HUMAN FACTORSNL
vereniging voor ergonomie

DINED: from 1D to 4D Anthropometry

Toon Huysmans
Assistant Professor in Ergonomics
t.huysmans@tudelft.nl
Faculty of Industrial Design Engineering
Delft University of Technology

Toon Huysmans, Maxim Smulders, and Johan Molenbroek

DESIGN FOR OUR FUTURE

TU Delft

HUMAN FACTORSNL
vereniging voor ergonomie

3D (and 4D) Anthropometry

- Quick introduction to 3D Anthropometry
- Overview of Dined Mannequin functionality
- Try it out yourself

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

3D Anthropometry Introduction

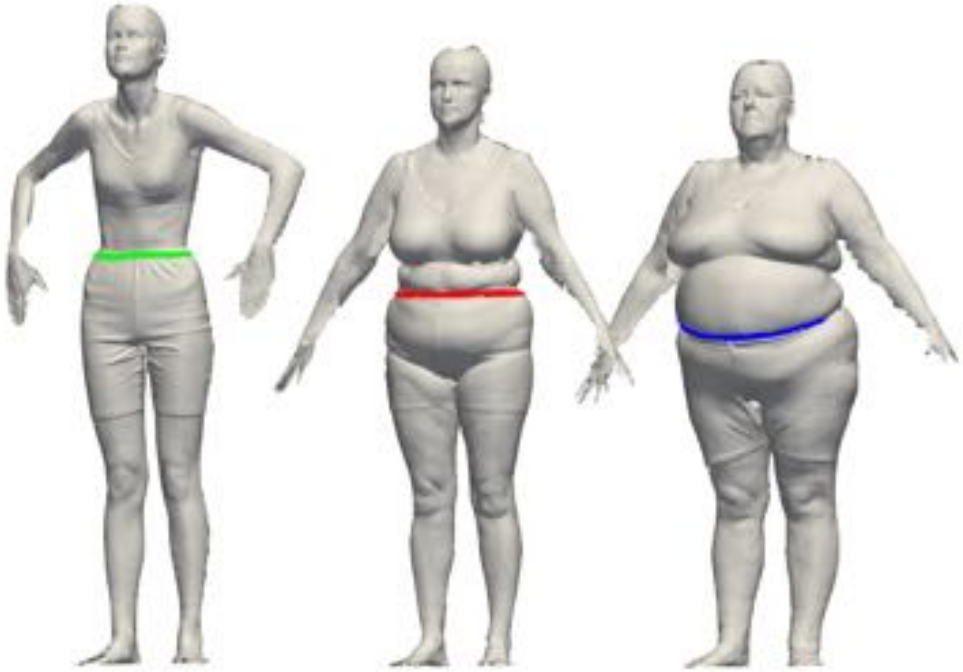
DESIGN FOR OUR FUTURE

TU Delft

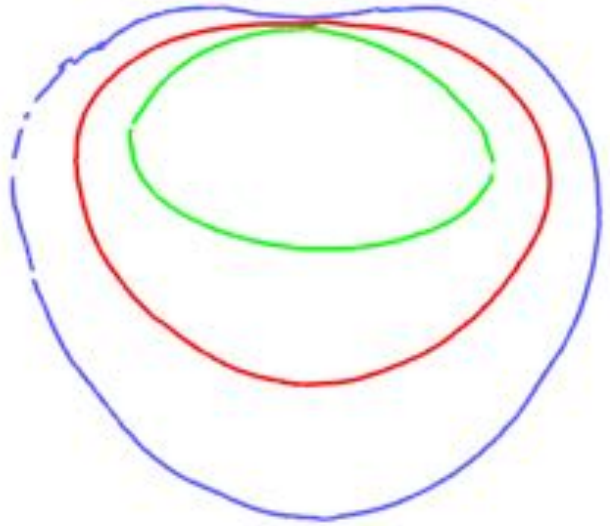
Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Why 3D Anthropometry



606 mm 872 mm 1271 mm



Traditional (1D, 2D) anthropometry poorly represents body shape

DESIGN FOR OUR FUTURE

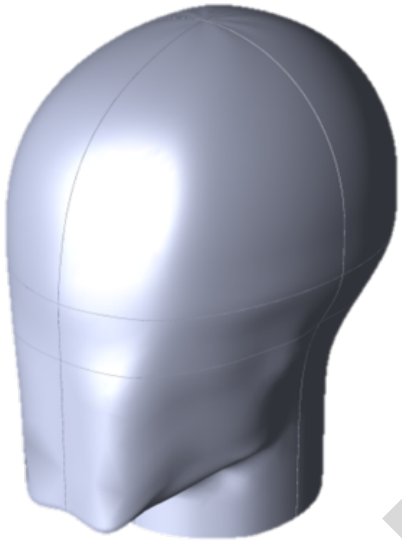
TU Delft

Toon Huysmans

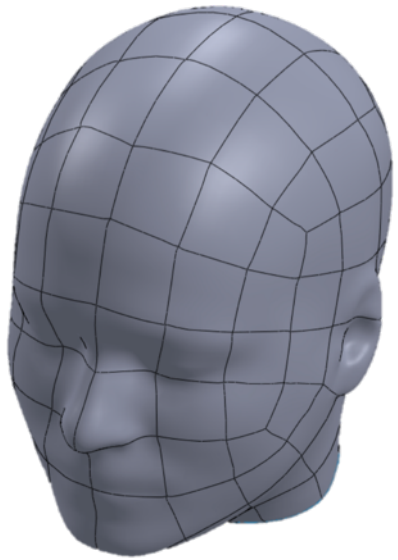
HUMAN FACTORSNL
vereniging voor ergonomie

Why 3D Anthropometry

https://grabcad.com/library/en960-j-headform-1
https://www.3dhumanmodel.com



EN960 manikin



full 3D manikin

traditional manikin

full 3D manikin

Very useful for wearables design

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

3D Scanning Demo

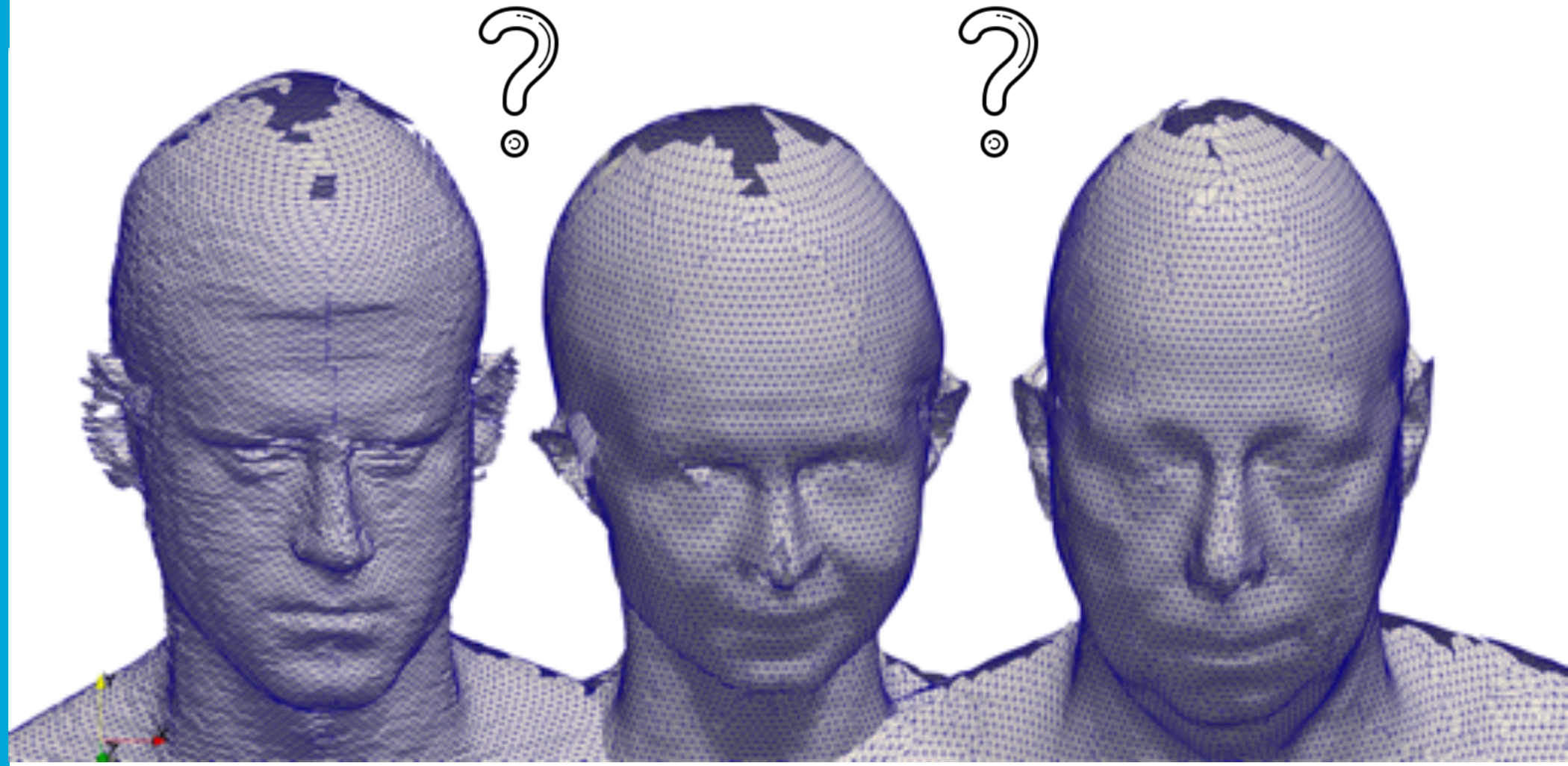
DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Working with 3D Scans is Challenging



