# FUSED REALITY

Ed Bachelder
Noah Brickman

# SYSTEMS TECHNOLOGY, INC.

- Employee-owned R&D small business established in 1957
  - 400+ Prime Research Contracts, 500+ Research Papers/Reports
- Aerospace
  - Dynamics, Control Systems, Flying Qualities, Pilot-Vehicle Systems (Pilot Models, PIO, etc.), Simulation
- Ground Vehicles
  - Dynamics, Simulation, Driver Performance
- Human Factors
  - Impairment (Drugs, Alcohol, Fatigue), Displays, Divided Attention
- Products
  - Driving and Parachute PC-based Simulators, Control System Design & Analysis Software, Various Computer Simulation and Analysis Tools
- Customers Include: NASA, DOD, DOT, NIH, and Aerospace and Automotive Industries (e.g., Boeing, Ford, GM, etc.)

# STI PERSONNEL BACKGROUND INFO

- Ed Bachelder
  - Former SH-60B pilot (East Coast)
  - Ph.D. MIT 2000, *Perception-Based Synthetic Cueing for Night Vision Device Hover Operations*
  - MIT Post-doc on modeling human/ automation interaction to facilitate identification of potential operator mode awareness hazards
  - Primary researcher for ongoing NASA Phase II SBIR “Intelligent Displays for Time-Critical Maneuvering of Multi-Axis Vehicles”, employing an optimal control flight director for use during helicopter autorotation

# STI PERSONNEL BACKGROUND INFO (SBIR-RELATED)

- Noah Brickman
  - Expertise in networking, 3D graphics, multimedia, 3D engine design, vehicle dynamics simulation, and artificial intelligence
  - Developed sophisticated software projects including networked multi-user simulation and entertainment products
  - Lead programmer for systems that variously integrated a head mounted display, spatial tracking system, speech synthesis, speech recognition, pinch gloves, tactile feedback systems, and gesture recognition

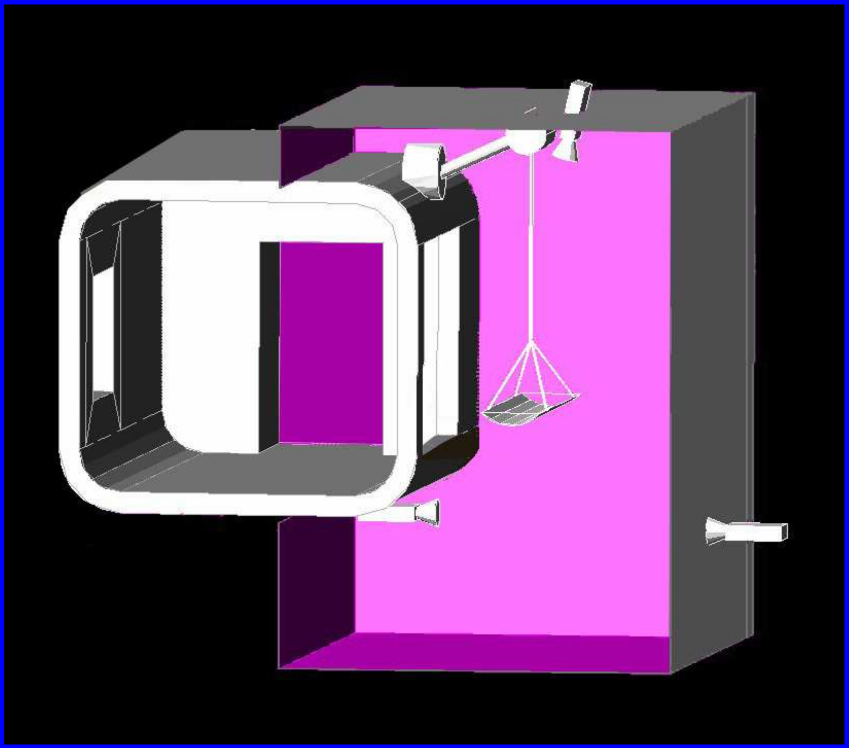
# INTRODUCTION

- The effectiveness and safety of complex, multi-role helicopter platforms require that the cabin crew interact seamlessly with the flight crew and a dynamic external environment
- Due to physical constraints and fidelity limitations current simulation designs fail to accommodate a wide range of training
- STI's approach to this challenge employs a novel and elegant method using three proven technologies – live video capture, real-time video editing (blue screen imaging), and virtual environment simulation

# FUSED REALITY

- Video from the trainee's perspective is sent to a processor that preserves near-space (cabin environment) pixels and makes transparent the far-space (out-the-cabin) pixels using blue screen imaging techniques.
- This bitmap is overlaid on a virtual environment, and sent to the trainee's helmet mounted display
- In this way the user directly views the physical cabin environment, while the simulated outside world serves as a backdrop.

