and Europeans, by 'traditional forms which they are in duty bound to preserve.' An American, he stated,

> is in duty bound to establish traditions in harmony with his ideals, his still unspoiled sites, his industrial opportunities, and industrially he is more completely committed to the machine than any living man. It has given him the things which mean mastery over an uncivilised land, comfort and resources.[11]

Conclusion

Archetypal spaces described in literature and built as architecture reveal the cultural dimension of environmental tempering. Further work in this field is planned to collect, analyse and evaluate literary and architectural evidence which supports the hypothesis. The author invites correspondence from interested parties.

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AIRVELOCITY AND THERMAL COMFORT

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Abstract

Complaints about draft rank first among complaints about thermal discomfort in rooms. The aim of this paper is to elucidate the correlations between the physical characteristics of airvelocity and of thermal comfort. Draft as an unwanted local convective cooling of a person, physically has to be investigated by investigating the convective surface heat transfer coefficient. The method to do this and some results are described. But which values of this coefficient are "unwanted"? This is answered by the help of a physical and physiological view. It contains the dry heat balance of a person and the reaction of the coefficient on its surface temperature.

Posing the problem

Among complaints about thermal environment conditions in rooms, the complaints about draft rank first (1).
These complaints are caused by too high local convective deheating of man, more exactly: by too deep lowering of the surface temperature. The corresponding formula is:

$$q_c = \alpha_c (t_{sf} - t_a)$$

q_c : density of the convective heat flow
α_c : convective surface heat transfer coefficient
t_{sf} : surface temperature of the body
t_a : air temperature.

From this equation we can take firstly the effect of cold air on the convection, secondly shows the equation that the convective surface heat transfer coefficient is the really interesting result with regard to a further analysis of air movements regarding draft.

Measuring methods

In the meantime we have three different methods to measure the convective surface-heat transfer coefficient. Two of these methods are described in (3). Compared to these two methods, the NTC-ladder-method as described in the following is easier to handle and is illustrated in figure 1. Six NTC-resistors of small size are mounted in distances of 2 mm similar to rungs of a ladder. By measuring the resistance of the precalibrated resistors, you get the temperatures of the resistors. This is done by measuring the voltage difference at the resistors with constant input current. Because of the small size of the resistors and wires, these temperatures represent the corresponding airtemperatures. Calibrated at three temperature-levels of 0.010 ^{o}C, 29.771 ^{o}C and 39.450 ^{o}C by the help of triplepoint cells (water, gallium, rubidium) this instrument permits an accuracy of measurement of $\pm$ 0.1K airtemperature. In connection with a datalogger and computer, several NTC-ladders fixed at the skinsurface of different parts of the head deliver the wanted α_c-values around the head.

It can easily be shown that out of the measured decay of airtemperature, e.g. in front of the forehead, directly follows the wanted α-value (3).

Measuring results

Measurements of the convective surface heat transfer coefficient at an artificial head in laboratory have proved that not only the mean air velocity, but also the turbulence determines the convective heat transfer coefficient and thus also the draft sensation. The results of first measurements with flow directed to the front of the head are summarized in figure 2. According to this, there is a parabolic connection between the product from turbulence degree (quotient from standard deviation and mean air velocity value) and mean air velocity value on the one hand and the convective surface heat transfer coefficient on the other hand.

Practical use of the results and field measurements

Considering former exemplary measurements of indoor climate in air-conditioned offices and clean rooms, where a maximum admissible convective surface heat transfer coefficient of c. 12 W/m^{2}K was measured (dotted lines in figure 2), surrounding temperature of 22 ^{o}C, as well as considering a heat balance equation for dry heat emission of man (here not explained in detail), we can derive the provisional evaluation curve as shown in figure 2.

Besides an evaluation curve for thermal comfort (free of draft) in dependance of the surrounding temperature and the convective surface heat transfer coefficient, results of measurements in buildings with and without air conditioning are entered (4). Putting into relation the evaluation curve

in figure 3 with figure 2, we receive the values listed in table No.1 in the different turbulence degrees as limit for draft discomfort. We can see from table No. 1, that there is draft f.i. at 22 ^{o}C and a turbulence degree of 0,6 from mean air velocity of 0,10 m/s onwards.