3D scanning artefacts, mesh correspondence, multivariate statistics, …

Toon Huysmans

DESIGN FOR OUR FUTURE

TU Delft

HUMAN FACTORSNL
vereniging voor ergonomie

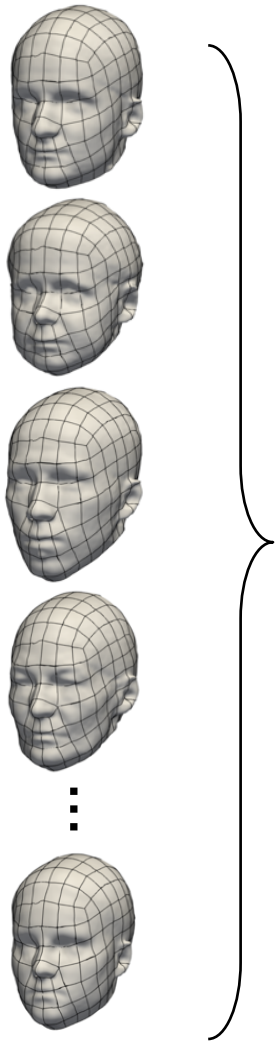
3D Anthropometry Web Platform: Dined Mannequin

DESIGN FOR OUR FUTURE

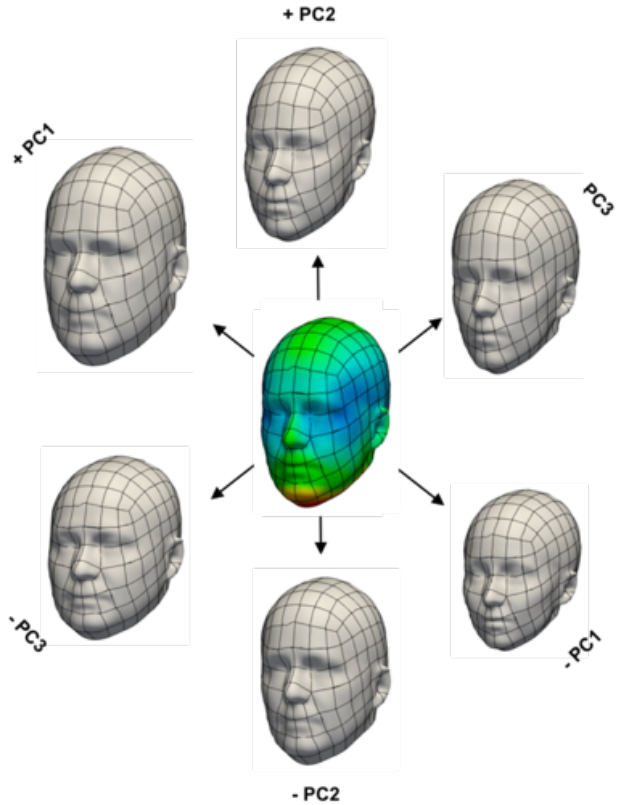
TUDelft

Toon Huysmans

Anthropometric Statistical Shape Modeling



population sample



B-spline statistical shape model

subject features

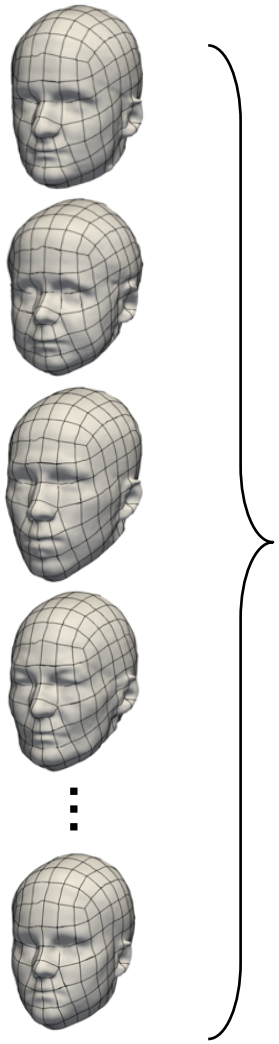
	A	B	C	D
1	bizygomatic breadth	face length	head breadth	head circumference
2	124	103	138	529
3	132	106	149	541
4	120	117	147	559
5	130	108	143	538
6	126	108	143	552
7	131	108	143	532
8	140	108	144	538
9	133	107	146	547
10	143	114	155	583
11	135	102	145	544

$$\mathbf{\Pi}[f_1 \dots f_{n_f}\ 1]^T = \mathbf{w_i}\,.$$

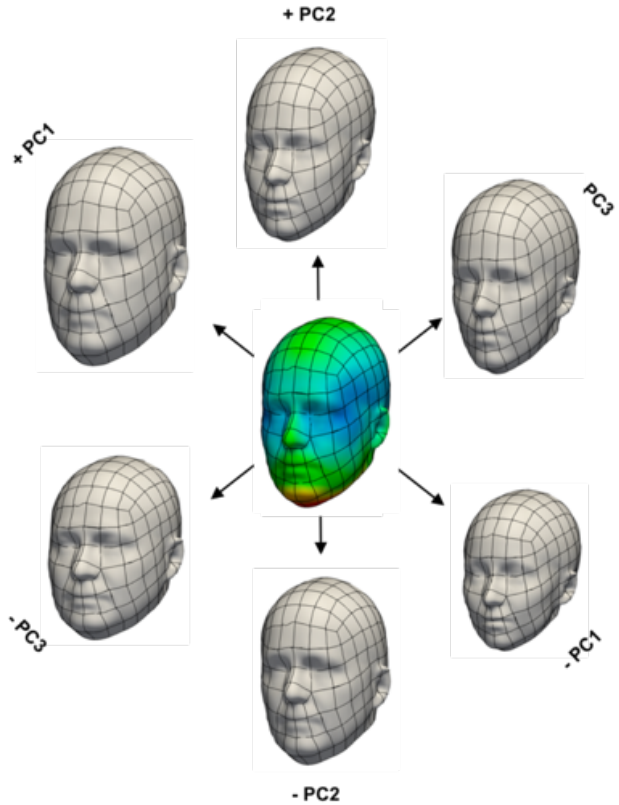
$$\mathbf{\Theta} = \bar{\mathbf{\Theta}} + \sum_{i=1}^{n_s-1} w_i\, \ddot{\mathbf{\Theta}}_i \longrightarrow \mathbf{\Theta}(f_1, \dots, f_{n_f}) = \bar{\mathbf{\Theta}} + \ddot{\mathbf{\Theta}}\mathbf{\Pi}[f_1 \dots f_{n_f}\ 1]^T$$

