AIRIUS®

air flow circulation

AIRIUS®
saving you energy

How Air Circulation and Destratification Improves Thermal Comfort and saves A/C Energy

Thermal Comfort

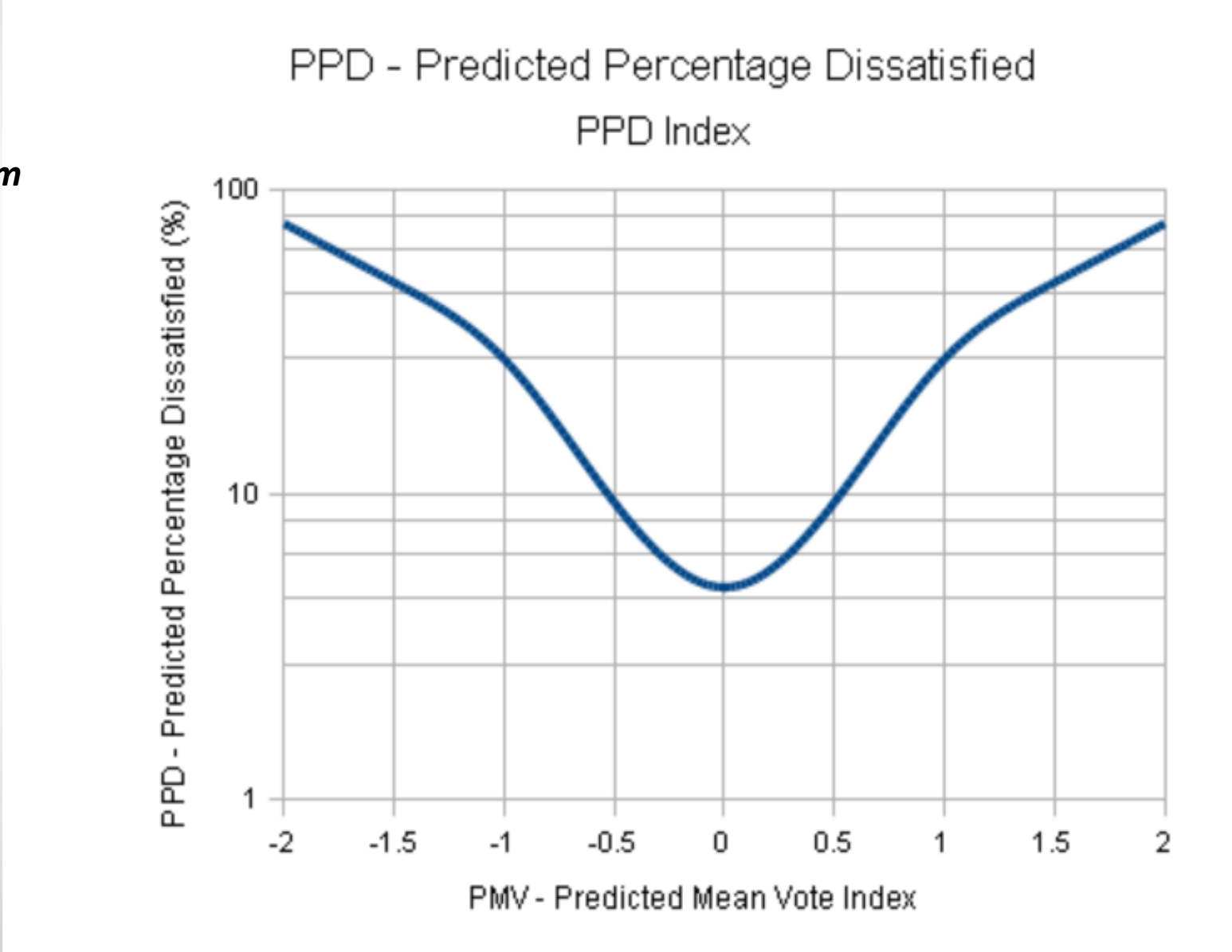
- **Thermal comfort** is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation (ANSI/ASHRAE Standard 55).[1]Maintaining this standard of thermal comfort for occupants of buildings or other enclosures is one of the important goals of HVAC (heating, ventilation, and air conditioning) design engineers'. Wikpedia, accessed 24.08.15
- Should be for Architects too!

Air Conditioning consumes up to 50% of a building's energy footprint!

- If the inhabitants are uncomfortable, why bother?

5-15% will always be uncomfortable!

+3 hot
+2 warm
+1 slightly warm
0 neutral
-1 slightly cool
-2 cool
-3 cold



ASHRAE 2010: Adaptive Comfort Standard for Naturally Ventilated Buildings

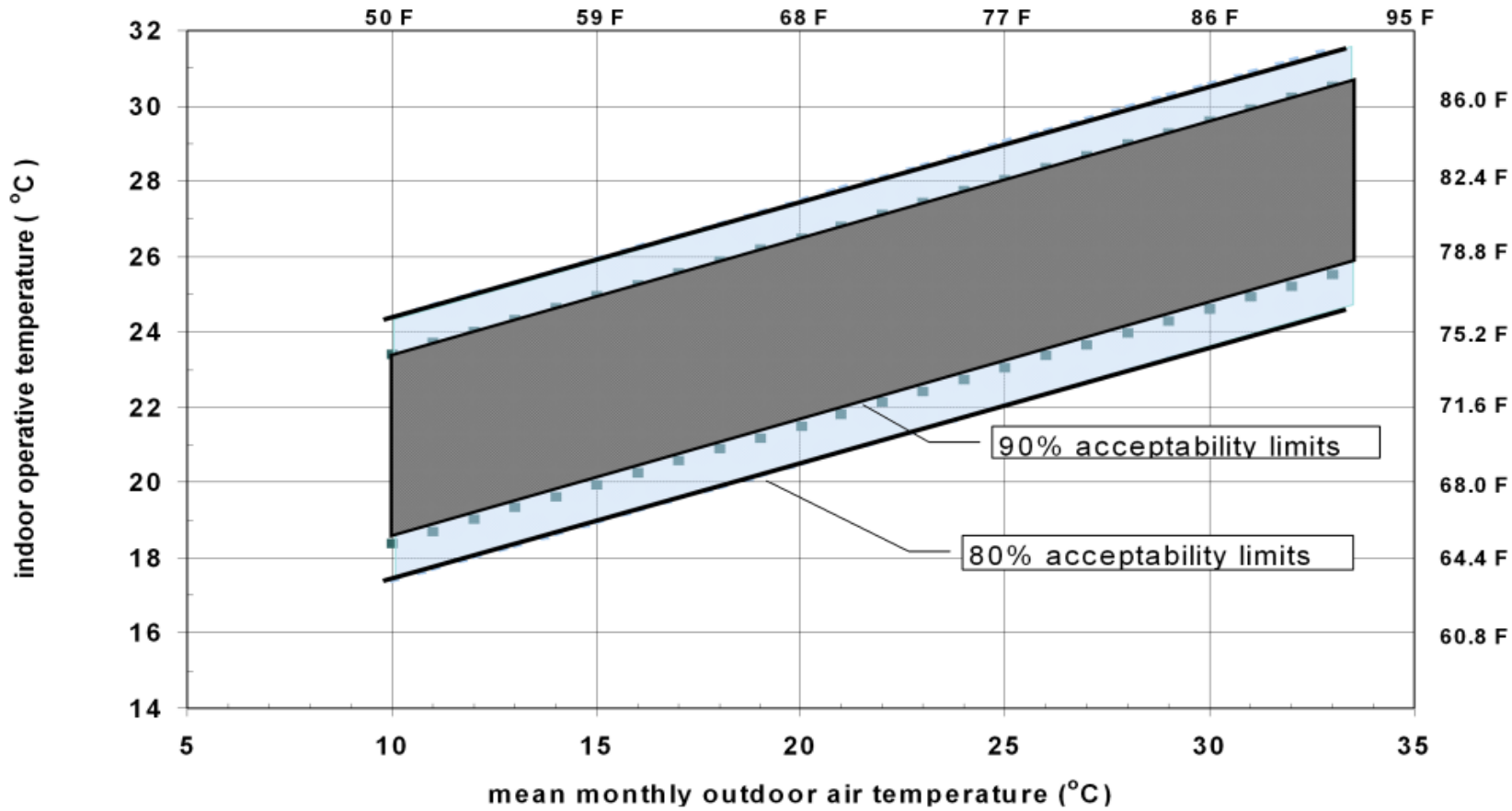


Figure 5.3 Acceptable operative temperature ranges for naturally conditioned spaces.

