

COOL THE OFFICE WITH MOVING AIR

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SUMMARY

Personal control over moving air will eliminate the number one complaint in the office environment – thermal discomfort. The use of moving air to cool provides the ability to accommodate different needs among people for comfort due to varying metabolism, efficiency of heat rejection, and clothing. Cooling with moving air saves substantial energy through increased ventilation effectiveness and higher operating temperatures. Increased comfort means increased productivity. Workstation design can be adapted to provide both personal air control and displacement ventilation at reduced first cost with faster construction, lower operating costs, cleaner air and 100% personal satisfaction.

DISCUSSION

The number one complaint of office occupants is an uncomfortable environment. People can, however, adjust conditions to meet their personal need for thermal comfort by simply adjusting air flow from a local air supply at their workstations. A study by Khedari and others [1] showed the dramatic effect of moving air on people. Also a survey by the University of California at Berkeley showed that most people in an office setting preferred more moving air.

The best use of the cooling effect of moving air is to get away from the mind set of air conditioning buildings with a “one environment fits all” approach that fits no one. The aircraft and automotive industries have taken advantage of moving air controlled by occupants for many, many years. Unfortunately, because of lack of space, the velocity of the air in both cases is high and tends to feel drafty.

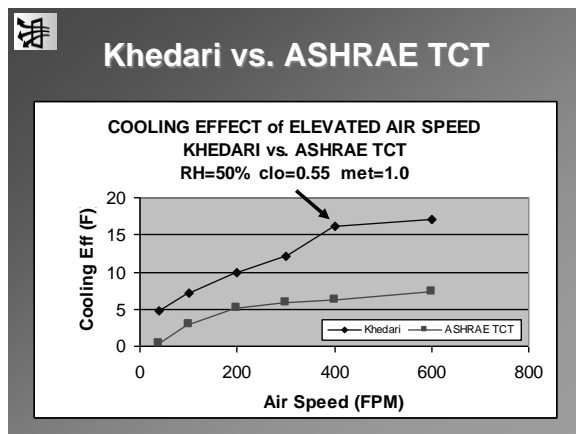


Figure 1

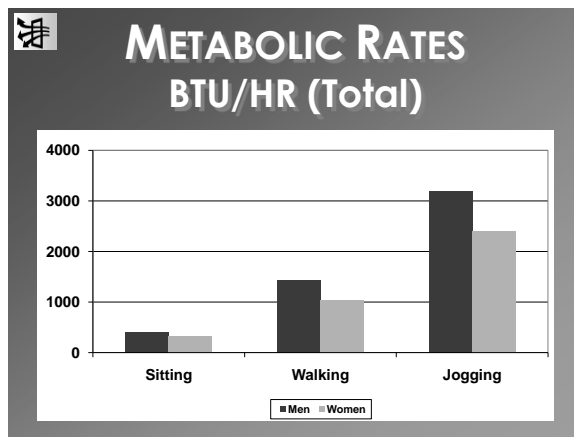
Tests by Fred Bauman and his group at UC Berkeley have demonstrated that changing the air flow can change the cooling temperature perceived by occupants from 0° to 15°F (0° to 9°C). In the Khedari study of 288 college students, air at 80°F (27°C) moving at 400 FPM (2 m/s) feels like 65°F (18°C), a difference of 15°F (9°C).

ASHRAE Standard 55 through 2004 (p. 6) suggests the use of moving air, provided it's under personal control. Khedari found that the effect shown in Standard 55 and reflected here (Fig. 1) as ASHRAE Thermal Comfort Tool, or TCT, is understated and probably is based on sensible cooling only.

So, by varying the air flow you can control the perceived temperature from 80°F to 65°F (27° to 18°C). That range should satisfy 100% of occupants at all times.

Providing personal control will eliminate the number one complaint – thermal discomfort – and improve productivity in every office. The system does this by accommodating the vastly different needs among people for comfort.

Why is there so much difference in people's needs? Because basic metabolism varies from person to person (Fig. 2).

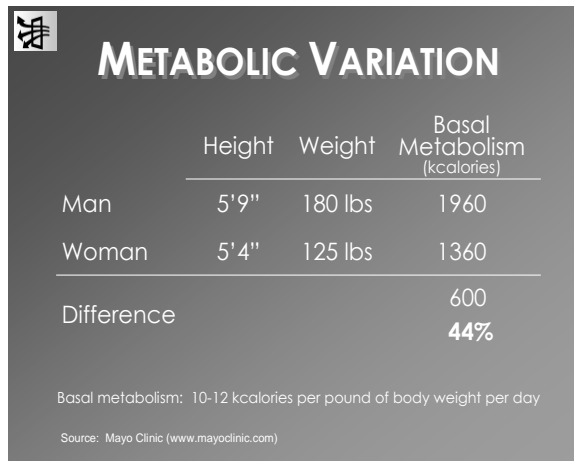


On top of that, metabolism can vary at any time due to varying conditions, such as controversial phone calls; or being rushed; or not feeling well due to health problems, etc.

