



# NAVAIR Human Systems Digital Human Modeling Program

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NAVAIR 4.6.5.4

# Presentation Outline

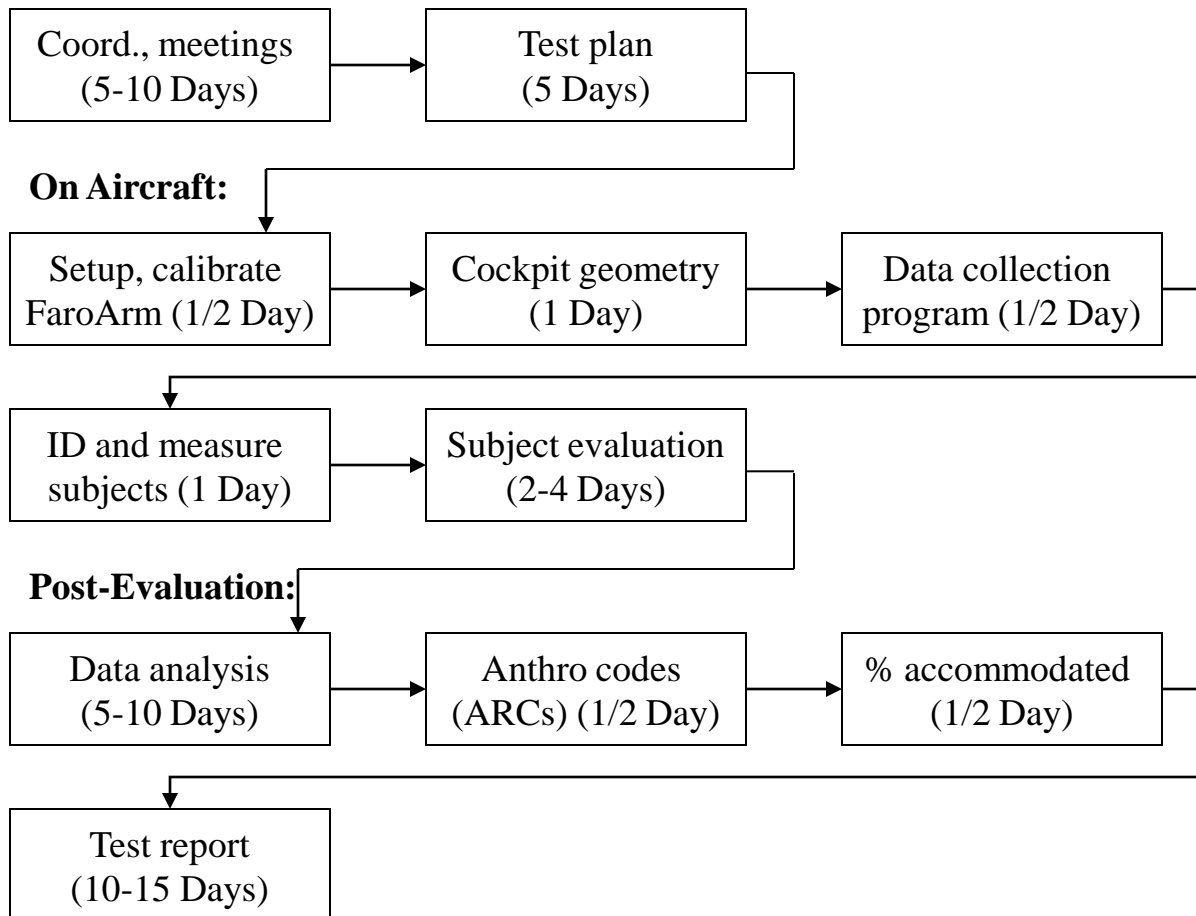
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- Current Aircrew Accommodation Process
- Key Areas & Advantages of New Process
- Teammates
- Challenges
- Other Possibilities

