

N94-22366

UNSTRUCTURED SURFACE GRID GENERATION

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- o INTRODUCTION
- o REQUIREMENTS
- o SURFACE APPROXIMATIONS
- o METHODS
- o GEOLAB EFFORT

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- o Complex Shapes
- o Turn-Around Time
- o CPU Time
- o Applications
 - o Advancing Front
 - o Prismatic Elements
 - o Delaunay (Steiner Triangulation)

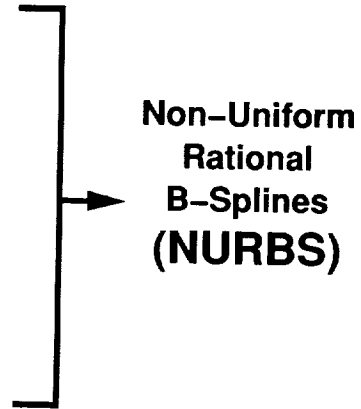


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REQUIREMENTS

Curves, Surfaces, Solids, Text

- o Curves and Surfaces
 - o Bicubic Patches
 - o Conic Sections
 - o Splines (any order)
 - o B-Splines
 - o Parametric Splines
 - o Points and Tabulated data
 - o Ruled Surfaces
 - o Surfaces of Revolution
 - o Trimmed Surfaces



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REQUIREMENTS Cont.

- o Spacing
- o Stretching
- o Over 50 Surfaces
NURBS, Trimmed
- o User Input
Turn-Around Time (Day)
- o Adaptivity
- o Parametric Study



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REQUIREMENTS Cont.

Few Surfaces
Simple Configurations

Present

Lots of Patches
More User's Time

Lots of Surfaces
Complex Configurations

Future

Few Patches
Less User's Time

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SURFACE APPROXIMATION (I)

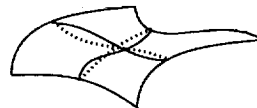
CAD DATA



BOUNDARY CURVES



GRID



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SURFACE APPROXIMATION (II)

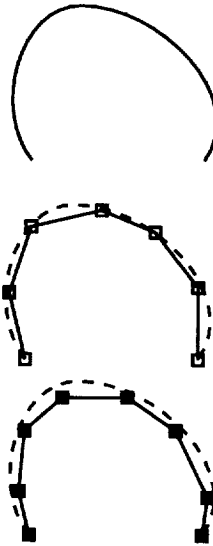
CAD DATA



POINTS



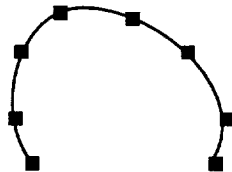
GRID



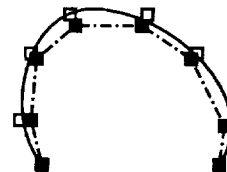
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EXACT SURFACE REPRESENTATION

Direct Surface Triangulation



Type I and II +
Projection



LANGLEY HAS TWO PROJECTION
CODES FOR STRUCTURED AND
UNSTRUCTURED GRIDS

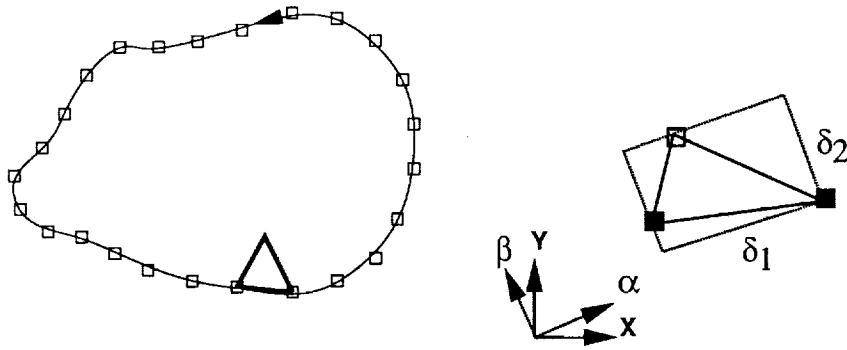
AIAA 93-3454 (august 1993)

info: jamshid@geosun1.larc.nasa.gov

copy: pkerr@geolab2.larc.nasa.gov

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Advancing Front



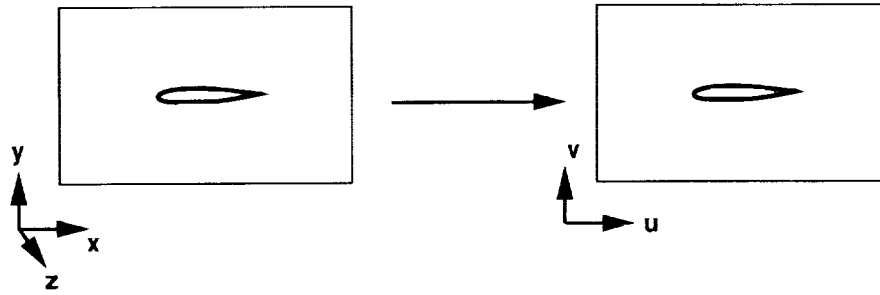
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METHODS

- o 2D (Planes, Triangulation is performed in the parameter space)
- o 2 1/2 D (Triangulation is performed in the Parameter Space)
- o 3D (Triangulation is performed in the Physical and Parameter Spaces)

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2D (PLANES)



