Graphics Research and Analysis Facility (GRAF) and Lighting Environment Test Facility(LETF)

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Graphics Research and Analysis Facility (GRAF)

Resolving human factors issues in spacecraft design, analysis and planning using computer aided technology:

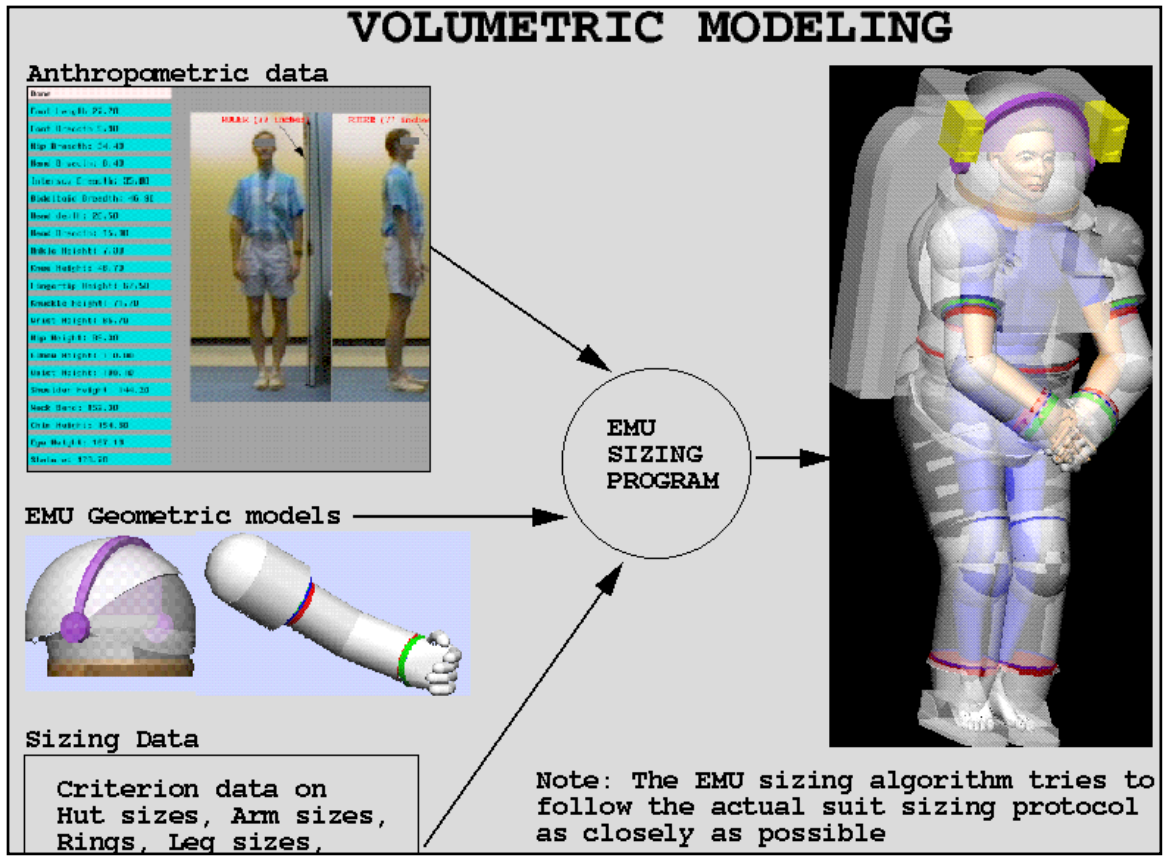
- Digital Human Models
- Lighting Models
- Interior and Volume Control Models

