



# CFD Modeling of Thermal Manikin Heat Loss in a Comfort Evaluation Benchmark Test

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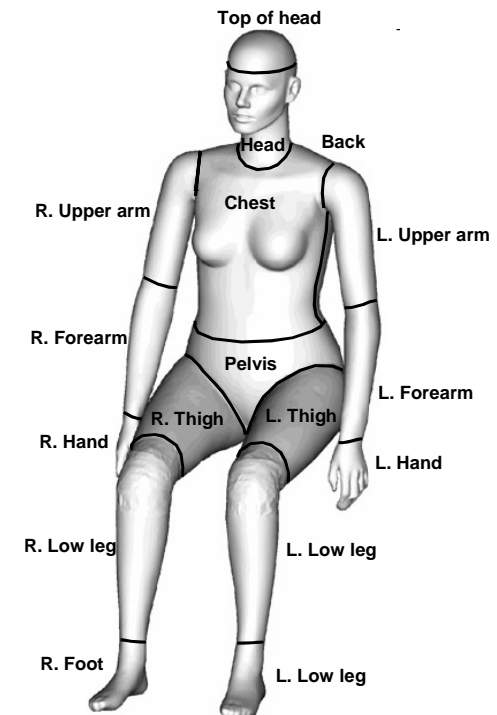
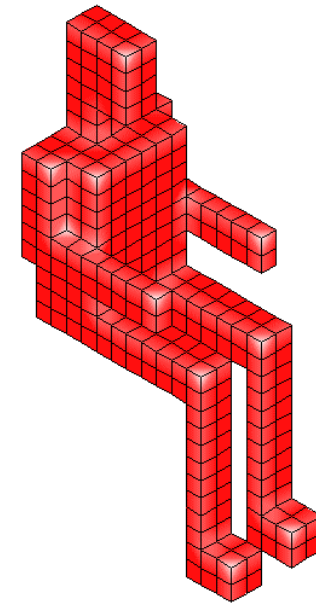
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# CSP research today

Researchers around the world have developed many configurations in order to represent a **C**omputer **S**imulated **P**erson (**CSP**).

These virtual CFD manikins are often very **different** with respect to size, form, heat generation, turbulence models and computer codes used.



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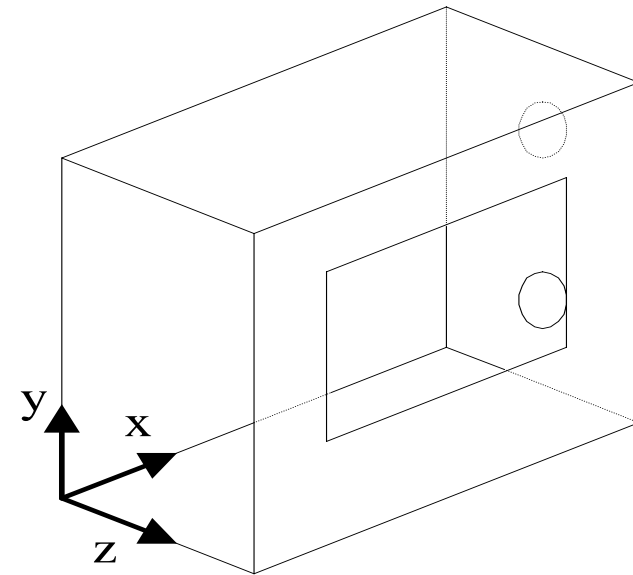
# Why a new benchmark test?

The two main ideas behind the new benchmark test have the following reasons:

- **Verify** that the *simulated* heat losses equals *measured* heat losses in order to support comparisons with human experiences
- **Compare** different versions of CSPs with exactly the same boundary conditions. Later new decisions on the geometrical level of detail, turbulence model, type of grid etc. can be made.

# The experimental setup

A wind tunnel with box shaped geometry with a window on the side at Aalborg University.



