

Standardization of Digital Human Models for Posture Data Exchange

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(RROI) #23-178817-BCA

GLOBAL PRODUCT DATA INTEROPERABILITY SUMMIT 2023



Presenters Bio

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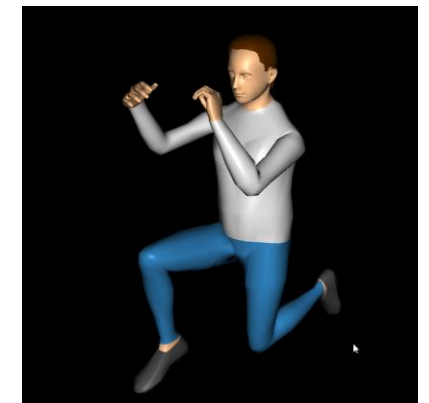
**Product Data Management
Engineer at
Boeing**

- **Professional Interests:**
 - Applications of VR to engineering, manufacturing, assembly, maintainability, product integration
 - Ergonomics
 - Software development, massive model visualization
 - Improving safety and quality of products and processes
- **Personal Interests:**
 - Music
 - Sailing, mountain sports, outdoors in general
 - Motorcycles
 - Family, friends, and food.

Overview

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- **Background of current standards efforts**
- **Problem definition and motivation**
- **Example of exchanging posture data between Digital Human Models (DHM)**
- **DHM standard technical topics**
- **Challenges to standardizing digital human model joints and postures**
- **Conclusion**

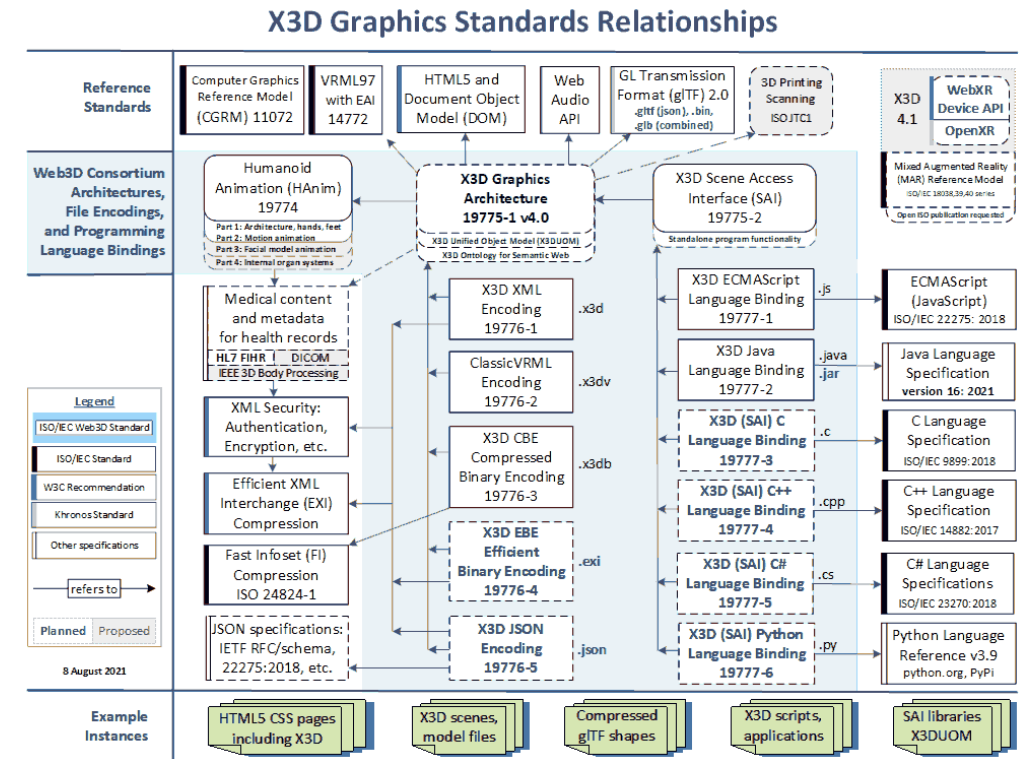


Background

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- Standards are in development of DHM, joint definitions and coordinate systems, skeletal hierarchy, feature points, human motion, etc
- ISO/IEC 19774
- Extensible 3D (X3D) Graphics and Humanoid Animation (HAnim)
- International Society of Biomechanics
 - Recommendations on definitions of joint coordinate systems:
 - ankle, hip, and spine
 - shoulder, elbow, wrist and hand