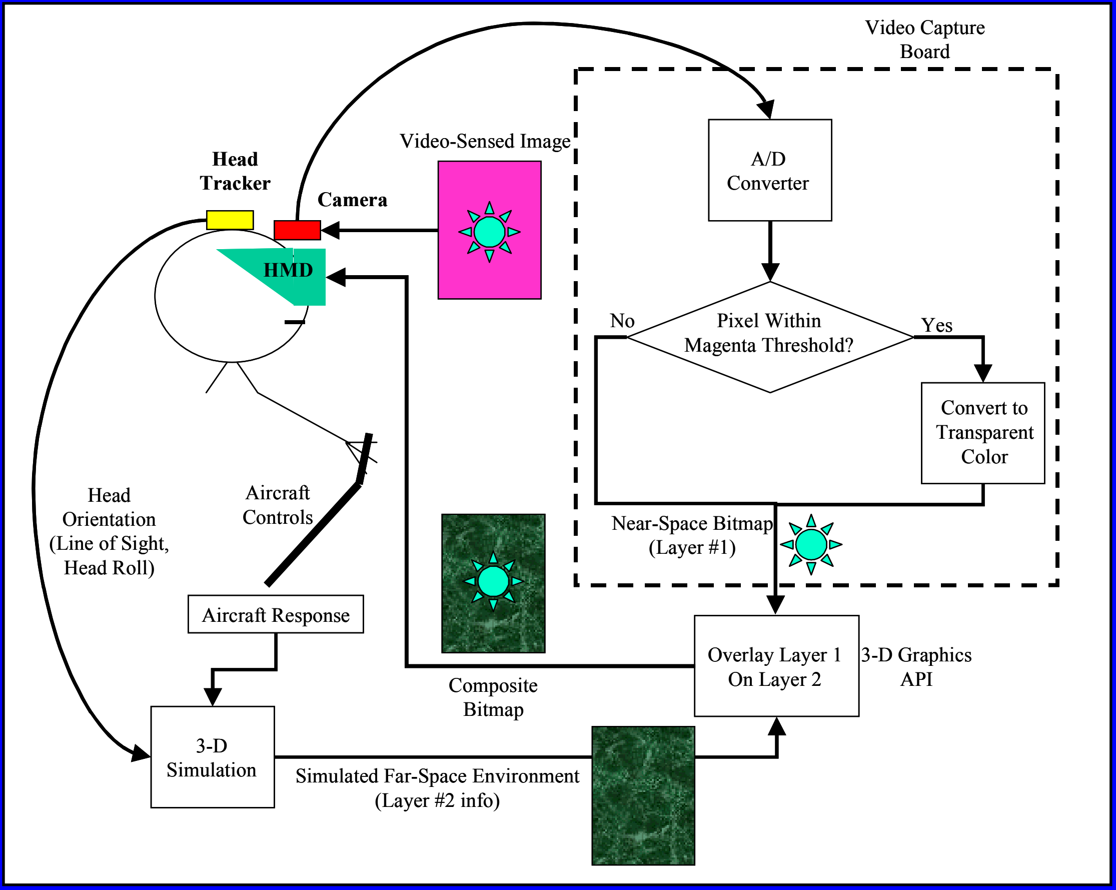
# FUSED REALITY



Frontal View of Cabin Enclosure

Virtual Environment Backdrop (Including Virtual Cockpit).