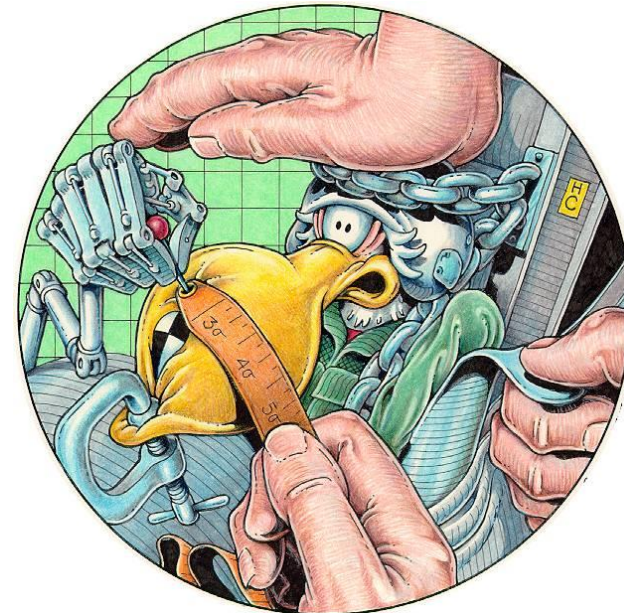
# Current AIR-4.6.5.4 Accommodation Process

Current process iaw OPNAVINST 3710.37A, NAVAIRINST 3710.9D,  
and NAWCADPAX/TM-2000/2

## Pre-Evaluation:



**Task Time ranges due to:**  
# Subjects (usual 10-15)  
# Flight gear configs (usual 1-2)  
Level of test complexity

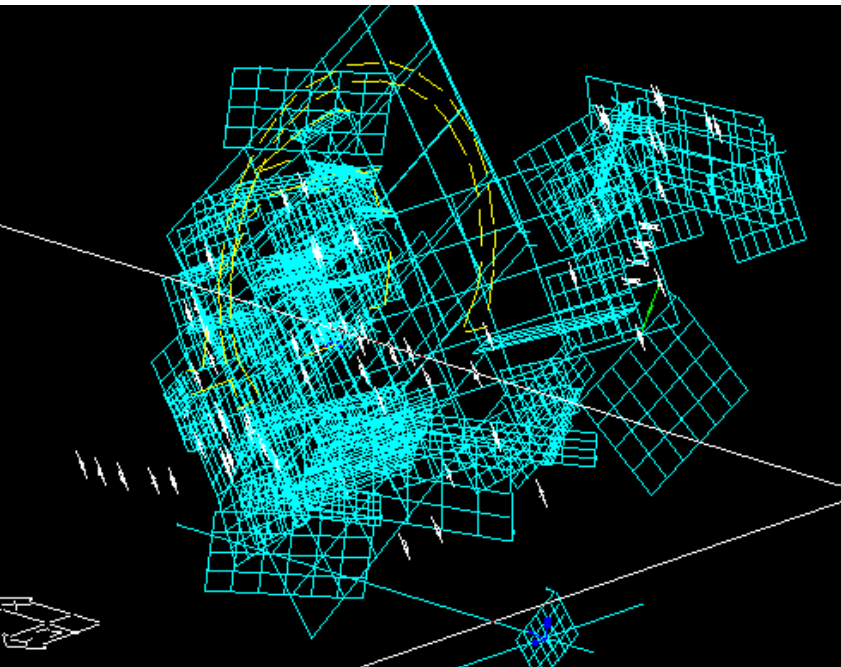


# Crew Station Geometry

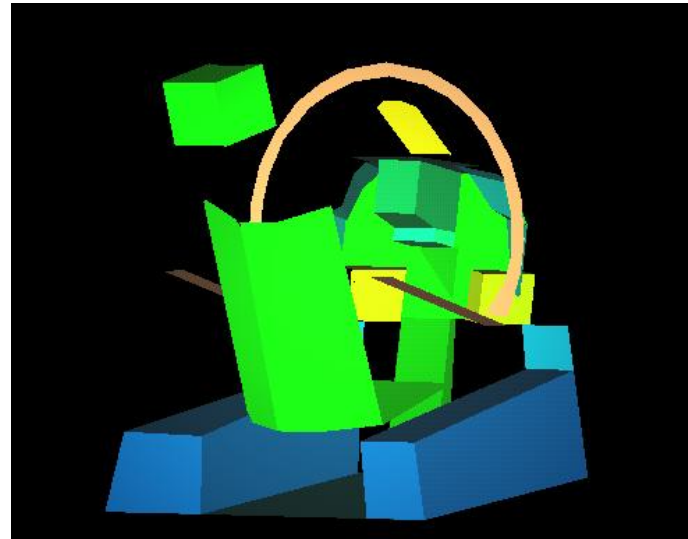
- FaroArm™
  - Coordinate measurement machine
  - Collects 3-D data in an AutoCAD® drawing
  - Creates 3-D drawing of the crew station



