

4D Digital Human Model for Designers

based on Virtual Reality and 3D scanning techniques



Problem statement

the need for a new ergonomic design tool

Human Centered and User Centered Design strategies, which focus on the user and usage of products when designing, are gaining popularity (Acosta & Morales, 2011). Tools range from data sheets, reach envelopes or 2D manikins to advanced Digital Human Models (DHMs), real test subjects or combinations of these (Lombaers, Molenbroek, & Osinga, 1986). The data these tools represent, however, are often old and outdated. New research is costly and does not generate revenue for their investors. Data usually comes from research on military populations and not civilians which causes unrealistic dimensions when designing for civilian populations (Robinette, Daanen, & Paquet, 1999). On top of this, designers often lack the knowledge and experience to interpret ergonomic

data correctly (Duffy, 2009). Where bigger companies can hire ergonomic and human factors experts, most design agencies rely on their designers for including ergonomics in the design process. As a result, responsibility lies with a group of engineers of which less than 10% have had as much as a single course on human factors and ergonomics (Chaffin, 2005). When working with advanced tools like DHMs in Computer Aided Design (CAD) programs like SolidWorks, designers have to position the model realistically which is currently a very slow process. Concluding, ergonomics are important when designing user products but designers lack the knowledge and experience to correctly apply ergonomics in the design process.



figure 3. Screenshots from the virtual world and 4D DHM in use.

4D Digital Human Model for Designers: based on Virtual Reality and 3D scanning techniques
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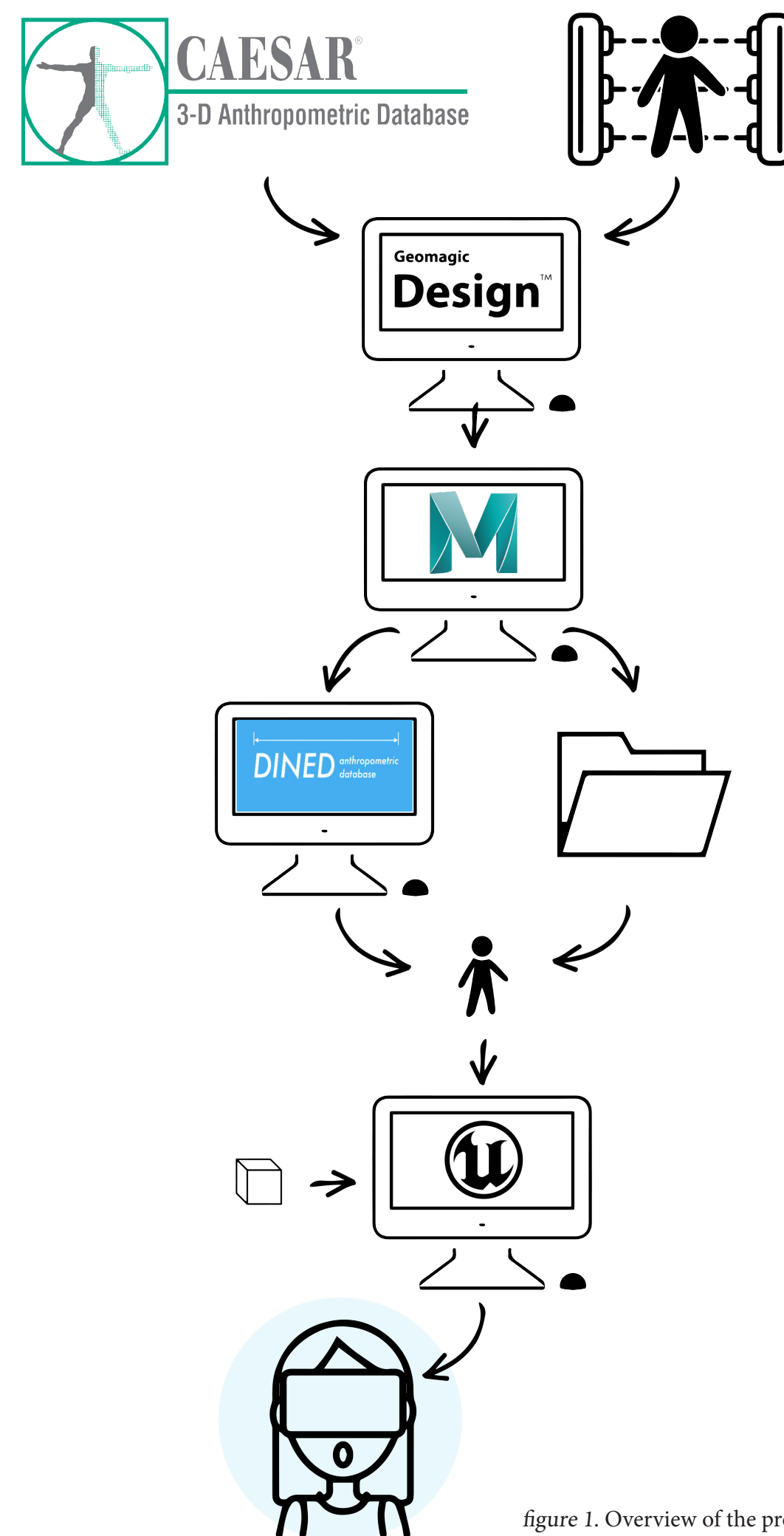