ASHRAE 2012-Air Flow and Thermal Comfort

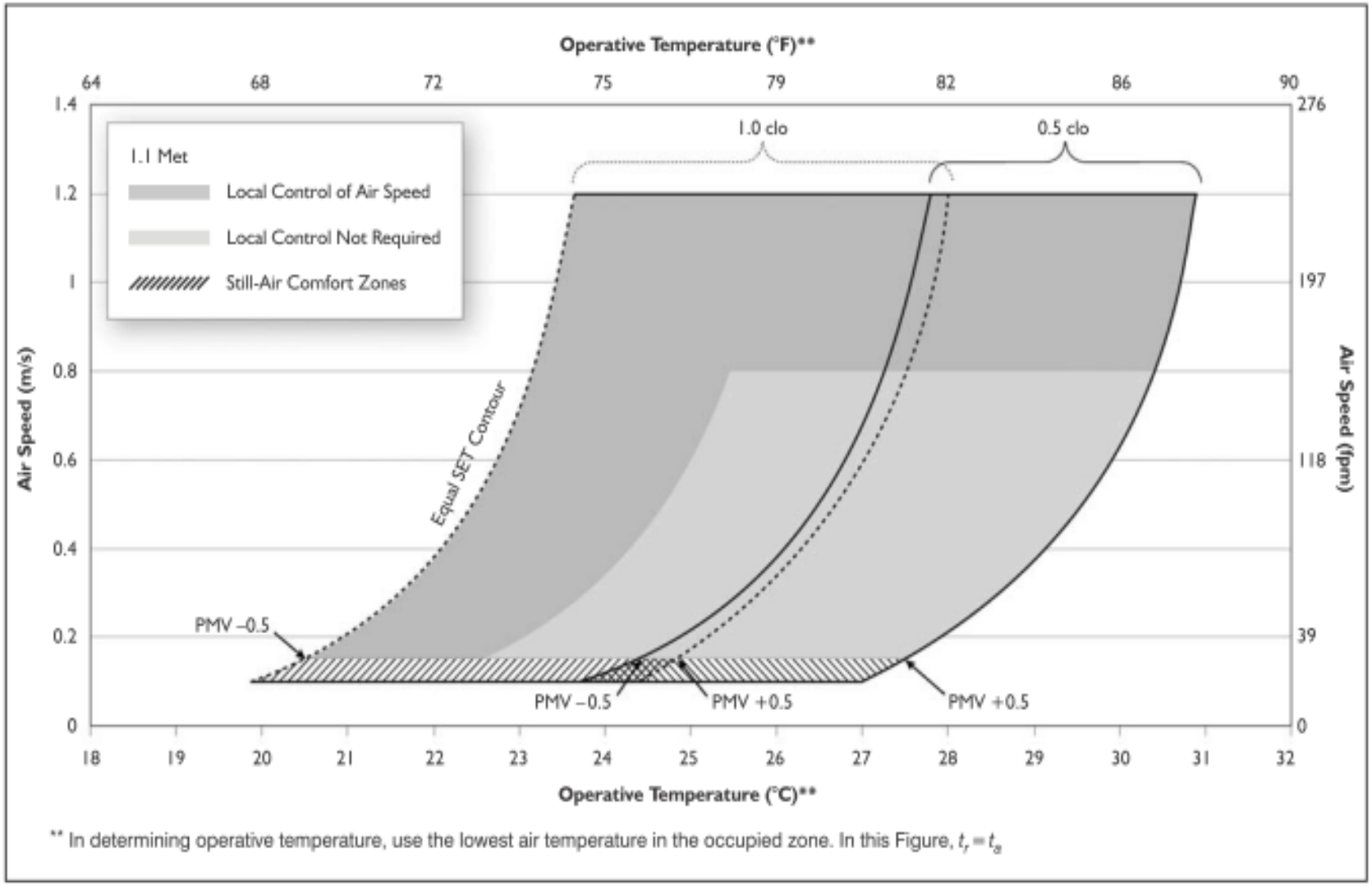
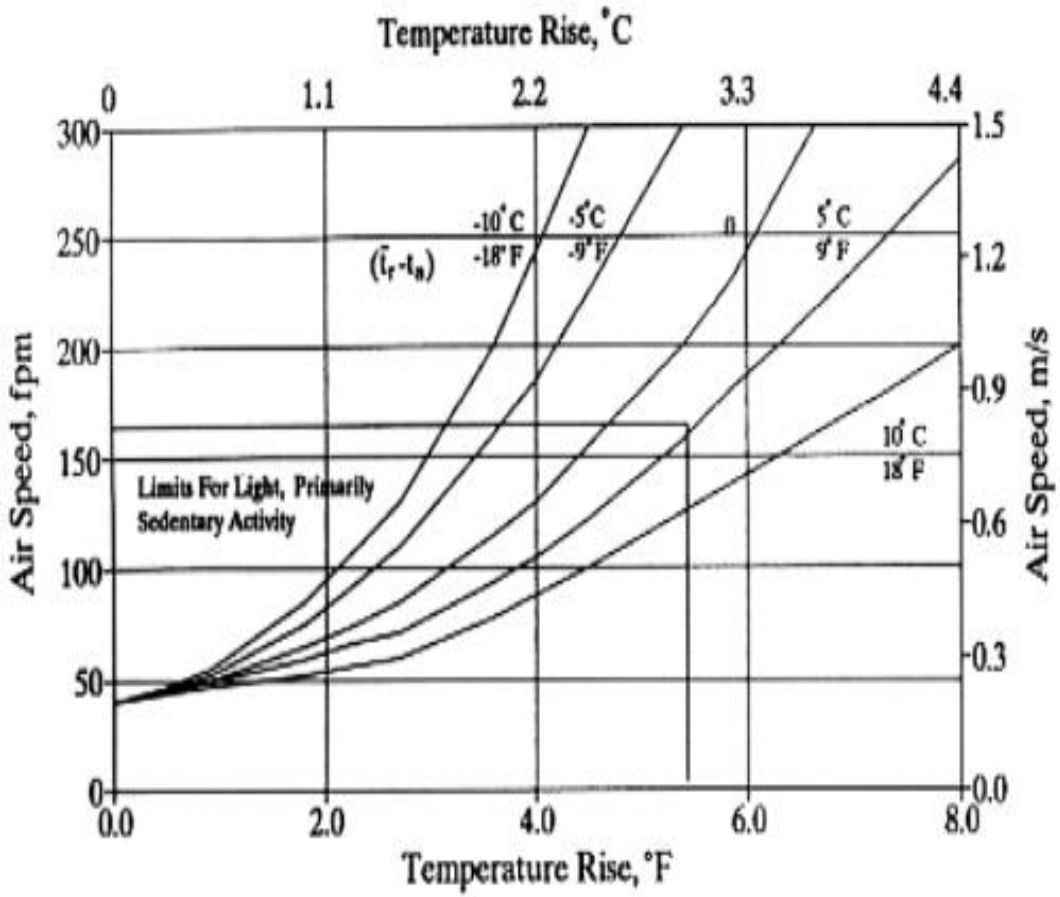


Figure 5: Elevated air speed for warm air temperatures.

ASHRAE Says –'air speed helps improve comfort'

- The human body reacts to air speed
- Sydney summer climate- 70% humidity
- 4 deg K offset @1m/s air speed
- For radiant and air temperature
- Air speed 0.4m/s will offset a 2.2 degree temp rise



igure 5.2.3-1. *Air speed required to offset increased temperature.*

Air Flow and Cooling Value

When:		
Air temperature	=	35 °C
Mean radiant temperature	=	35 °C
Air velocity	**=**	**3 m/s**
Relative humidity	=	70 per cent
Metabolic rate	=	1.0 met
Clothing Insulation	=	0.22 clo
SET*	**=**	**29.3 °C**

The benefit of 3.0 m/s air velocity can be quantified by reducing air velocity to 0.15 m/s. A typical value used for assessing people engaged in light sedentary activity is 1.0 met.

When:		
Air temperature	=	35 °C
Mean radiant temperature	=	35 °C
Air velocity	**=**	**0.15 m/s**
Relative humidity	=	70 per cent
Metabolic rate	=	1.0 met
Clothing Insulation	=	0.22 clo
SET*	**=**	**36.3 °C**

The cooling effect of increasing a uniform air speed from 0.15 m/s to 3.0 m/s can be seen to be 7.0°C, the

Research by the US utility company Reliant Energy indicated that for each degree Celsius rise in the thermostat setting above 25°C in summer, a cooling energy saving of between 9–12 per cent can be achieved (Reliant, 2006).

The cooling effect of 3 m/s air movement of up to 7ºC from circulating fans can be used in conjunction with raising the air conditioning SET* sensing thermostat to achieve significant savings while maintaining thermal comfort. (Aynsley, 2005a).

….then the net savings after accounting for energy used by the circulating fans would be from 35 per cent (5 x 7 per cent) up to 50 per cent (5 x 10 per cent) in active areas such as gymnasia. In office space air speed constraints limit local air speeds less than 1 m/s with a cooling effect of around 3ºC with energy savings for cooling of approximately 20 per cent.