Conclusions

Conclusions of the contribution are:

- In future, the statement "free of draft" will have to fulfill more requirements than low mean air velocity as up to now. These new requirements must comprise marginal values of mean air velocity as well as of temporal dynamic behaviour of air movements, that is, the turbulence intensity and possibly the frequency hereof.
- The convective surface heat transfer coefficient includes these physical quantities.
- Therefore in future, this coefficient should be taken as basis for the judgement of thermal comfort instead of mean air velocities.
- The present requirements according to German standard DIN 1946, part 2 (1983) will not be sufficient with higher turbulence and with temperatures below 22 ^{o}C. Low turbulence - as in clean rooms - allows air velocities higher than to date to be accepted.
- More measurements - physical as well as psychophysical will be required to make a more detailed and comprising statement of the effect of air motions on the convective loss of heat and thus, on the thermal comfort of man.

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Range of turbulence degree T_v	Surrounding temperature [°C]	Draft starting at conv. surf.heat transf. coefficient [W/m²K] of:	Draft starting at mean air velocity in [m/s] of:
laminar range f.i. in clean rooms with espec. high requirements $T_v < 0,05$	20 22	8 12	0,30 1,35
transition range f.i. common clean rooms $0,05 \le T_v \le 0,4$	20 22	8 12	0,05 0,15
turbulent range f.i. in air-conditioned and unair-conditioned office rooms $T_v > 0,4$, f.i. $T_v = 0,6$	20 22	8 12	0,05 0,10

Table No. 1: Admissible mean air velocities in typical ranges of turbulence and surrounding temperatures.

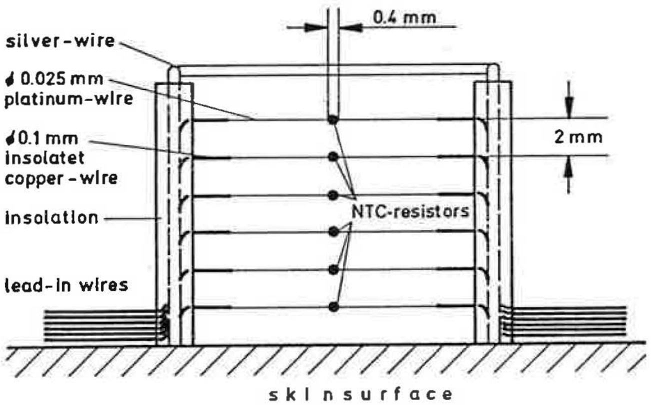

Figure 1. Construction of the NTC-ladder

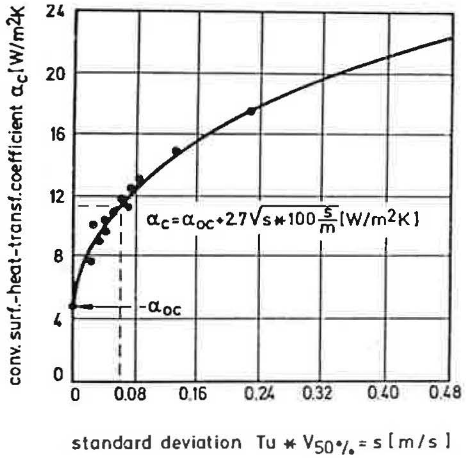

Figure 2. Measured (dots) and calculated (curve) correlation between the product of turbulence intensity, Tu, and mean air velocity, $V_{50\%}$, that means standard deviation, s, on the one side and convective surface heat-transfer coefficient, α_c, on the other beginning with the value of own connection, α_{oc}.

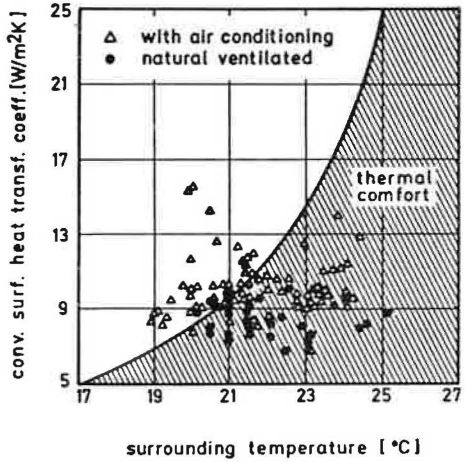

Figure 3. Provisional evaluation curve for thermal comfort depending on the surrounding temperature and on the convective surface heat transfer coefficient, as well as on results of measurements in buildings without and with air conditioning.