- web3D consortium (web3d.org)



Problem Definition and Motivation

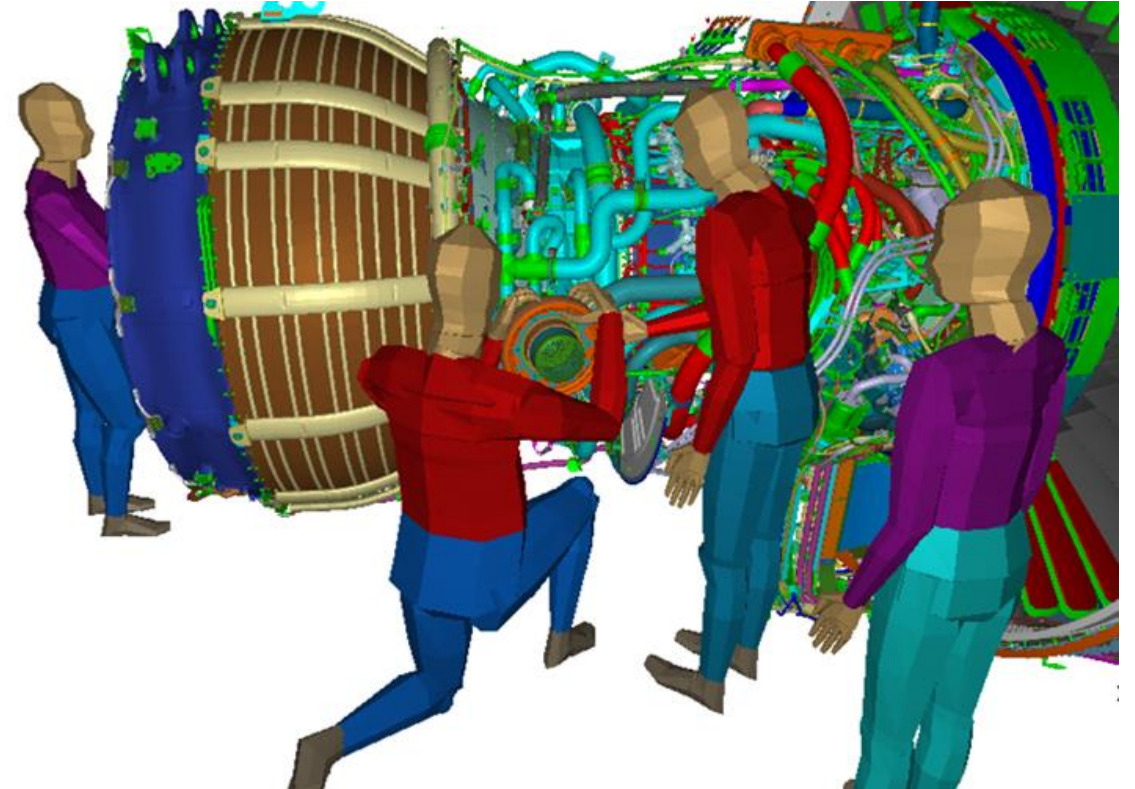
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- **Standards are still lacking in some contexts for applications of Digital Human Models**
- **Updates to the current standards for DHM software are needed/desired that would allow seamless interchange of joint data, posture data, and so forth.**
- **In practical applications of DHMs, exchanging and replicating data such as joint angles and postures between DHM systems is difficult**

Problem Definition and Motivation (continued)

