



Panel: EVA-Human Modeling

Near-term applications, needs, and challenges of Human-Suit modeling capabilities to inform xEMU development

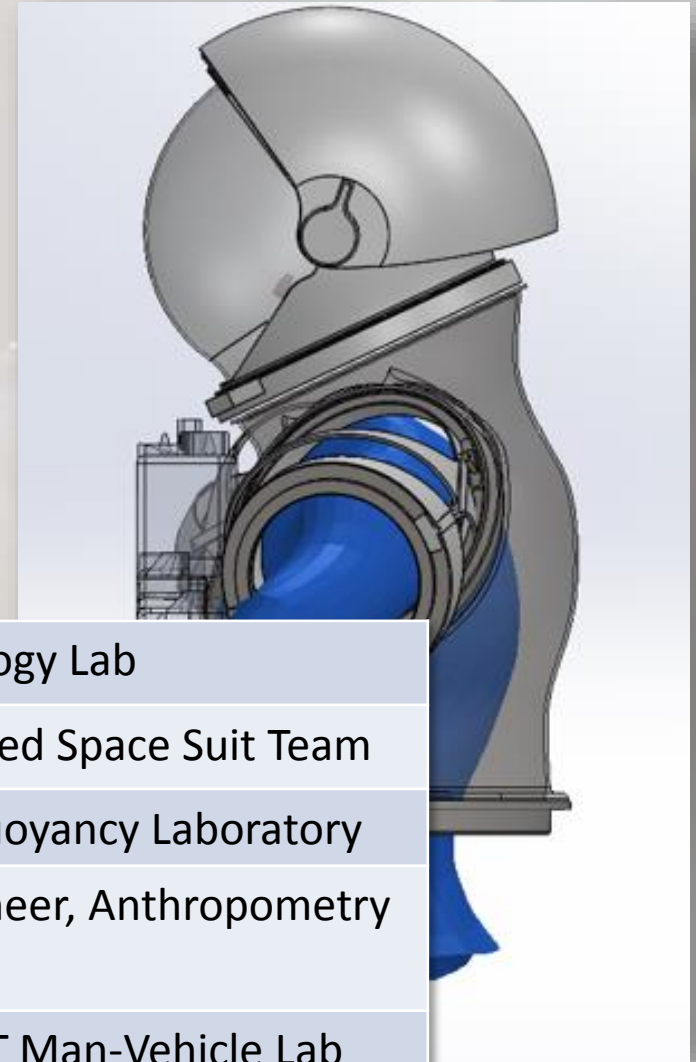
18 October, 2017

Moderator: Andrew Abercromby

Panel: EVA Human Modeling



- Panel Topic Description
- Panelist Presentations
- Q & A / Discussion
- Wrap-Up



Andrew Abercromby	Lead Scientist – EVA Physiology Lab
Richard Rhodes	Space Suit Engineer, Advanced Space Suit Team
Bob Sanders	Medical Director, Neutral Buoyancy Laboratory
Han Kim	Human Factors Design Engineer, Anthropometry & Biomechanics Facility
Leia Stirling	Professor & Co-Director, MIT Man-Vehicle Lab

Panel: EVA Human Modeling



- *Topic Title: Near-term applications and needs of Human-Suit modeling capabilities to inform xEMU development.*
 - Focus on near-term applications of existing models rather than what we could do with better models 5-10 years from now.
 - Are our current models good enough to be helpful? Or do their limitations make them misleading?
 - What EVA-Human models do you already use, if any? What works and what doesn't work?
 - If models are not already being used, why not?
 - What are potential applications of model(s) to xEMU development if they are not already being used? What questions / problems can they address, how soon, and are these actually important problems?