The large inlet to the far left followed by the chamber with a window; manikin and the two exhaust holes in the back with ventilation ducts.

# Thermal manikin measurements

The measurements were made with a female manikin Comfortina. The manikin run in constant surface temperature mode at 34°C, without clothing in order to get fast and accurate heat loss levels.

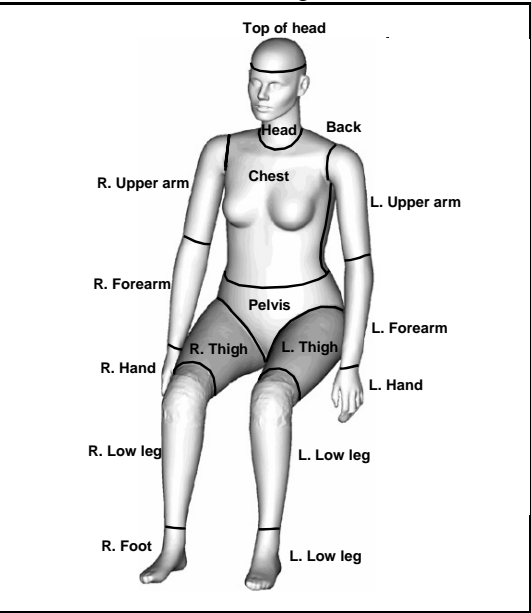


The flow field situation was made as identical to the earlier benchmarks with the intention that data will be interchangeable and comparable between the two tests.

# Heat loss benchmark results

All heat loss measurements made with Comfortina can be downloaded from [cfd-benchmarks.com](http://cfd-benchmarks.com).

Thermal manikin: Comfortina, No clothing, Software 3.0.30.

	Body Segments	
1	L. Foot	
2	R. Foot	
3	L. Low leg	
4	R. Low leg	
5	L. Thigh	
6	R. Thigh	
7	Pelvis	
8	Head	
9	Top of head	
10	L. Hand	
11	R. Hand	
12	L. Forearm	
13	R. Forearm	
14	L. Upper arm	
15	R. Upper arm	
16	Chest	
17	Back	
18	All	

Heat losses from the 17 manikin zones as well as whole body heat loss and air velocities plus air temperatures are reported in great detail.