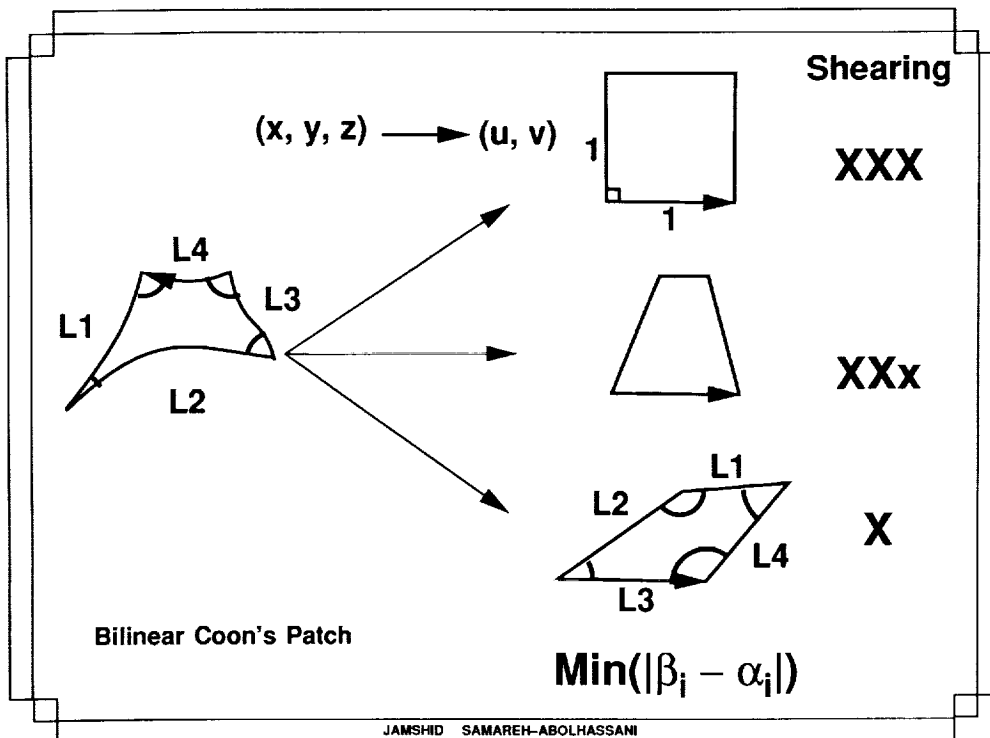
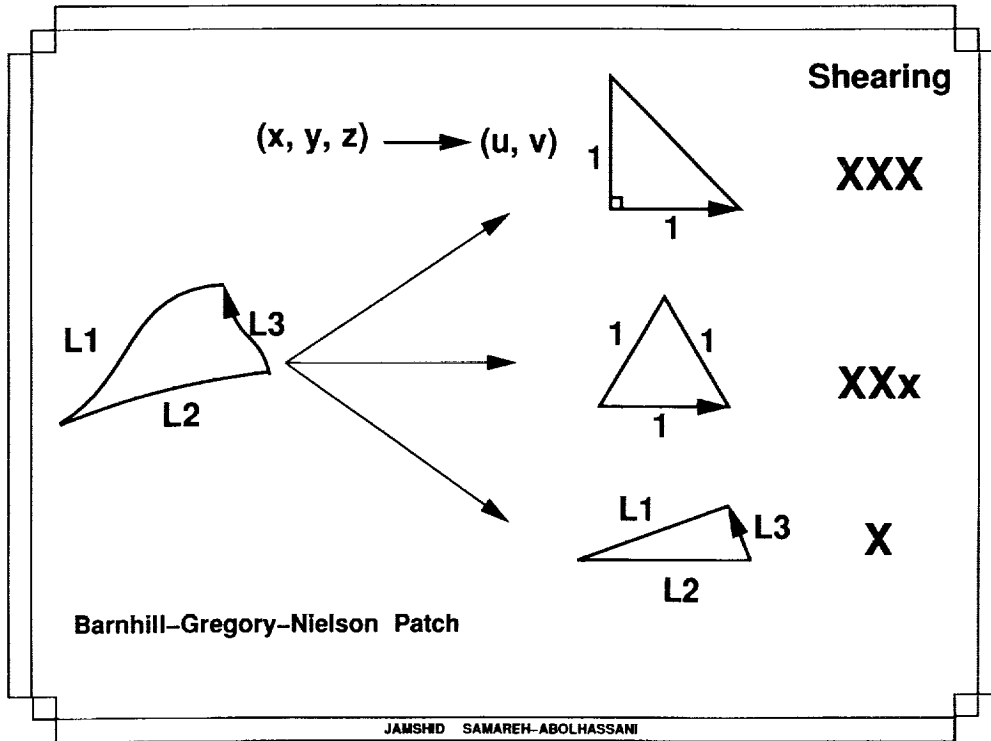
- o Exact
- o No Shearing (Exact shape and size)
- o Speed (0)

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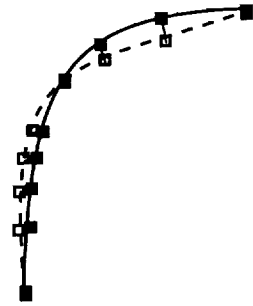
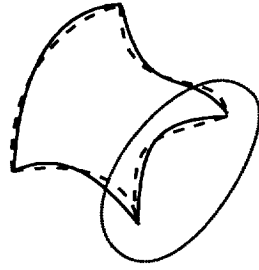
2½D Advancing Front Type I



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PROJECTION



Cons:

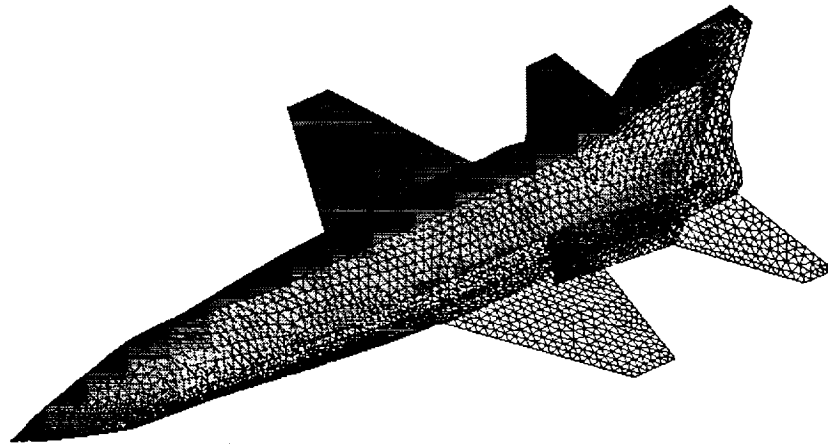
- o Shearing
- o Speed (1)
- o 3/4 Sided-Patches Only
- o More Patches Are Needed

Pros:

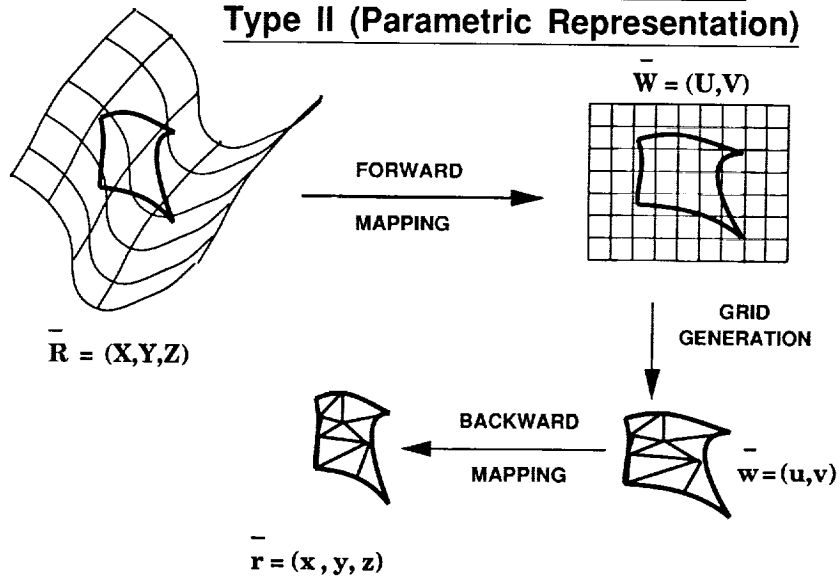
- o Surfaces Are Exact
- o Multiple Surfaces
- o T-Connections