Virtual Fit Check: Parametric Human Body and Suit Models

EVA Technology Workshop 2017

October 17, 2017

Han Kim (Leidos)

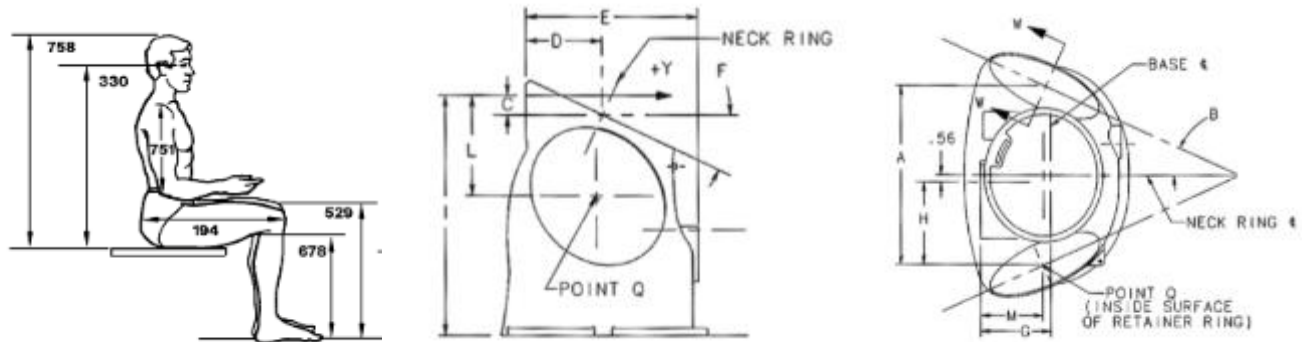
NASA JSC Anthropometry & Biomechanics Facility

Predictive Suit Fit Check: Former Techniques



- Linear Measurement Based Technique

- Compare linear dimensions between suit and crewmembers
- However, linear measurements do not represent 3-D body and suit geometry



- 3-D Scan Technique

- Overlay 3-D body scans with CAD drawing to assess overlap and clearance
- However, scans do not represent the entire ranges of crewmember body shapes