# Equivalent “experienced” temperature

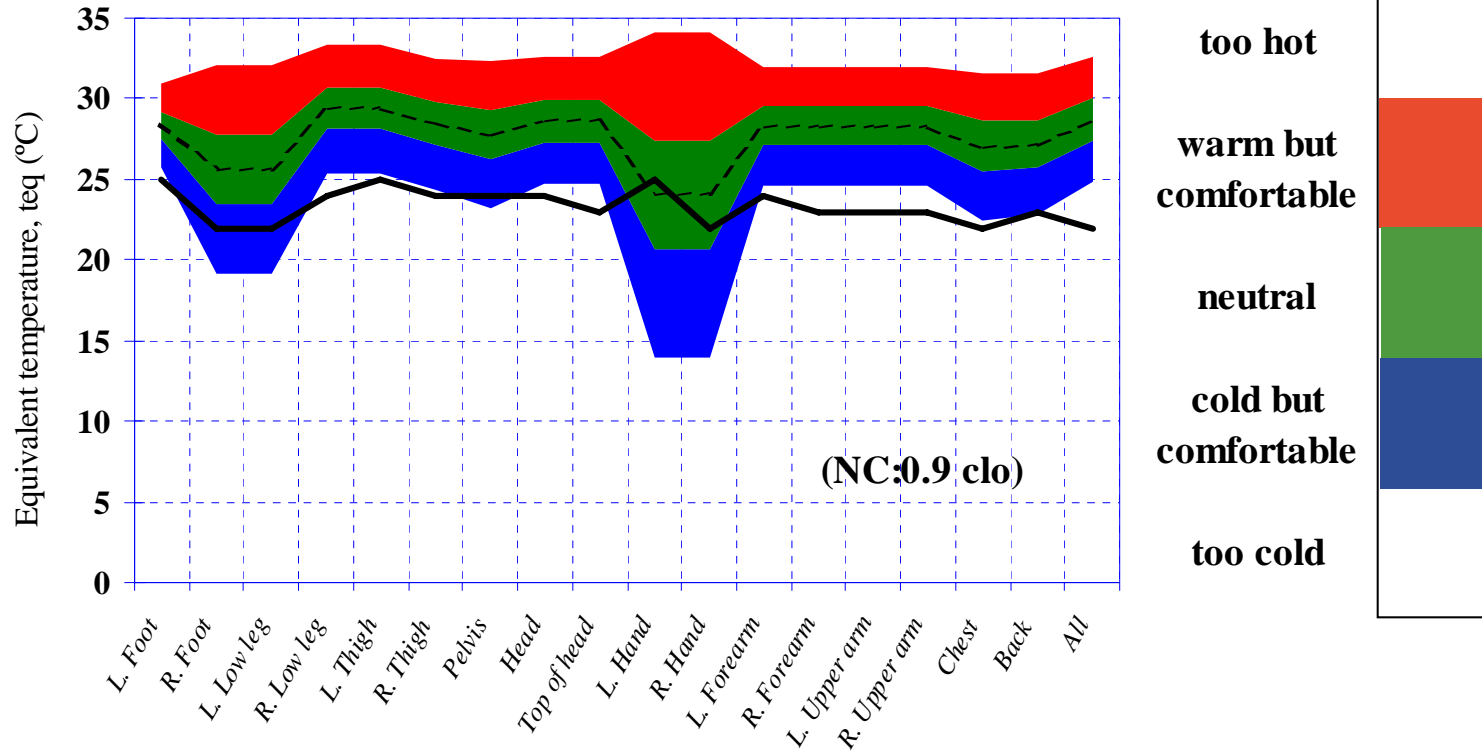


As it is rather difficult to communicate the combined effects from different “heat losses” is it very useful to convert these values into something easier to understand, like equivalent “experienced” temperature ( $t_{eq}$ ).

# Comfort zone diagram evaluation

## Manikin Heat Loss Benchmark

Comfort Zone Diagram (HONilsson 2004)

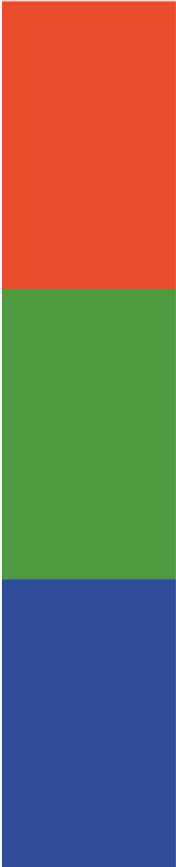



Comfort zone diagrams adapted for Comfortina type of manikins. This spreadsheet can be **downloaded** from the Thermal Manikin Network or the CFD-Benchmark

site



# CSP research in the future ...

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- a new benchmark test now focuses on the different **heat losses** from the manikin
  - connect results from thermal **manikin measurements** with real **human experiences**
  - results can be presented as **local information** as well as **whole body influence**
  - integrated use of new **heat loss benchmark tests** and new **standardized evaluation methods** for comfort evaluation
  - research will lead to **general requirements** for the design and development of future CSPs and **CFD**



# Working with manikins? Want to host the next meeting? International Thermal **M**anikin and **M**odelling **M**eetings (I3Ms)

Hosting the meeting is a great opportunity to get the whole manikin world to visit you and present the state of the art manikin research.

The **seventh** meeting (**7I3M**) 7<sup>th</sup> International Thermal Manikin and Modeling is scheduled to take place sometime during the year of 2008.

The venue is still to be decided by a committee based on previous organisers (Ingvar Holmér, Håkan Nilsson, Mark Richards, Victor Candas and Jintu Fan).