Digital Human Modeling

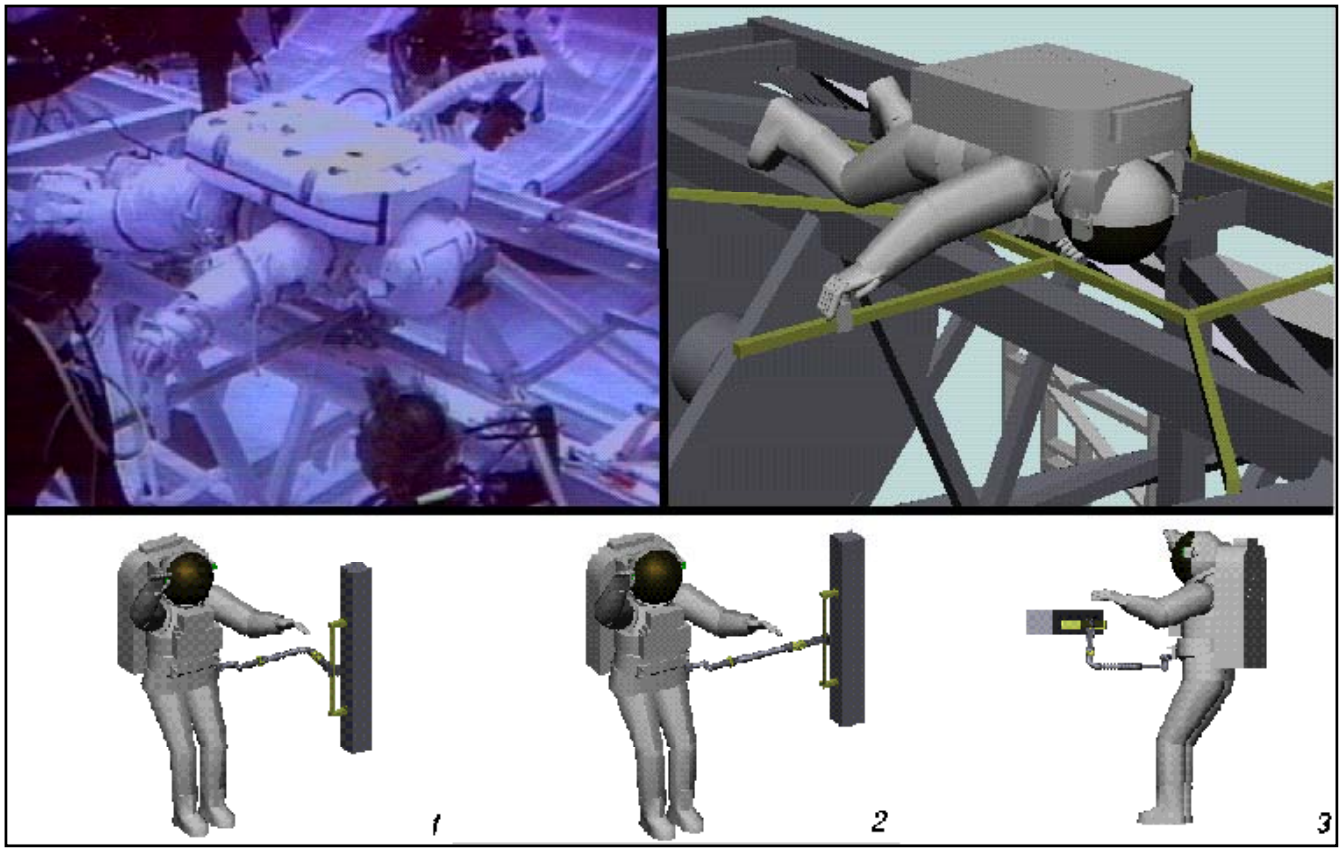
•We currently use an in-house human modeling system.

•It models both suited and unsuited humans.

•Anthropometry is derived from Astronaut Candidate Database.



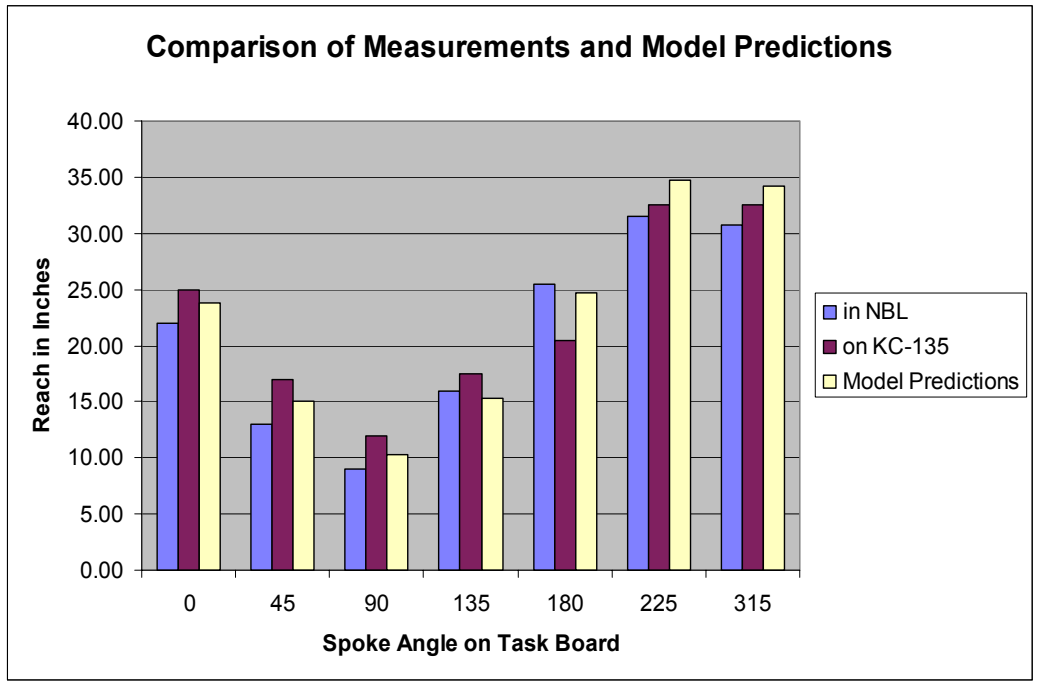
Digital Human modeling is as effective as and less expensive than physical mockups.