figure 1. Overview of the process from 3D scanned data to a 4D Digital Human Model.

New anthropometric data

from 3D scan to 4D Digital Human Model

A literature study revealed the possibilities of using 3D scans for their anthropometric data. A 2003 research proved that 3D scans are as good or better in terms of accuracy than anthropometric measurements done by hand (Robinette & Daanen, 2006). This meant a quick way to renew outdated datasets was found. 3D scanned data still needed to be converted to DHMs for use in CAD programs in order for designers to be able to take advantage of it (Veitch et al., 2009). This thesis proposed a way of doing so. In figure 1 the process from 3D scan to 4D DHM can be seen. At first a 3D scan needs to be taken from either the CAESAR database or an own scan can be made. After post processing the scan in Geomagic (filling holes, smoothening the surface and dividing the mesh equally), the mesh is still static. In order to be able to move the 3D scan it needs to be Rigged. Rigging is connecting a motion controlling skeleton to a surface or skin (Lunström, Case, & Högberg, 2010), and is often used in the movie and gaming industry. For this thesis Maya was used for rigging. To make this model positionable in VR a so called Blueprint, a visual scripting language, was written in Unreal Engine. This script allows a user wearing the HTC Vive head mounted display to not only see the DHM but also position it in realtime.

User Interface Design

using VR to visualize and interact with the 4D DHM

As a medium to visualize the 4D DHM Virtual Reality was chosen for its intuitive human - computer interaction possibilities. Starting on the left top of figure 2, a designer is working on a digital prototype in a CAD program (Solidworks, Rhinoceros or Maya for example) and needs to check its dimensions to see if it fits the user. The designer then saves the digital prototype in the VR folder and goes to the DINED (the TU Delft ergonomics website) to select a DHM representative for the products target group and saves it to the VR folder. Unreal Engine is started and the hardware, HTC Vive, connected according to the guidelines found online, making use of SteamVR. The designer enters the virtual world by putting on the head mounted display and picking up the controllers. In the virtual world the designer can walk up to the model and grab handles on the DHM's body and push/pull/rotate them to position the model into position. To measure inside VR the designer can grab a tool from the toolbox inside the virtual world. By stretching the hands the distance between the two points can be found. For measuring angles three points can be positioned of which the middle indicates the angle between the other two points. The designer can furthermore walk around the product and DHM to see if the product has the right dimensions.