Latest Research- U Syd- heatwaves and fans for cooling

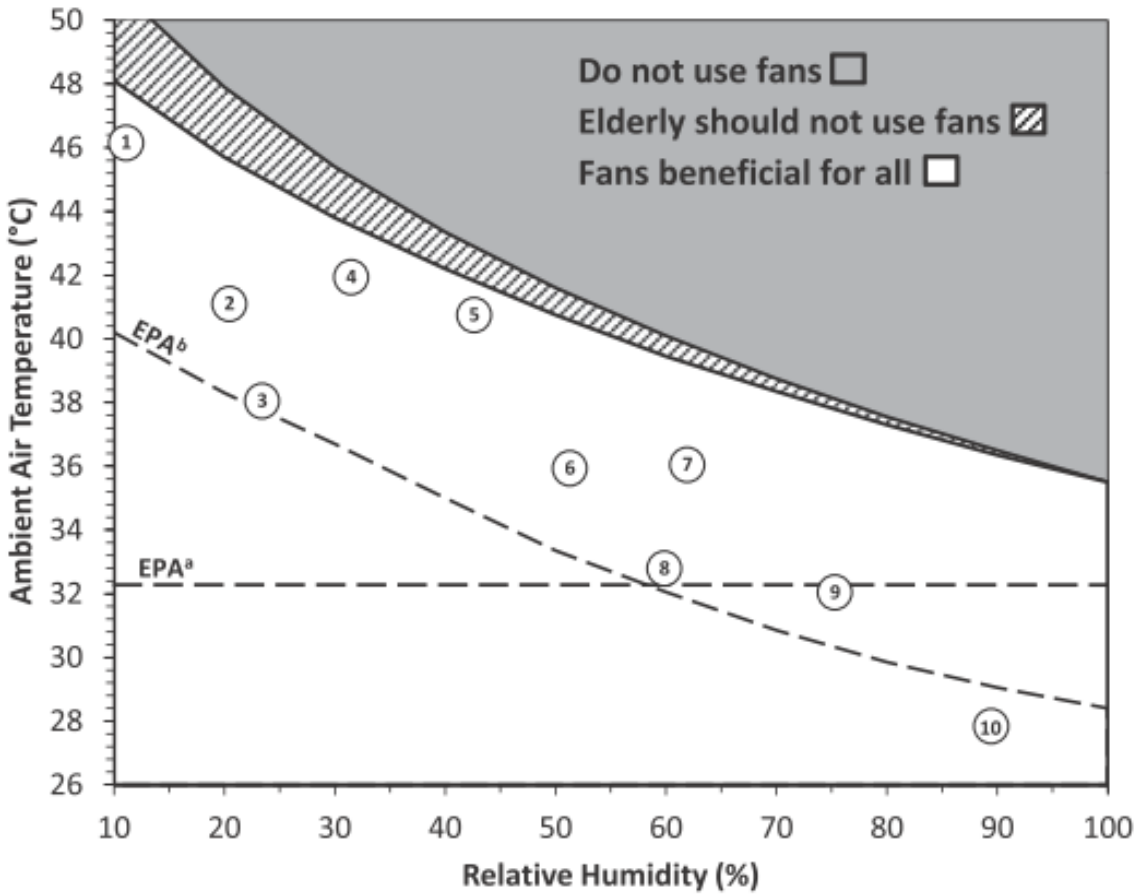


Fig. 3. Predicted critical environmental limits at which electric fan use becomes harmful. Peak hourly outdoor heat wave conditions for: Sydney, 2013 (1); Washington DC, 2012 (2); Paris, 2003 (3); Newark, 2011 (4); Chicago, 1995 (5); New York, 2006 (6); Chicago, 1999 (7); Washington DC, (night) 2012 (8); Chicago (night), 1999 (9); Paris

Air Movement

- Air Movement in buildings is a key contributor to thermal comfort of inhabitants in summer
- *The dominant loss of heat from the skin at over 30 Deg C is by evaporation of perspiration*
- Air movement has been used for millennia to provide cooling
- Air movement can be high or low in energy use
- Blowing air is a lot easier than sucking air
- Natural buoyancy of hot and cold air can be assisted using strategic air movement
- Controlling the direction of air flow is important
- Air Changes an hour -crucial for removing heat loads.
- Provides the dynamics not found in static A/C type environments

AIRIUS®
saving you energy

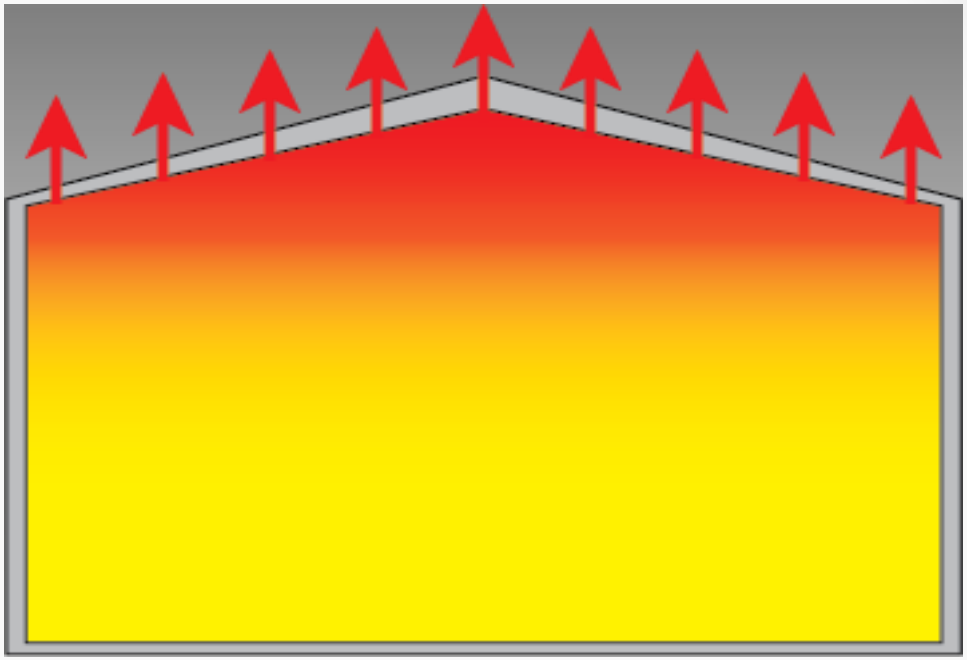
DESTRATIFICATION SYSTEMS

"Thermal de-stratification is one of the top three carbon reducing initiatives in buildings" Carbon Trust UK

"Thermal stratification is the single biggest waste of energy in buildings today." – DTE Energy

(one of the USA's largest energy suppliers)

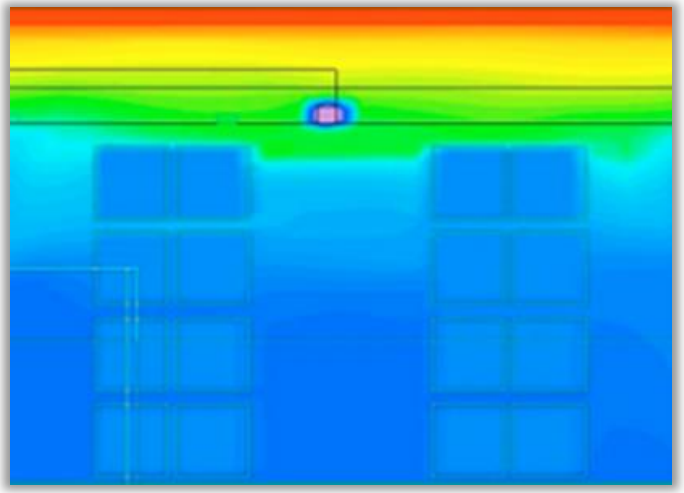
Heat Loss in Winter



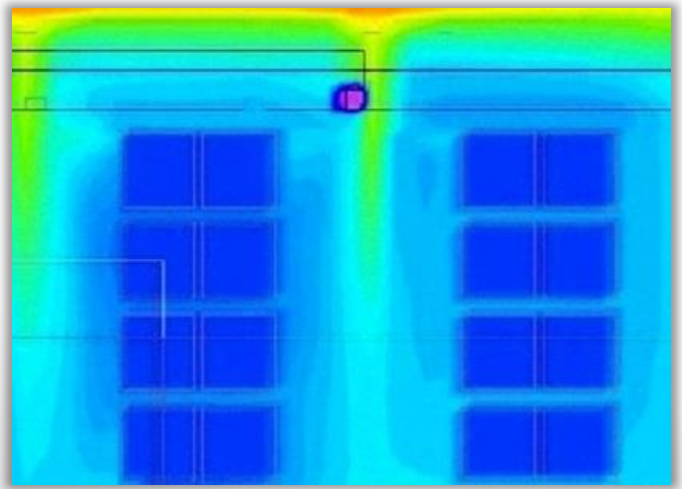
The higher the temperature at the roof in winter creates a high Delta T T(int)/T(out). This accelerates loss of heat out through the roof.

Your heating system is not just over-delivering to make up for that lost heat, its also trying to make up for the hot air under the ceiling that should be down where you are located. = wasted heat.

What is Thermal De-stratification?