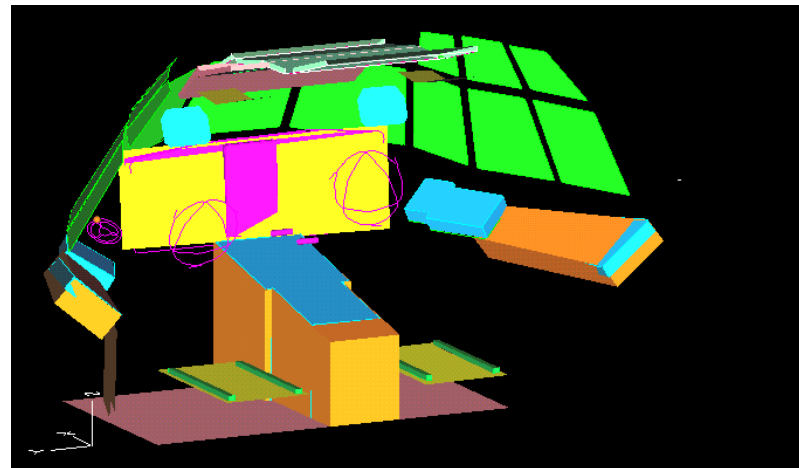
# Crew Station Geometry



Non-Rendered Drawing of AV-8B



Rendered Drawing of AV-8B



Rendered Drawing of C-130J

# Subject Evaluation



Evaluation of F-35 Mockup



Two seat aircraft evaluation

# Data Analysis

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- Organize data
- Perform multiple regression analysis
  - Independent variables: seat positions and anthro measurements
  - Dependent variable: miss or over reach distances pertaining to accommodation issue
  - Outlier analyses performed to refine data
  - Five equations are produced to predict accommodation based on anthropometry

# Products

- Anthropometric Restriction Codes
- Percent Accommodated (JPATS population)
- Confirmation of Boundary Case Accommodation



# Accomplishments

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- Performed analyses for over 30 USN/USMC aircraft
- Enterprise efforts within USN and with US Army and Coast Guard
- Released 3 technical reports, 1 technical memo
  - ARCs for trainers, tactical, rotary wing, fixed wing nonejection, USCG HH-65 and HU-25
- Released NAVAIRINST 3710.9D on Anthropometry
- Active involvement through iterative assessments on F-35 and H-53K programs

# Key Areas & Advantages of New Process

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- Updated Anthropometry
  - Primarily using 1988 ANSUR & subsets
  - New survey will provide current data that is more representative of our population
- Scanning, Modeling, & Animation
  - Opportunity to create models on aircraft for which no CAD data exists (or is too difficult to obtain)
  - Models can be updated to reflect modifications
    - Seat upgrades - new crashworthy seat, cushion changes
    - Changes to layout
  - Switches and controls can be animated
  - Bodyborne clothing/equipment and other objects can be captured

# Key Areas & Advantages of New Process

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- Digital Human Modeling (DHM)
  - Evaluate early in design
  - Save time & money
  - Can evaluate many sizes in multiple equipment configurations
  - Doesn't tie up aircraft and personnel
  - Ease in scheduling/coordination
  - Easier data collection & analysis
  - Can use boundary cases
  - Safer than using human subjects
    - industrial areas, fall hazards, noise, heat, aircraft damage

# Teammates-Anthropometry Update

- Potential efforts with Dr. Claire Gordon U.S. Army NATICK, Dr. Greg Zehner Air Force Research Laboratory, and/or Dr. Bruce Bradtmiller – Anthrotech
- Depends on funding, timing, and scope of effort
  - Full USN/USMC survey
  - Pilots only
  - Mini-survey
  - Creation of subset & boundary cases from 2010 ANSUR



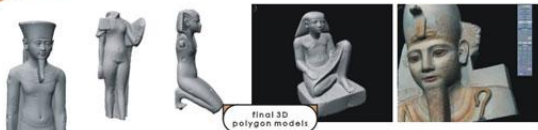
# Teammates-Scanning, Modeling, Animating

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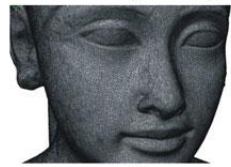
- Direct Dimensions, Inc (DDI) on contract to provide assistance in selection of scanning equipment and software.
- DDI also to provide training and to assist on first three projects
- DDI is very experienced in numerous scanning applications including aircraft.
- Probable software purchases are Polyworks, and 3ds Max.
- <http://www.directdimensions.com/>

# ancient egyptian SCULPTURES

Direct Dimensions 3D laser scanned and modeled Ancient Egyptian sculptures from a major museum collection to create exact digital copies. Rapid prototypes were made using the 3D models which were in turn used to create high quality reproductions for the Museum Gift Shop.