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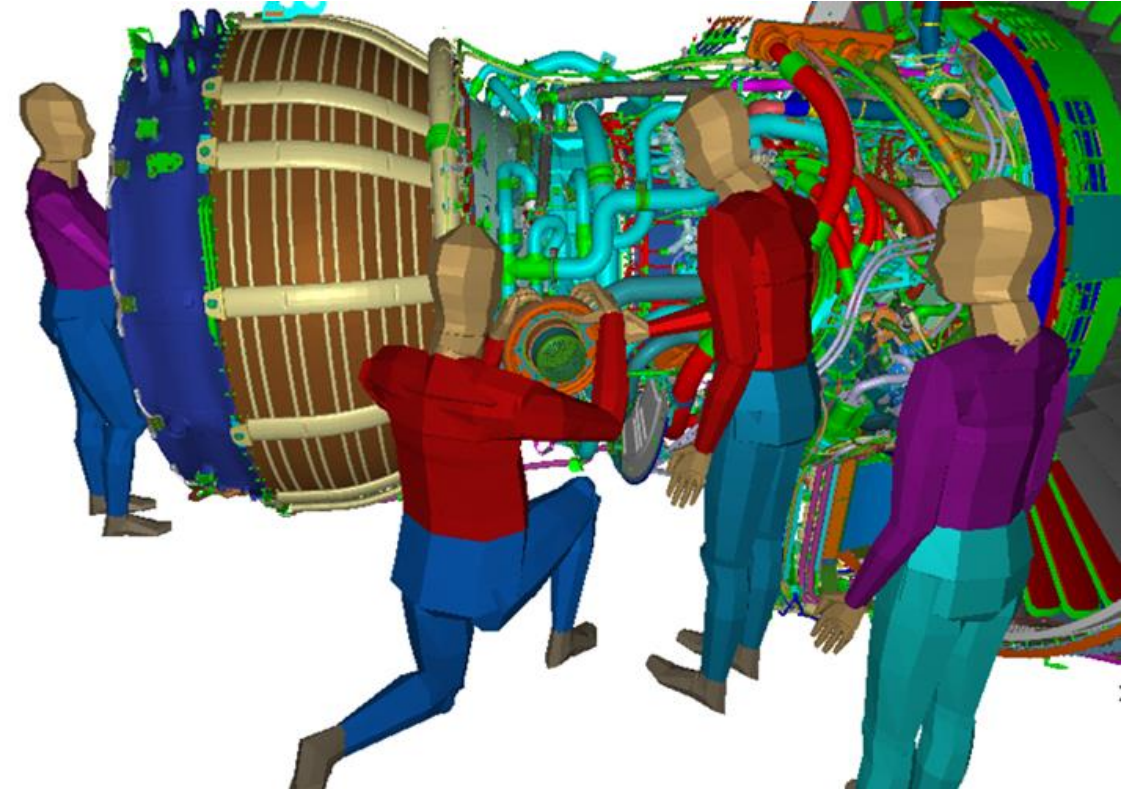
- **Many DHM exist in the marketplace**
- **Within companies, research institutions, etc., different DHM are used for different purposes**
- **There is a range of application contexts, use cases, and varying capabilities of DHM.**
 - Simple human model
 - Ergonomics simulations and studies
 - Immersive VR avatar, body tracked human model
 - Motion capture biomechanical skeletons
 - Segmented and skinned models
 - ... more



Problem Definition and Motivation (continued)