- Stratified building



- De-stratified building

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Heating Energy Savings

Yearly Average

AIRIUS saving you energy

Heating Mode:

City	Energy Saving(%)for 2C	Energy Saving(%)for 4C	Energy Saving (%)for 6C
Sydney	7.8	19.0	29.0
Melbourne	8.4	17.1	27.8
Brisbane	9.8	20.8	25.6
Adelaide	7.8	11.8	18.7
Canberra	11.2	17.0	21.2
Hobart	5.4	8.9	13.4
London	8.9	13.6	19.7
Perth	7.3	12.4	18.9

How much will you save in an A/C building if you remove ductwork ?

- 30% capital costs?
- Energy reduction with no ductwork -10-20%
- Commissioning – 5%
- Opportunities to reduce building height etc – lots saved
- Reduced services design coordination costs - $$
- Maintenance costs ↓

No ductwork –Marks and Spencer

Destratification without ductwork – perfect.

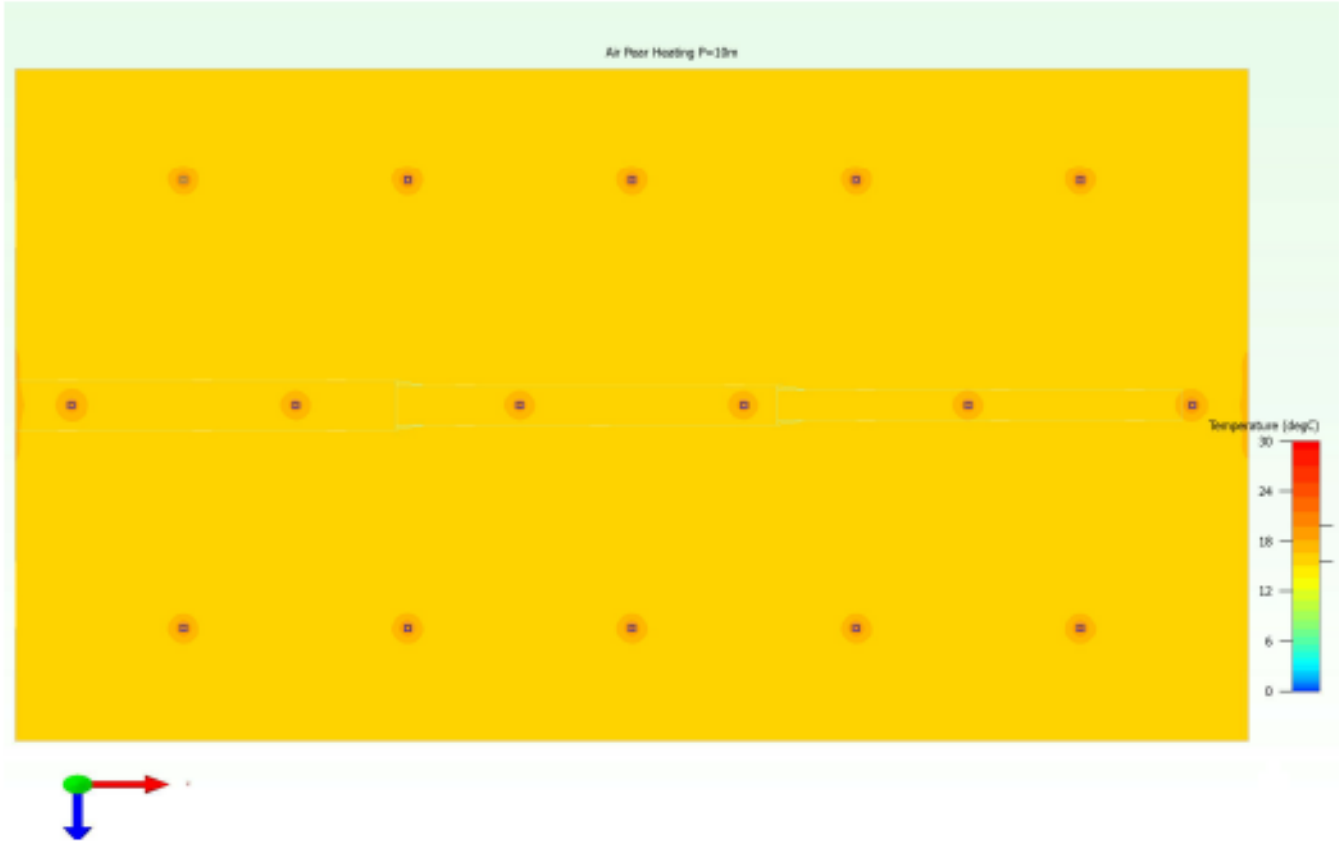


Figure 21 Temperature contours on a horizontal plane at 1500mm affl

Figure 20 and Figure 21 show the velocity and temperature contours respectively on a horizontal plane at 1500mm affl. As can be seen the air distribution has improved significantly. The temperature is quite even around 16 deg C across the entire floor.

Central spine duct cooling

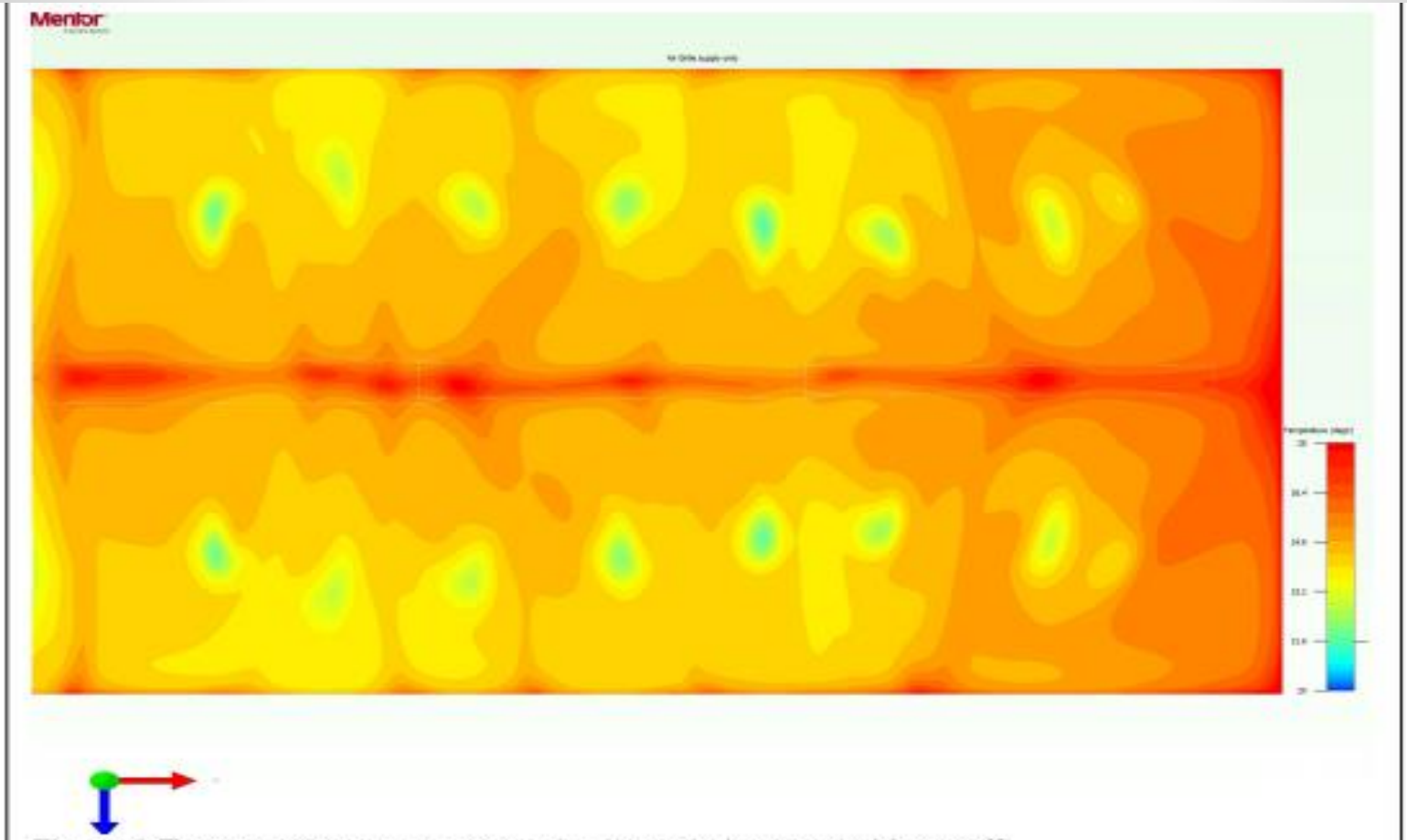


Figure 9 Temperature contours on a horizontal plane at 1500mm affl

Figure 8 and Figure 9 show the velocity and temperature contours respectively on a horizontal plane at 1500mm affl. As can be seen the air distribution is very uneven with cold air dumping in front of each register.