# FUSED REALITY

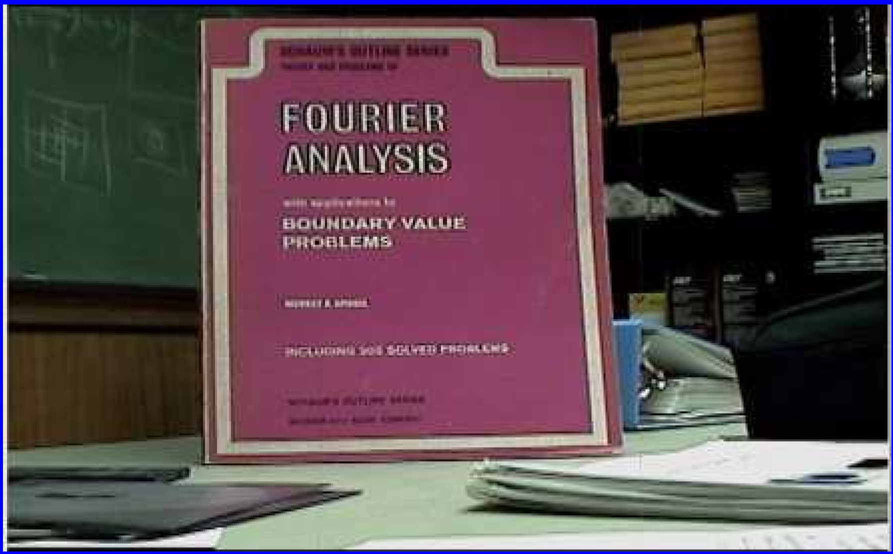


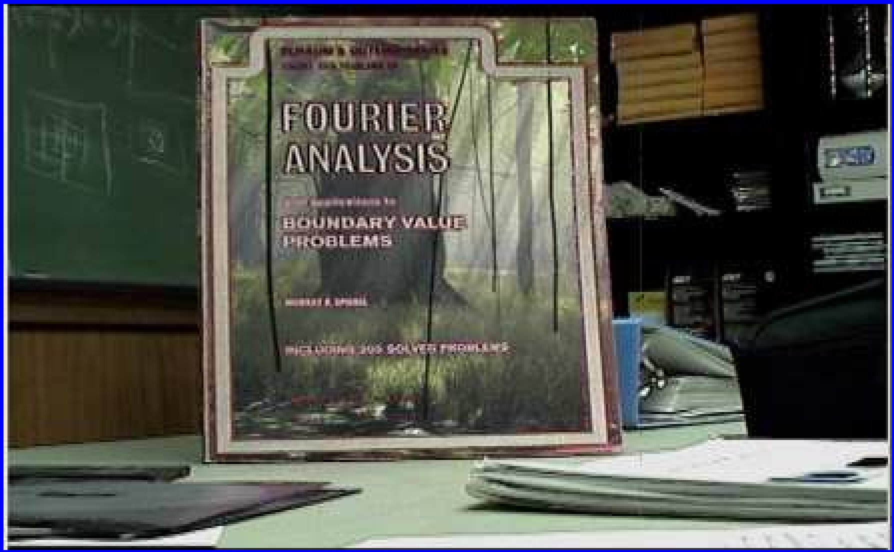

Fused Reality Representation

# FUSED REALITY DEMONSTRATION


Video Camera Aimed at Objects Appearing in Sensed Image Layer

# FUSED REALITY DEMONSTRATION

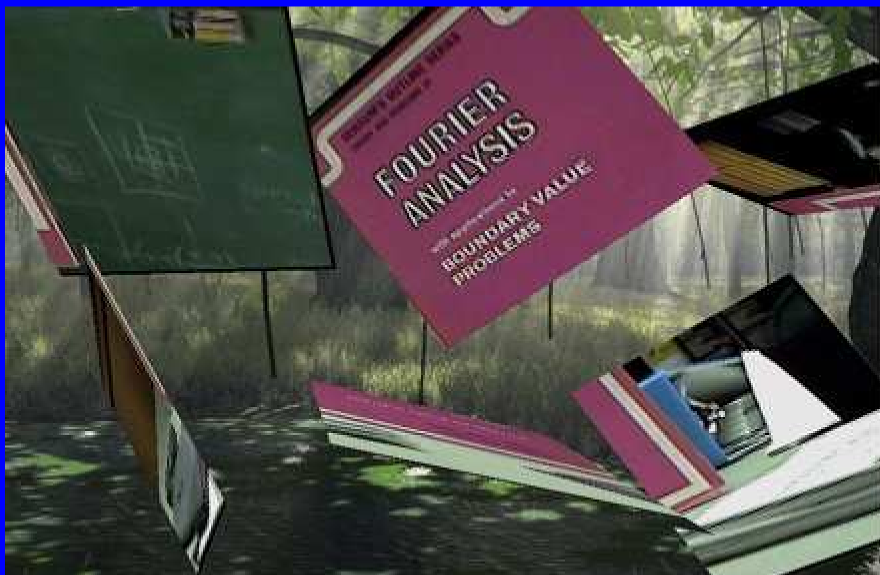


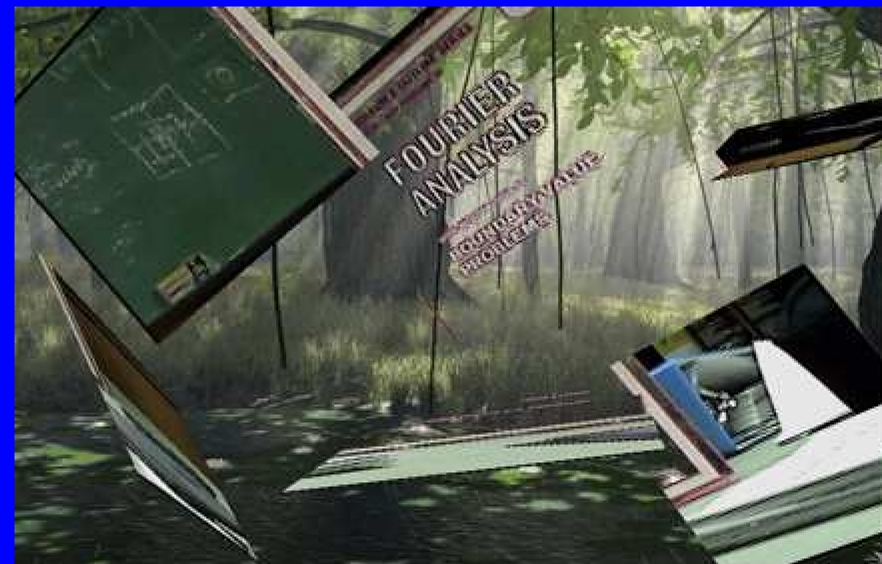
# PROCESS DETAILS

- Processing and rendering is being conducted in *real time*, at 30 frames per second
- Thus349,920 pixels are processed per frame, or 10,497,600 pixels per second
- Depth perception during manual tasks is somewhat degraded when stereoscopic vision (two different images of the world are presented to each eye, from each eye’s perspective) is not available
- Given the apparent spare processing capacity of the video card, it may be possible to conduct dual-camera processing and further enhance the technique’s realism.