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X-15

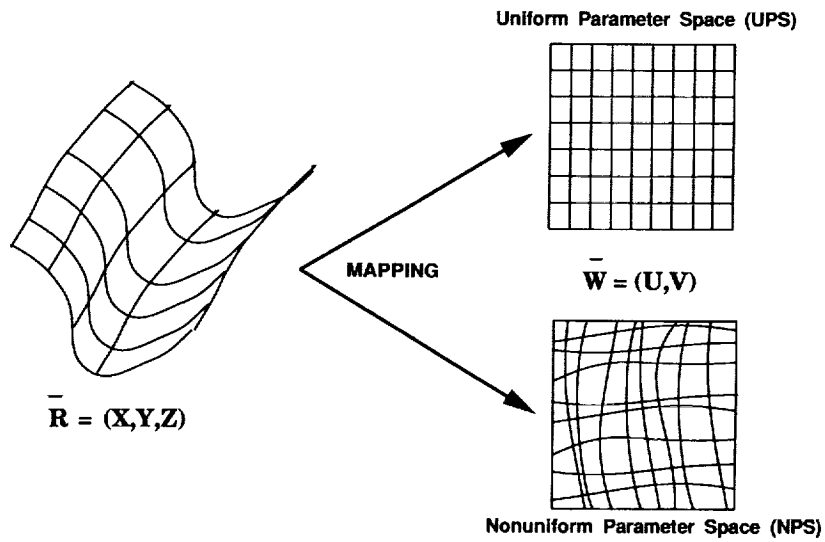


2½D Advancing Front Type II (Parametric Representation)

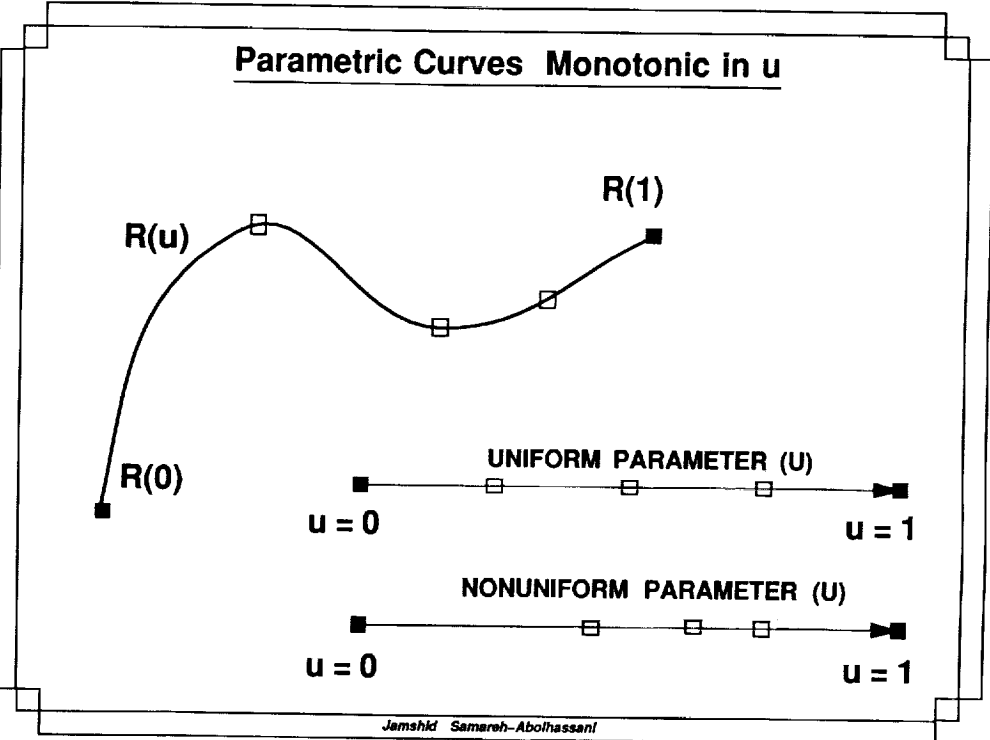
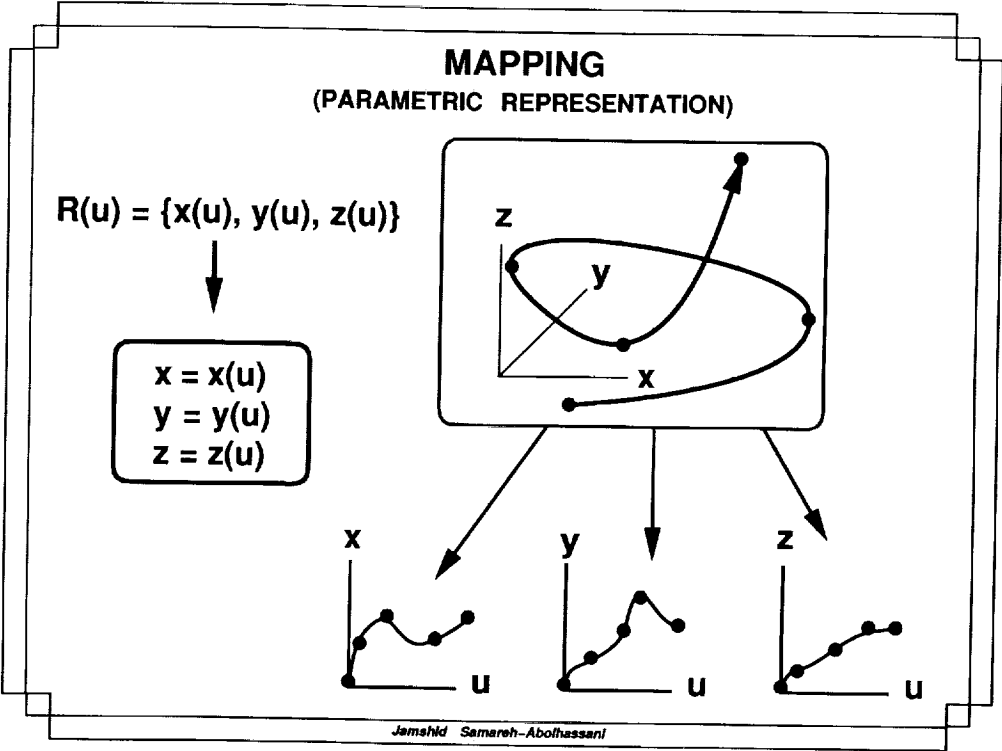