Central spine duct cooling with Air Pears

Figure 25 Temperature contours on a horizontal plane at 1500mm affl

Figure 24 and Figure 25 show the velocity and temperature contours respectively on a horizontal plane at 1500mm affl. As can be seen, there is good air movement at ground level, and the temperature distribution is fairly even across the floor plan. The temperature range is between 23 and 26 deg C, which compares well with the design temperature of 24 deg C.

99 Bikes in Perth

‘We are really happy with the effectiveness and low energy properties of the Airius fans. in open ceiling spaces. This is a great, cost effective way of traversing the aesthetics issues with flexible duct.’

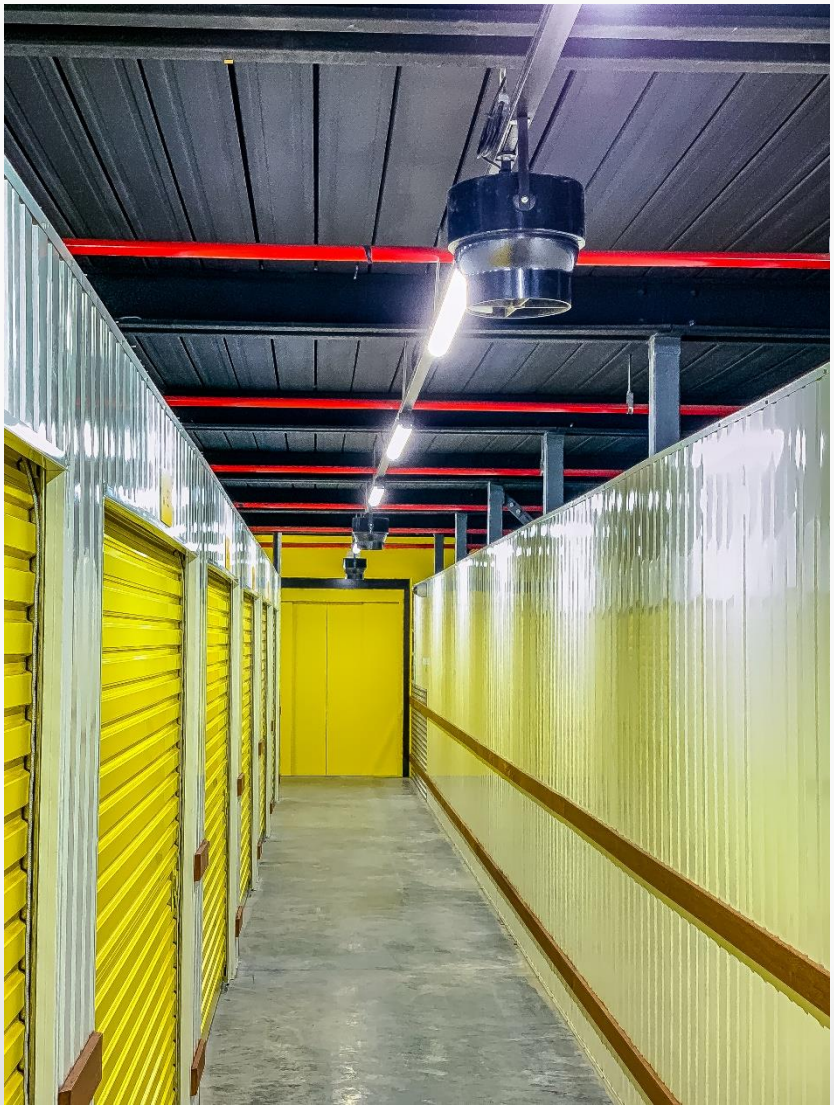
Gareth Halliday; ECO - Climate Solutions

Air Pear versus large sweep fan

Brisbane Boys College – 5 courts

Moonee Valley City Council Cooling and Heating

National Storage Bundall, QLD



Dandenong Markets

Axeman's Hall of Fame TAS.

Turned 60% of their heating off 2 days after installing four Airius fans !

Standard Whisky Distillery, VIC

Non A/C School Library QLD

Church Sydney

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Thank You

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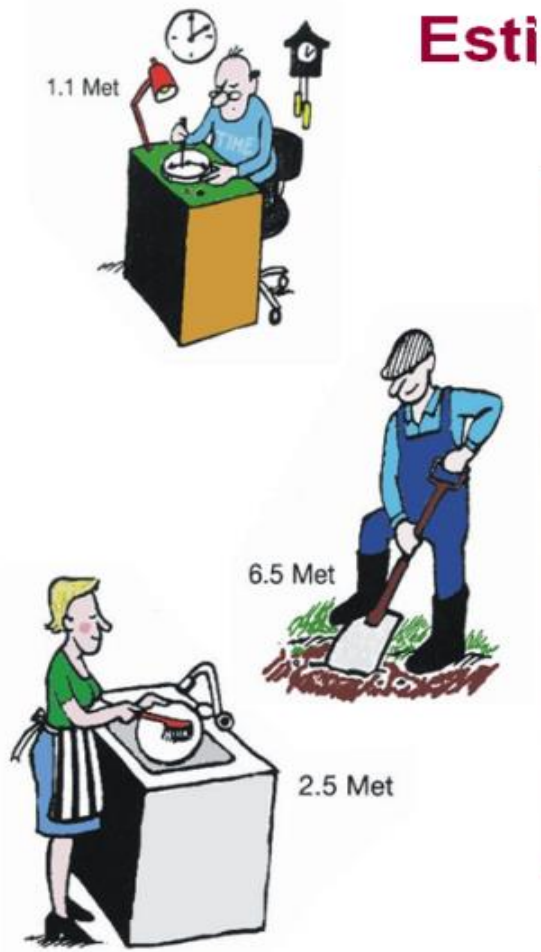
- John Brodie
- www.airius.com.au
- Info @airius.com.au
- 0401848888

Refuel
CPD provider network

Activity generates more heat



Estimation of the Human Heat Balance Parameters: Metabolism

Activity	Metabolic Rates [M]	
Reclining	46 W/m²	0.8 Met
Seated relaxed	58 W/m²	1.0 Met
Clock and watch repairer	65 W/m²	1.1 Met
Standing relaxed	70 W/m²	1.2 Met
Car driving	80 W/m²	1.4 Met
Standing, light activity (shopping)	93 W/m²	1.6 Met
Walking on the level, 2 km/h	110 W/m²	1.9 Met
Standing, medium activity (domestic work)	116 W/m²	2.0 Met
Washing dishes standing	145 W/m²	2.5 Met
Walking on the level, 5 km/h	200 W/m²	3.4 Met
Building industry	275 W/m²	4.7 Met
Sports - running at 15 km/h	550 W/m²	9.5 Met

http://lumasenseinc.com/EN/products/thermal-comfort/

Thermal Delight

"The thermal environment has the potential for sensuality, cultural roles, and symbolism [and delight] that need not, indeed should not be designed out of existence in the name of a thermally neutral world"

(Heschong 1979 *Thermal Delight in Architecture* p.17)

Physics of Thermal Comfort

- The basic principle borrowed from indoor thermal comfort researchers is that the human thermal climate can be described by four environmental parameters affecting the body's energy balance:
  - Air temperature (convective exchanges)
  - Mean Radiant Temperature (radiative exchanges)
  - Air speed (convective and latent exchanges)
  - Humidity (latent exchanges)
- Supplemented by two personal parameters
  - Clothing insulation (thermal insulation)
  - Metabolic rate (internal heat production)

More air please its too hot!