People are comfortable when the heat removed is equal to the heat they generate and absorb from external sources, such as the sun, lights, office machines, etc.

Figure 2

According to information from the Mayo Clinic, the basal metabolic rate for people is 10-12 kilocalories per pound (22-26 kilocalories per kilogram) of body weight per day. Fig. 3 compares the caloric output of 1360 kilocalories for a typical woman weighing 125 pounds (54 kg)



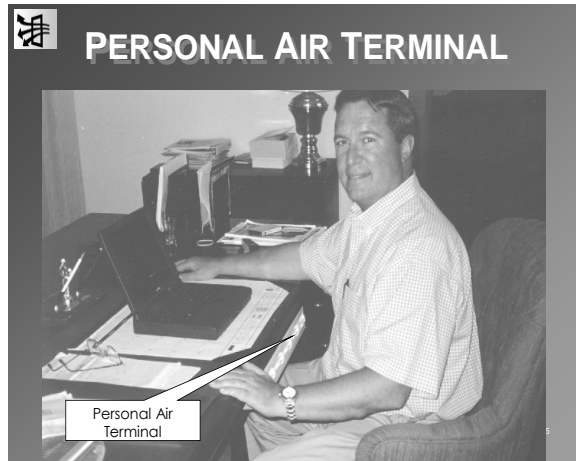
to that of 1960 kilocalories for a typical man weighing 180 pounds (86 kg): a difference of 600 kilocalories, or 44%!

If more heat than is generated through basic metabolism is removed, the person feels cold. Any less and he feels hot.

Figure 3

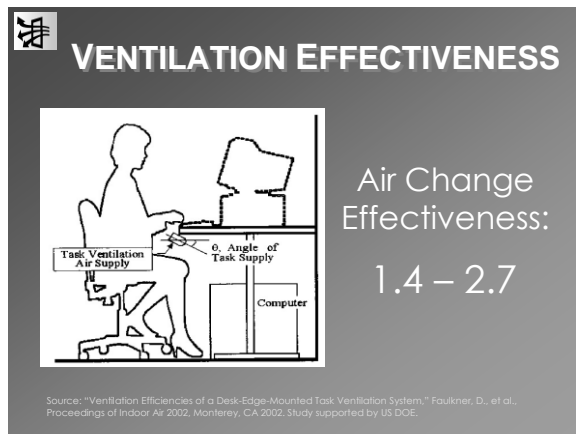
Is it any wonder that both people cannot be comfortable under the same temperature conditions?

In addition, differences in efficiency of heat rejection and clothing affect the cooling needs of men vs. women. A smaller body is a more efficient radiator, further increasing the need for individual environmental control. The simple solution is the system shown in Fig. 4.



By introducing air at the desk level, the occupant can change the cooling effect with a damper - just like in his car. Because of better space availability compared to a car, velocities are lower, and, therefore, air flow is quieter and more comfortable. This arrangement is familiar to everyone from his or her car without special training!

Figure 4



The system also saves substantial amounts of energy.

Tests at UC Berkeley have shown that discharging supply air flow near the occupant increases ventilation effectiveness - a savings both in energy and the cost of filtration (Fig. 5).

Figure 5

Furthermore, a very great savings in energy is achieved by using moving air instead of cold air. Room temperatures can be set substantially higher because of the cooling effect of the moving air. As we have seen, moving air lets people set “perceived temperatures” from 80° down to 65°F (27° to 18°C) – a range of 15°F (9°C).

The thermograph in Fig. 6 shows 60% of heat is given off by the upper body, and, thus, a personal air terminal positioned at the worksurface is most effective in making people comfortable with the least expenditure of energy.

Many studies show that increased comfort means increased productivity [2]. Now let’s put productivity in perspective.