Model Predictions

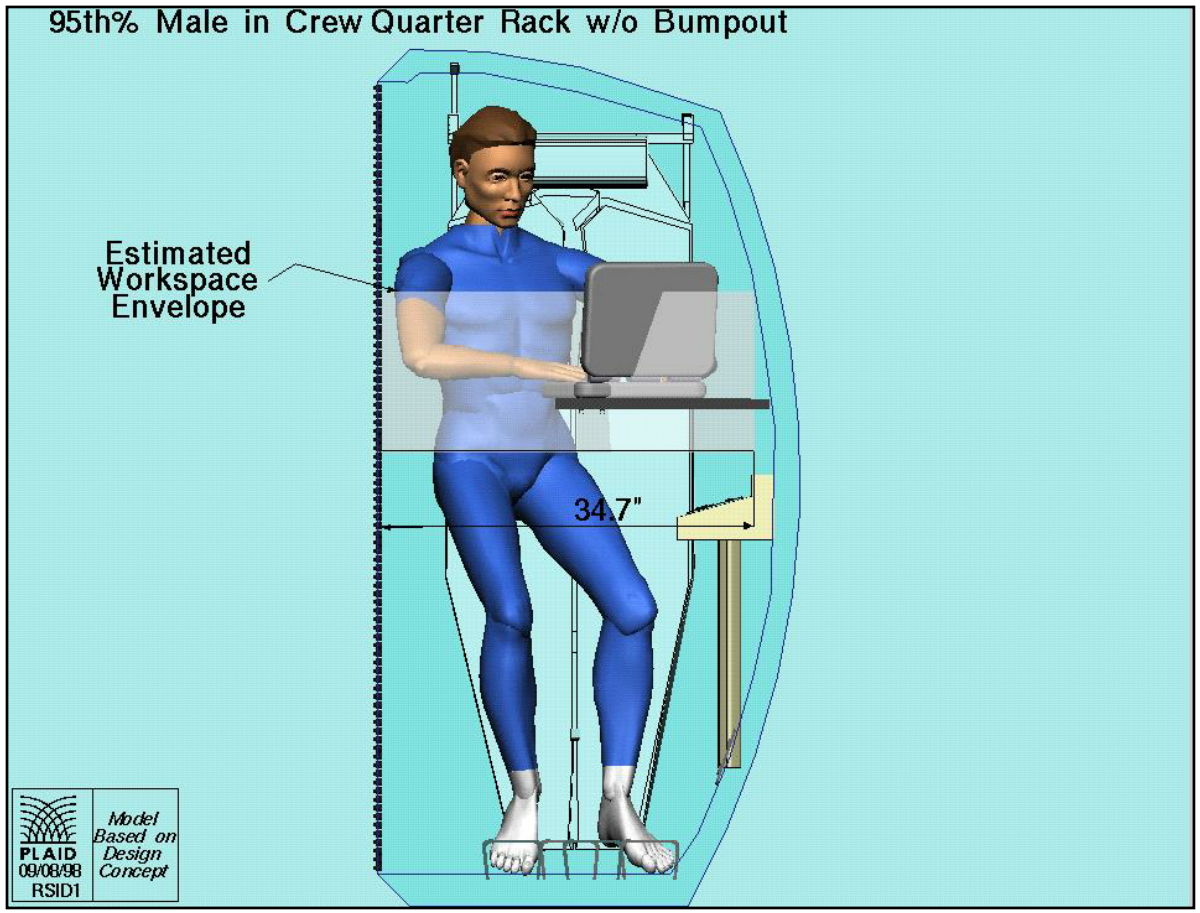
•Model predictions were as accurate as actual measurements of EMU suited reach limits using body restraint tether in the Neutral Buoyancy Lab (NBL) and on the KC-135 airplane for zero gravity simulation.