# CAPTURED VIDEO

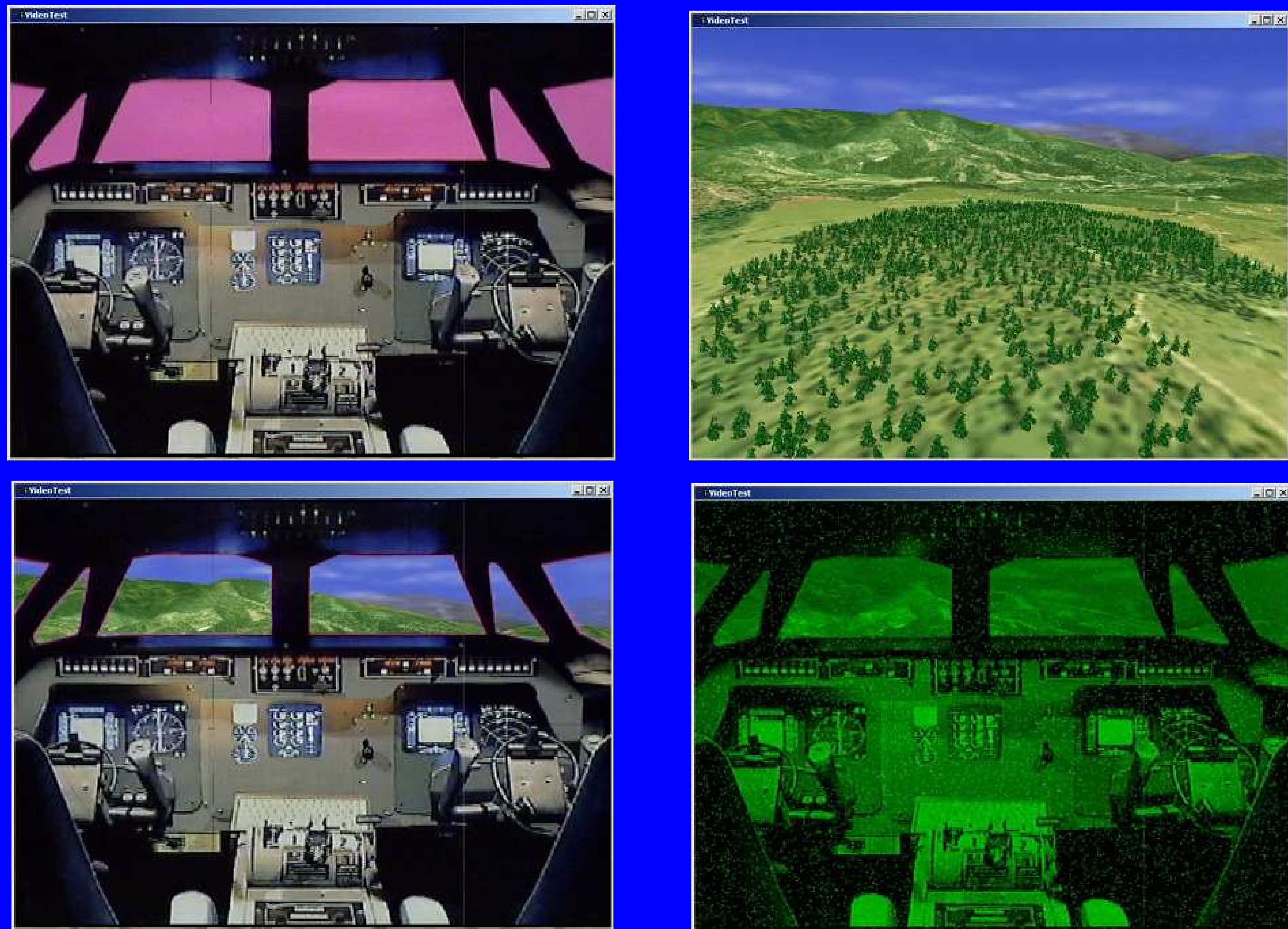



b.




- Captured video data is converted to a texture map
- This texture map can then be operated on a pixel-by-pixel basis in exactly the same way as the simulated environment, which gives the capability to transform the video texture map so as to simulate a Night Vision Goggle (NVG) scene

