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**TIGER: A User-Friendly Interactive Grid Generation System
For Complicated Turbomachinery And
Axis-Symmetric Configurations**

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Abstract

The issue of time efficiency in grid generation is addressed by developing a user-friendly graphical interface for interactive/automatic construction of structured grids around complex turbomachinery/axis-symmetric configurations. The accuracy of geometry modeling and its fidelity is accomplished by adapting the Non-Uniform Rational B-Spline (NURBS) representation.

A customized interactive grid generation code, TIGER¹⁻⁶, has been developed to facilitate the grid generation process for complicated internal, external, and internal-external turbomachinery fields simulations. The FORMS Library⁷ is utilized to build user-friendly graphical interface (Figure 1). The algorithm allows a user to redistribute grid points interactively on curves/surfaces using NURBS formulation⁸ with accurate geometry definition. TIGER's features include multi-block, multi-duct/shroud, multi-blade row, uneven blade count, and patched/overlapping block interfaces. It has been applied to generate grids for various complicated turbomachinery geometries (Figure 2), as well as to rocket and missile configurations (Figure 3).



Objectives

To develop an interactive grid generation system with user-friendly graphical user interface (GUI) customized for complicated turbomachinery configurations.

- Accurate and Efficient
- Cost Effective (Labor time in overall grid generation)
- Timely for Engineering Design

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Features

- **Compatible with various major industry formats for blade/shroud/duct/hub definition**
- **Multi-block, multi-blade row, multi-level duct/splitter uneven blade count**
- **CH/HH topologies with automatic domain mapping**
- **Journal capability**
- **External, internal, external-internal flow fields**
- **Automatic/default grid generation**
- **Interactive/iterative spacing specification**
- **User interaction for grid manipulation**



Approach

- Originally developed as a module in GENIE
- Rewritten both in C and Fortran77 for better algorithm
- GUI with FORMS Library
- NURBS curve/surface for point re-distribution
- Bezier curve for grid line design/manipulation
- Weighted TFI for both surface/volume grid interpolation
- Elliptic system for surface/volume grid generation



TIGER System

○ Grid Module:

Automatic/Default grid generation
User-Interactions:

RULER

FRAME

3D Manipulation

○ GUV Module:

Allows any block number, any number of patches in each block
Gouraud shading/Wireframe rendering
General Configurations

○ ToolBox Module:

Converts various alien formats for geometry definition
2D LE/TE circle fitting

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Applications

○ External flow fields:

Hamilton Standard SR-7 (10 min) GE counter-rotating Propfan (15 min)
Naval CCOSC Torpedo (1 hour) Various Missile Configurations

○ Internal flow fields:

Rotor-67 (20 min)
Fuel Inducer (Have not yet tested with TIGER-II)

○ External-Internal flow fields:

NASA Pressure Ratio 1.15 Ducted Fan (1 ~2 hours)
Pratt & Whitney Advanced Ducted Propfan (ADP) (1 ~2 hours)
GE Energy Efficiency Engine Mockup (1 ~2 hours with fan only)



Future Developments

- Grid Module:**
 - Mixed Grid Topologies (CO/CC/HO/HC)
 - 2D capability
 - Tip Clearance Modeling
- Flow Module:**
 - Flow Solver Coupling (Whitfield/Janus/Chen/Taylor)
 - Common I/O, Data Structure
- Visualization Module:**
 - Flow Solution Visualization (Contour/Vector/Particle Trace)
 - Flow Solver BC/IC Setup Panel
- ToolBox Module:**
 - Rotor Tip Cutter (Spherical)
 - 3D Blade LE/TE Circle Fitting
 - CAD Interface (CAGI)