Toon Huysmans

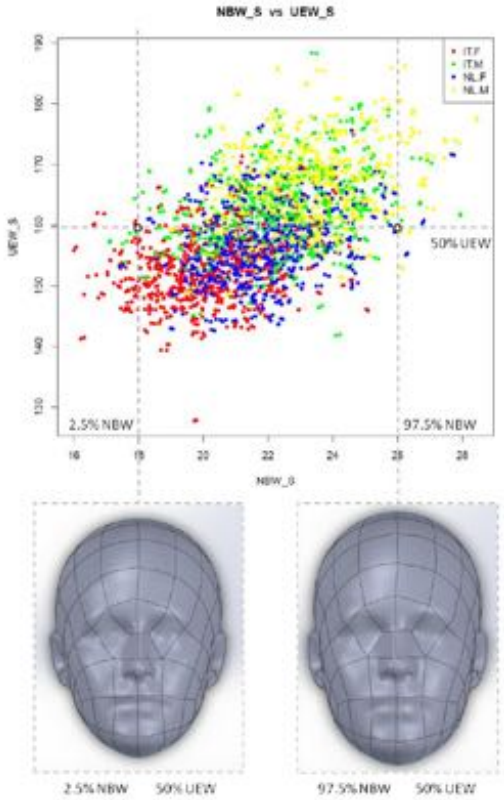
Anthropometric Statistical Shape Modeling



population sample



B-spline statistical shape model

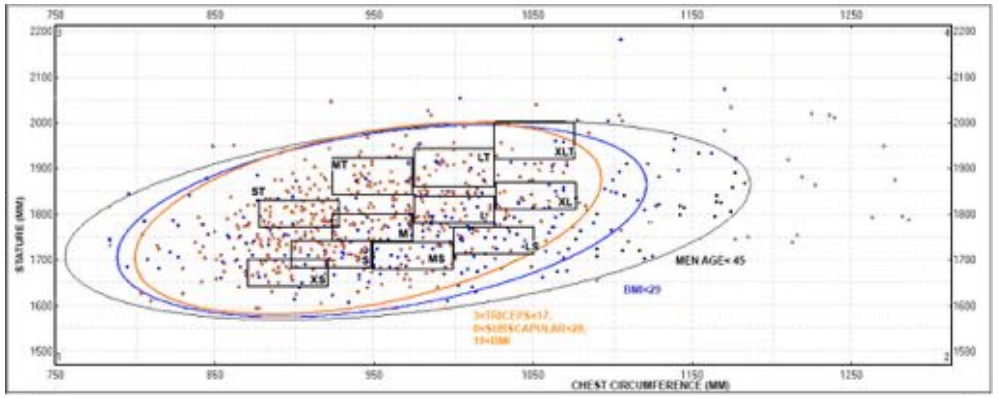


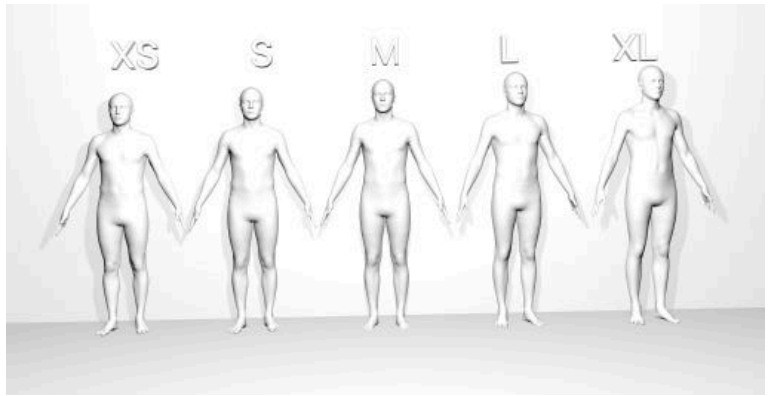
$$\boldsymbol{\Theta} = \bar{\boldsymbol{\Theta}} + \sum_{i=1}^{n_s-1} w_i \, \ddot{\boldsymbol{\Theta}}_i \longrightarrow \boldsymbol{\Theta}(f_1, \ldots, f_{n_f}) = \bar{\boldsymbol{\Theta}} + \ddot{\boldsymbol{\Theta}}\boldsymbol{\Pi}[f_1 \ldots f_{n_f} \; 1]^T$$

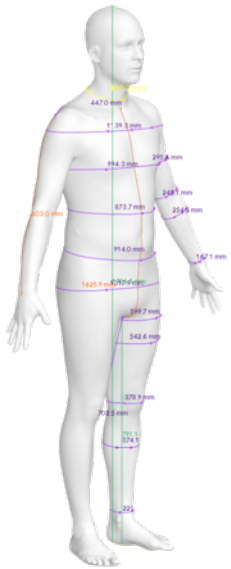
Toon Huysmans

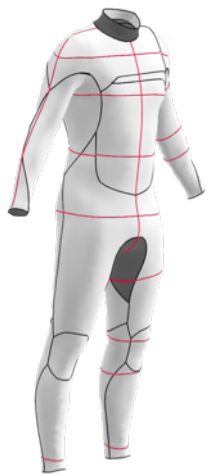
HUMAN FACTORSNL
vereniging voor ergonomie

Wetsuit Design: 3D Anthropometric Approach









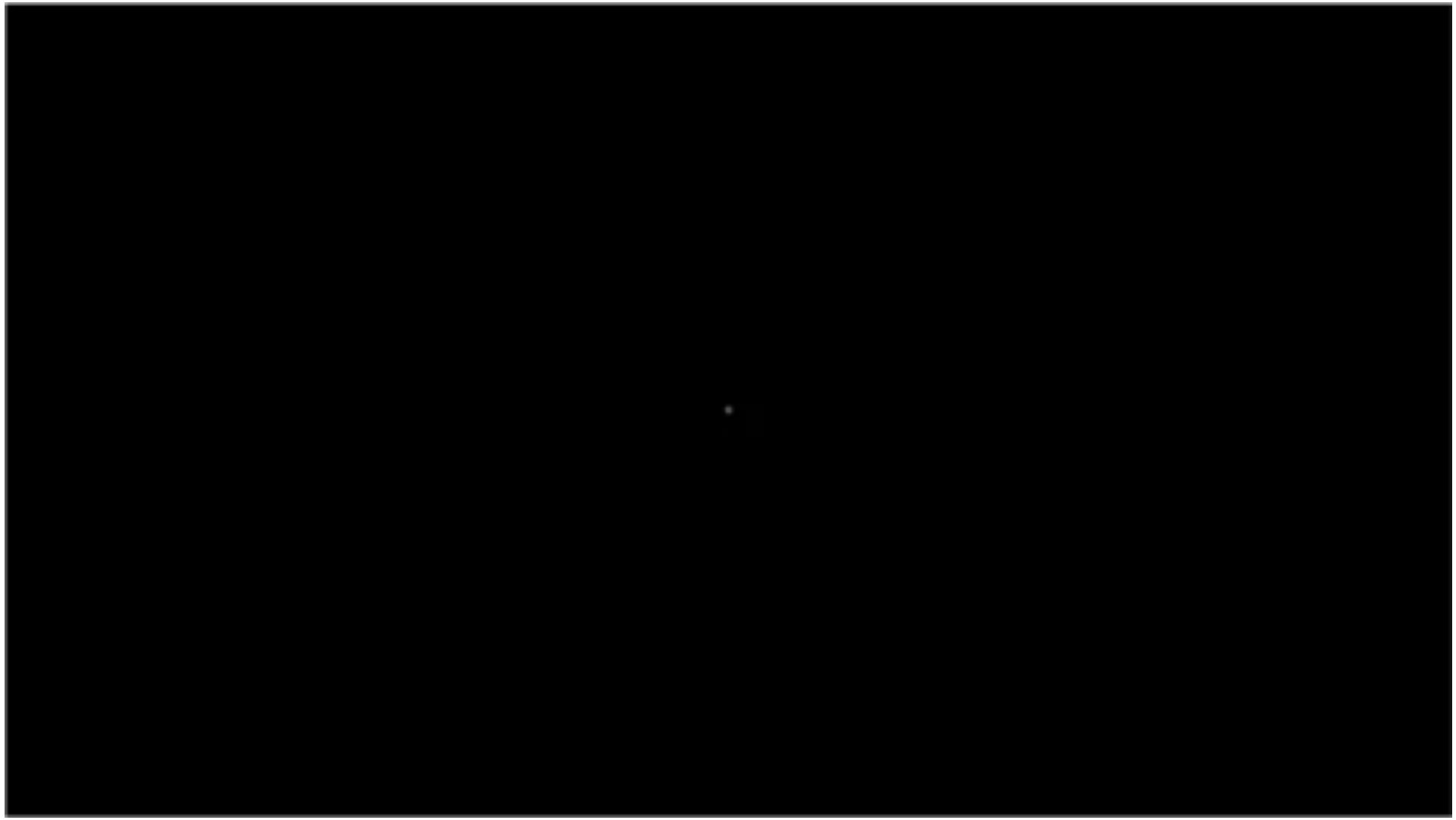
Timon Staal .(2019). Wetsuit Design: With a Focus on Methodology. TU Delft.

