INL/MIS-23-73401-Revision-0

3D Modeling of Safety-Related Upgrade Pilot Project

July 2023

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Changing the World's Energy Future

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Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy

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Click to edit Master title style Overview and Scope

- Project Introduction
- 3D Model Development and Tools.
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- Demonstration of 3D Modeling used in the Pilot Project
  - New State Vision
  - Functional Requirements Analysis and Function Allocation
  - Task Analysis
  - Conceptual Verification
  - Preliminary Validation
- Final Remarks and Future Work

Click to edit Master title style 3D Modeling Used as a Human Factors Evaluation Tool for the Pilot Project

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- 3D modeling was used to support the pilot project with Constellation Energy by:
  - Creating a visual scaled representation of the Main Control Room (MCR) for the Limerick Generating Station.
  - Determining ideal locations for Human System Interface (HSI) displays.
  - Supporting the relocation of current instrumentation and controls (I&C).

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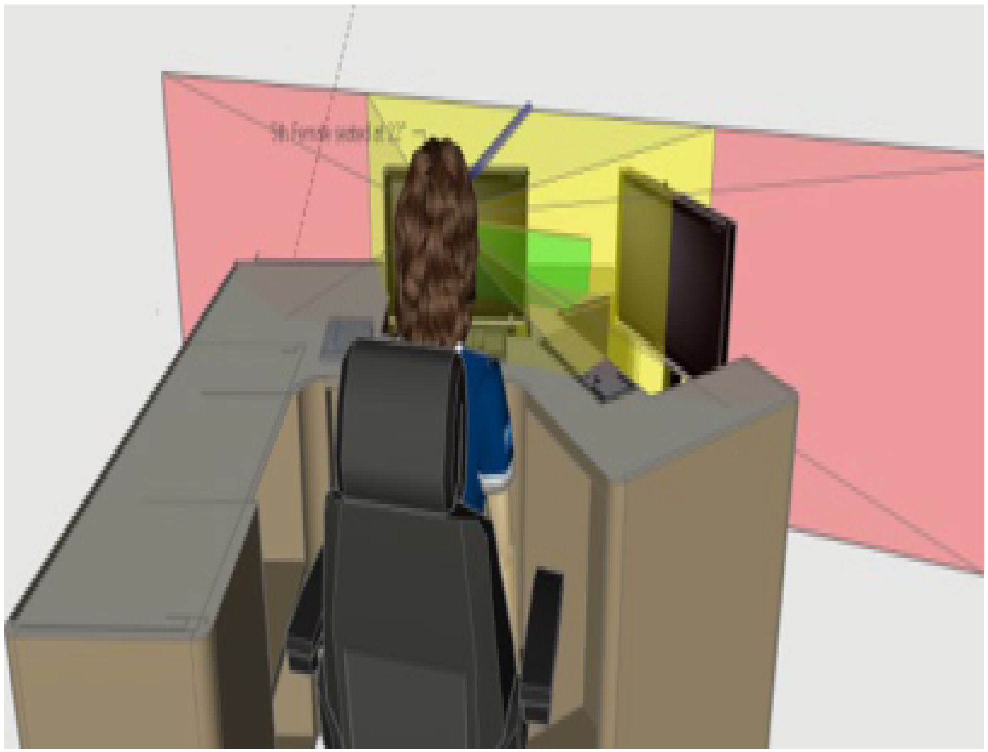
3D Modeling Software

- Trimble Sketchup software was used as the primary 3D modeling software for the pilot project.
- Allows different types of files to be merged into the 3D such as:
  - Layout Drawings
  - Equipment Drawings
  - Images
  - 3D model files (dwg, and other support types)

(Mohon, Kovesdi, Joe, & Hunton, 2023)

Digital Human Models use in 3D Modeling



(Mohon & Kovesdi, 2022)

- CGM Ergo Loader software was used to create Digital Human Models (DHMs).
- DHMs are used to evaluate anthropometric considerations such as:
  - Functional Reach
  - Viewing Angles and Sight Lines