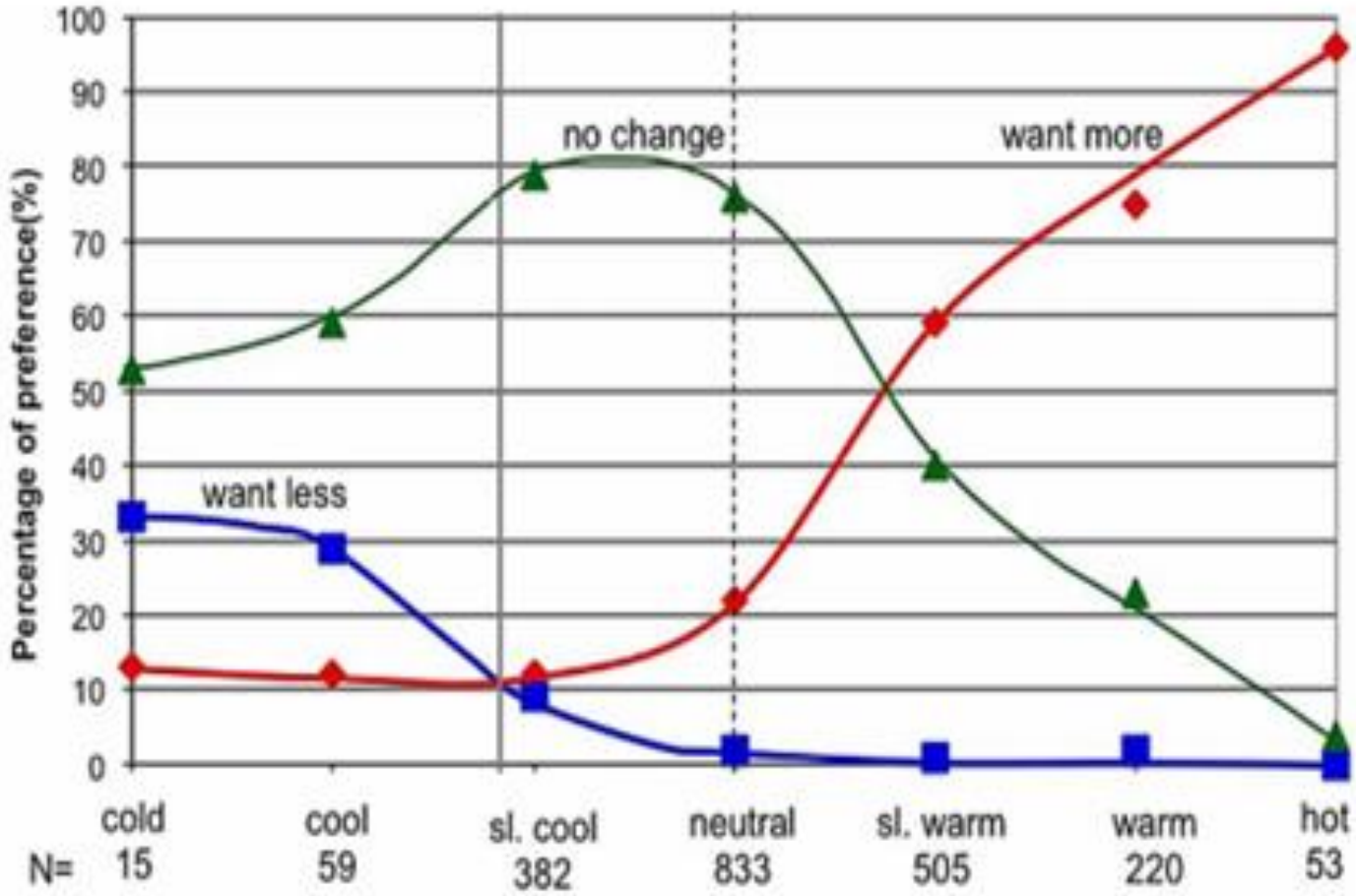


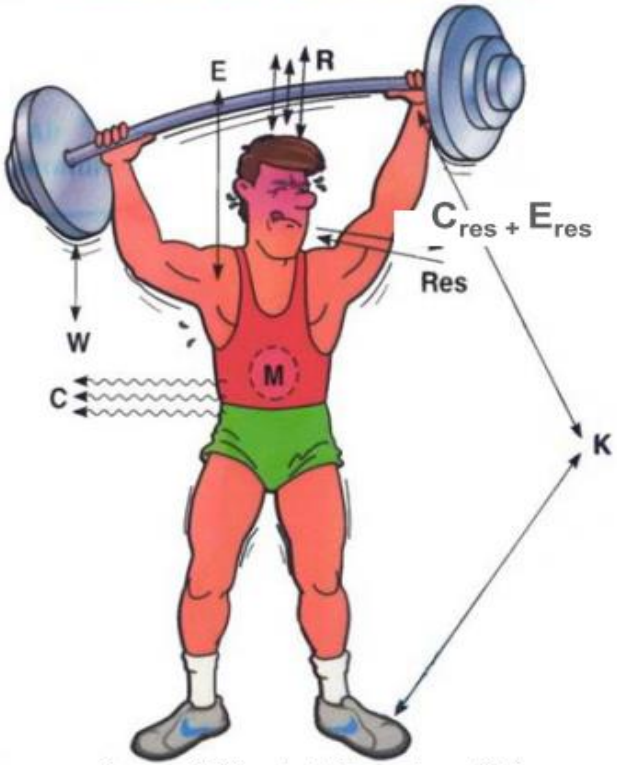
Figure 9 Air movement preference versus thermal sensation
Source: Zhang et al. (2007)

Evaporative heat loss is 25% of the heat loss equation –hello 'air movement'…

The Human Energy Balance

- The dry heat loss (**R+C**) represents ~70% at low Clo-values and ~60% at higher Clo-values.
- The evaporative heat loss (**E**) represents ~25% at moderate activities
- Heat Loss by Conduction (**K**) and Respiration (**RES**) are normally insignificant compared to the total heat exchange, so it is usually ignored.

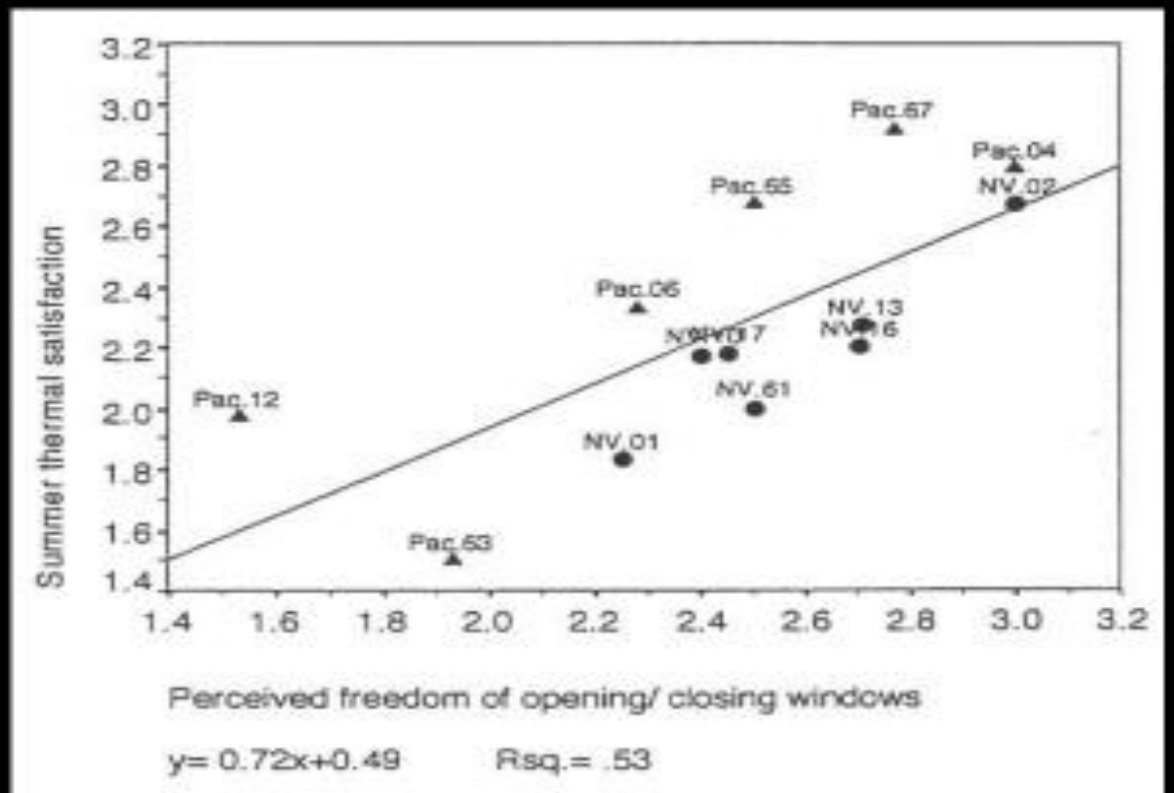
Parameters influencing the heat exchanges of a person



http://lumasenseinc.com/EN/products/thermal-comfort/

If people have more control over their environment they will tolerate a greater range of temperature.