DESIGN FOR OUR FUTURE

TU Delft

HUMAN FACTORSNL
vereniging voor ergonomie

Wetsuit Design: Incorporating Motion (4D)



Timon Staal .(2019). Wetsuit Design: With a Focus on Methodology. TU Delft.

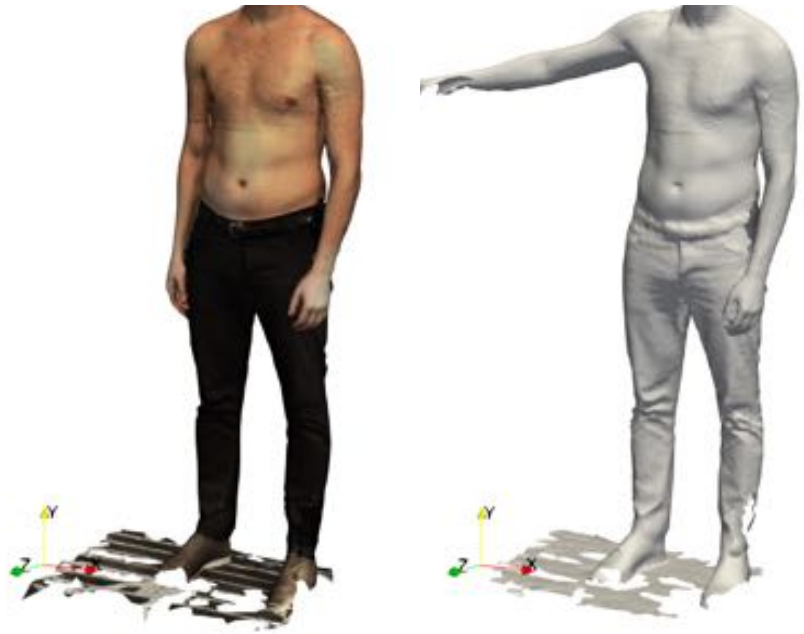
DESIGN FOR OUR FUTURE

TU Delft

HUMAN FACTORSNL
vereniging voor ergonomie

Future: Dynamic (4D) Anthropometry

Our 4D scanning facility



DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Dined Mannequin Functionality

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

3D Anthropometry Web Platform: Dined Mannequin

DESIGN FOR OUR FUTURE

TUDelft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

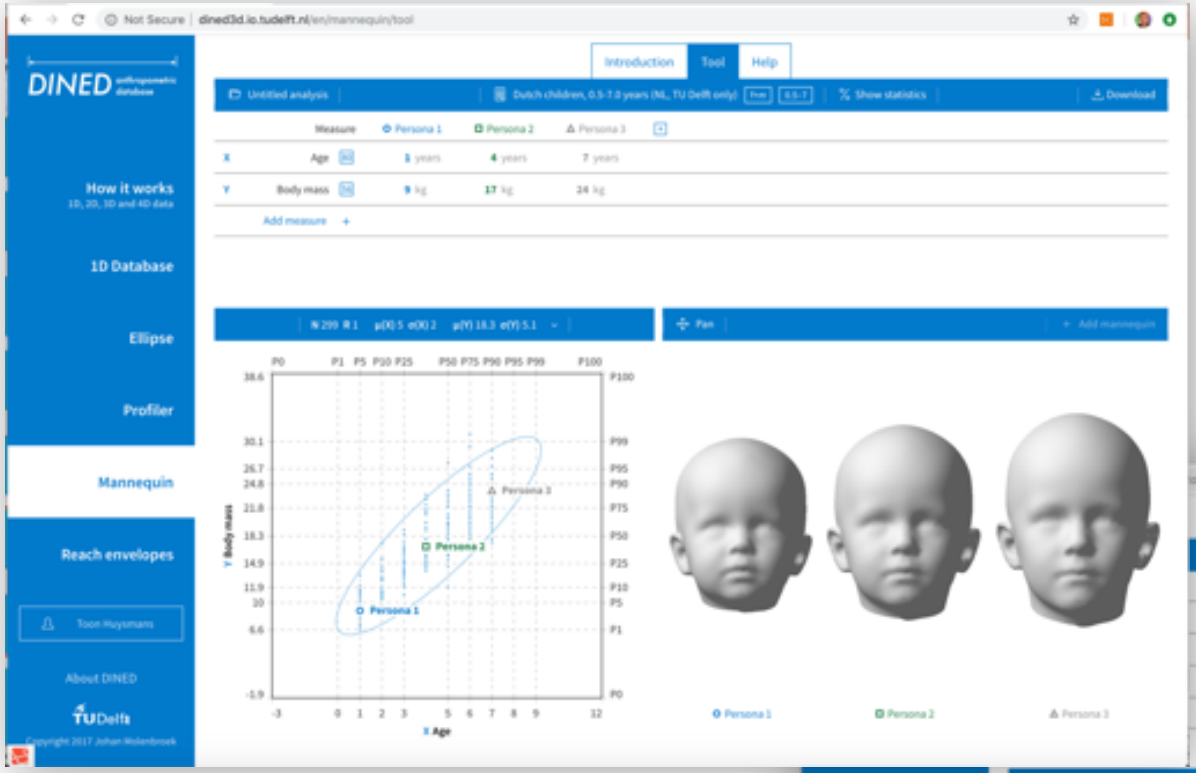
Population Selection

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



Goto, L., Lee, W., Molenbroek, J. F., Cabo, A. J., & Goossens, R. H. (2019). **Traditional and 3D scan extracted measurements of the heads and faces of Dutch children.** International Journal of Industrial Ergonomics, 73, 102828.

Robinette, K. M., Daanen, H., & Paquet, E. (1999, October). **The CAESAR project: a 3-D surface anthropometry survey**. In Second International Conference on 3-D Digital Imaging and Modeling (Cat. No. PR00062) (pp. 380-386). IEEE.