Click to edit Master title style Functional Reach Analysis using 3D Modeling

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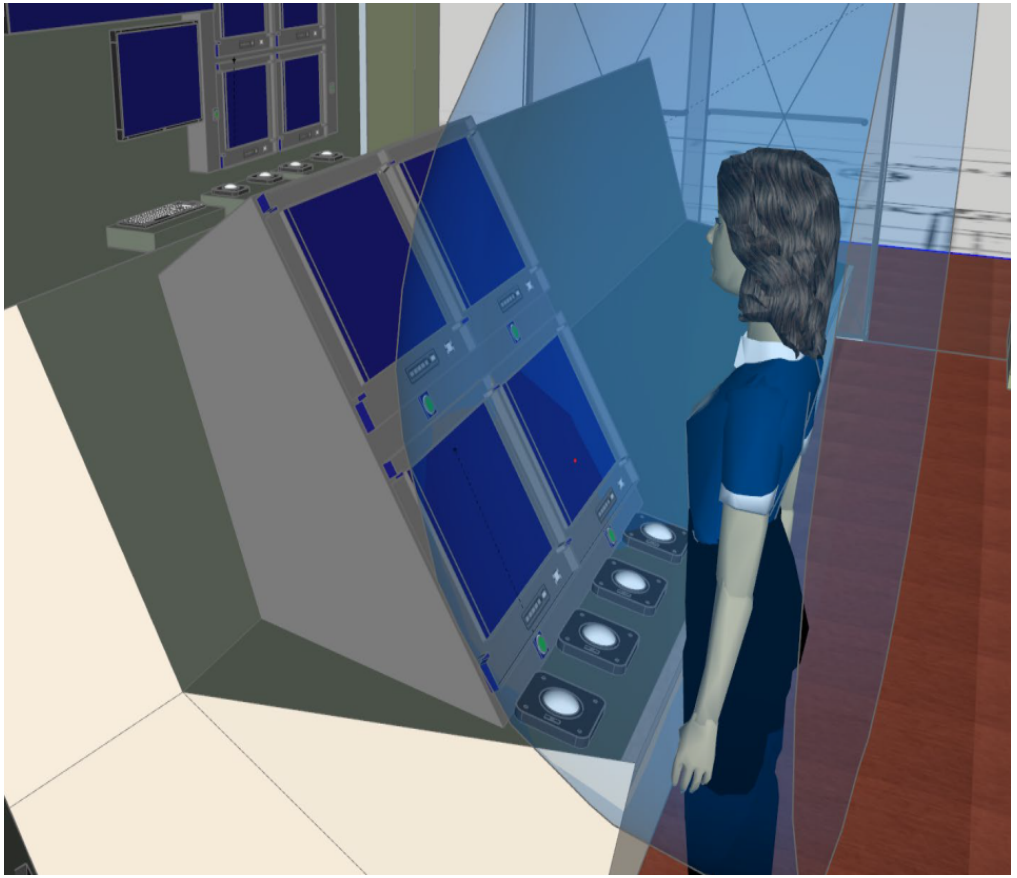
- 95th percentile male and 5th percentile female DHMs are used in the 3D models.

- DHMs were used to apply NUREG 0700 and MIL-STD-1472G functional reach guidance.



(Mohon, Kovesdi, Joe, & Hunton, 2023)