# FUSED REALITY COCKPIT DEMONSTRATION



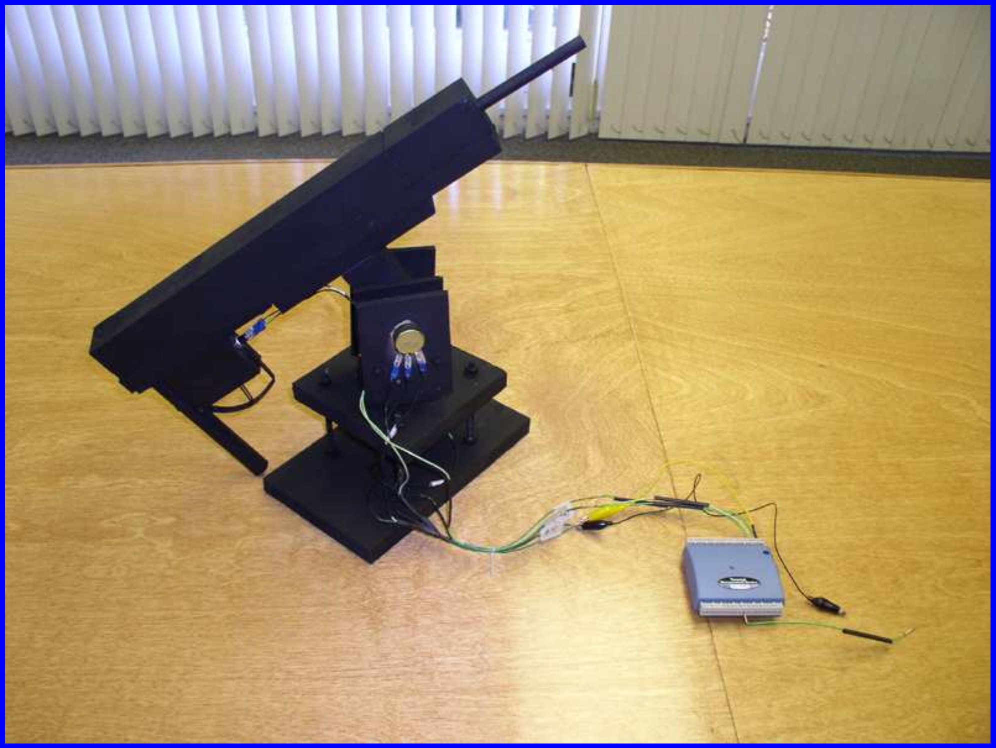
# Fused Reality Video

# Key Hardware Elements of Fused Reality

Helmet-Mounted Display, Helmet-Mounted Micro-Camera, Interactive Hardware (Sub-Machine Gun), Portal Surface (Magenta Dish).

# . VR Headset Mounted with Micro Camera and Inertial Head Tracker

# Interactive Sub-machine Gun Model



Sub-machine Gun Model shown with Computer/Sensor Interface

# Fused Image

Actual Sub-Machine Gun and Operator’s Hand in Foreground, and Simulated Background (Helicopter Airframe, Tank, Gunfire (Note Dirt Splashes in Front of Tank), and Geo-Specific Scene)

# Sequence of Fused Images (1)

Ordnance Striking Dirt In Front of Tank

# Sequence of Fused Images (2)

Tank Struck and Igniting

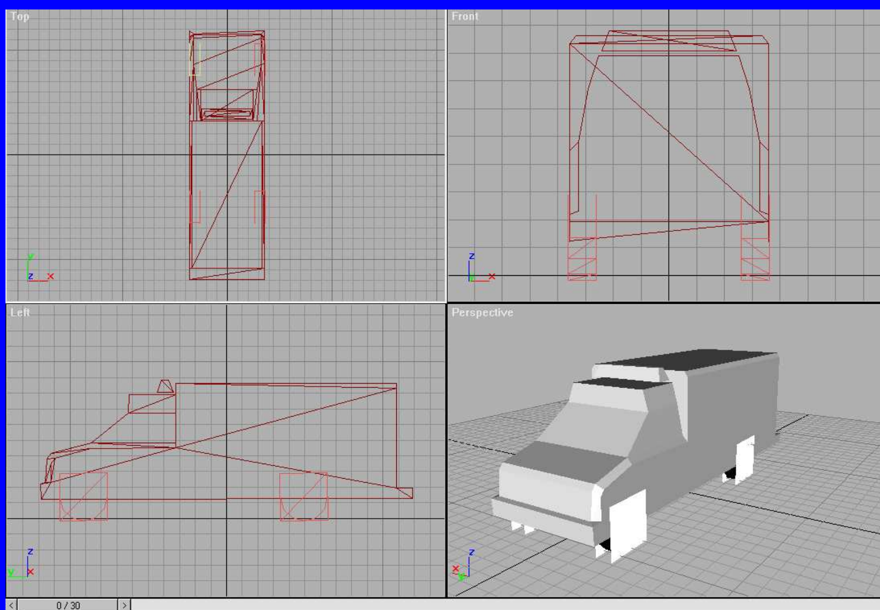
# Sequence of Fused Images (3)

Tank Engulfed in Fireball

# Fused Reality Gunnery Demonstration at HC-3 North Island

Red Arrow Indicates Gunner’s Window Where Sub-Machine Gun was Mounted and Magenta Dish Erected