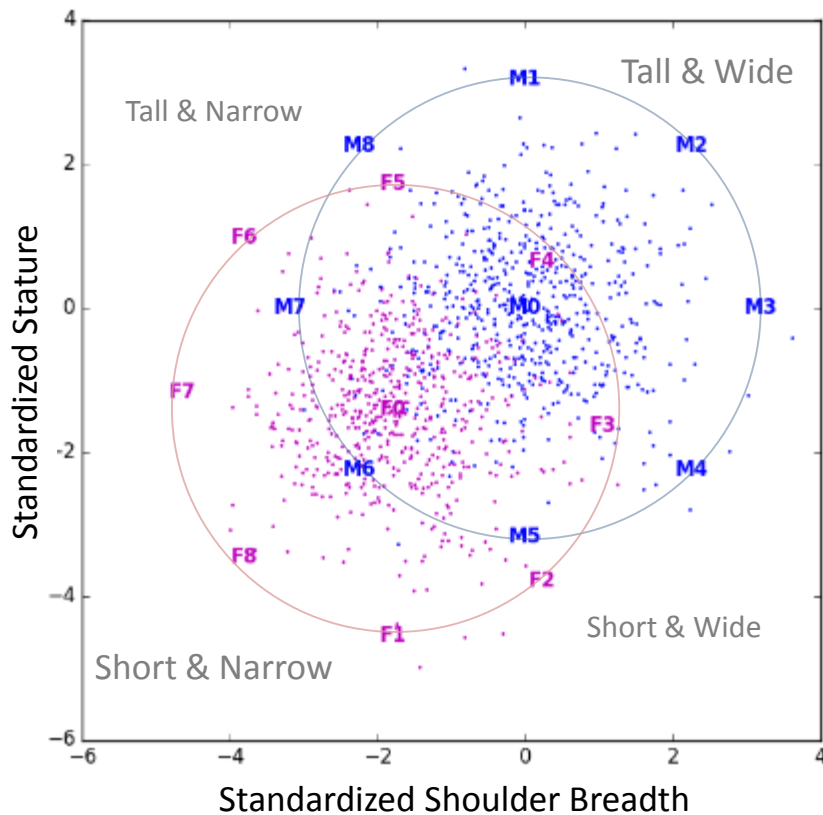


Boundary Subject Sampling

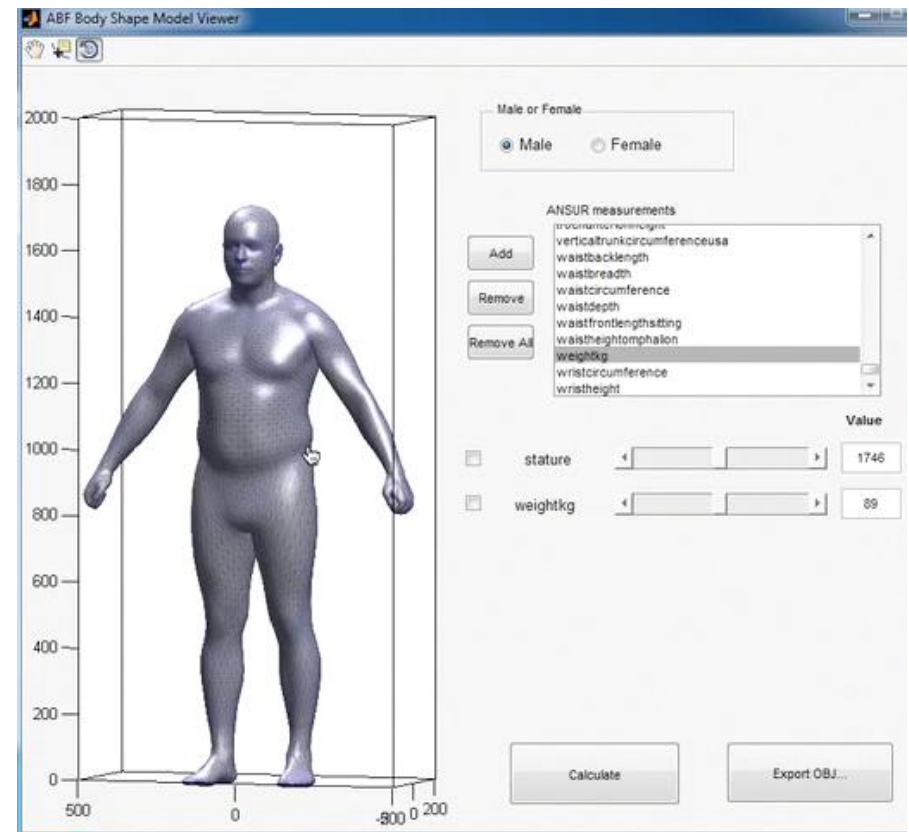


- Body dimensions were strategically sampled to include 99% of population (“boundary subjects”)
- Formerly used a nearest-neighbor scan data, but at present using a parametric body shape model