DESIGN FOR OUR FUTURE

TUDelft

HUMAN FACTORSNL
vereniging voor ergonomie

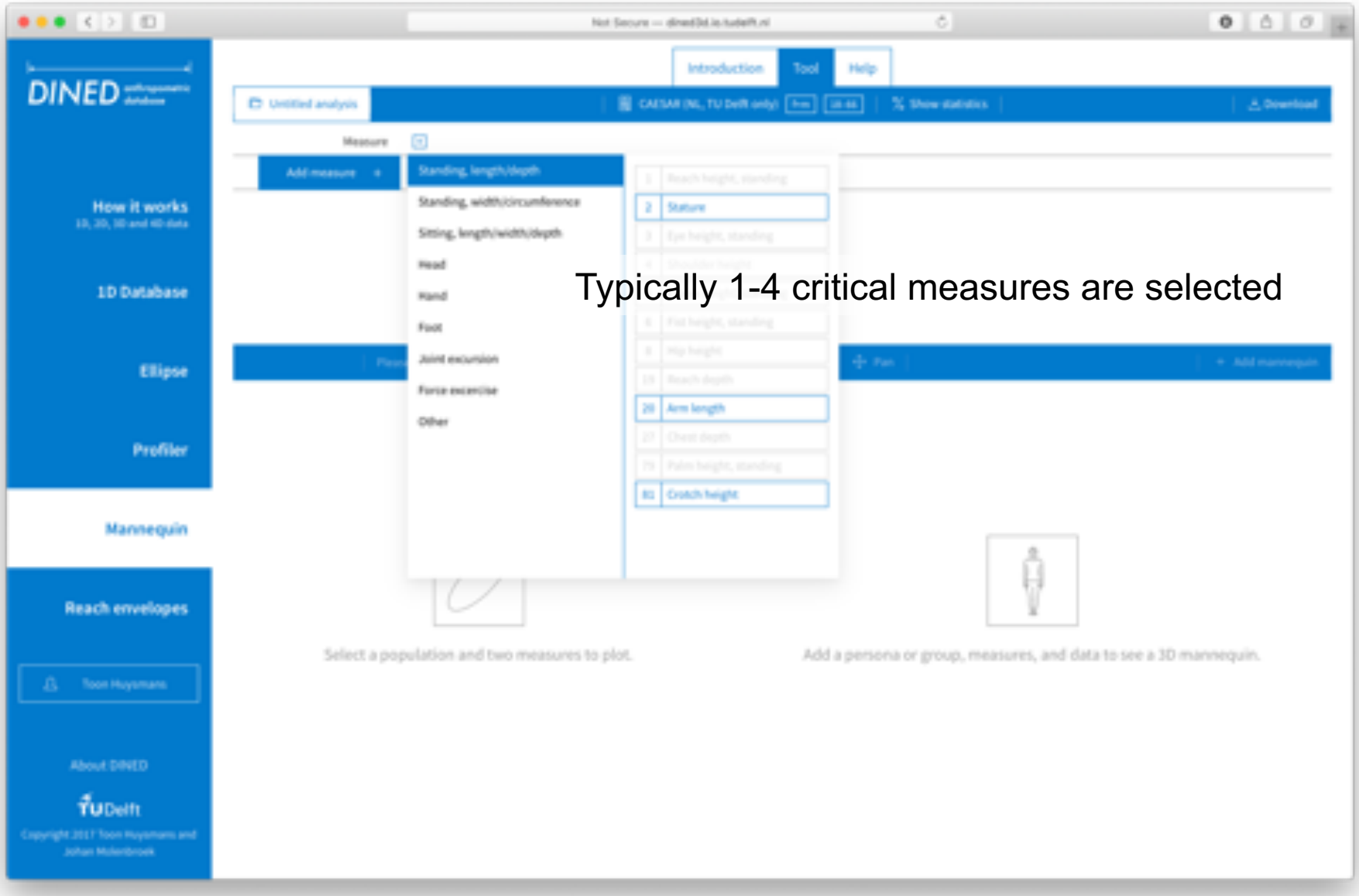
Measures Selection and Manikin Definition

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



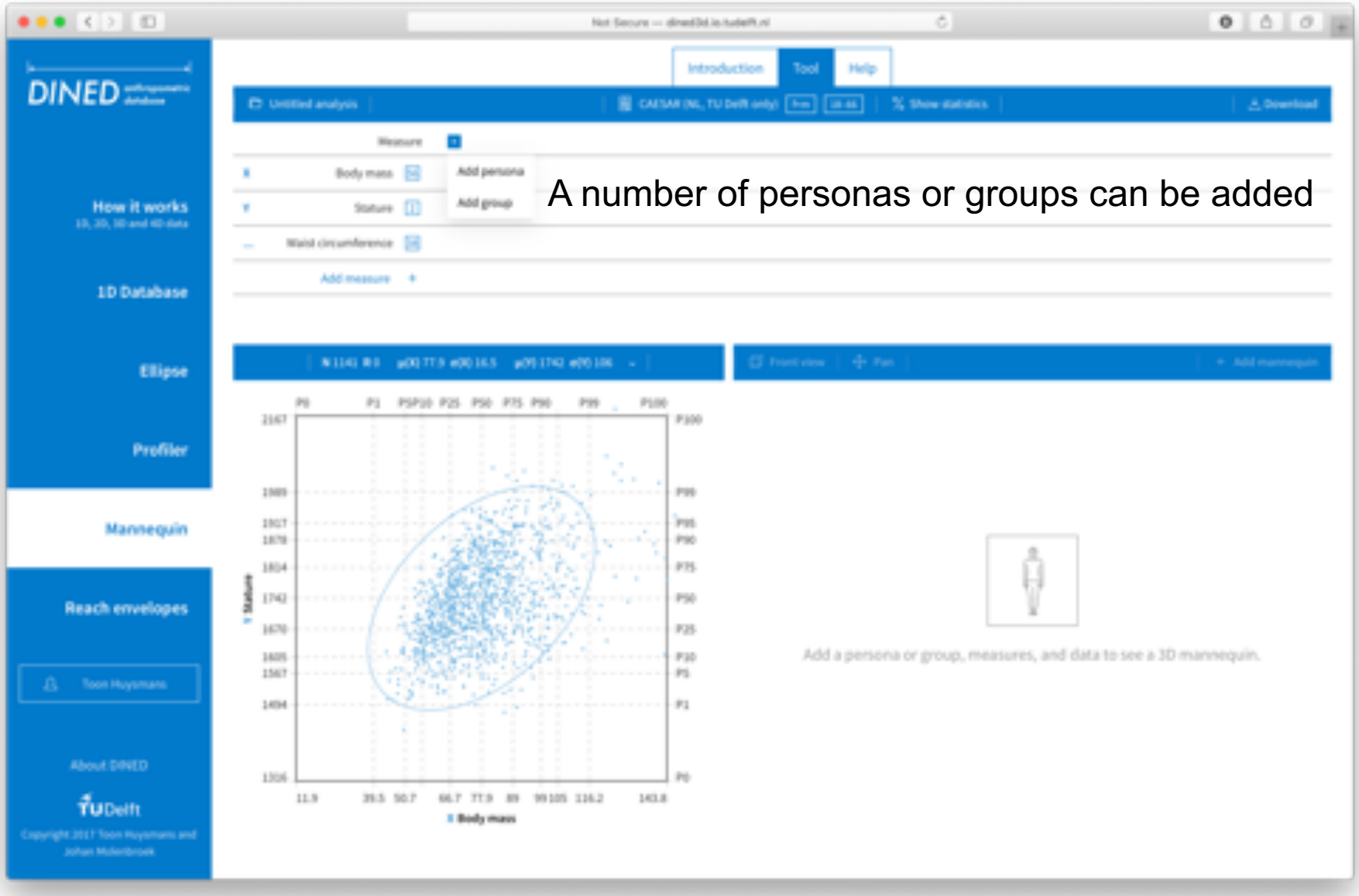
Typically 1-4 critical measures are selected