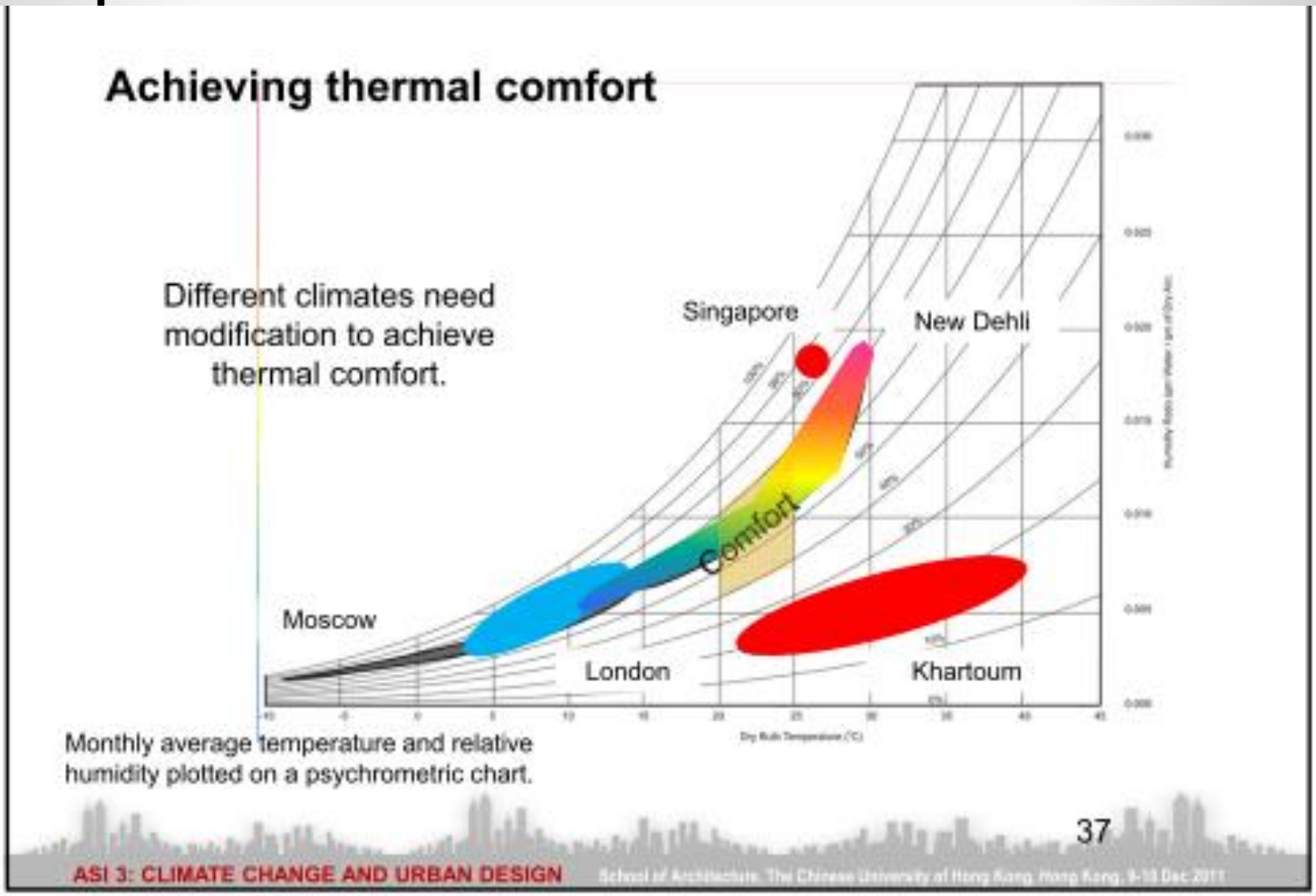
Comfort and control



Current Air Conditioned Spaces…

- Like living in a vault
- 22.5 Deg. C and 300 lux for the rest of your life?
- Static ‘dead’ environment
- Unhealthy due to no environmental variation or thermal delight
- Unhealthy due to air recirculation
- Same level of discomfort as a non-conditioned space
- High energy consumption
- High capital costs
- Creates great amounts of concentrated heat
- High running costs
- Maintenance
- Massive contributor to global warming
- Where is the thermal delight here?

Modification of the environment is required to achieve thermal comfort



Static A/C Environments

- As Professor Richard de Dear (2011) stated:

‘If the very best that can be achieved in an isothermal, cool, dry and still indoor climate is ‘neutral’ or ‘acceptable’ for little more than 80% of a building’s occupants at any one time, then the standards that have been set to date leave much to be desired’.

Alliesthesia

Thermal Pleasure versus Thermal Boredom

- The phenomenon of Alliesthesia is used to differentiate thermal pleasure from thermal neutrality and acceptability.
- Alliesthesia represents a fundamentally different way of thinking about thermal comfort.
- …..people perceived neutral conditions as comfortable, but not as 'very comfortable'.
- The 'very comfortable' votes happened only in asymmetrical environments…..
- *It might be feasible to achieve higher levels of thermal comfort or pleasure than are currently possible, through appropriately designed asymmetrical and transient thermal environments.* (Arens, 2006)

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Air Changes an Hour to Remove Heat

Internal Heat Gains / Area	100	W/m²	Cooling Setpoint	26	°C	Select Weather Files
Minimum Ventilation Rate	0.697674	sL/s/m²	Heating Setpoint	20	°C	Run / Export Results
Limiting Outdoor Dew Point	17	°C	Night Start	18	h	About
Ceiling Height	5	m	Night End	5	h	

AUS_QLD.Brisbane.94578_RMY.epw

Direct Cooling

100 W/m²	Manual Setpoints	Adaptive 80%	Adaptive 90%
Ventilation Rate	9.711	8.575	9.817
(ACH) ±	7.832	6.469	7.562
% Effective	62.2	65.1	63.9
% Too Cold	0	0	0
% Too Hot	15.8	5.06	8.82
% Too Humid	33.7	33.7	33.7

Night Cooling

	Manual Setpoints	Adaptive 80%	Adaptive 90%
Cooling Potential	4.379	4.856	4.568
(W/m²•ACH) ±	2.681	2.946	2.741
Days Needed	199	178	188
% Effective	52.3	47.8	49.5

Directional Air Circulation will:-

- Provide controllable cooling in your space in summer
- Remove/reduce condensation off your surfaces in buildings including indoor pools etc.
- Reduce heating energy in your indoor spaces
- Provide cooling via controlled air movement in your large spaces such as halls and sports centres
- Evacuate hot air out of the space if correctly designed and located
- Assist with natural ventilation as required by moving air into and out of spaces
- Can be used in lieu of ductwork horizontally
- Work as a cost effective 'air curtain' if properly designed.
- Enable reduction of air conditioning energy use

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Destratification

AIRIUS® saving you energy

- Stratification is the separation of hot and cold air in a building
- Cold air falls making hot air rise
- Stratification in hot buildings wastes enormous amounts of heat
- Stratification in cool A/C environments reduces the optimisation of air conditioning systems
- Equalising the temperature in the space improves comfort and saves energy in conditioned environments

Air Circulation and Destratification Products

- Airius Air Pear® Thermal Equalizer®

- HLVS Fans; eg; 'Big Ass' Fans

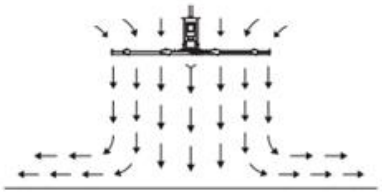
- Normal ceiling fans
- Extraction fans
- Pedestal fans

Understanding airflow patterns

Correct fan placement is crucial for maximizing airflow distribution while adhering to safety standards.

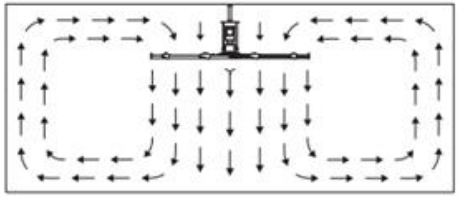
Airflow in an open area

The airflow moves from the fan toward the floor. When airflow hits the floor, it moves outward in all directions. The deflection of air off the floor is called a "floor jet."



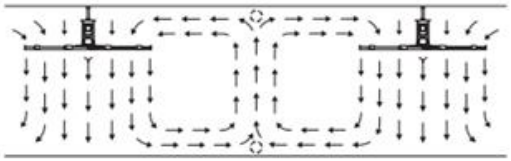
Airflow in an enclosed area

The floor jet radiates outward until it reaches the walls, which deflect the jet upward. After it hits the ceiling, the upward flow is directed inward to the low pressure area above the fan where it is then pulled down toward the floor. This creates a convection-like air current that gathers momentum. Once this current is established, the fan begins to move air outside the current, escalating its cooling effects.



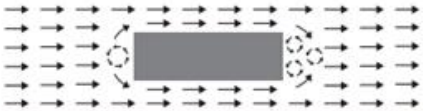
Airflow with multiple fans

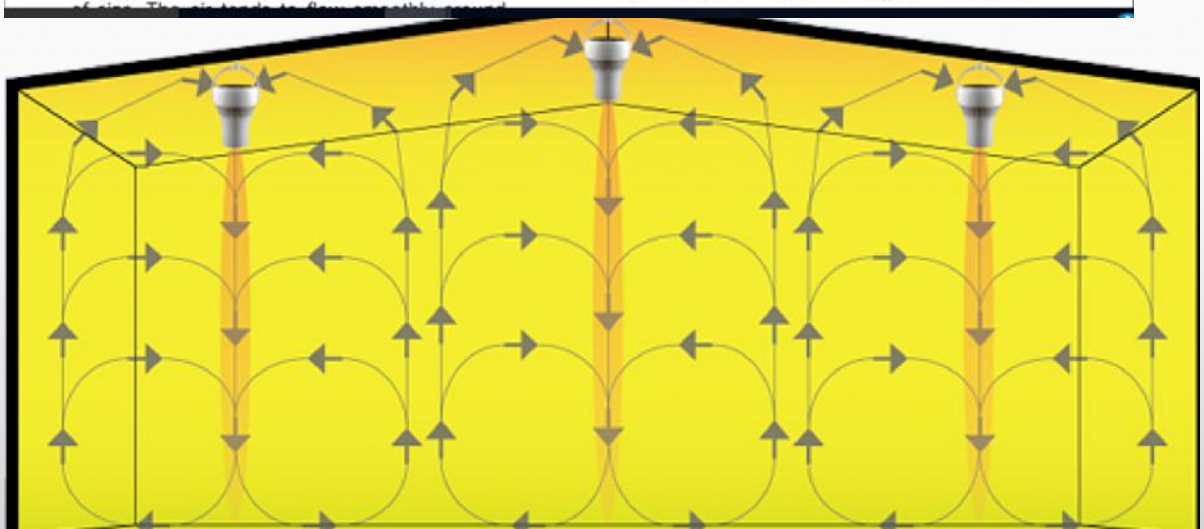
Where there are multiple fans appropriately spaced, the expanding jets of adjacent fans meet to create a pressure zone. The pressure zone acts like a wall, causing each fan to behave like a single enclosed fan. Typically, a single fan's performance will increase when working in conjunction with other fans.