final 3D polygon models



3D polygon model detail



final rapid prototypes



laser scanning egyptian pieces



**DIRECT**  
dimensions  
rapid solutions to 3D problems.<sup>SM</sup>  
www.directdimensions.com

# fallen soldier MEMORIAL

Precise 3D models were required in order to rapid prototype double-size components that would aid in creating the final bronze memorial. DDI laser scanned and digitally modeled each piece and delivered the necessary 3D polygonal files.



final polygonal models



2x and half-size rapid prototypes



laser scanning tread pattern



final bronze memorial

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# plastic surgery nose RECONSTRUCTION

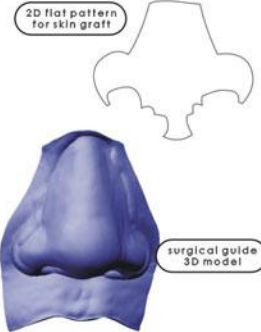
Combining the scan data of the injured nose and of the sculpted new nose, DDI was able to model a surgical template that would guide surgeons when rebuilding the new nose. A 2D flat pattern of the nose surface area was also used so the surgeons knew how much skin to remove from the forehead to cover the cartilage.



laser scanning sculpted nose



new nose digital model



surgical guide 3D model

2D flat pattern for skin graft



initial scan of injured face



captured 3D FaceScan



rapid prototype surgical guide in use

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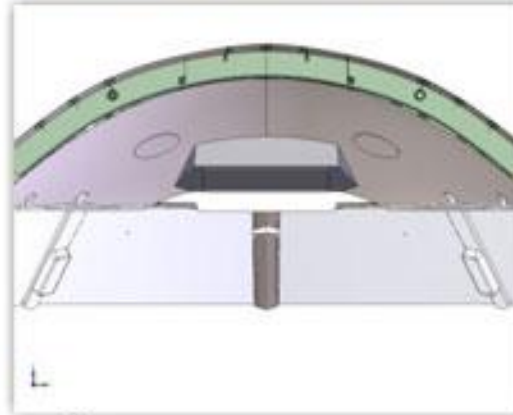
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# aircraft COCKPIT

Precise locations of every component in an aircraft was needed in order to properly build a complete aircraft simulation. DDI used digitizing techniques to gather all of the 3D geometric data so that an exact reverse engineered model could be created.



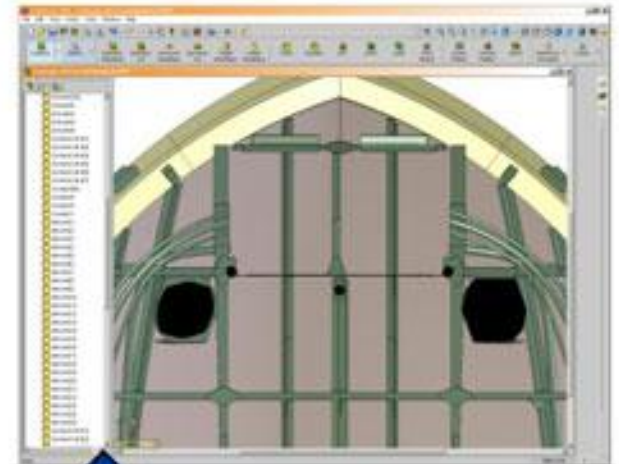
digitizing  
the cockpit



cockpit controls  
3d solid model



rapid solutions to 3D problems...®



cockpit ceiling  
3d solid model

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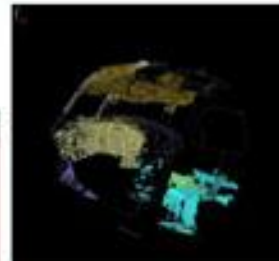
fax 410-998-0887

# cockpit SIMULATION

Direct Dimensions captured scan data and digitized geometric features in order to build a cockpit virtually. Using this data, surfaces could be fit and component locations could be found. After parts were in place reference images were then texture mapped onto the individual parts.



raw laser scan data



creating initial surfaces



building and aligning parts



blank polygonal model



data acquisition



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gauges texture mapped

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# Teammates- Digital Human Modeling

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- Partnered with the University of Iowa
  - 2 Seats of Software for 1 year
  - Grad student support for 1 year
  - Training on DHM and possibly Maya for custom avatars
- Evaluating SANTOSHUMAN™ software to determine if it will meet our needs
- Providing input to developers
- <http://www.santoshumaninc.com/>