Identification of Boundary Subjects



Parametric Body Shape Modeling

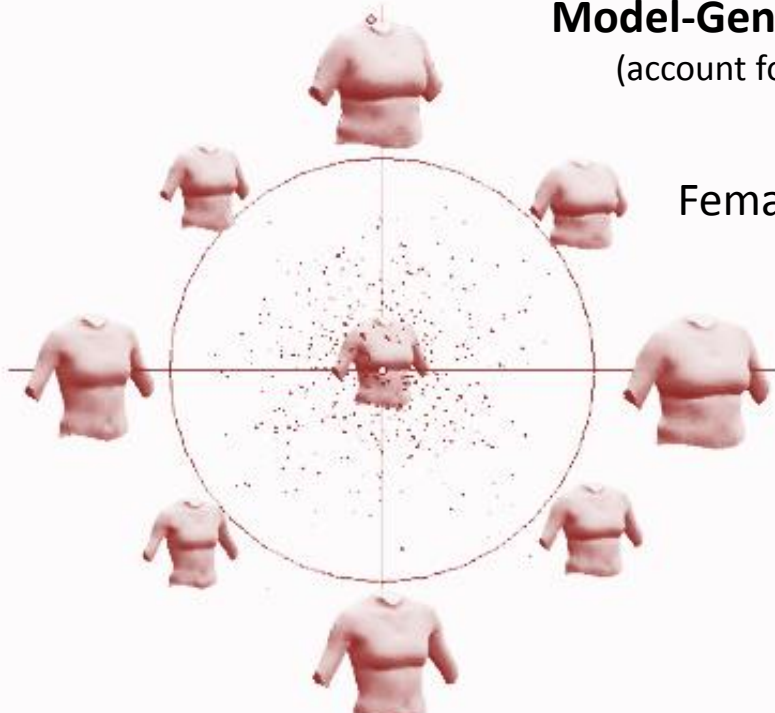


Boundary Manikin Family

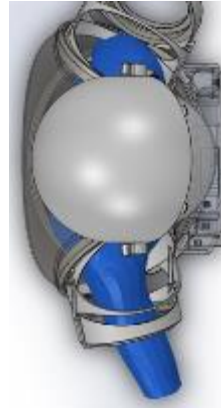
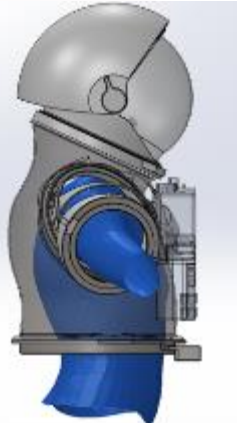
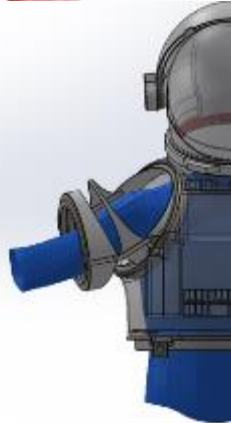
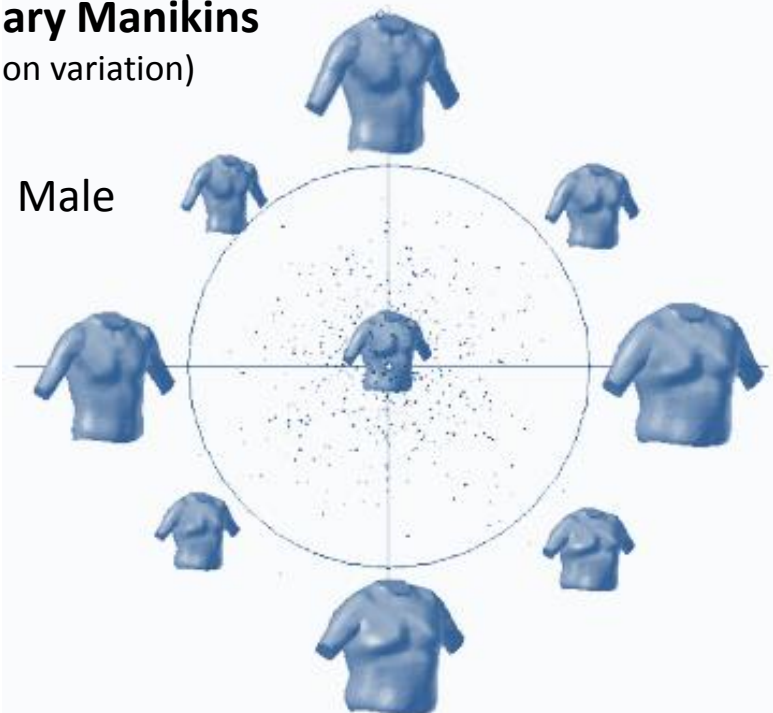


Model-Generated Boundary Manikins (account for 99% of population variation)