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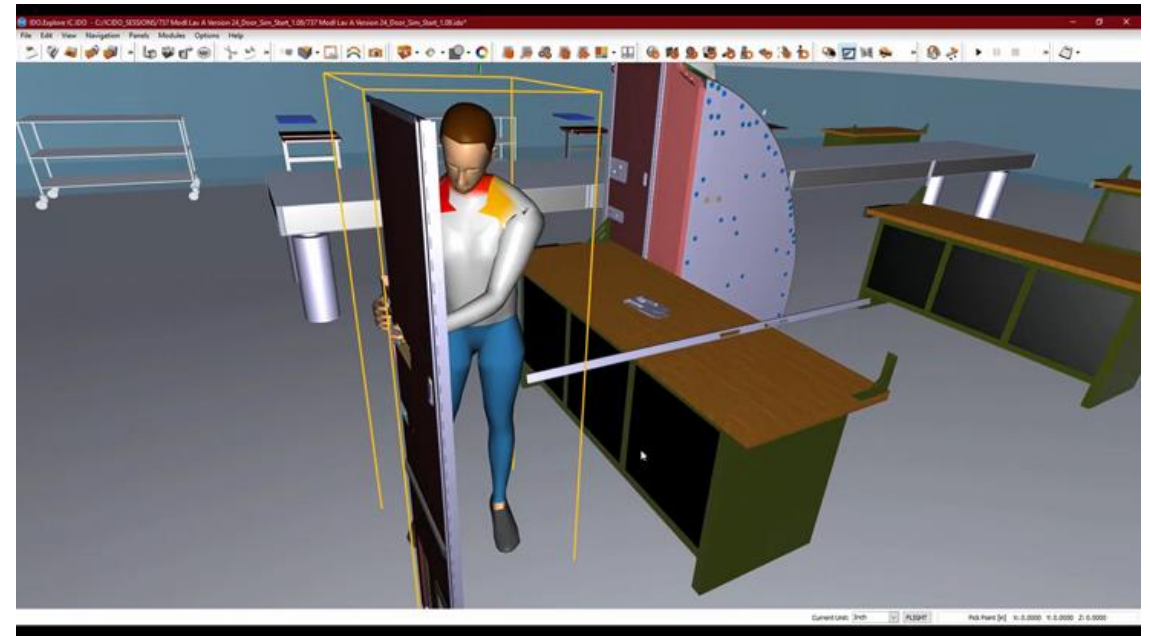
- **DHM application uses include**
 - Design and Manufacturing
 - Ergonomics
 - Gaming
 - Film and animation
 - Biomechanics and therapy
 - Virtual meetings
 - Metaverse, avatars
 - Virtual Reality
 - Sales and marketing
 - more ...



Problem Definition and Motivation (continued)

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- **Collaboration between business units, industry/research institutions, companies and suppliers is challenging if they have different DHM systems.**
- **Postures derived in one DHM application and use case are difficult to replicate in another DHM system**
- **Postures have to be re-created in each DHM system**
- **Inefficient, time-consuming, opportunities to iteratively optimize solutions/products are reduced**



Problem Definition and Motivation (continued)

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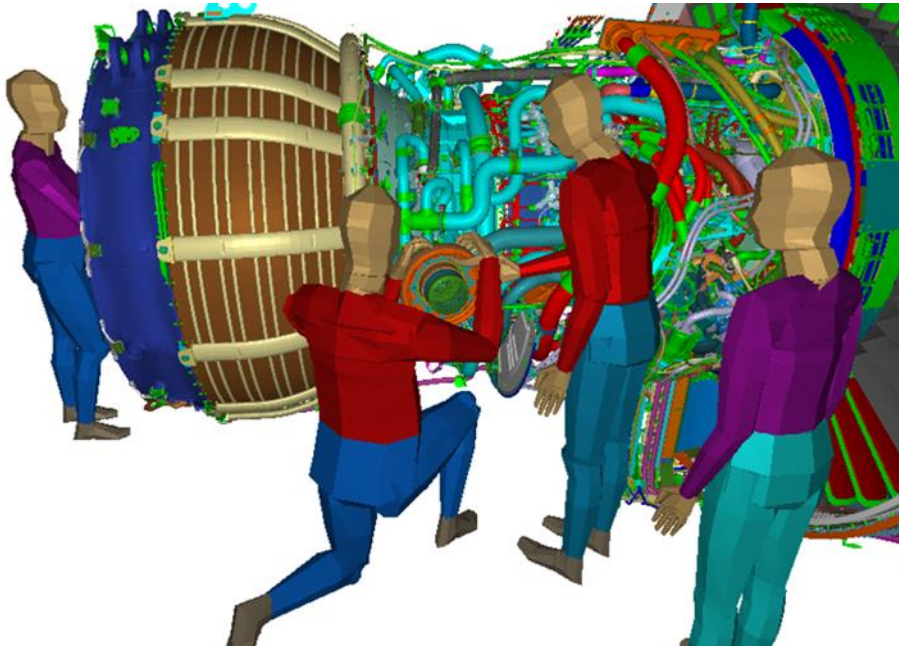
- **Desired Goal :**