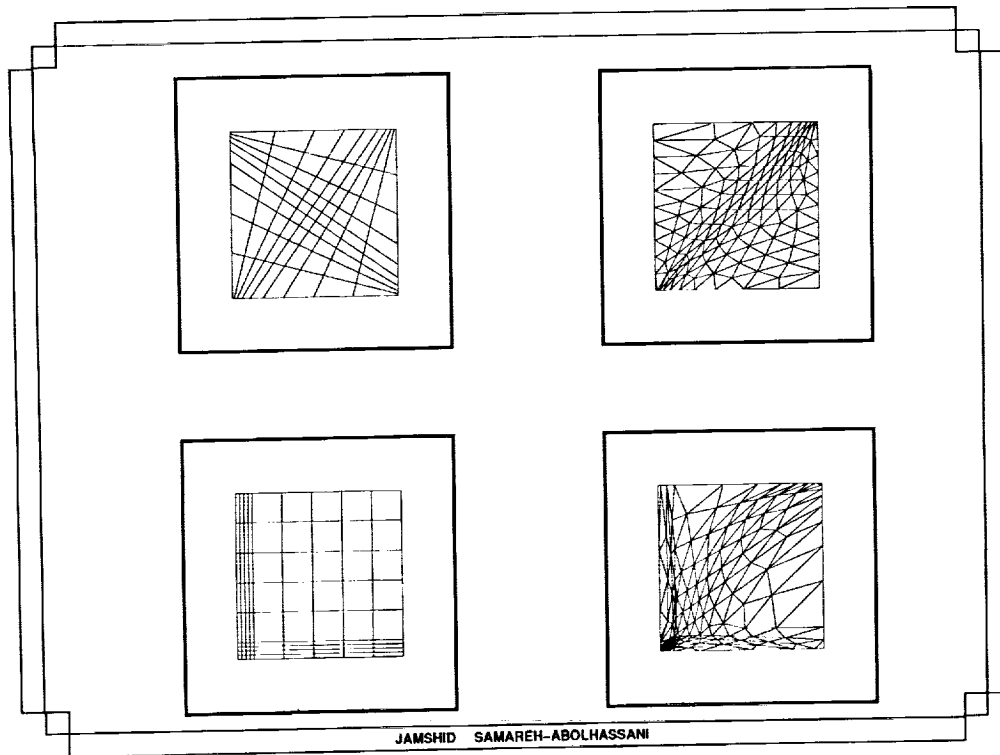
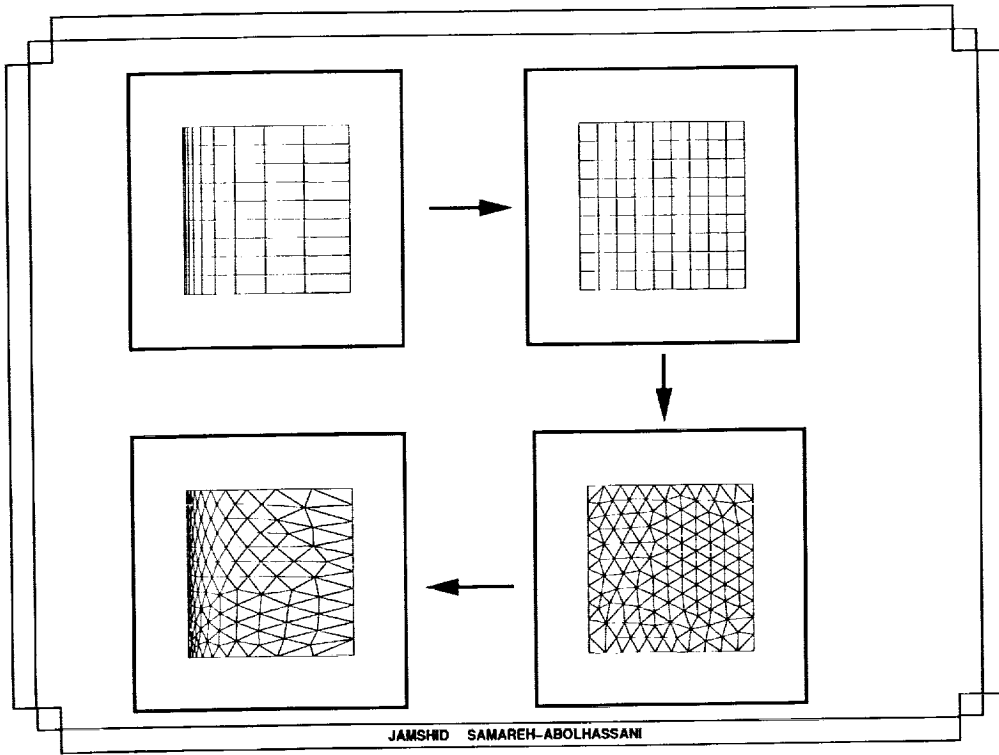
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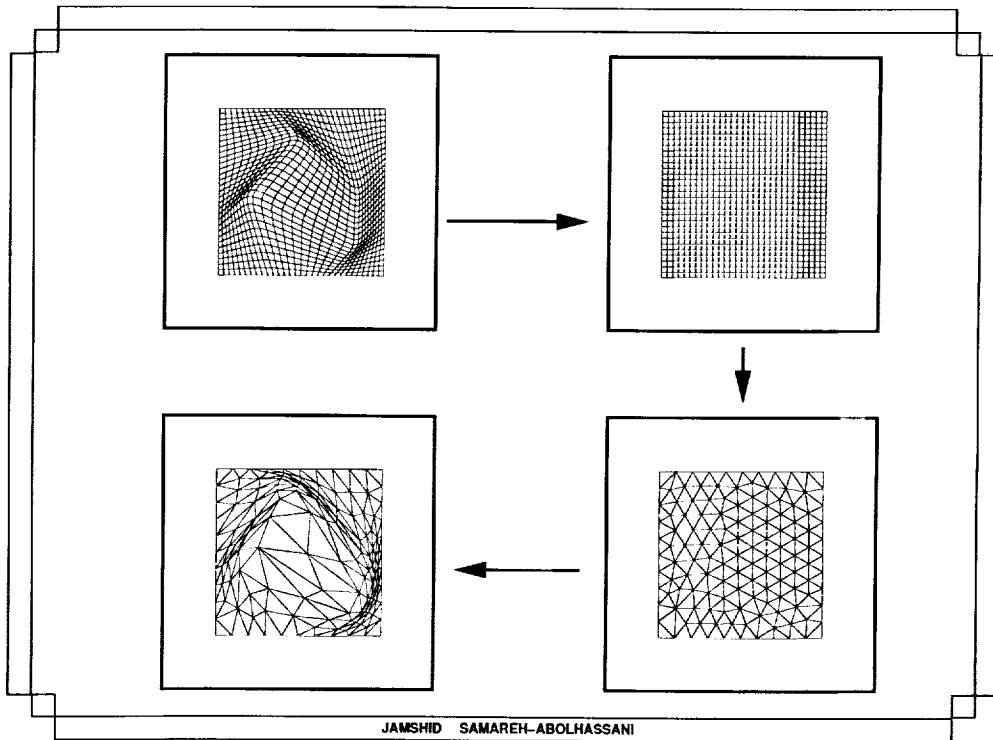
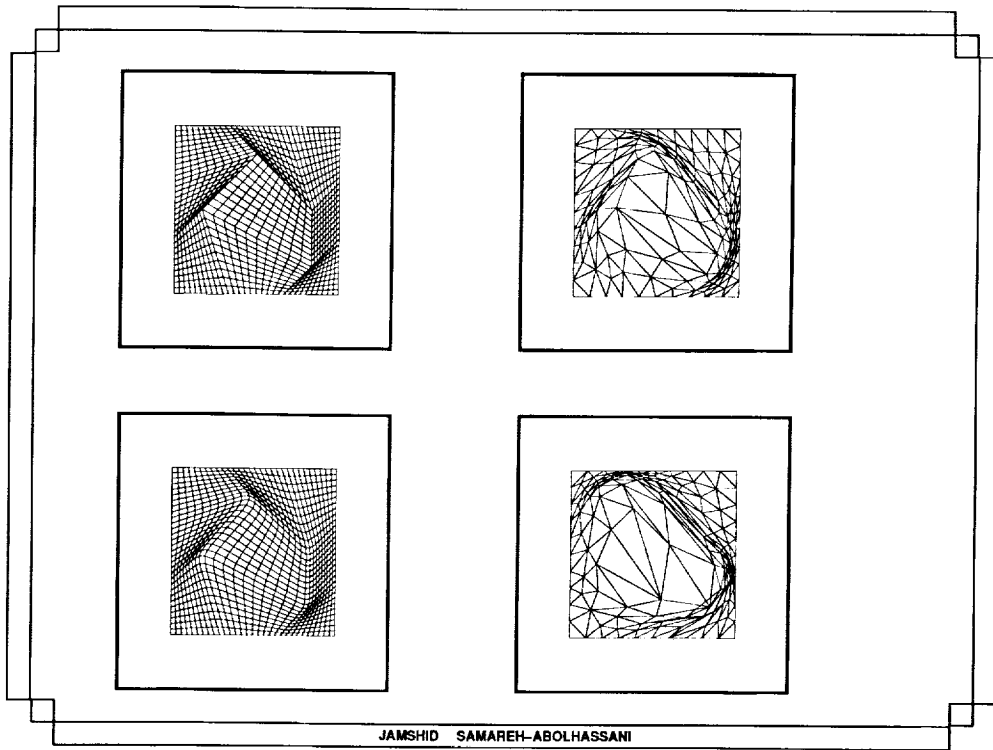
2½D Advancing Front Cont.

