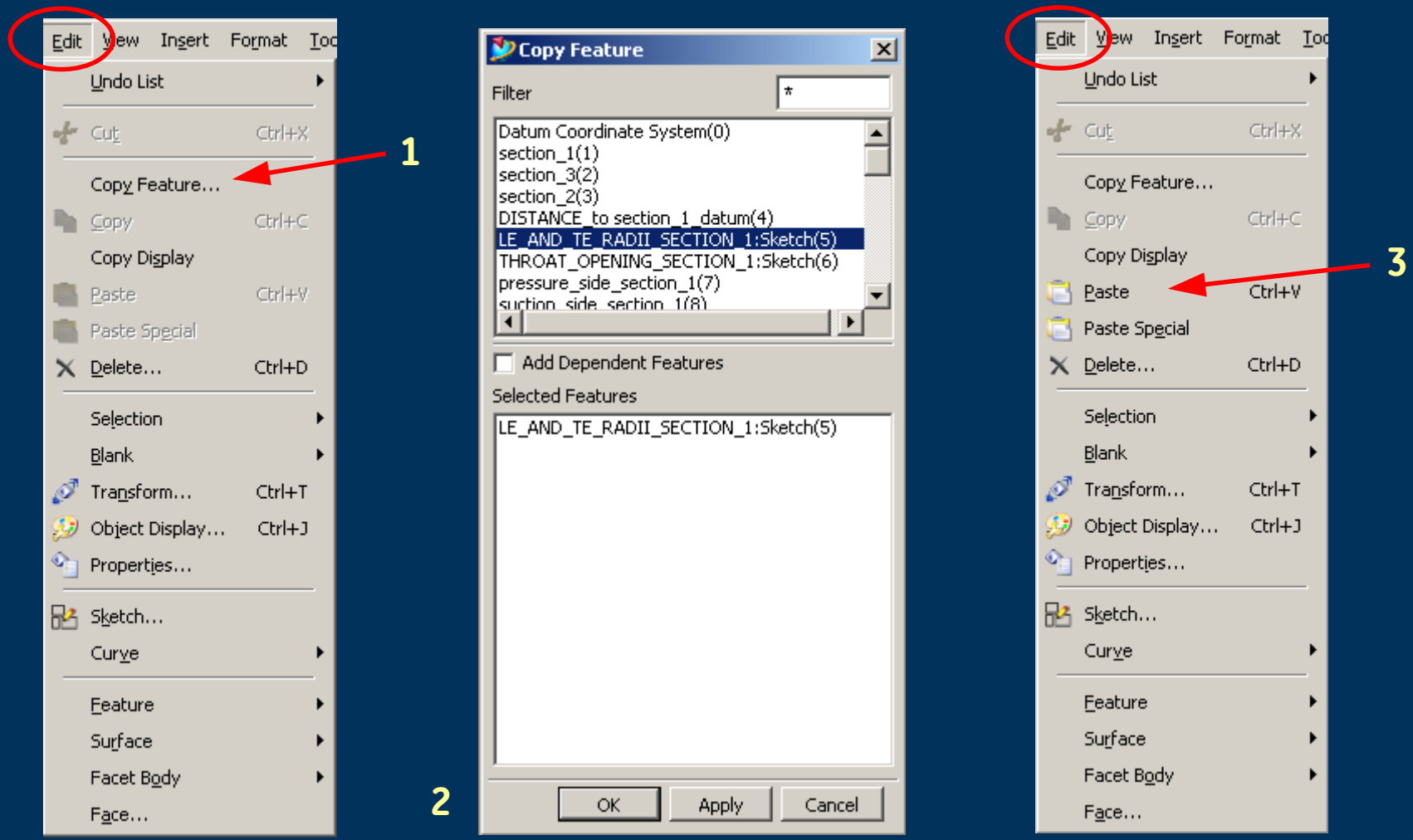
in

Formula

OK | Apply | Cancel

Achieving DoE with Part Families

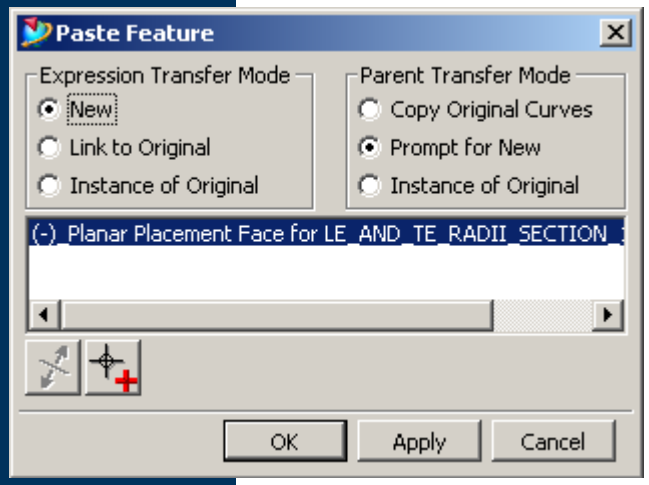
Copy / Paste Feature

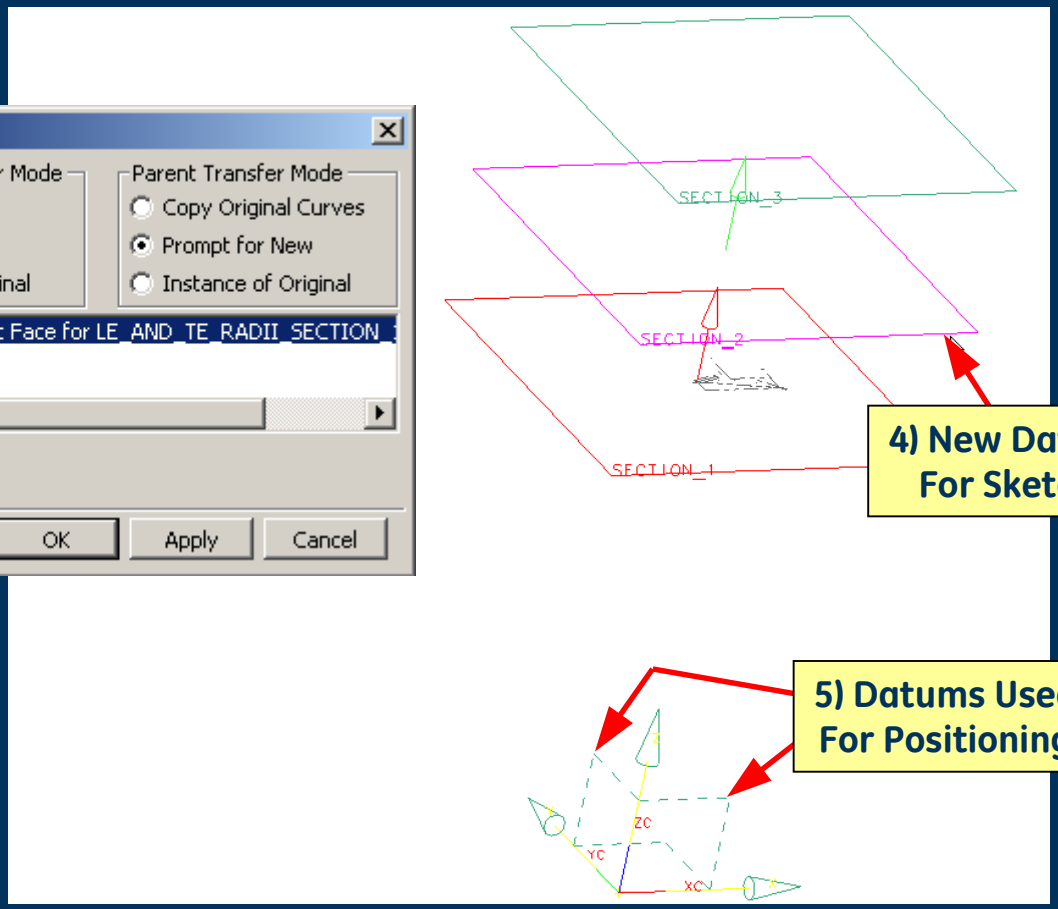