A Standard that facilitates the exchange of manikin postures between digital human modeling software systems

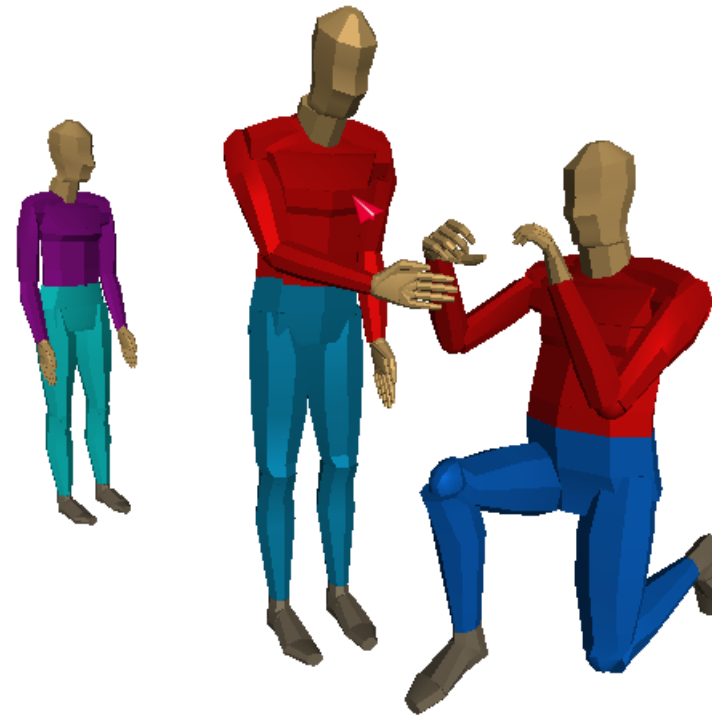
Example of Use Case of Multiple DHM – Posture Data Exchange

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- **Simple example: Maintenance operation**