Click to edit Master title style Sight Line Analysis

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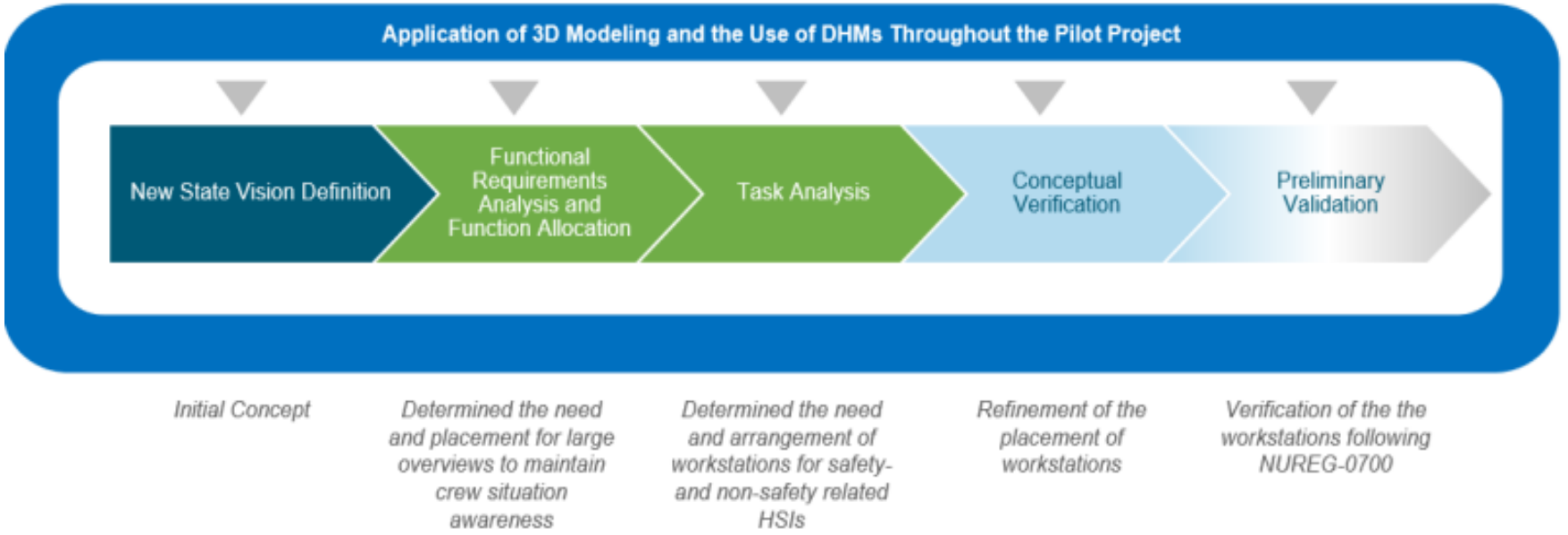
- Guidance from NUREG-0700 was used to review sight lines and viewing angles.
- DHMs were used to determine ideal locations for placement of new HSI displays.

(Mohon, Kovesdi, Joe, & Hunton, 2023)

Click to edit Master title style Human Factors Engineering Program Activities



- New state vision definition
- Functional requirements analysis and allocation
- Task analysis
- Conceptual verification (CV)
- Preliminary validation (PV)

(Mohon, Kovesdi, Joe, & Hunton, 2023)

Click to edit Master title style Phase: New State Vision Definition

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- The current state of the Limerick MCR was developed and shared with an engineering and operations teams for review.
- The 3D model was used to begin identifying areas would be able to support placements of new HSI displays.

- Anthropometric evaluations using guidance from NUREG-0700 to help evaluate potential human factors issues.

Click to edit Master title style Design Phase Functional Requirements Analysis and Function Allocation Workshop 3D Model Example

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(Mohon, Kovesdi, Joe, & Hunton, 2023)

Click to edit Master title style Design Phase: Functional Requirements Analysis and Function Allocation

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- The 3D modeling team identified new HSI locations on the 3D model for engineering and operations review.
- New HSI display positions and locations were evaluated using the 3D model using NUREG 0700 guidance.
- The 3D modeling team created a new iteration of the 3D model that presented new HSI display locations for future workshops.

Task Analysis Workshop 3D Modeling Activities

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- The 3D model was used in the task analysis workshop evaluate HSI display locations with an engineering and operations team.
- Feedback from operations was used to begin evaluating new HSI display locations.

- A new five-pack concept of four safety and one non safety display placed was evaluated.

Control Room Design Human Factors Task Analysis Workshop 3D Modeling Example

(Mohon, Kovesdi, Joe, & Hunton, 2023)

Conceptual Verification (CV) and Preliminary Validation (PV) Workshop 3D Modeling

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- The HSI display locations after the task analysis workshop were anthropometrically evaluated using NUREG 0700 guidance.

- The CV and PV workshops were used to further evaluate and test the planned HSI display locations with operators.

- Feedback for the planned HSI display locations was mostly positive.

Click to Edit Master title Conclusions and Future Work

- 3D modeling helps to identify human factors issues, ergonomic, and anthropometric considerations early and throughout the design.
- 3D modeling can help to reduce O&M costs by providing visualizations throughout the project.

- Future 3D modeling work for this project will continue to help evaluate future design changes.

Click to edit Master title style References

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