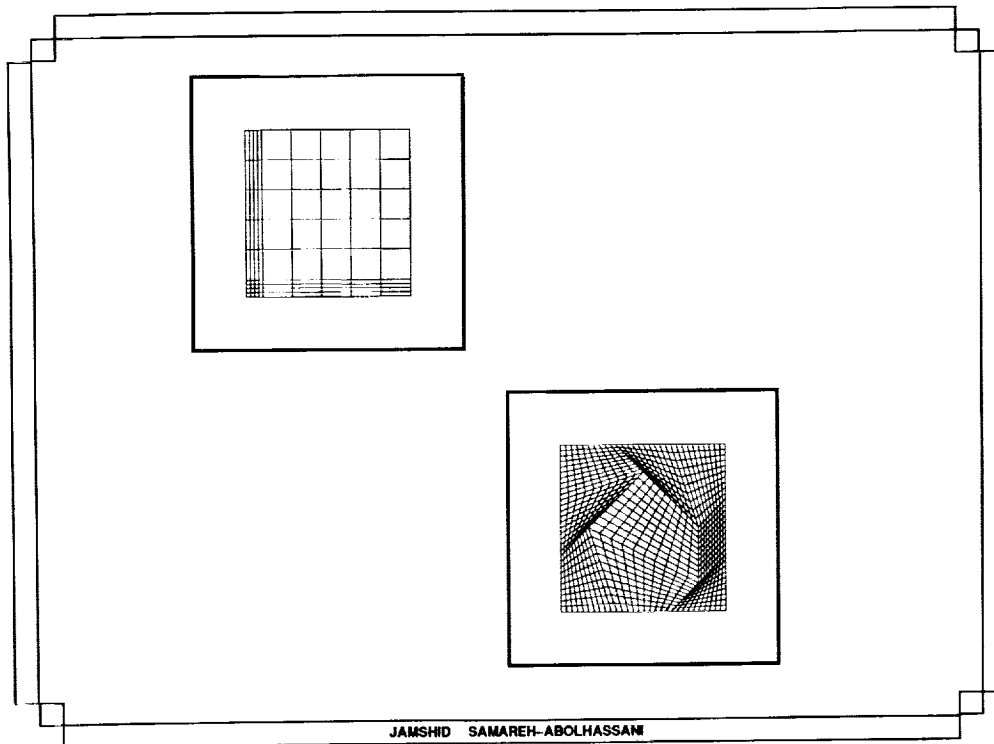
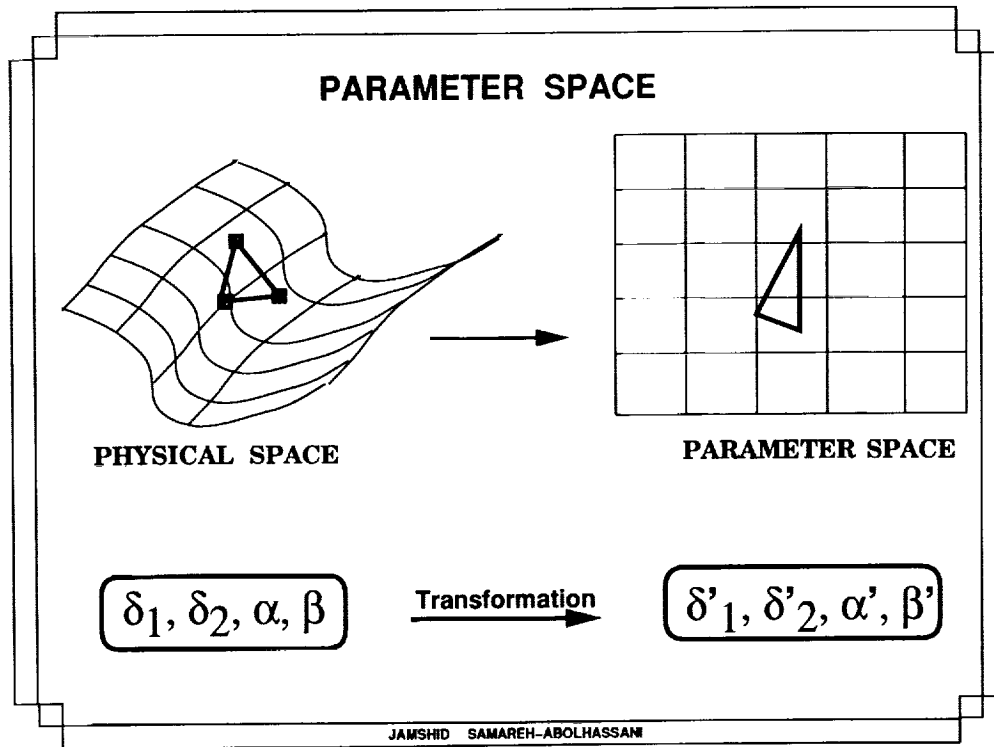


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Cons

- o Metrics Transformations
- o Speed (2)
- o One Surface Only
- o Singularity Could Cause Problems

Pros

- o Exact Surface
- o N-Sided Patches
- o Trimmed Surfaces
- o Fewer Patches
- o No Shearing (?)