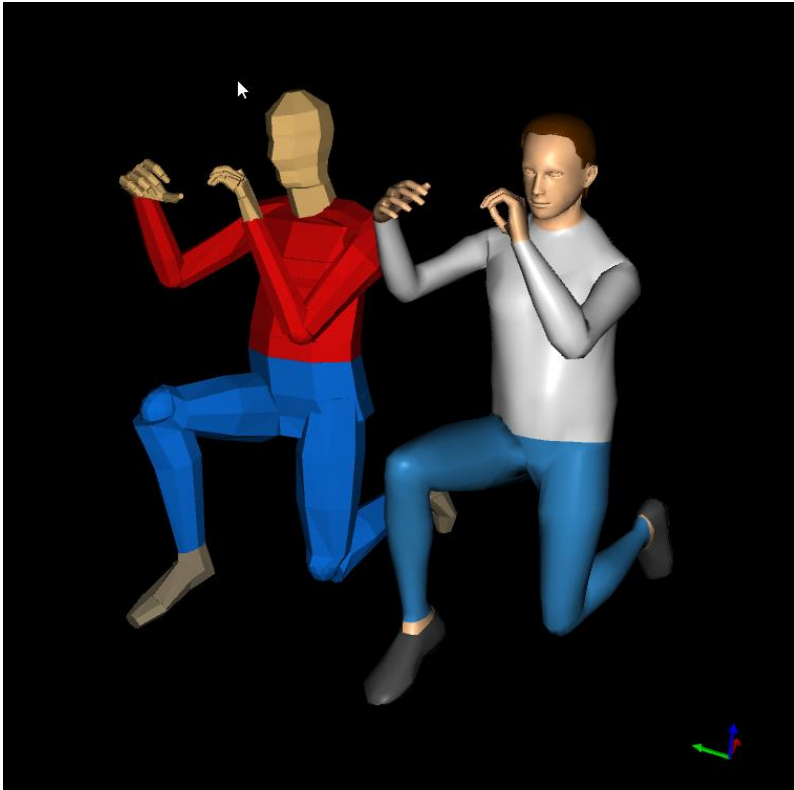
- **Manikin posture to evaluate...**



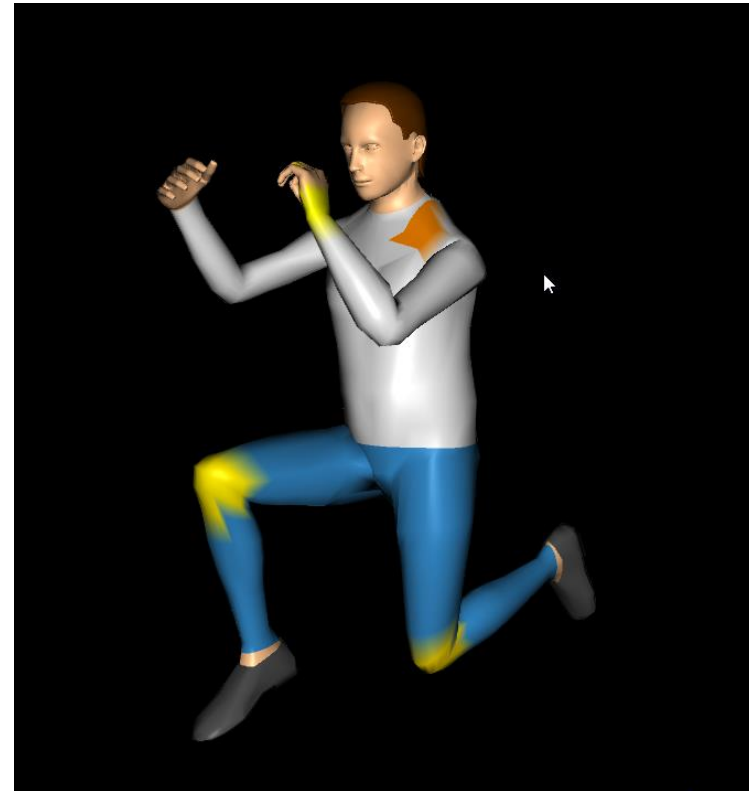
Example of Use Case of Multiple DHM – Posture Data Exchange (continued)

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- Replicate manikin posture in another DHM software