# Examples of University of Iowa Partners

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- U.S. Army NATICK Soldier Systems Center
- Caterpillar
- ESI
- USCAR (Chrysler, Ford, GM)
- US Army RDECOM
- National Automotive Center
- US Army TACOM
- Rockwell Collins
- DARPA
- US Air Force

- ✓ **High-Fidelity Musculoskeletal System**  
more than 205 degrees of freedom, biomechanically accurate
- ✓ **Physics Based**  
reacts to and imposes forces on all objects in virtual world
- ✓ **Dynamic**  
models difference in behavior associated with different tasks
- ✓ **Predictive**  
not based on motion capture
- ✓ **Real-time**  
designed to operate in real-time  
for most functions
- ✓ **Optimization-Based**  
motion based on user-defined  
performance measures
- ✓ **Realism**
- ✓ **Easy to Use**



# Santos Modules



## Santos™

**Hand**  
Modeling and Simulation

**Clothing**  
Mathematical Modeling

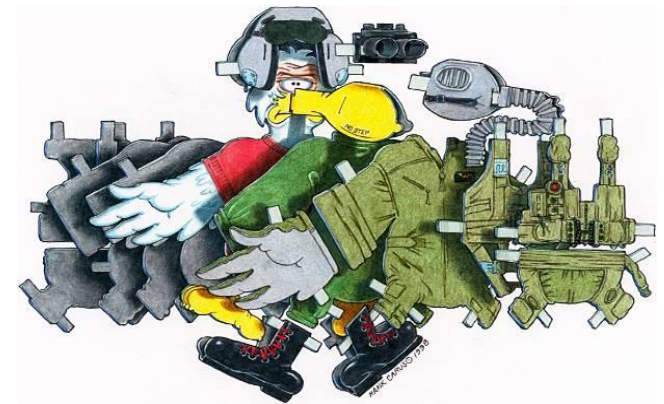
**Force Feedback & Interactivity**  
Work *with* Santos

**Scenario Generation**  
Create, render, and analyze multi-segmented tasks



# Known Challenges

- SANTOS
  - Avatars are currently created based on scan data, not traditional anthropometric measurements
  - Anthropometry cannot be easily or accurately adjusted
- Obtaining/creating representative models of clothing and equipment for Avatars
  - how to simulate effects (compression, restriction) of clothing/equipment on the avatar
  - multiple sizes needed
  - can be time consuming
- Effect of Restraints
- Positioning/Posture
- Validation!



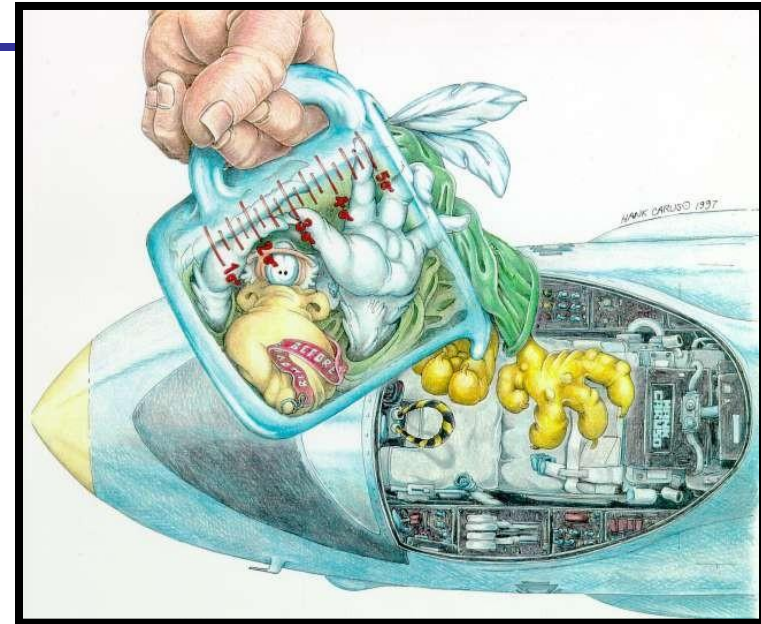
# A Few Other Possibilities

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- Design for maintainer/maintainer requirements verification
- Potential to simulate dynamic environment
- Emergency egress simulations
- Troop/passenger seat accommodation
- Crew resource management
- Crewstation display and control configuration
- Mockup & Simulator Design

# We welcome opportunities for collaboration!

## Thank You



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