•Replacing most of the reach limit measurements with model predictions would reduce time and cost in the NBL and KC-135.



Reach and Fit Analyses

Human Models and Interior Models are combined to provide a volumetric assessment a crew quarter rack.



Lighting Models

•A modified version of Radiance, developed at Lawrence Berkeley Labs, is the primary tool. It has been validated and verified for our applications.

•It has been used to optimize the number of external luminaires required for EVA translation paths.

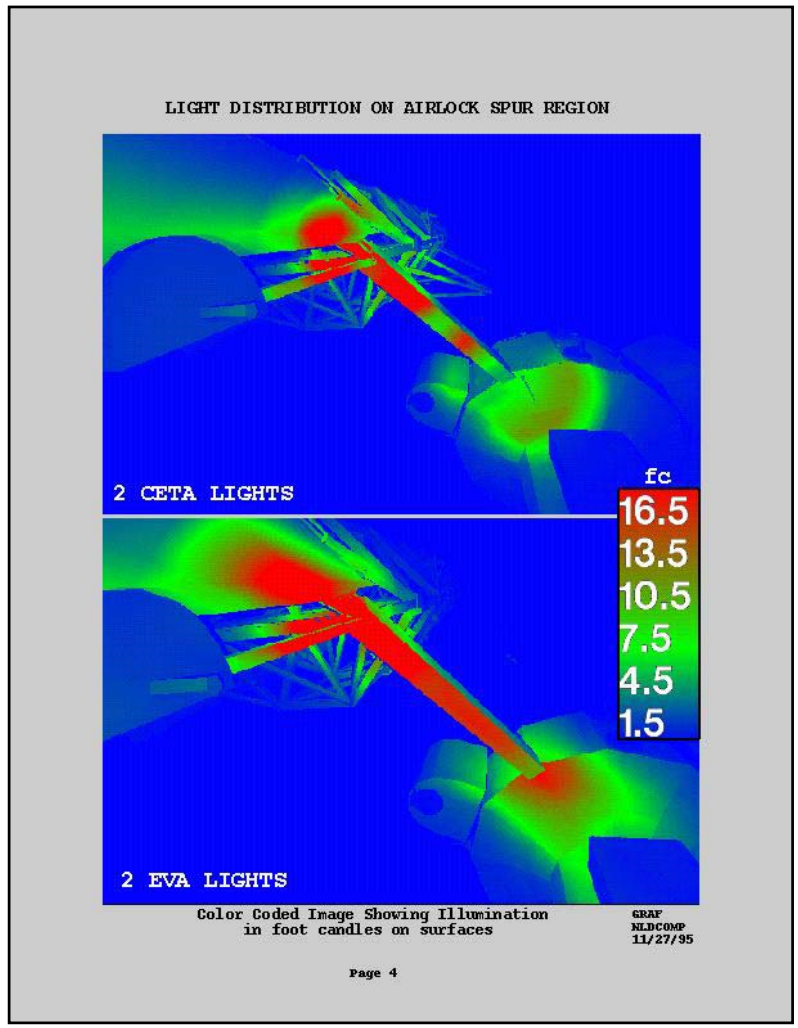
•It is being used for predicting lighting conditions for the Space Vision System (SVS) during berthing operations for Space Station assembly.

•It is being used for designing new interior luminaires.