# Texture Mapping

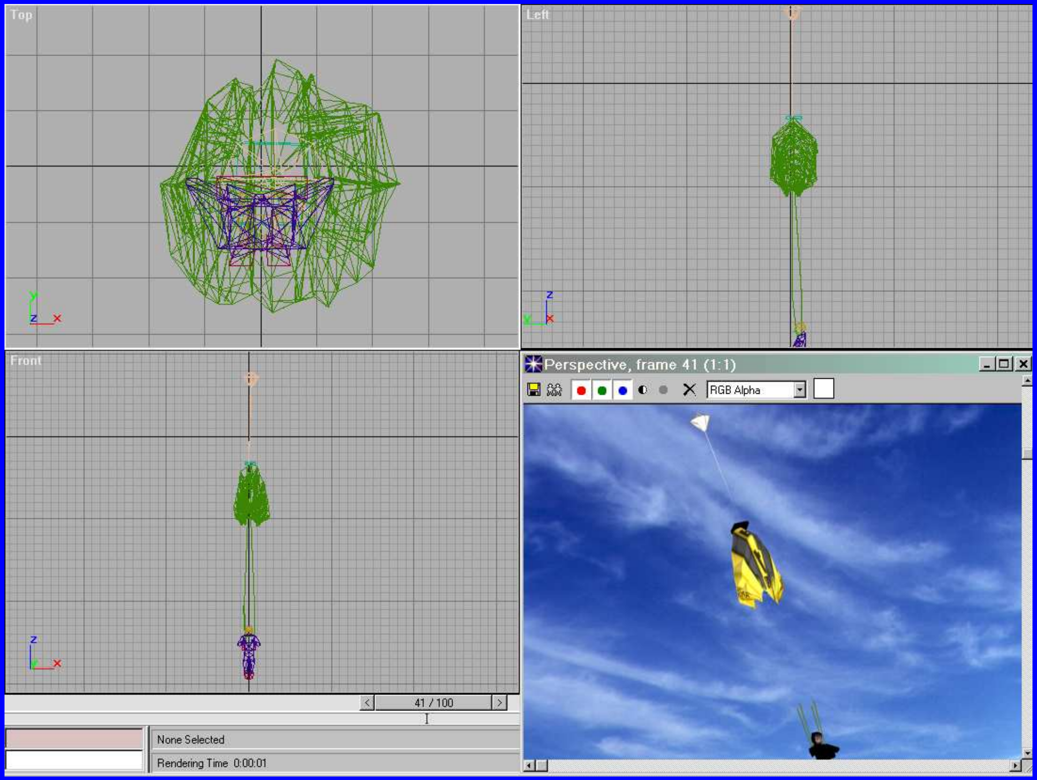



Simplified Ambulance Geometry,
Rendered Ambulance Model After Applying Texture Maps

# Morphing

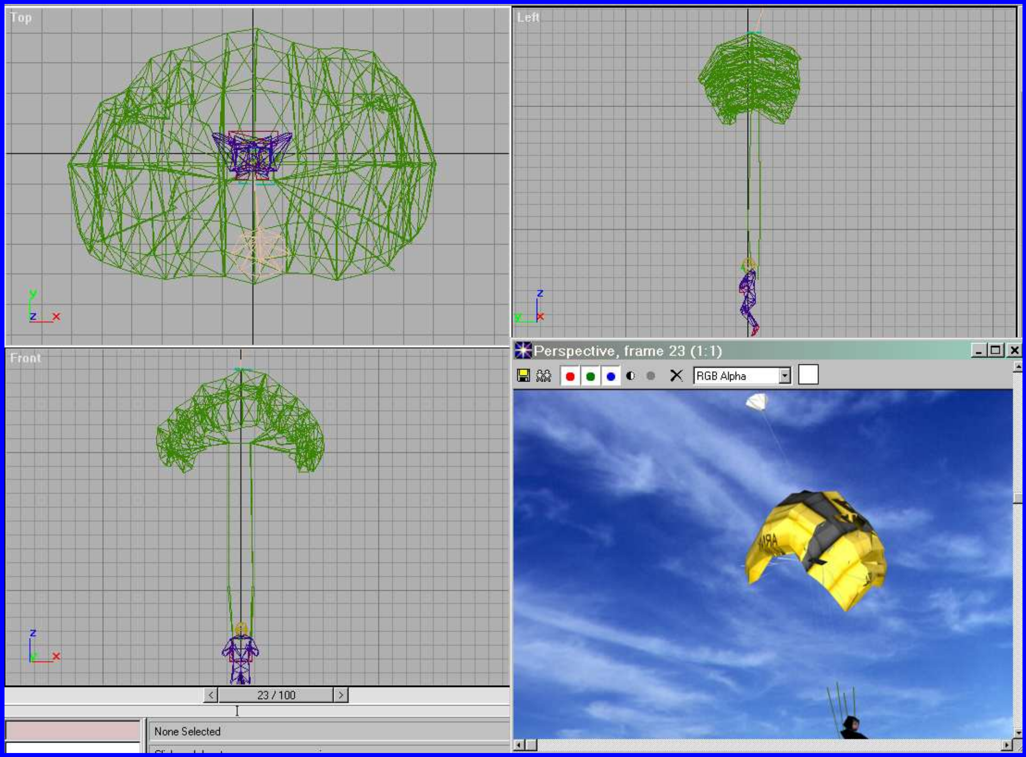
- The opening sequence of a deployed parachute is depicted in the following figures with model animation
- Manipulating the original parachute model into various deformation states created a series of chute models
- These states were then set as morph targets in the simulation, and a computer algorithm was used to generate the smooth animation of an opening parachute by interpolating vertex positions between each model