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3D Advancing Front Curved Surfaces

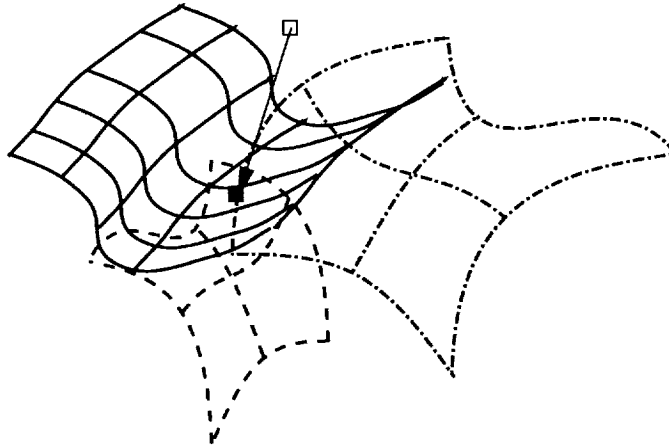
- o Surface Points
- o Surface Normals
- o Loops in 3D

Trimmed Surfaces

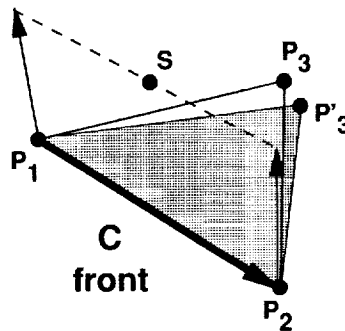
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PROJECTING POINTS ONTO NURBS SURFACES

AIAA-93-3454



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Steps:

1. Compute a plane normal to (P_1, P_2, S)
2. Generate a New Point (P'_3) on the Plane (Spacing and Stretching)
3. Project Point (P'_3) onto the Appropriate Surfaces
4. Compute a Plane Based on (P_1, P_2, P'_3)
5. Repeat Steps 2-4 Till Changes in P'_3 Are Very Small

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3D Advancing Front Curved Surfaces

Cons:

- o Surface Normals Are Required
- o Projection Is Required
- o Trimmed Surfaces
- o Speed (4)

Pros:

- o Triangulation Is Performed in the Physical Space
- o No Shearing Due Parameter Space
- o Metric Transformation Is not Needed
- o N-Sided Patches with With Multiple Loops
- o Multiple Surfaces
- o Fewer Patches

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	2D	Type 1 2½ D	Type 1 2½DP	Type 2 2½ D	3D
User Input Factor(# of Patches)	1	4	4	3	2
CPU Time Factor	1	2	3	4	5
Surface Types	P	NA	NURBS	NURBS	NURBS
Surface Accuracy	good	poor	Good	Good	Good
δ, α, β Transformation	simple	simple	simple	Difficult	NA
Problems With Shearing	None	Yes	Yes	Possible	None
Parametric Study	0	0	2	3	3
Number of Surfaces	NA	Many	Many	One	Many
N-Sided Patches Possible	Yes	No	No	Yes	Yes
Problems with Singularity	No	No	Yes	Yes	Yes
Surface Normals Required	No	No	No	No	Yes
History	4	3	3	1	0

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CSC/GEOLAB/TAB EFFORT

- o NURBS Based (IGES , NASA IGES)
 - o NURBS Surfaces
 - o NURBS Curves
 - o Trimmed Surfaces
- o Points (network)
- o Single Interactive Interface
- o Surface Grid Generation
Based on 3D Advancing Front
- o Projection

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STEPS

- o STEP 1 POINTS/CURVES/PATCHES
 - o allowing for future *additions*
 - o Surface (points)
 - o create points/curves/patches for vgrid3d (or other systems)
- o STEP 2 Background Grid
- o STEP 3 PROJECTION/SMOOTHING/QUALITY CHECK
- o STEP 4 ADD SURFACE GRID GENERATION
(Direct Surface Triangulation)
- o STEP 5 MOTIF / X BASED (other platform)

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I / O

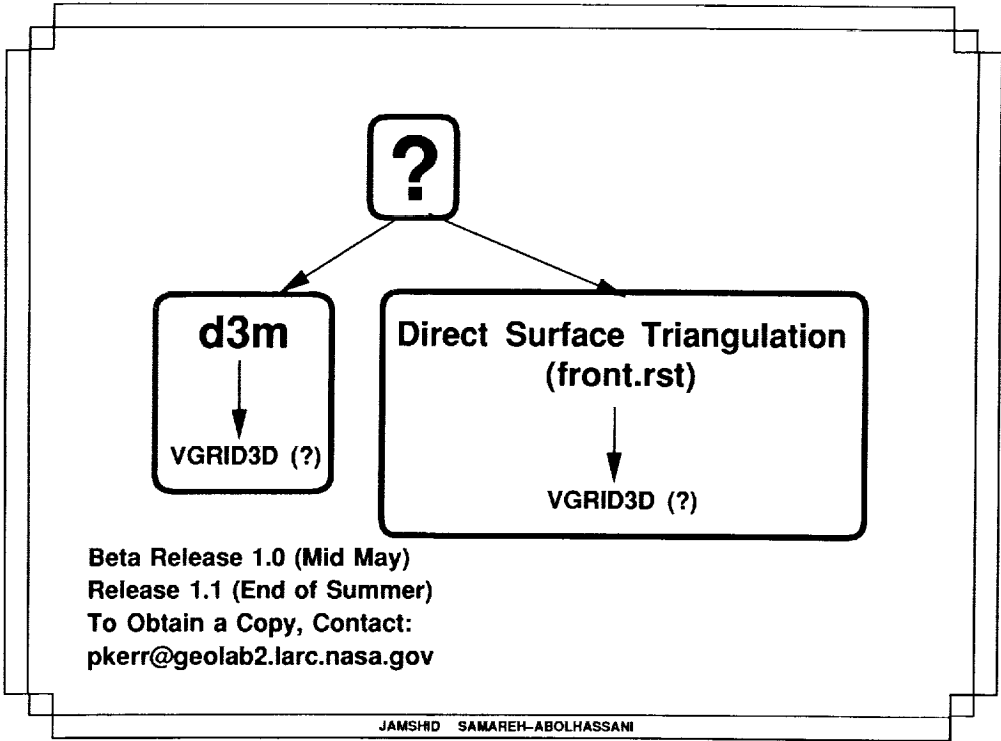
	INPUT ASCII	INPUT Binary	OUTPUT ASCII	OUTPUT Binary
Restart	X	???	X	???
HESS	X	NA	X	NA
D3M	X	NA	X	NA
GRIDGEN	X	X	X	X
PLOT3D	X	X	X	X
LaWGS	X	NA	X	NA
IGES-128	X	NA		

