

# CYBOR CONCEPT FOR THERMOPHYSIOLOGICAL SIMULATION OF DRY AND WET HEATFLOW

B. Kurz<sup>1</sup> and W. Uedelhoven<sup>2</sup>

<sup>1</sup>Institute for Applied Ergonomics (IfaErg), München, Germany

<sup>2</sup>Bundeswehr Institute for Materials, Explosives, Fuel and Lubricants  
(WIWEB), Erding, Germany



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boundary layer to the clothing is avoided.

**Thermodynamic Modeling**

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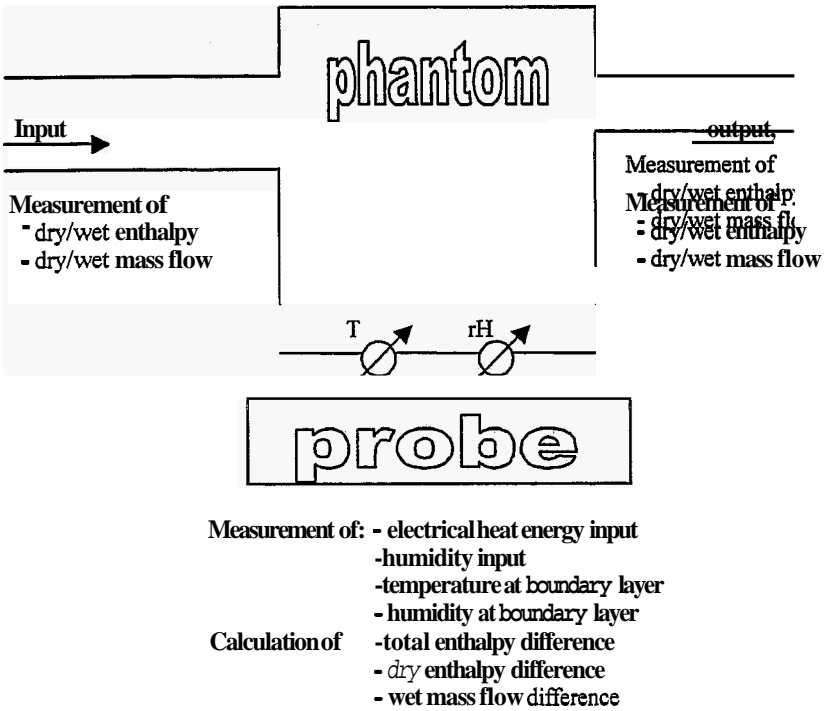


Figure 1. CYBOR heat and mass transport thermodynamics.

To determine interactions of the gas stream with the clothing system, it is important to know the differences between input stream and output stream values, specifically: (1) total heat gained or lost,  $h$ ; (2) *dry* heat gained or lost,  $h_d$ ; and (3) humidity gained or lost,  $\dot{m} h$ .

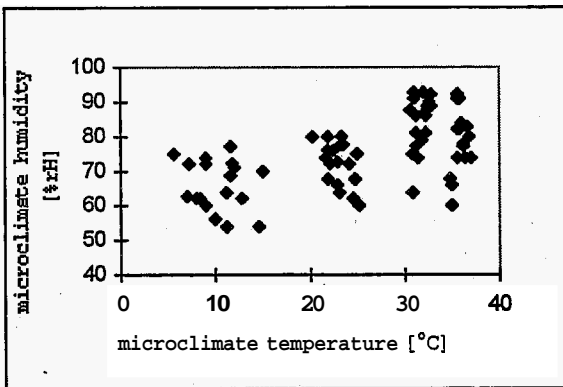


Figure 2. Microclimate conditions in shoes during wearing tests.

## TESTS AND RESULTS

To evaluate the correlation of results **from** wearing tests and CYBOR-simulation tests, the following test procedure was designed

**During** hundreds of wearing tests, under several test conditions, temperature and humidity levels measured in standardized shoe systems (reference shoe) have been recorded and are summarized in Figure 2.

In the study described above, the microclimate variables inside the reference shoe are the steady state variables to be controlled by the CYBOR-device, according to the specified test conditions. The *dry* energy and wet mass flow necessary to obtain the desired microclimatic conditions in the shoe are measured during the test (see Table 1).

**Table 1.** Set point and measured values of wearing and simulation test.

<i>Measurements</i>	Environmental temperature (°C)			
	-16	0	16	32
RH (%)	60 ± 19	60 ± 23	75 ± 16	84 ± 14
T (°C)	10 ± 5	22 ± 2.5	30 ± 2	36 ± 2
$\Delta \dot{m}_h$ (mg·s <sup>-1</sup> )	1.0 ± 0.7	3.5 ± 2	4.0 ± 2	7.0 ± 1
	3 ± 1.0	4 ± 1.5	7 ± 2.0	10 ± 1.0

more regulatory influences, the body-segment heat production and loss depend on global exogenous parameters like the temperature of the environment, physical work load, and clothing isolation. In order to determine the set point for the

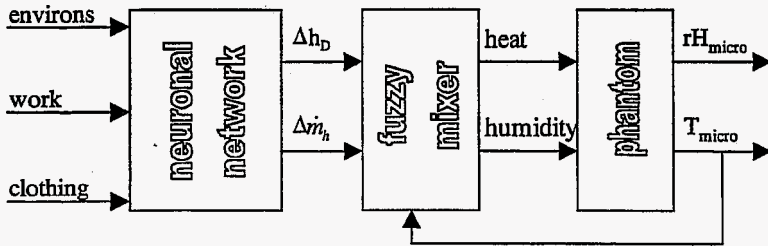


Figure 3. Neuro-fuzzy-concept of CYBOR-process-control

CYBOR-simulation, either the mathematical relations among all the interacting parameters must be known, or the empirical interdependencies have to be established in a neural network (see Figure.3).

#### REFERENCES

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