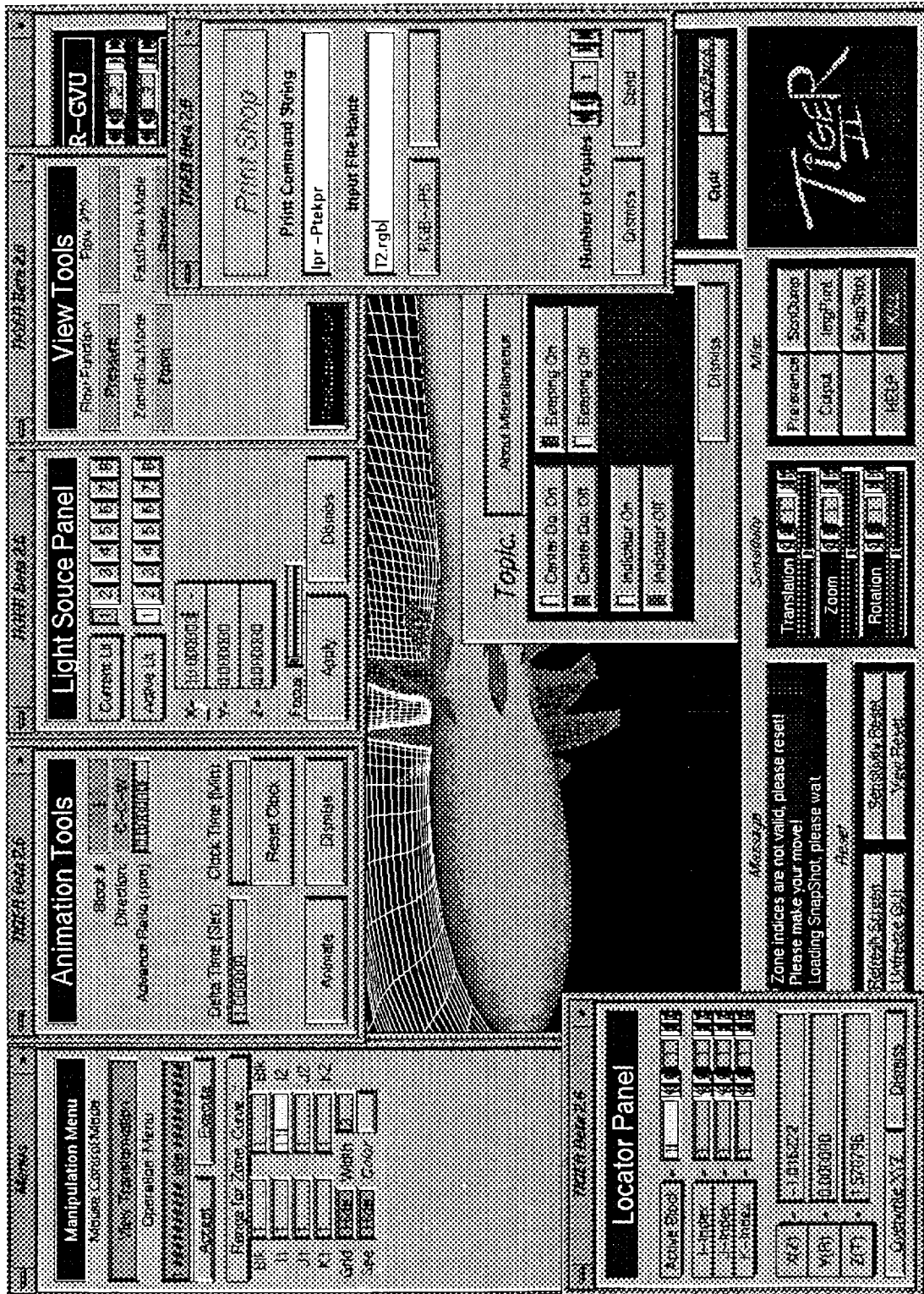


Figure 1. Tiger Graphical User Interface

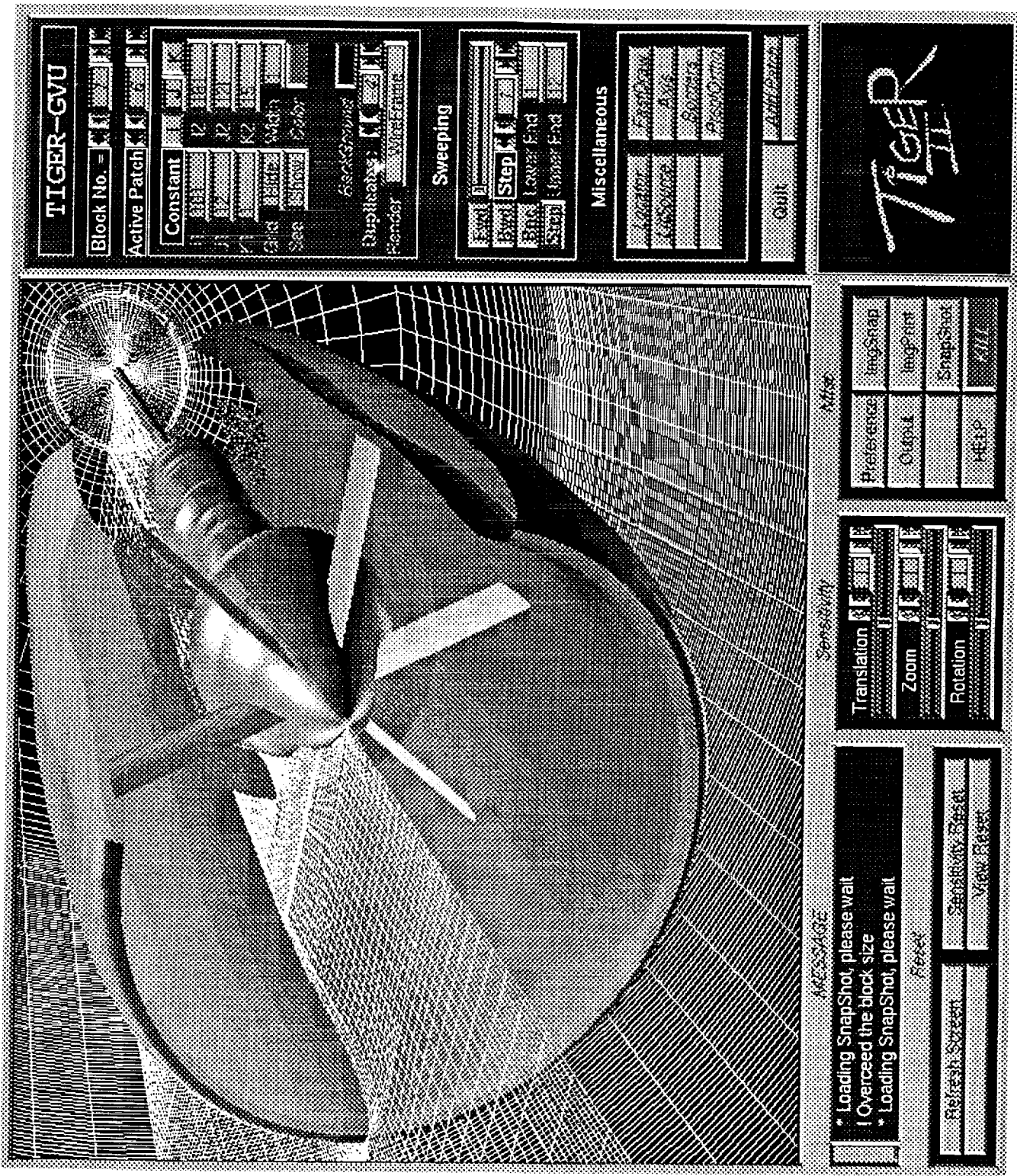