Achieving DoE with Part Families

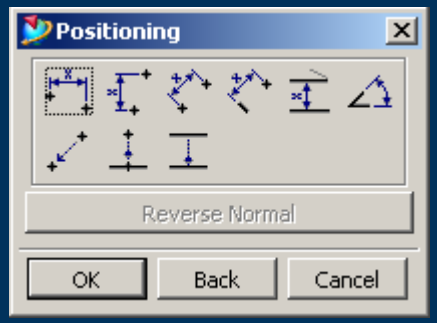
Copy / Paste Feature

4



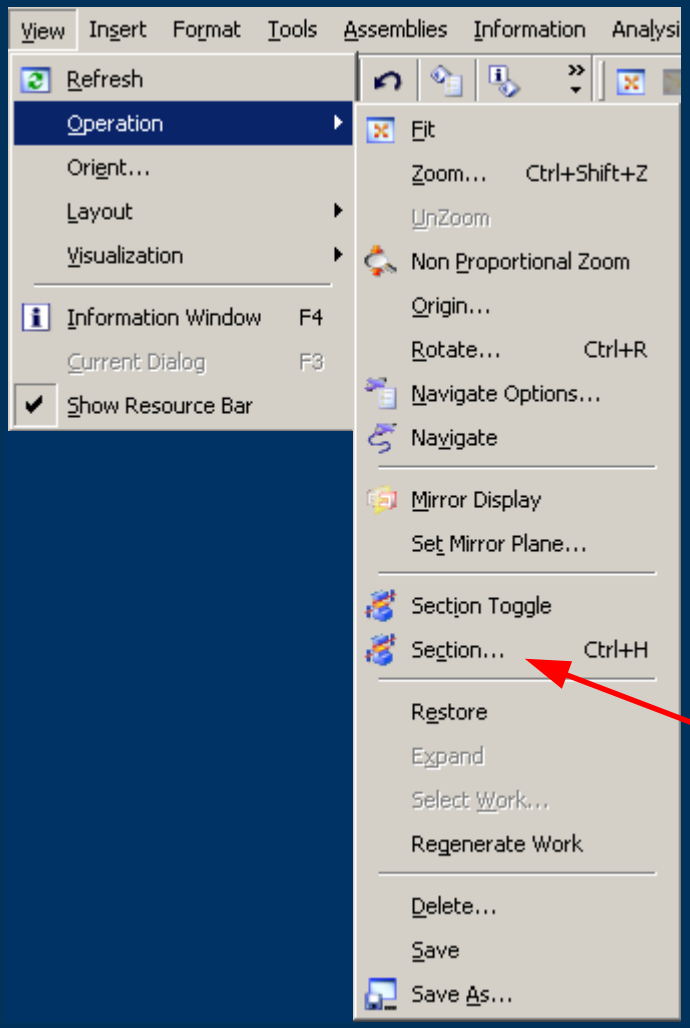


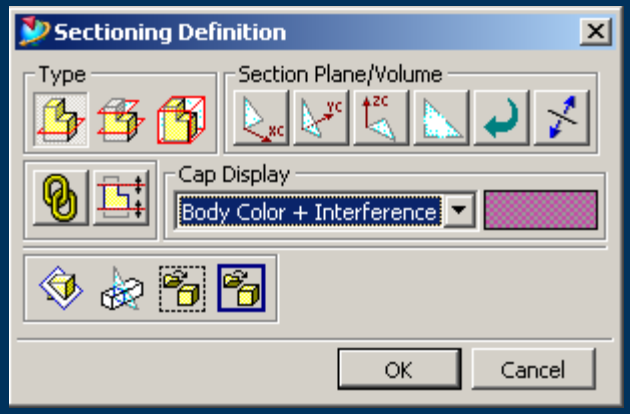
5



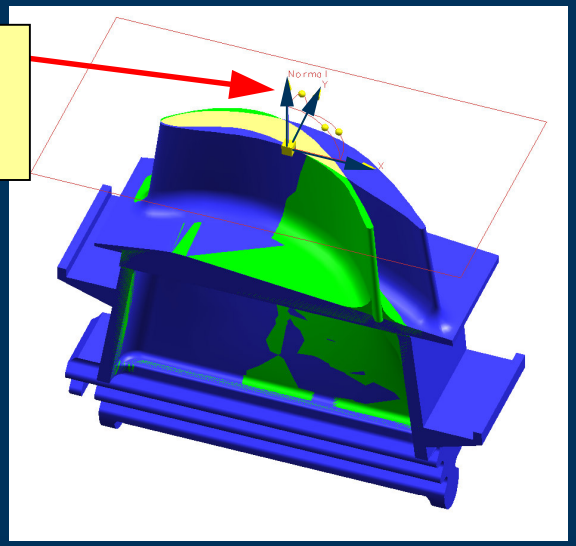
Achieving DoE with Part Families

Model Sectioning





Pick Arrow and Drag Normal to Section Plane



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Questions?