Female



Male



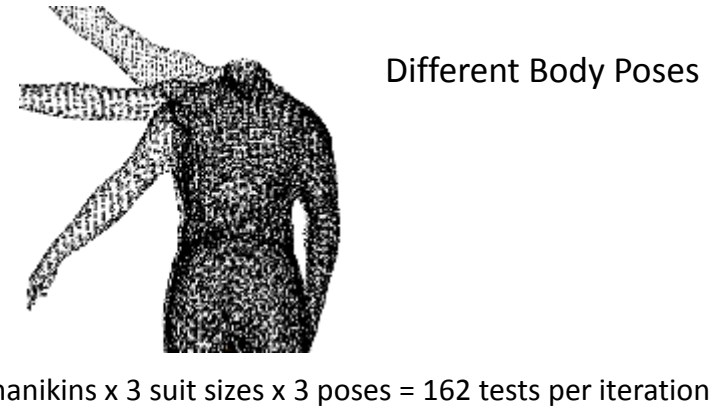
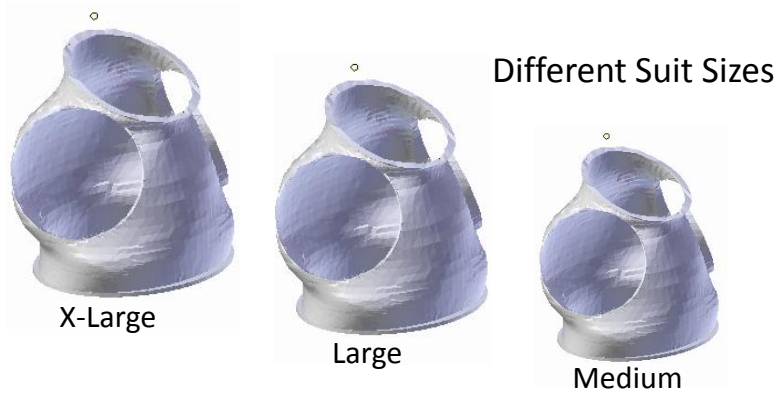
Virtual Suit Fit Check:

- Overlay with suit CAD drawings
- Estimation of overlap

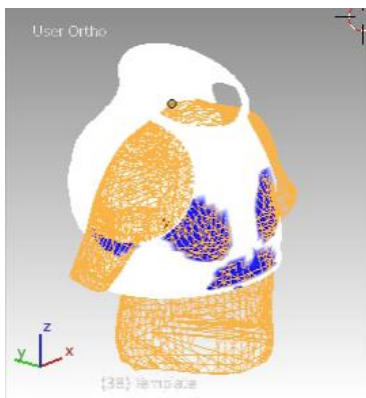
Fit Check Techniques for Large Dataset



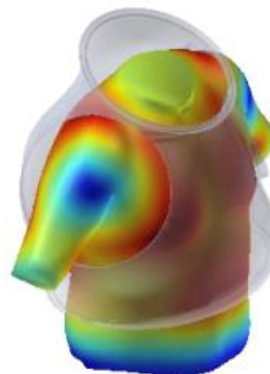
- *Manual* fit assessments become extremely difficult with a large number of suits and body poses



- *Programmatic* techniques were developed to automatize suit positioning and clearance quantification
- A reposable manikin was developed to articulate upper extremity poses