Figure 2. Engine Mockup

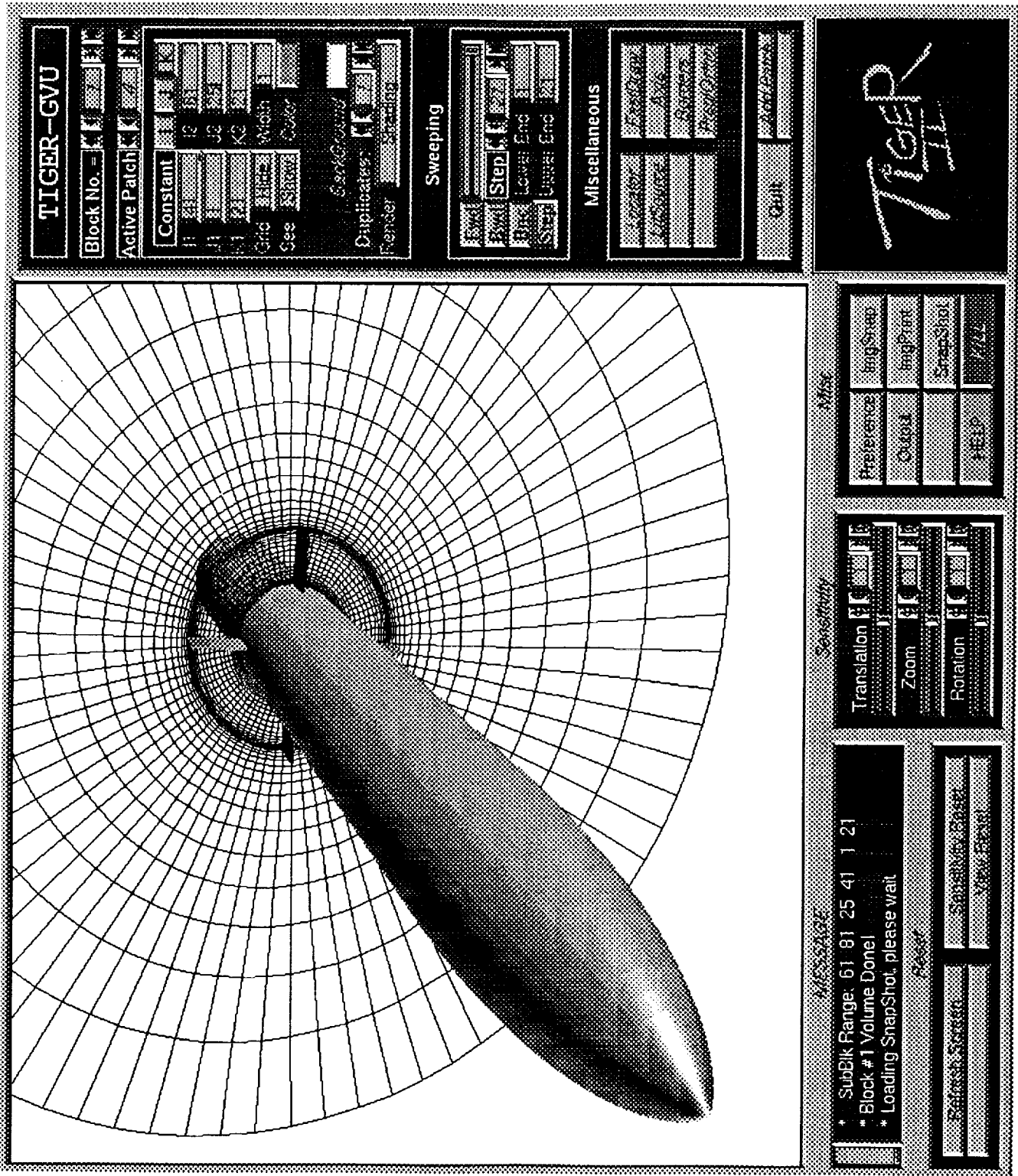


Figure 3. Missile