Exterior Luminaire Evaluation

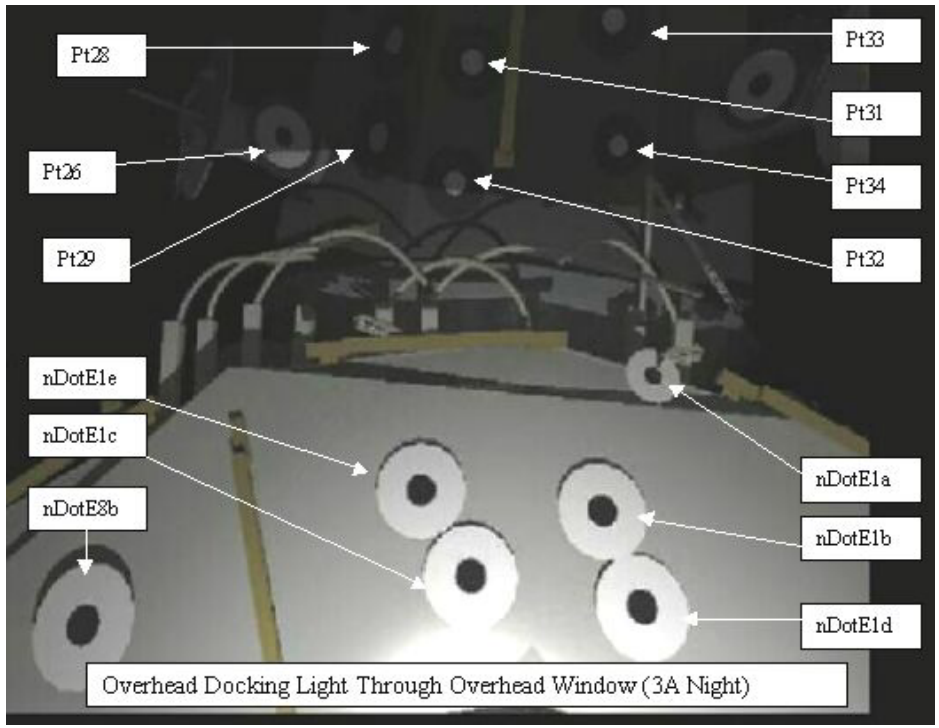
•The goal was to evaluate the location and number of external fixed luminaires or lights required for extra-vehicular activity at key translation paths.

•The evaluation determined that the number of luminaires can be safely reduced by 50%, reducing installation and maintenance costs for the Space Station.



International Space Station Assembly Operations

Predictions of luminance levels for SVS operations, are used to select cameras, select lights, support training, and provide real-time mission support for time-line updates and mission contingencies.



Lighting Environment Test Facility (LETF)

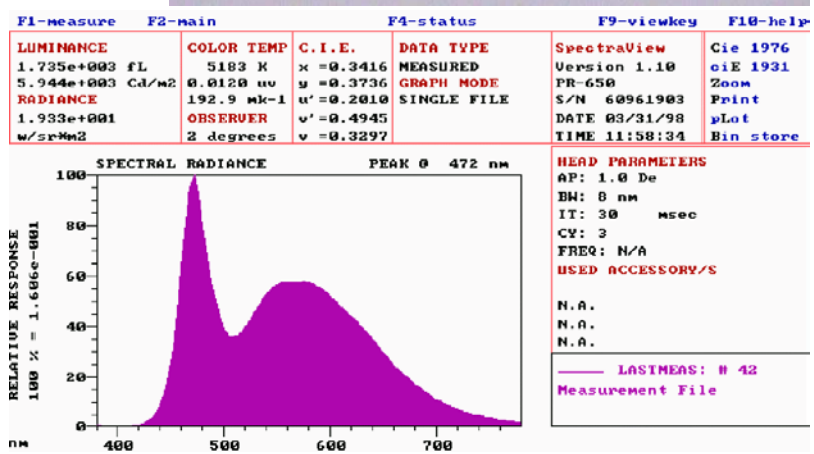
•Investigate and evaluate, both objectively and subjectively, proposed lighting systems for use on space vehicles for both direct and indirect viewing.

•Assess impacts of lighting, artificial and natural, on utilization of crew equipment.

Solid State Task Light

LETF provides evaluation of luminaires (lights) such as, docking lights, portable lights, navigation lights, habitability illumination and task specific luminaires.

Products are measurements and evaluations such as photometric measurements of luminaires, scattering properties of surfaces (BRDF), and color measurements of luminaires and materials.