Programmatic
Suit Positioning



Automatic
Clearance Quantification

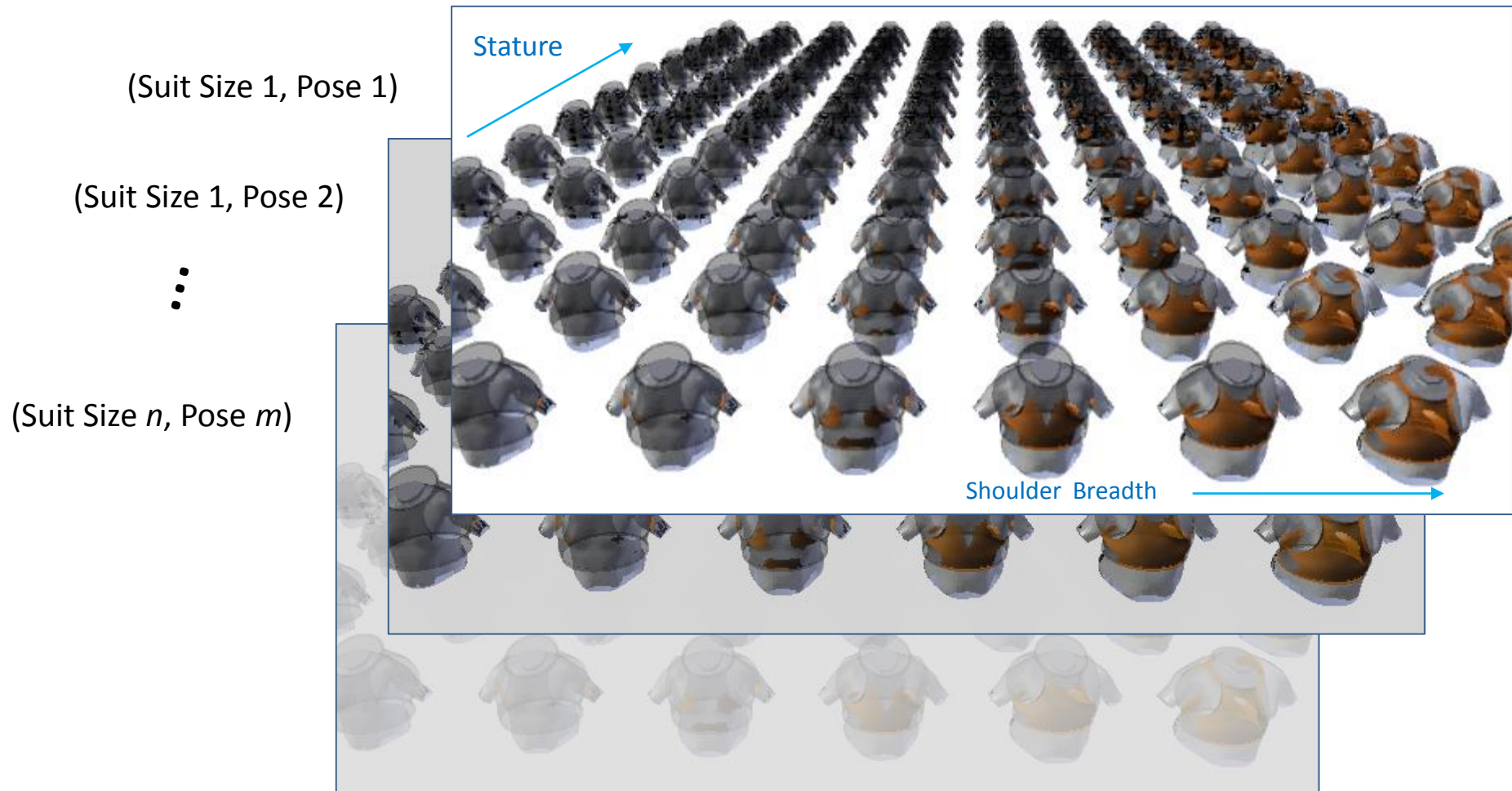


Parametrically
Reposable Manikins

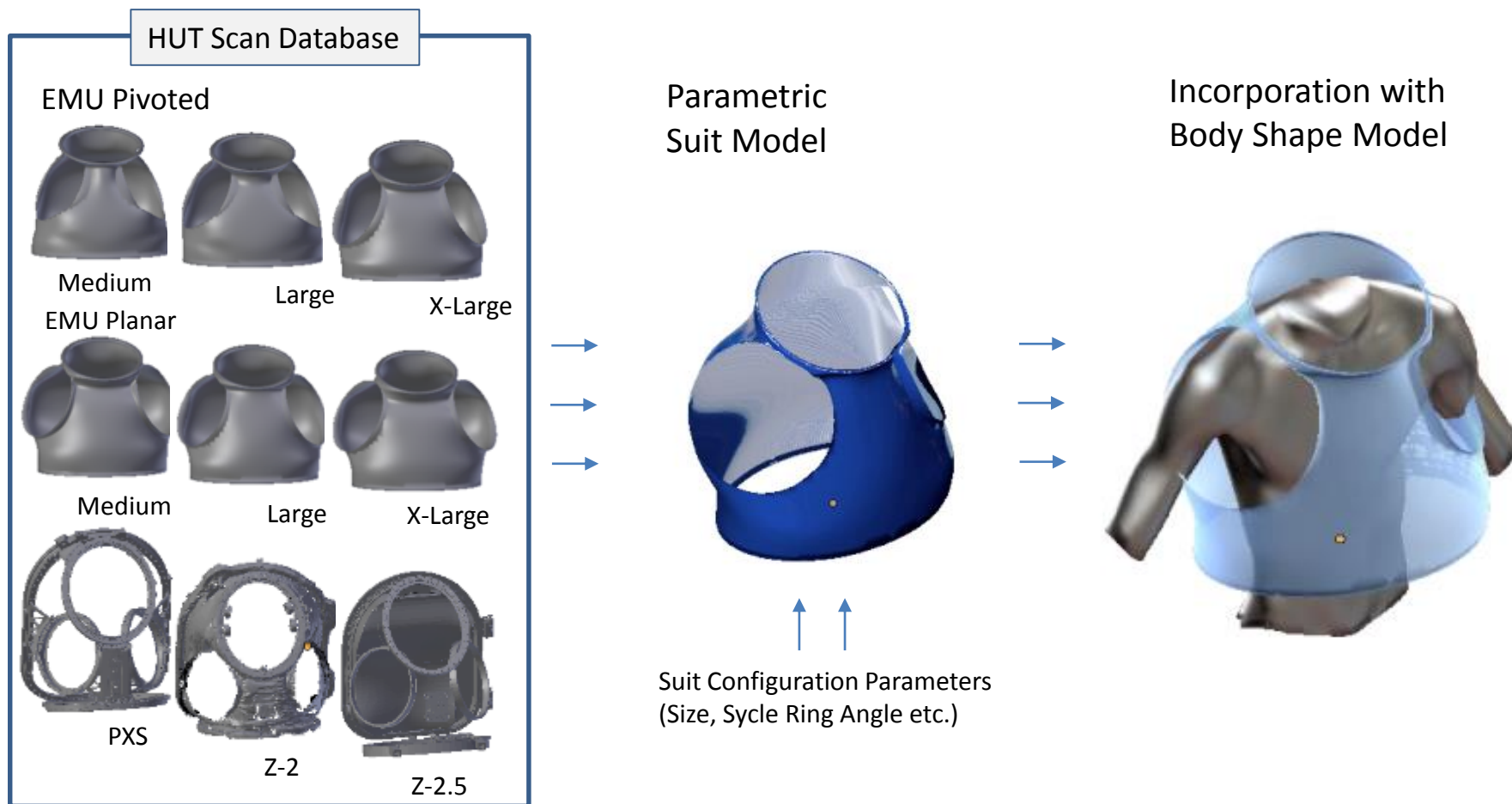
Monte-Carlo Suit Fit Assessment



- A large dataset of body shapes will be generated by a parametric model
- Programmatic suit positioning and volumetric assessment applied to models
- All permutations of suit sizes and body poses will be tested for fit assessments



- Previous suit fit check required an end-product CAD or 3-D scan of suit
- In the near future, suit geometry will be parametrically modeled from suit scans
- Suit fit can be predictively assessed for variations of suit configuration and body shape parameters





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