Configuration

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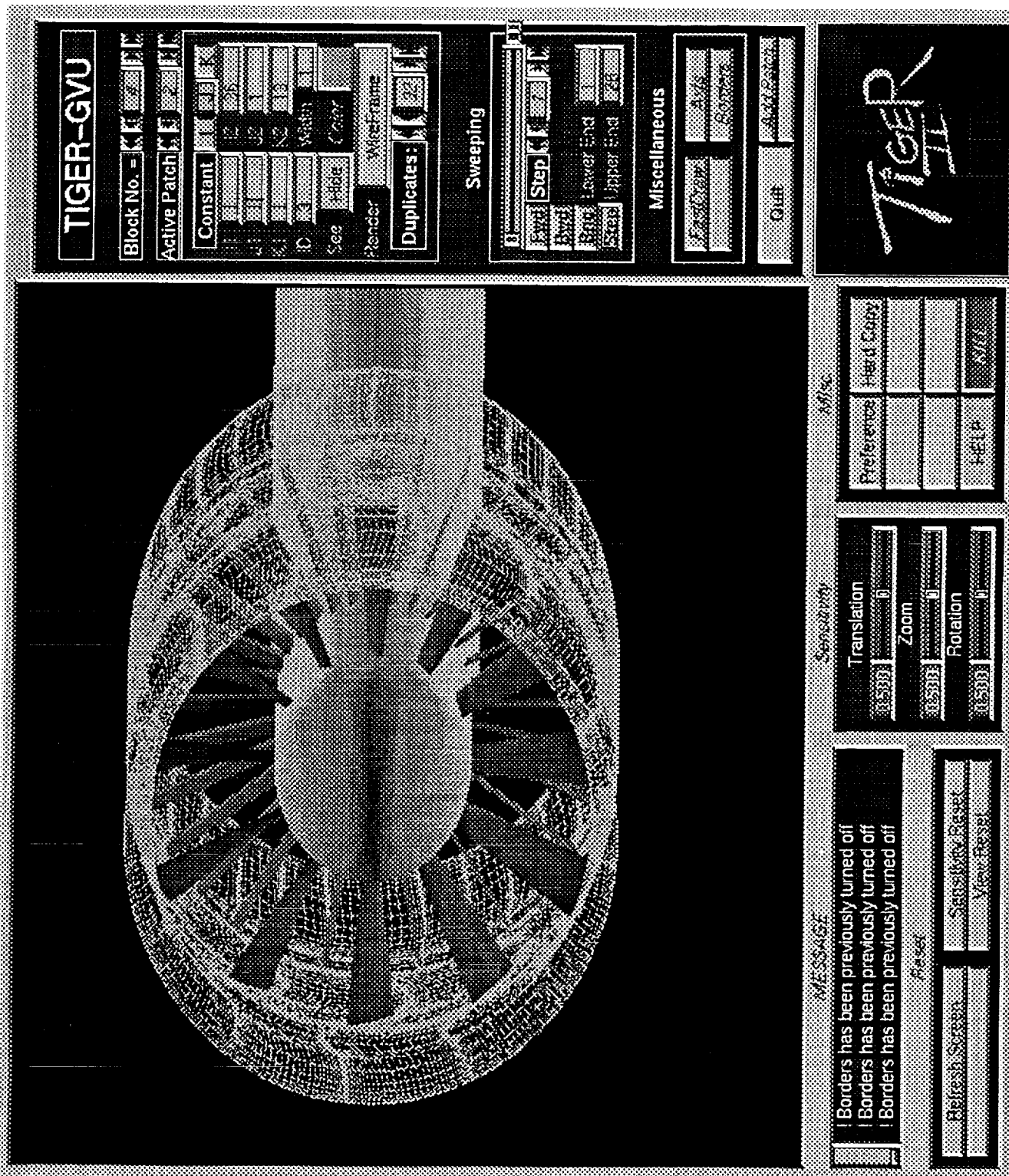


Figure 4. NASA Pressure Ratio 1.15 Ducted Fan

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