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SURFACES

- o NURBS (NonUniform Rational B-Spline)
- o Converts hess, gridgen, plot3d, lawgs to equivalent NURBS surfaces
- o Defined everywhere
- o Display Path (write the grid out)

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GridTool (Questions and Comments: jamshid@geosun1.larc.nasa.gov)

GridTool

Exit	I/O	Controls	Attributes	Pls/Curve	Help
	TBA	Misc	Patches	Bg Grids	

Status

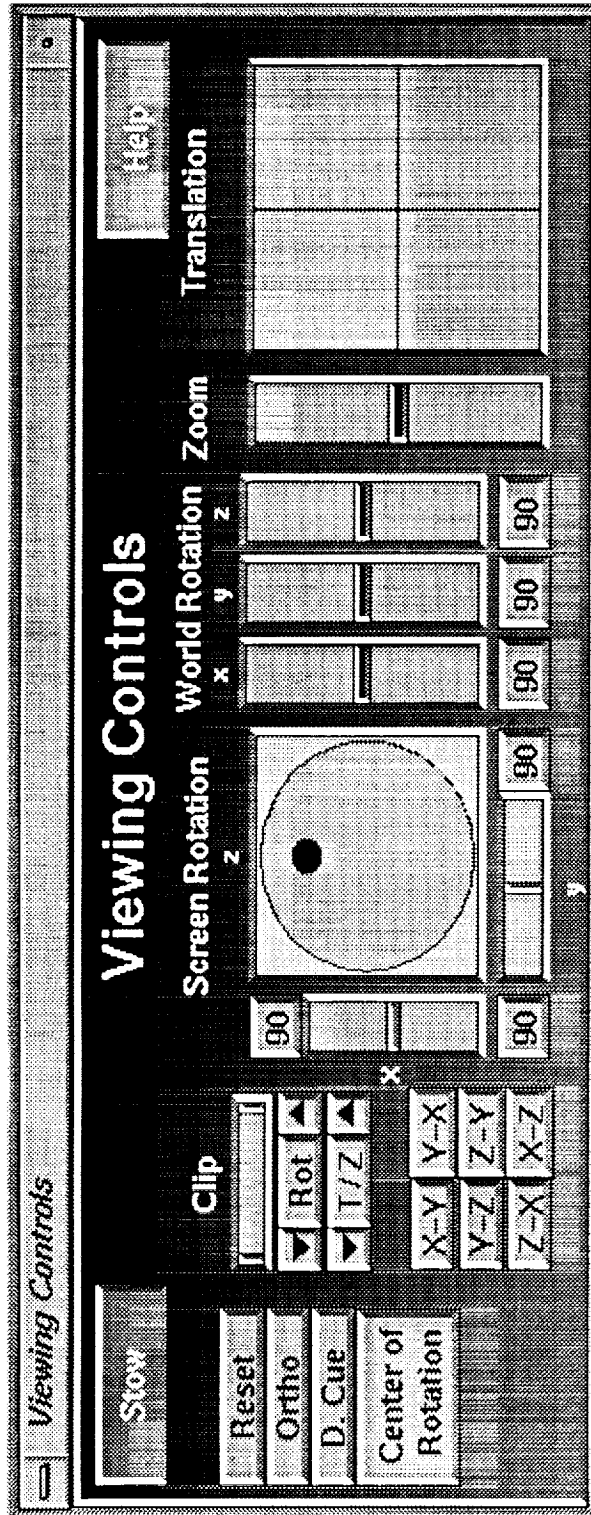
Patches

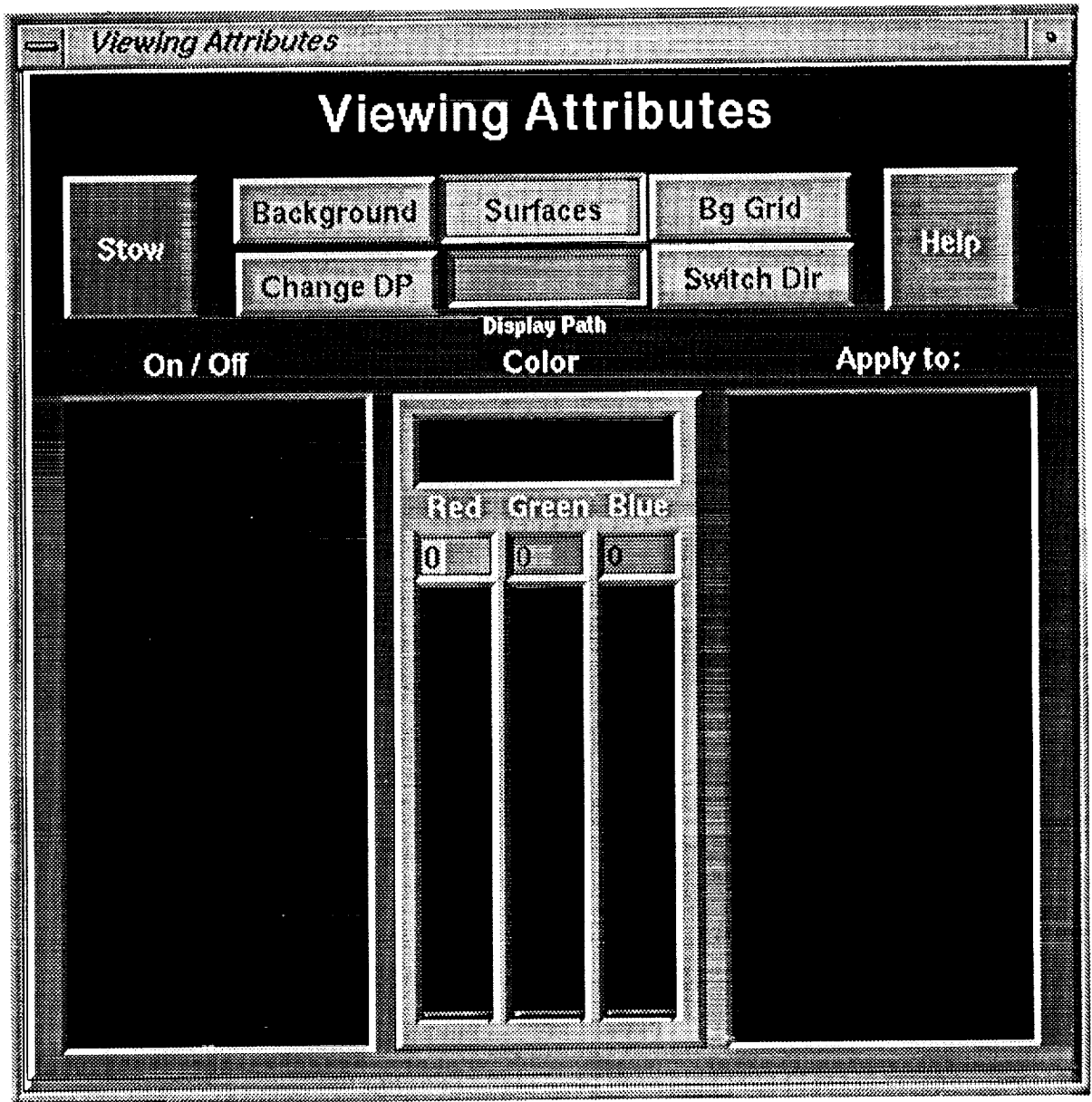
Stop	Patches					Help
Next Patch	Apply BC/Fam	Auto Patch	Reverse Patch	Delete Patch	Delete Family	1 / 1
Accept Edge	Find Edge	Reverse Edge	Delete Edge	Connect Edge		
Box	Parallel Side	Labels				