DESIGN FOR OUR FUTURE

TUDelft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

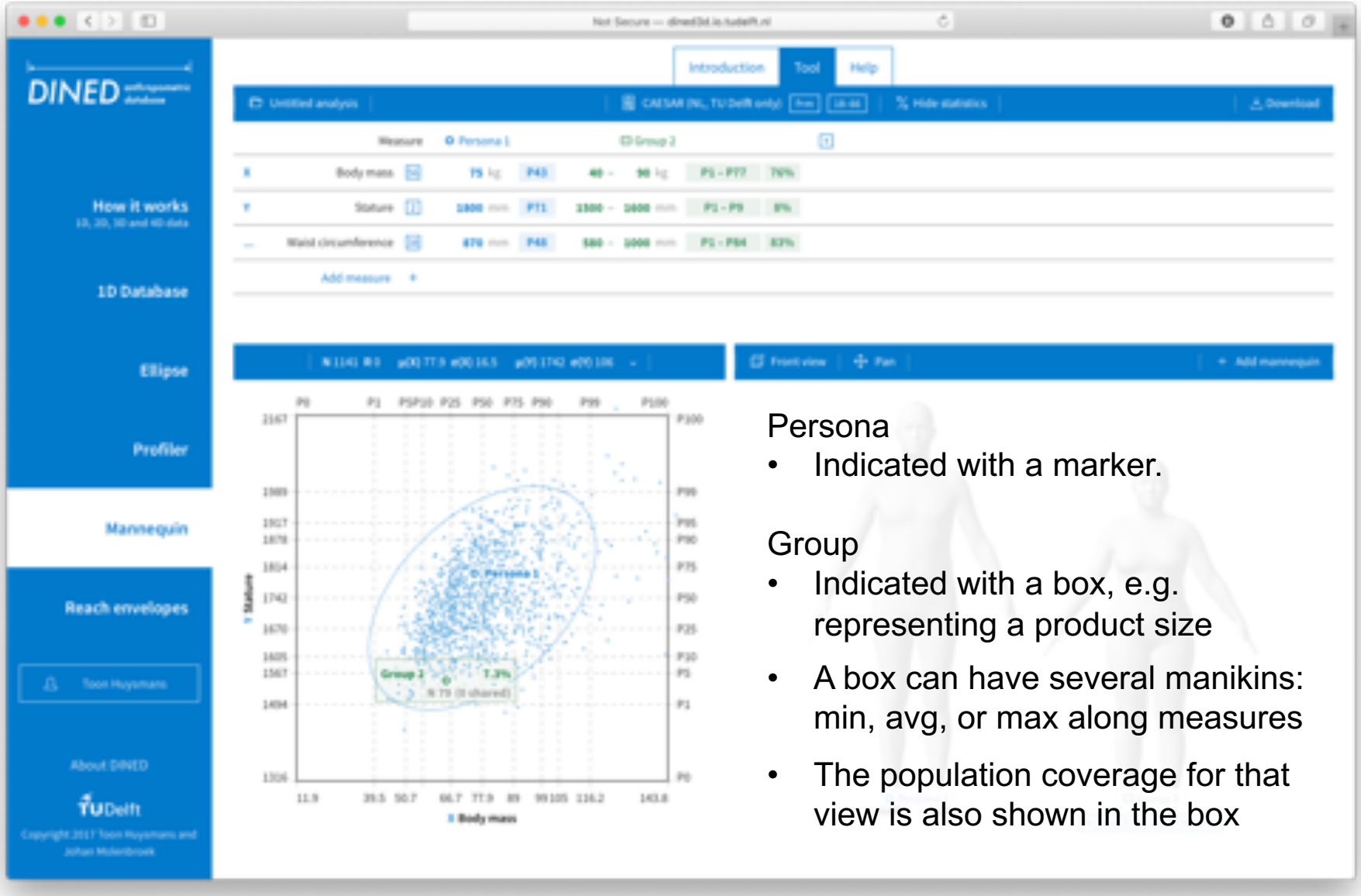


DESIGN FOR OUR FUTURE

TUDelft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



Persona
- Indicated with a marker.

Group
- Indicated with a box, e.g. representing a product size
- A box can have several manikins: min, avg, or max along measures
- The population coverage for that view is also shown in the box

DESIGN FOR OUR FUTURE

TUDelft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Population Exploration via Scatter Plotting

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

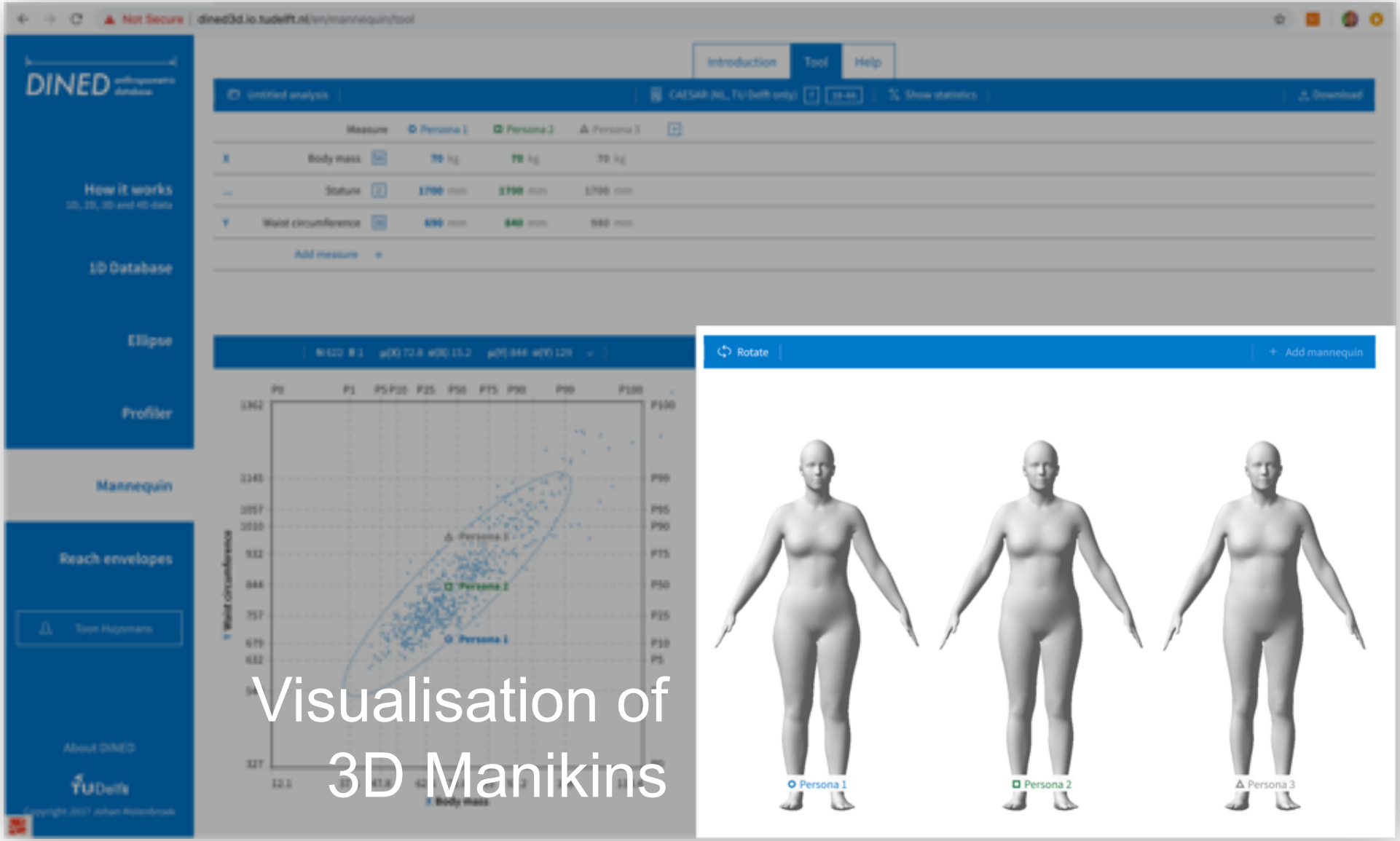
HUMAN FACTORSNL
vereniging voor ergonomie