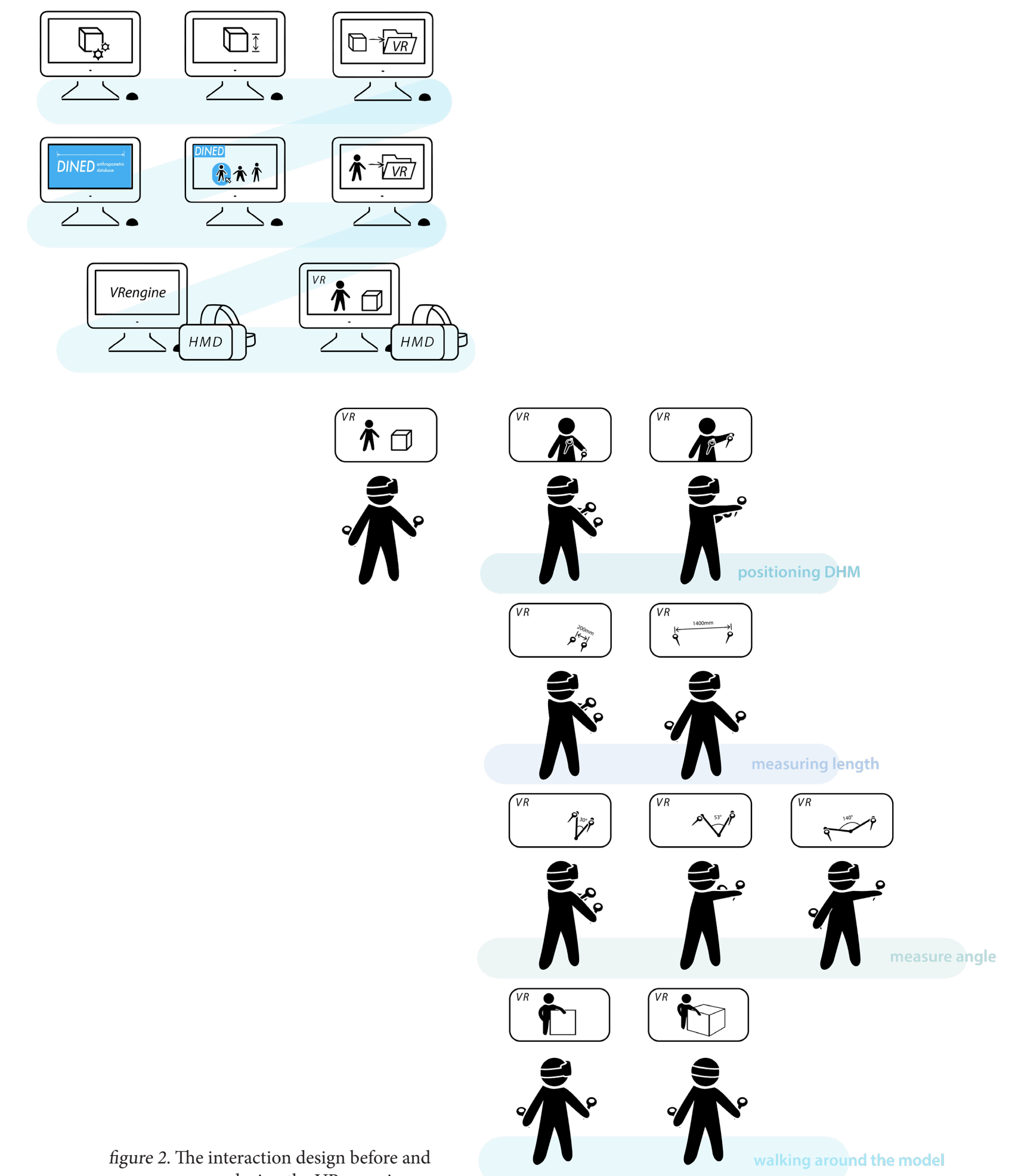


figure 2. The interaction design before and during the VR experience.