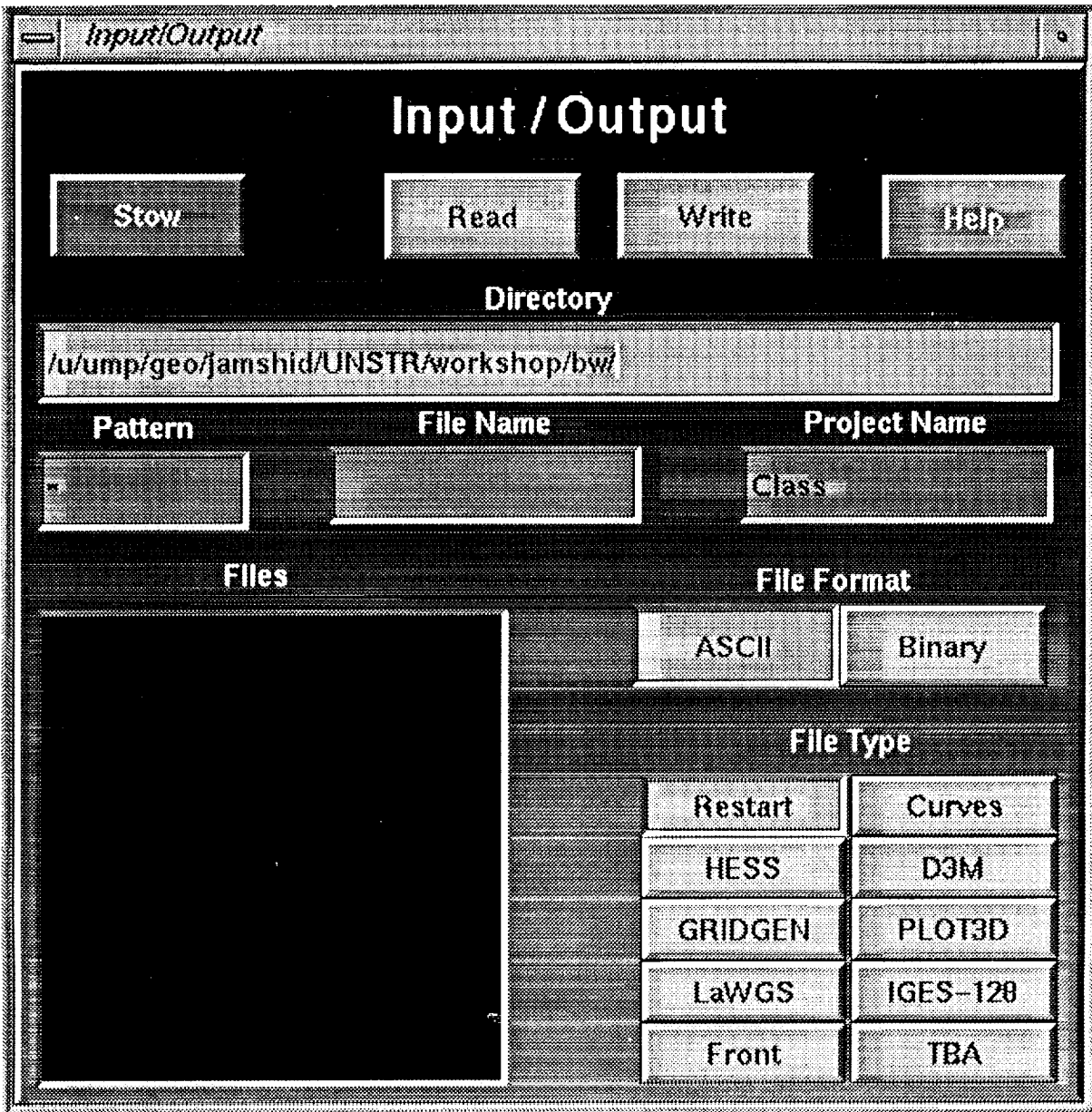
<input type="radio"/> Curves On	Tol	1e-06
<input type="radio"/> Patches On	Shrink	0.02
<input type="radio"/> Patch Family On	BC	0 freestream
<input type="radio"/> Bad Patches On	Family	Addams
	Patch Size	2, 2, 10, 10

Patches 23 (Closed 23)
 Closed
 Family Box
 BC inflow/outflow
 Gap 0
 patch has 4 side(s) 1 loop(s)

Curve Number	◀ 33 / 52 / Wing ▶
Patch Number	◀ P# 23/ne 4/ns 4 ▶
Edge Number	◀ e# +4 / s# 4 (#e 1) ▶







Points/Curves

Stop Points / Curves Help

On Surface Enrich (C0) Enrich (C1) -1 Combine 0

Next Curve Split Curve Combine Curves Copy Curve Project Curve Smooth Curve Delete Curve Delete Family

Next Point Delete Point Insert Point Project Point Auto Edge Delete Unused

Curves On

1.5
0.0970575
0.362222

X Arclength
Y 0.5888633
Z

Input / Output U, V
16, 22

4 / 19 Point Number

33 / 52 / Win Curve Number

2 (1 AS) Surface Number

U & V grid with navigation arrows and U/V input fields.

BOX

Stop BOX Help

-1.5 Xmin Xmax 4.5
-1.5 Ymin Create Box Ymax 1.5
0 Zmin Zmax 4.5

Background Grids

Stop Help

Next Source BGS on Point Number

Source Number

n1

S1

S2

U1 an

U2 bn

U3 Alpha

of BGS 15
Current BG family Sym

Misc

Stop Help