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



Visualisation of 3D Manikins

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

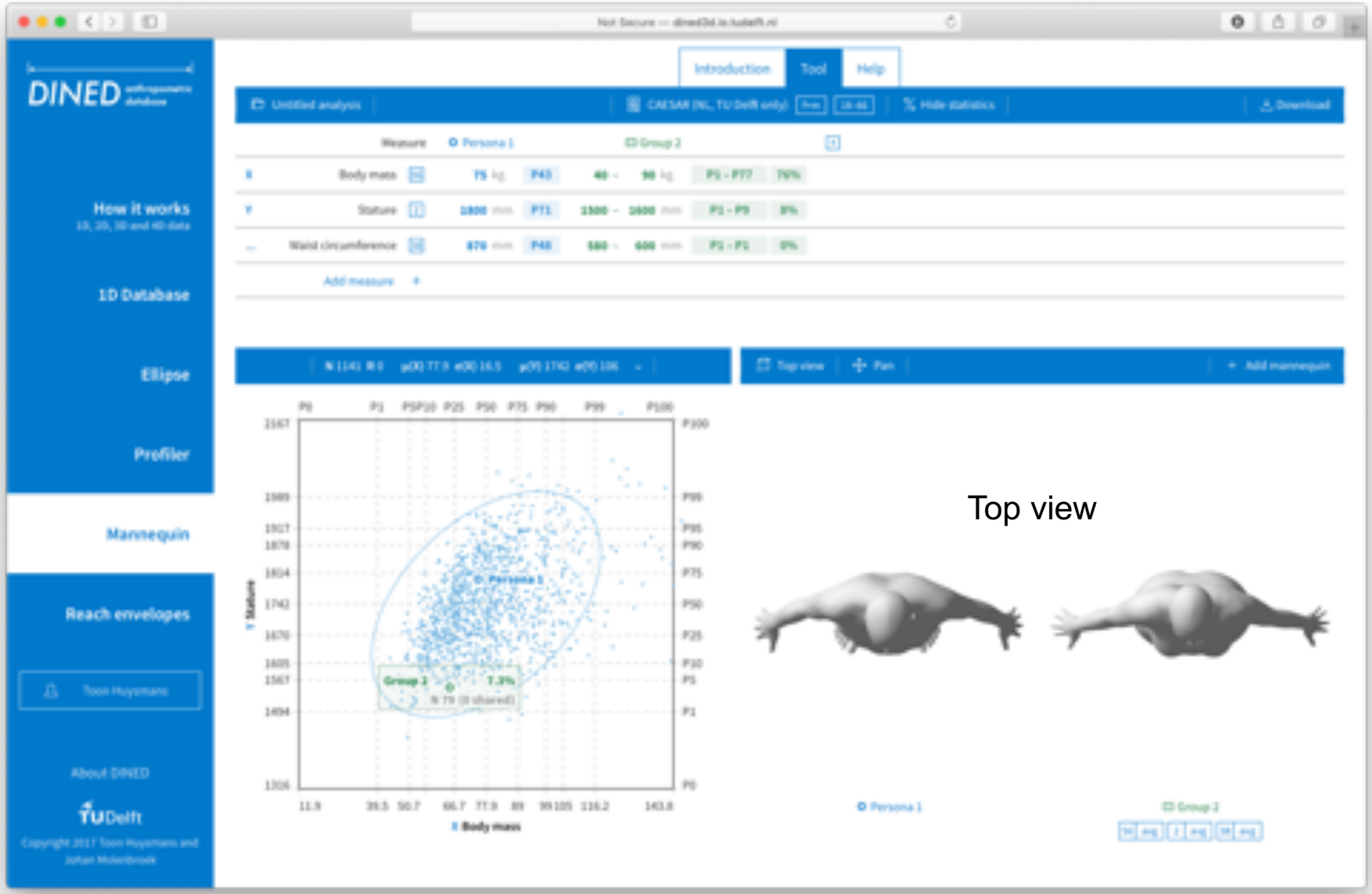
HUMAN FACTORSNL
vereniging voor ergonomie

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

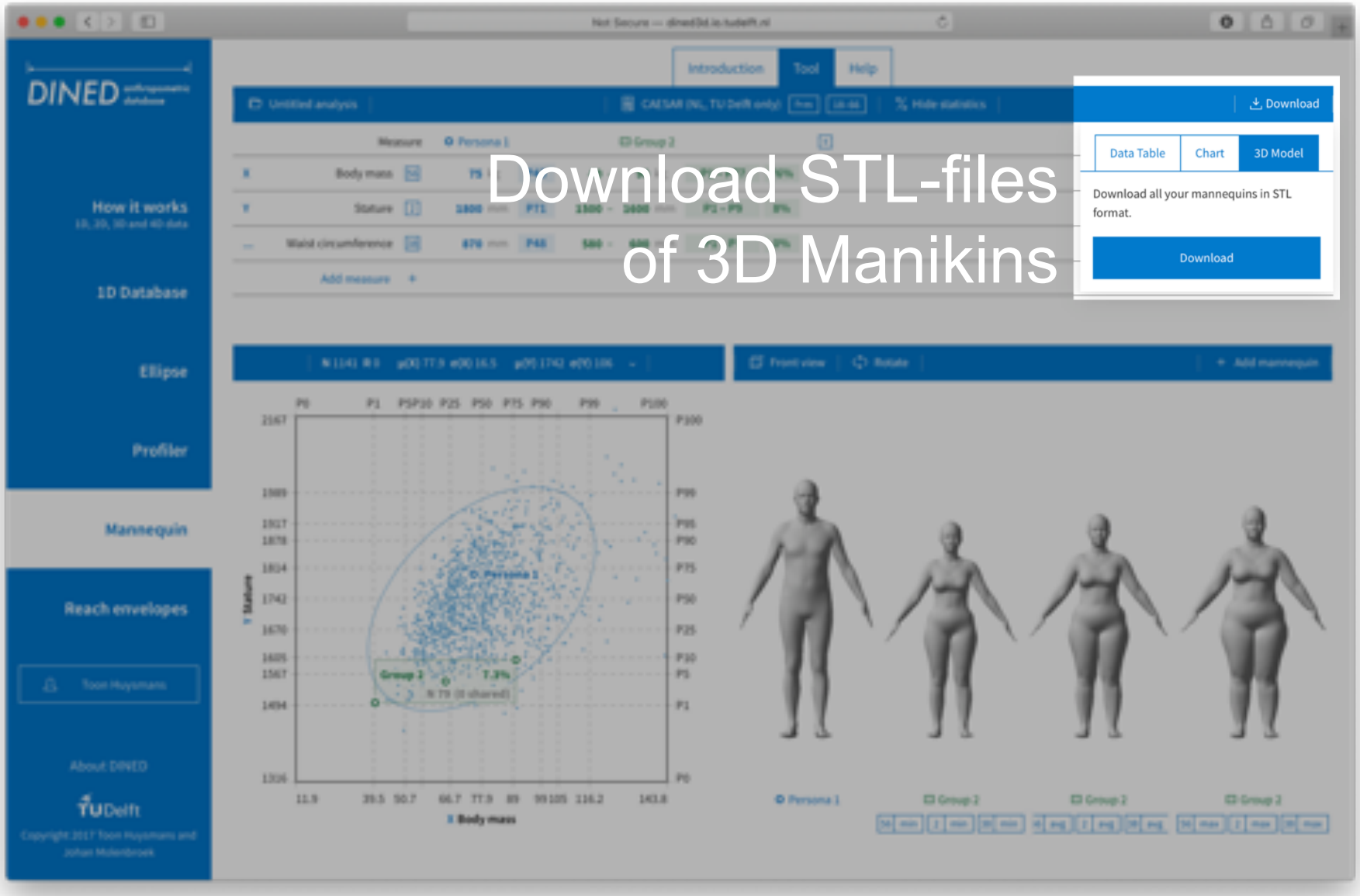
HUMAN FACTORSNL
vereniging voor ergonomie