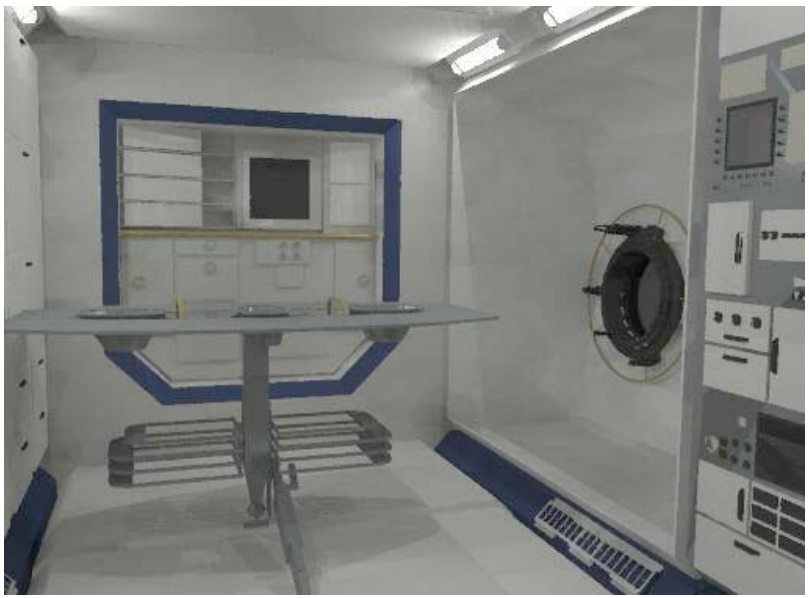


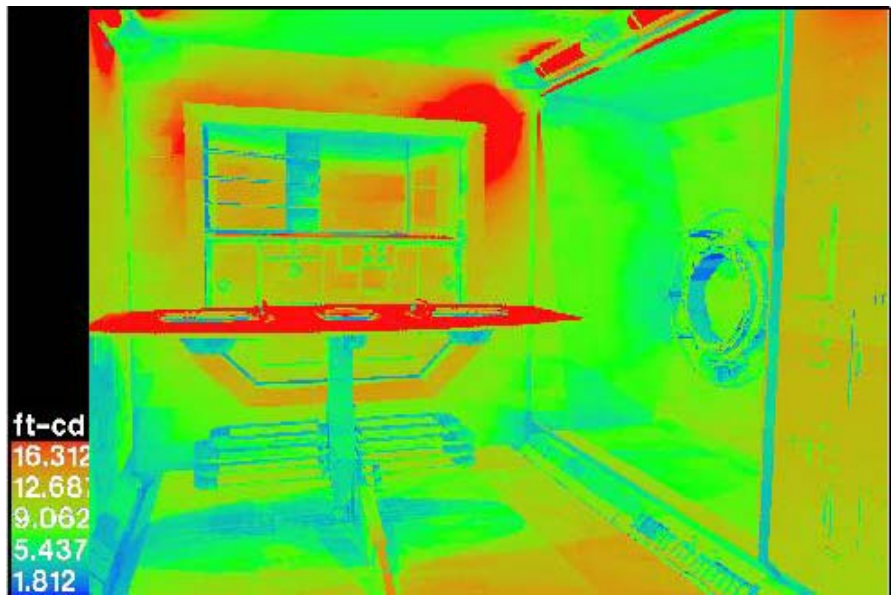
Colorimeter Output for White LED

Evaluation of Solid State Luminaires without diffuser.

SSL are being considered as replacement for fluorescents in ISS.

The design needed to provide equivalent illumination with the same form factor.





Augmented Reality

Virtual Reality (VR): A synthetically generated world (e.g. 3D segmentation model of the brain) that is presented to the user. The real world is occluded (typically by a head mounted display) from the user.

Augmented Reality (AR): A real view of the environment (the patient) merged with a synthetically generated world (e.g. 3D graphics models of critical structures like the tumor, blood vessels, ventricles etc.). The real world and virtual world objects are presented together on a single display device. There can be both real-time AR and Off-line Video tape based AR

Why use augmented reality technology?

There many potential applications such surgery, maintenance (just in time training), robotic operations, etc.

An example for Space:

Space Station and Shuttle tasks involve procedures that are very complex and highly dependent on the availability of visual information.

Extremely dynamic and harsh lighting conditions are common.

- On orbit, the sun rises or sets every 45 minutes on average.
- Shadowing can produce contrast or ambiguities .
- Glare is common.

Previous research has shown that augmentation of live video with dynamic overlay information (augmented reality) improved human performance.

Example of AR used for a docking target

Issues for AR

Registration
The registration of the synthetic, virtual world with the live image needs to be dynamic and accurate. This is the most difficult problem to solve for AR. There are currently two techniques which are used.

• Camera registration. The location and attitude of the eye point is known relative to a known environment.

• Image registration. Compute the location of the eye point using object recognition by image processing.

Issues for AR (cont'd)

View management
Determination of the correct amount and type of information to mix with the live image. Human perception issues are also involved. This is a rich field of options.

• Geometry – 3D models of the objects in the scene, 3D outlines and guidelines, predicted paths of motion, etc.

• Annotation – text information