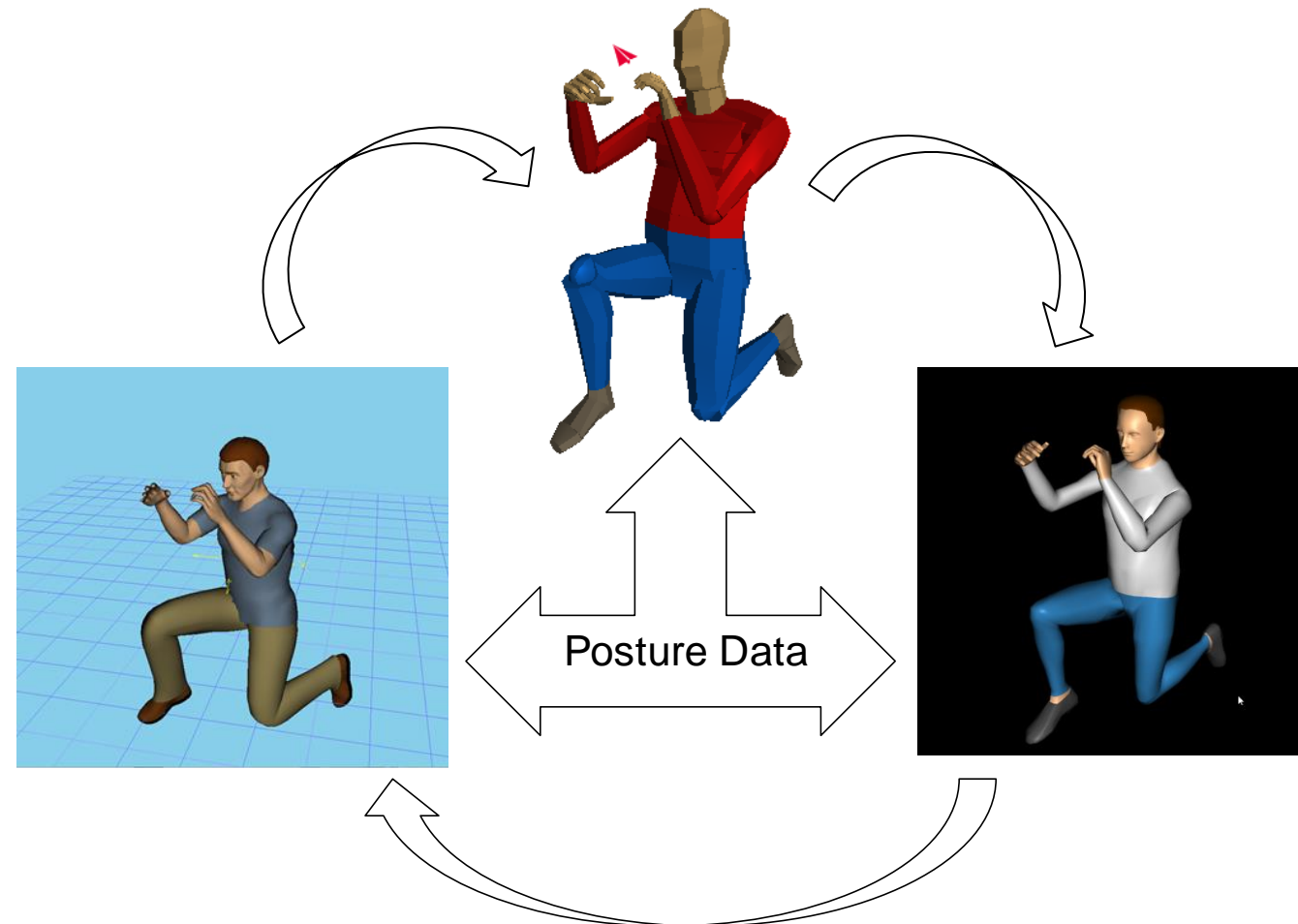
- Perform an ergonomics study for the maintenance task



Example of Use Case of Multiple DHM – Posture Data Exchange (continued)

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- Further analysis may be needed in a more specialized DHM for additional ergonomics studies
- Communicate results of analysis back to customer, including the new resultant manikin posture
- Iteration loops of design, manufacturing/assembly, ergonomics



Variability in DHM Joints, Skeleton, Modeling

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- **Each DHM has structural similarities (joints, body segments/skinned surfaces, kinematic chain, etc), but they are unique in their implementation**
- **A standard that supports homogenized commonality of posture data to between different DHM would greatly improve the work flow efficiency between DHM systems**
- **DHM software companies need to implement the interface between their model and the standard posture format**

DHM Standard Technical Topics

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- **Number of joints in DHM**
- **Standard joint definitions**
- **Standard coordinate systems for joints**
- **Body landmarks**
- **Independence/dependence of postures on digital human skin surface, landmark points**
- **Common file format for data exchange**
- **Units**