DESIGN FOR OUR FUTURE

TUDelft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



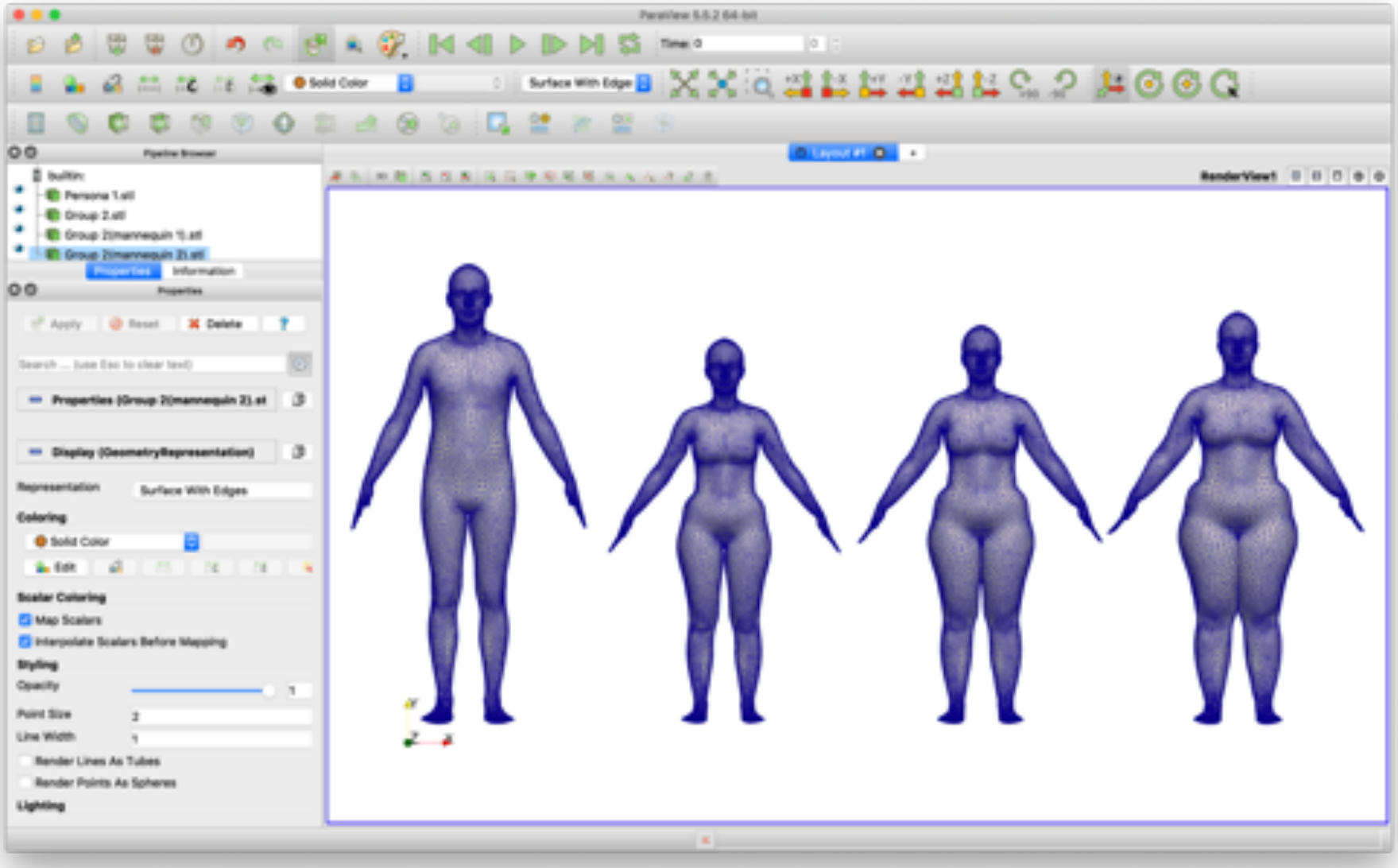
Download STL-files of 3D Manikins

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie



DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Dined Mannequin
Try It Yourself

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Try Out Dined Mannequin!

https://dined3d.io.tudelft.nl

1. Sign in or Sign up
2. Click acknowledge link in your mailbox
3. Go to Dined Mannequin tool

DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Try Out Dined Mannequin!

1. Select CAESAR population (specify Gender and Age)
2. Add a few measures, e.g.
   - Stature, body mass, waist circumference
3. Add a persona and fill in your measurements
4. Behold your 3D mannequin
5. Explore
   - Change measurements, choose other measures
   - Add more personas or create a group
   - Explore the population via the scatter plot
   - Download the STL file of your mannequins

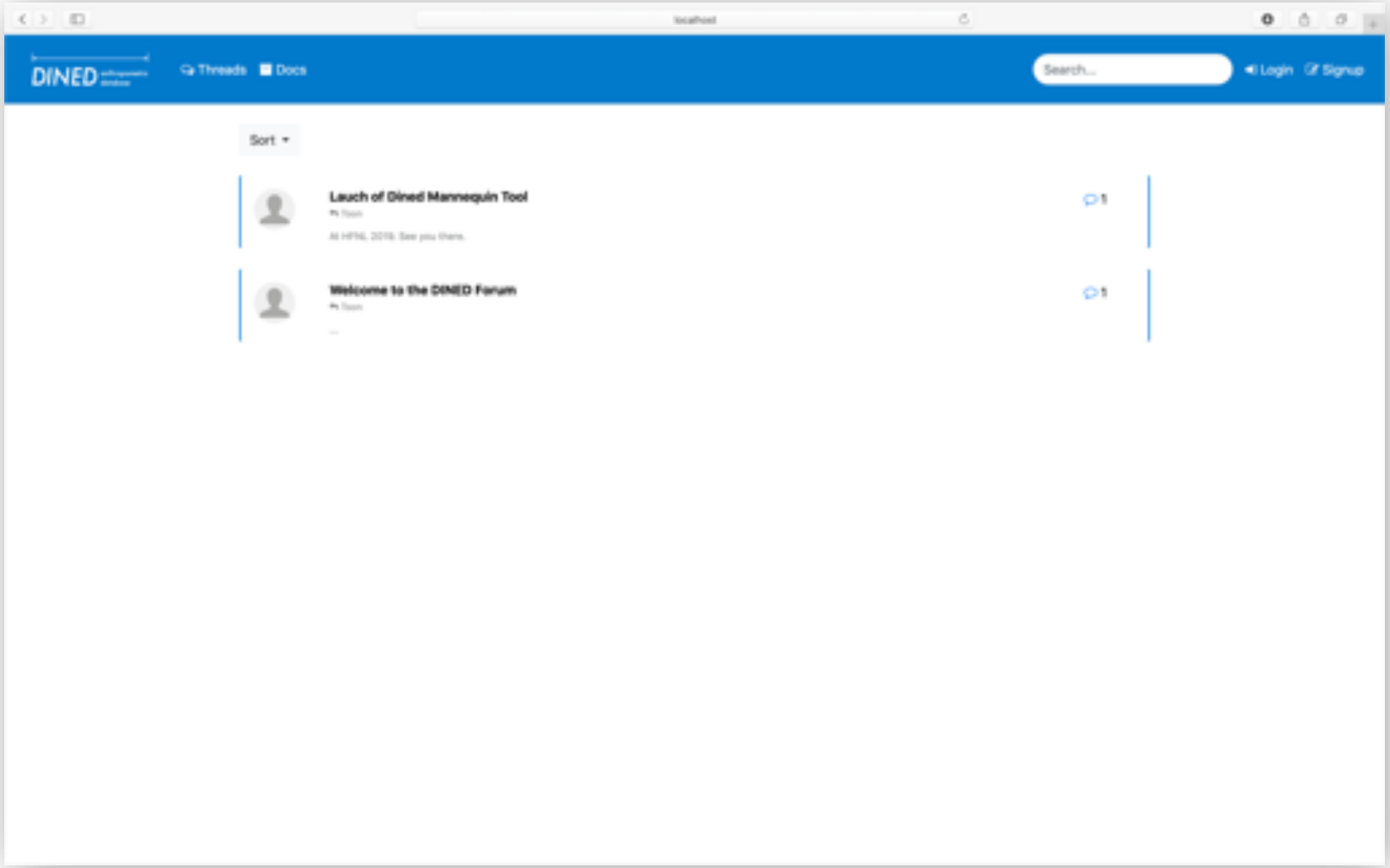
DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Dined Forum (Available End of December)



DESIGN FOR OUR FUTURE

TU Delft

Toon Huysmans

HUMAN FACTORSNL
vereniging voor ergonomie

Thank You

Toon Huysmans
Assistant Professor in Ergonomics
t.huysmans@tudelft.nl
Faculty of Industrial Design Engineering
Delft University of Technology

DESIGN FOR OUR FUTURE

TU Delft