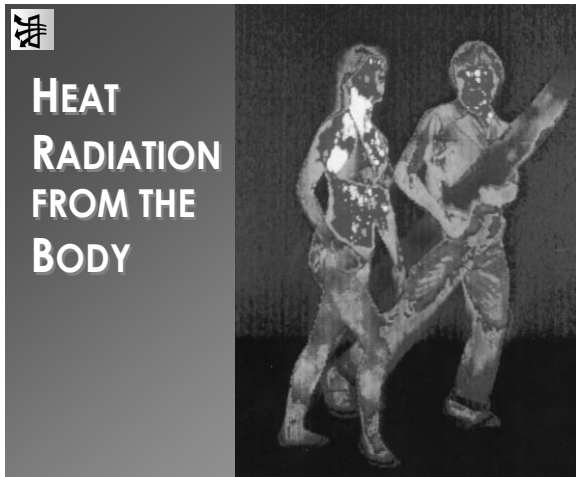


Figure 6

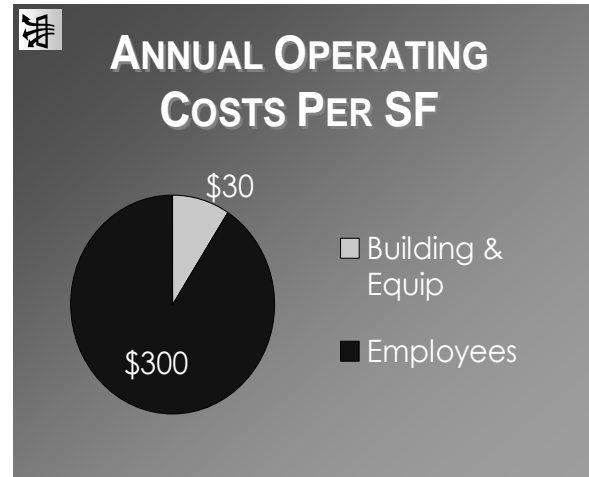


Figure 7

Annual payroll costs in office buildings are approximately \$200 to \$300 per square foot (\$2,150 to \$3,225 per square meter), or 90% of the total costs of owning and operating an office facility. Even a small increase in productivity can offset total annual building costs of \$20 to \$30 per square foot (\$215 to \$323 per square meter).

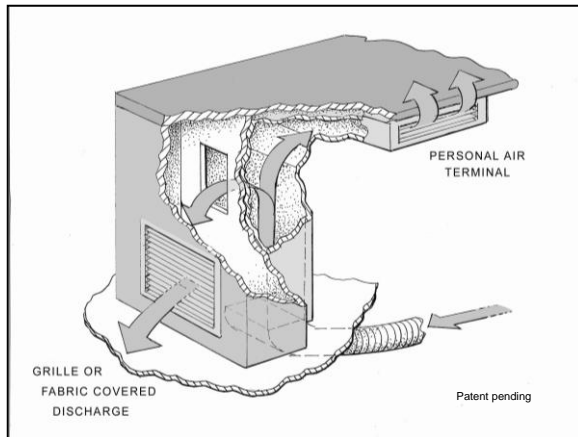


Figure 8

Fig. 8 illustrates a desk or workstation with a personal air terminal. Note that displacement ventilation can easily be added for better IEQ, cleaner air and reduced cross contamination.

Displacement ventilation has been proven to increase comfort, save energy and reduce absenteeism.[3]

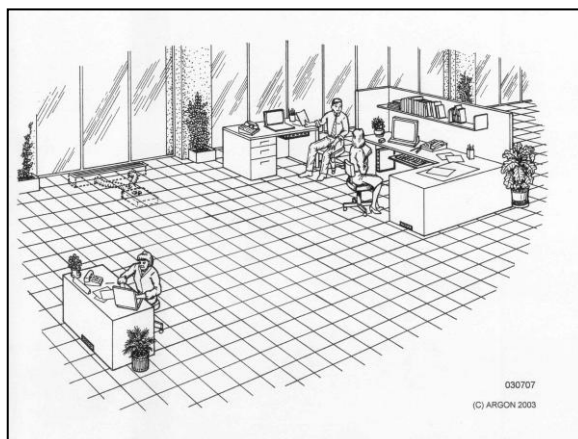
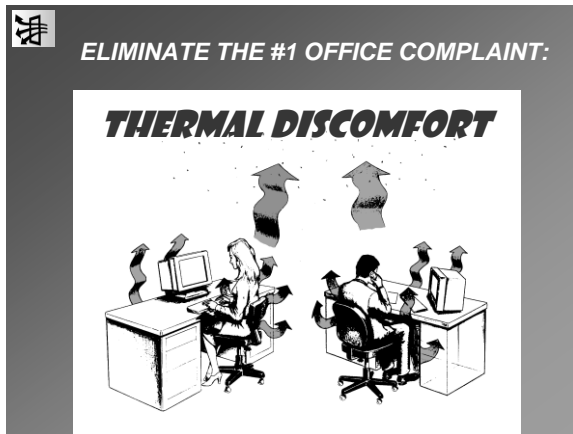


Figure 9

Fig. 9 shows a typical office with integrated task/ambient personal control and displacement ventilation. Note the near absence of floor grilles.

Moving air with task/ambient personal control and displacement ventilation can eliminate the #1 complaint of office workers, save energy, have cleaner air and increase productivity.

LEED credits can be earned with a sustainable green indoor environment, control by occupants, better IEQ, and lower energy cost.



All this can be done at reduced first cost.

Faster construction, lower operating costs, cleaner air and 100% personal satisfaction are the rewards.

Figure 10

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