Airflow with streamlined obstruction

Obstructions on the floor tend to block the horizontally moving air. Thin or streamlined obstructions do not block much airflow, regardless





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DFO Direct Factory Outlets

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TASMANIA

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HUNTER
MOTOR GROUP

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Colonial
First State

STARTRACK

BAKER HUGHES

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PERFECTION Fresh
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complete home and building

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Dairy Products
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on the Farm

Saint Stephen's College

Hilton Brown
SWIMMING
Where everyone learns to swim!

HALL & PRIOR
Health & Aged Care Group

Sanderson
GROUP

Sydney Girls High School

Mould Pro

The new Q50, ‘Eyeball’ and ‘Duckbill’!

SCEGGS Darlinghurst

Velocity at floor level using Air Pears

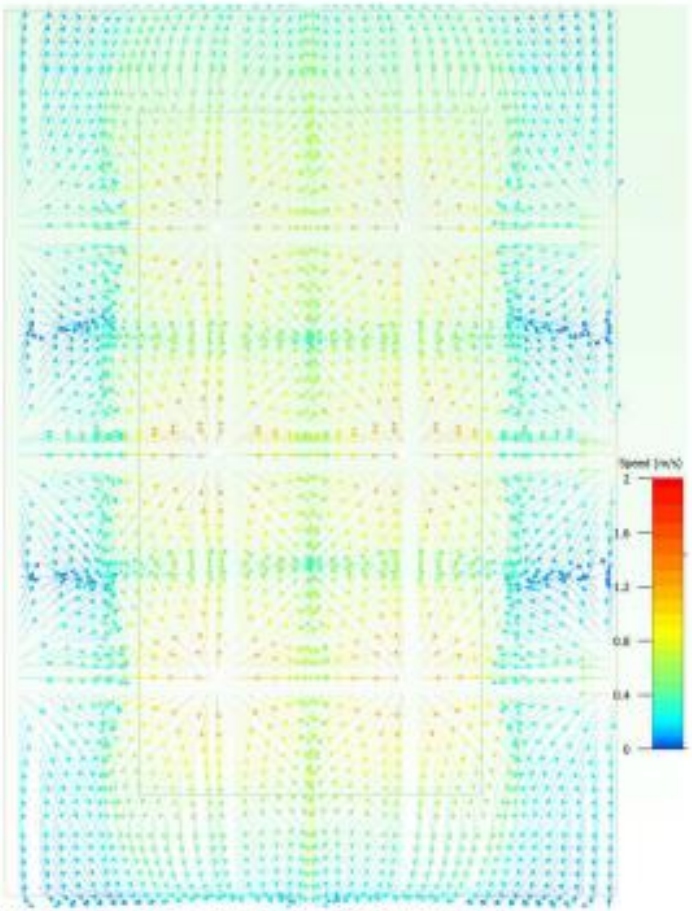


Figure 7 Velocity vectors on a horizontal plane 300mm affl

Figure 6 and Figure 7 show the velocity contours and vectors on a horizontal plane 300mm above floor level. As can be seen, there is significant air movement across the floor resulting in velocities ranging from 1.3m/s to 0.7m/s.

St Stephens College, Gold Coast

Indoor Pools

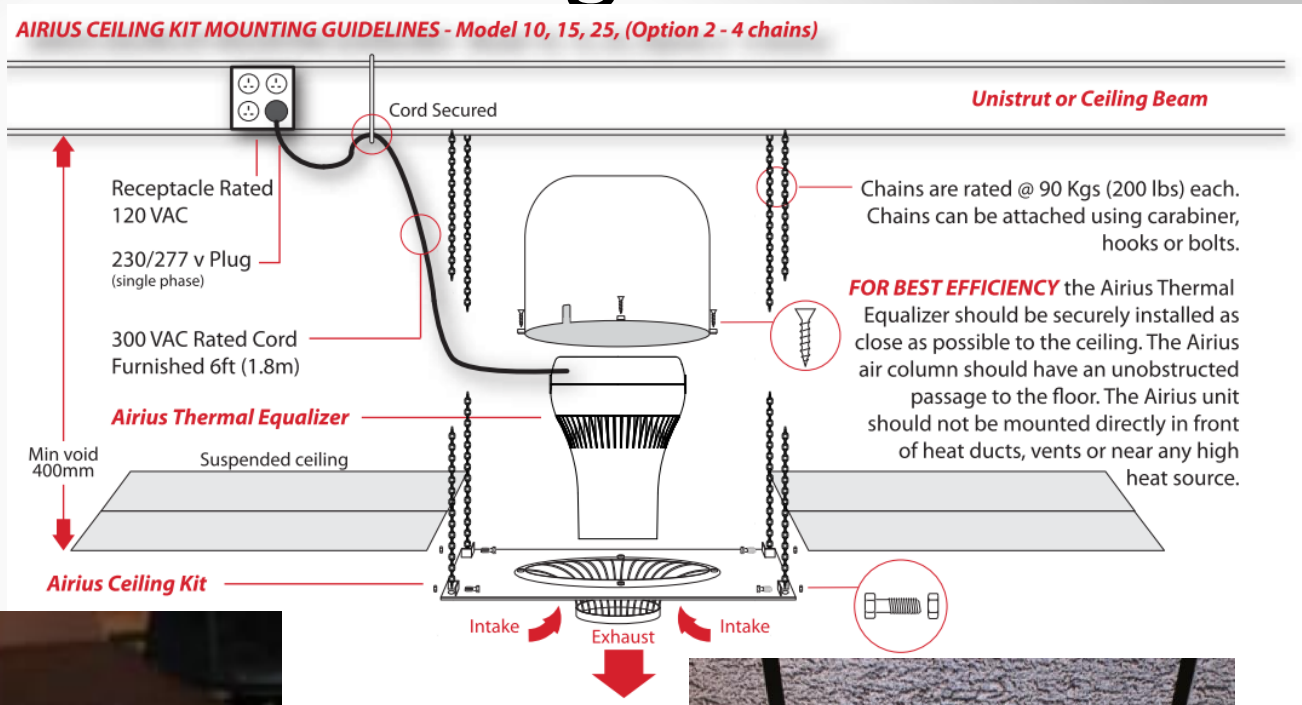
Melbourne house-Designer Series

Caloundra YMCA

Education Office Building

Coles

How the ceiling kit works



Tyco Warehouse Western Sydney

Horizontal Air Movement- SCEGGS NSW

The new ‘Eyeball’ at 6 metres

Australian Schools

St Johns Dubbo

St Thomas Aquinas Bowral

‘The domestic unit is fantastic!’

Andrew Sypkens, Architect

Other Applications

Offices

Theatres

Very, very large spaces !

Webstar Printers; NSW –Carpark Ventilation ?

Walter Pierce Pavilion; Rockhampton

QV Museum, Launceston.

Boathouse Tavern Coomera

Armadale Arena – 1,100 sq mts 4 fans only!

The new G400 EC Sapphire Plus

How strong are the competitors?

The original patented Air Pears

- From 2.5 -39 metres high
- 100% designed and manufactured in USA
- Millions spent on product development
- 50 Years old private company
- 14 years in production
- 130,000+ sold worldwide
- No maintenance
- Lightweight
- Fully patented worldwide
- Fully recyclable components
- Rebuildable
- Extremely low energy usage
- Gentle non turbulent directional air flow
- No exposed blades
- No strobing
- Simple to install into any building
- Horizontal or vertical applications
- 5 year manufacturers warranty and subsequent 5 year half ***new*** price rebuild warranty
- 90 day no question asked refund policy
- Minimal running costs (from $14 pa running 24/7)

9 Questions for you to answer

1. What do you consider are the key issues raised by the presenters and the discussion?
2. What in the presentation challenged you to think about architecture and its practice differently?
3. What did you learn from the presentation/discussion?
4. What impact will the material raised in the session have on your work place and the future practice of architecture?
5. What temperature reduction perception (in Degrees C) does 3m/s of air flow provide?
6. How does destratifying a building save winter heating energy?
7. What are the 4 main parameters that influence thermal comfort?
8. In the Sydney climate, what percentage of cooling air conditioning energy can be saved by implementing destratification if there is a 2 degree C temperature difference from floor to ceiling ?
9. How can controlled and directional air flow improve the cooling performance of naturally ventilated buildings?