# Morphing



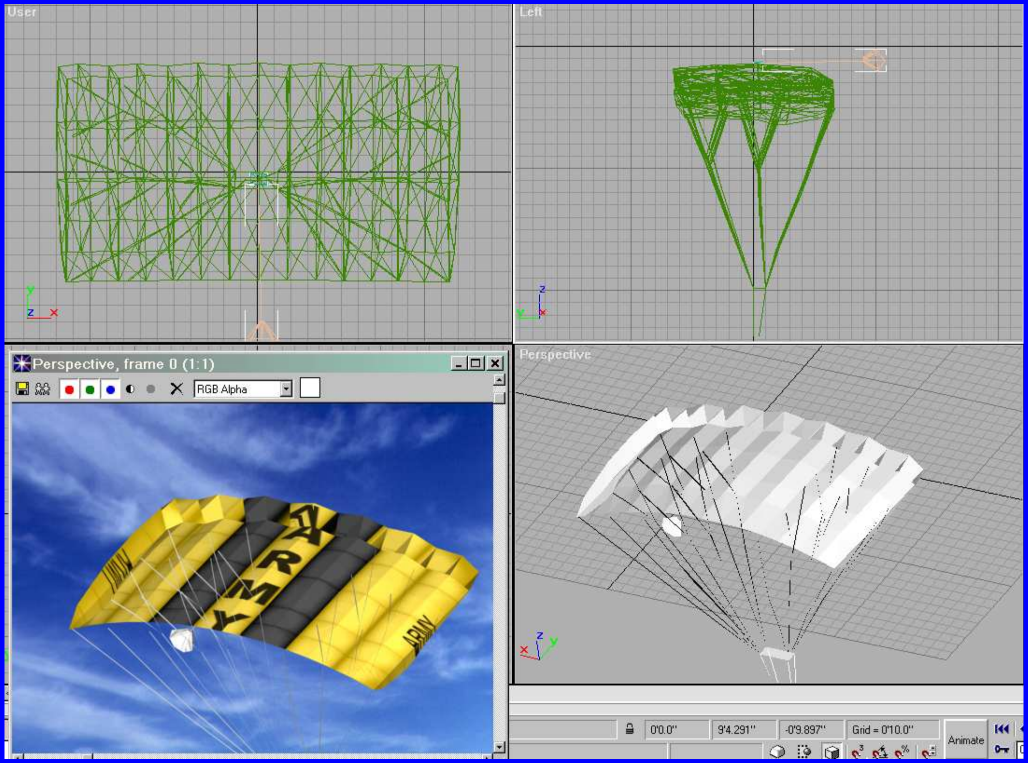

Chute Opening Sequence – Streamer

# Morphing




Chute Opening Sequence - Hung Slider
(Chute Malfunction)

# Morphing




Chute Opening Sequence - Fully Open

# Texture Map Applications

Litter Assembly

# TECHNOLOGY INSERTION AREAS

- Medevac
- Fire fighting
- Surgery simulation and medical therapy
- Driving
- Sports
- Entertainment Industry

# Patent Pending