DHM Standard Technical Topics : Joint Definition and Ranges, Coordinate Systems

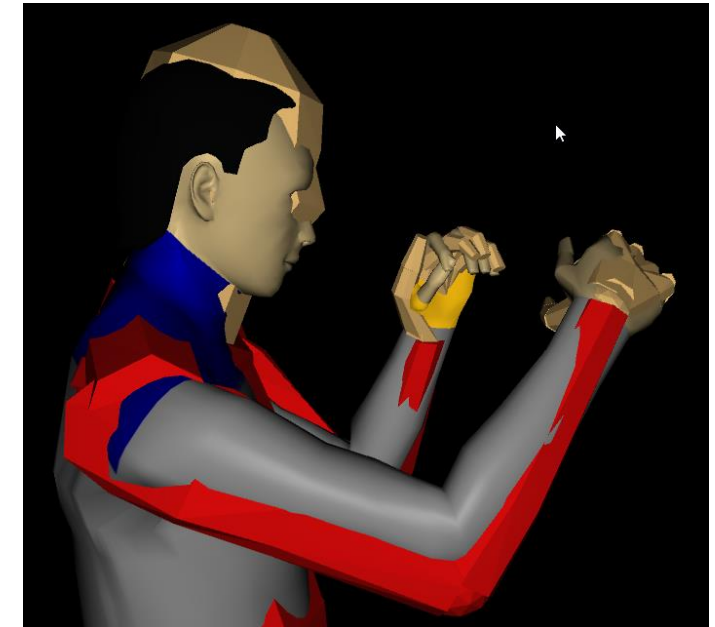
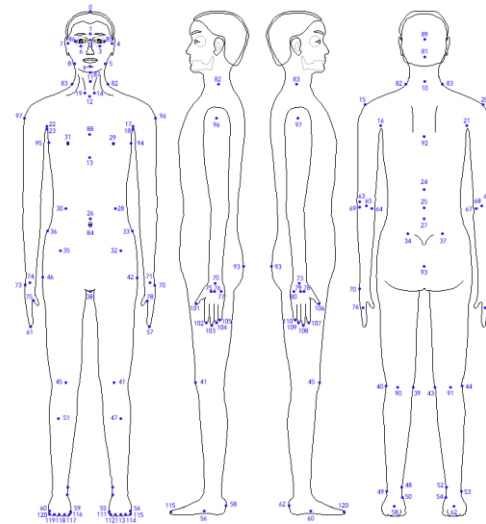
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- **Number of joints in DHM**
 - Define one or multiple models of varying complexity
- **Nominal body sizes?**
- **Standard joint definitions**
 - Naming convention
 - Degrees-of-freedom for Joints
 - Joint Degree-of-Freedom Ranges
 - Order of operations for rotations (X-Y-Z, Z-Y-X, or other)
- **Coordinate systems**
 - **Definition**
 - Location on manikin
 - Orientation

DHM Standard Technical Topics : Body landmarks

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- **Standard anthropometric landmarks exist (CAESAR®, etc)**
- **Include in posture data files**
 - Select a sub-set of body landmarks
 - For example: sellion, cervicale, acromion, ulnar/radial styloid, olecranon, asis, trochanterions, suprapatella, medial and lateral malleolus
- **Provide an additional landmark posturing object layer in DHM**
- **Match postures between DHMs with landmark targets, joint angles only, or a hybrid approach**
- **Landmark matching algorithms provide:**
 - A “goodness of fit” metric for postures between DHMs for same-sized manikins
 - An optimizing method for fitting postures of dissimilar (select/deselect landmarks to match)



DHM Standard Technical Topics : Standard File Format, Units

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- **Common file format for posture data exchange**
 - Select a file format (XML, VRML, JSON, etc)
 - Preferably ASCII (human readable) format
- **Units**
 - Selectable between metric/imperial for translations
 - Degrees or radians for rotations

Challenges to Standardizing Digital Human Model Joints and Postures

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- **The first challenge is determination, selection, and implementation of a standard that enable posture data exchange between DHM software systems.**
- **In order to perform the work required to craft the standard, collaboration from DHM software companies, industry practitioners, researchers, and academia is needed.**
- **Finally, implementation of standards in DHM software would need to be done to support the exchange of human model posture data.**

Conclusions

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- **This presentation is proposing additional definition in the current standard specific to posture data exchange.**
- **The current ISO standard work has many of the building blocks already in place.**
- **How do we move standardization efforts forward? What are the next steps?**
- **To achieve a Standard for DHM postures, collaboration between industry, researchers, academics, and digital human model companies is needed.**

• **Thank You!**

References

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- <https://www.web3d.org/standards/hanim>
- <https://pubmed.ncbi.nlm.nih.gov/11934426/>
- <https://pubmed.ncbi.nlm.nih.gov/15844264/>
- https://www.researchgate.net/publication/343305462_Exchange_data_between_Digital_Human_Modeling_systems_-_A_review_of_data_formats