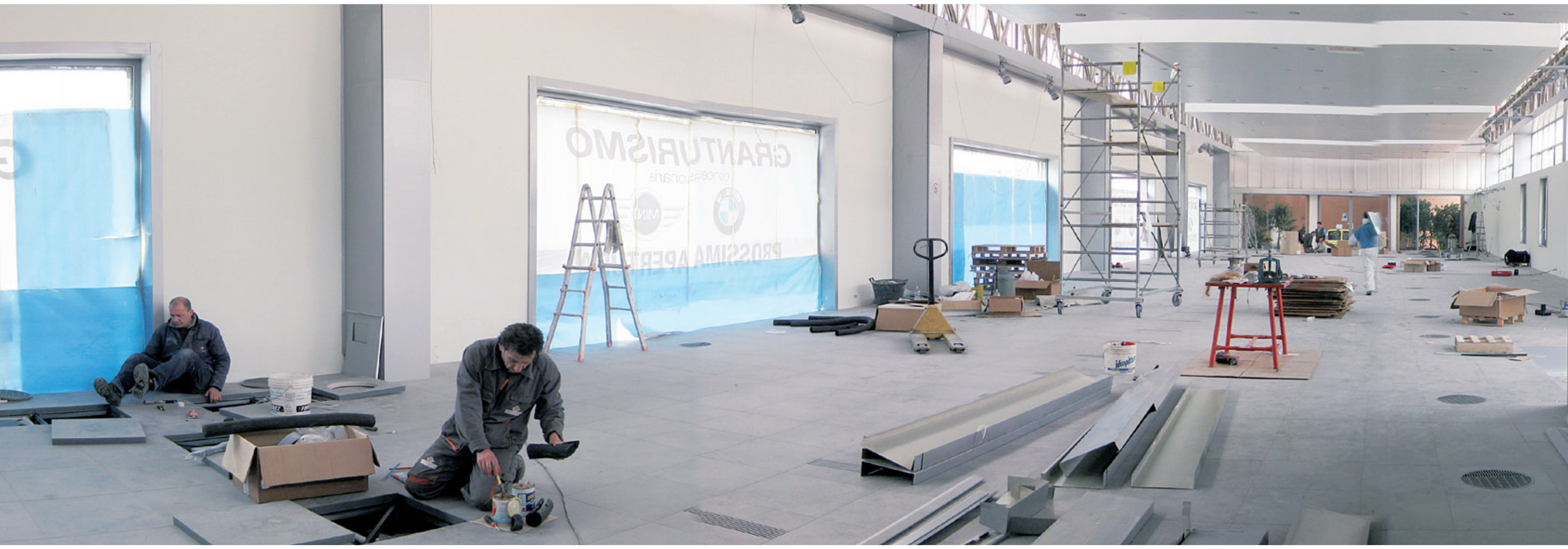

Underfloor air distribution in an office space

Underfloor Air Distribution

By Alberto Caporali
Head, Access Floor and UFAD Solutions
Schneider Electric, Conselve, Italy

and

Pankaj Pathak
Cooling Application Engineering Manager, Asia-Pacific and Japan
Schneider Electric, Mumbai

Abstract

Sustainability and energy efficiency are becoming the key considerations in architectural design. Architects and engineers face a new challenge in combining aesthetics, functionality and technology to match the multiple values demanded by customers. They are helped by the new set of standards and regulations, but they increasingly need integrated solutions. Underfloor Air Distribution (UFAD) systems offer one such solution.

The Asia Pacific region, a pioneer in UFAD, has over 72% of the world's UFAD systems, according to the 2014 IAQ report of Navigant Research. The compounded average growth rate (CAGR) in the region is expected to be 7.2% till 2020.

Introduction

HVAC is ranked as the highest guzzler of energy, and 50% of this energy is related to central air conditioning of public spaces, offices and educational and healthcare facilities. A huge amount of energy is often wasted for extra cooling, which is, at the same time, uncomfortable for occupants.

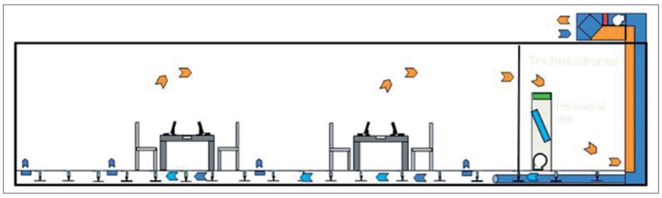

Figure 1: Operation of a UFAD system

Underfloor Air Distribution (UFAD), an application of displacement ventilation (slow speed of air moving from the floor to the ceiling) that uses a raised floor as a plenum for distributing air in the occupied space, is an effective technology to save energy by avoiding overcooling. *Figure 1* shows the operation of a UFAD system in an office.

The system is based on central high energy-efficiency air conditioning units combined with underfloor variable air volume devices that provide cooling in specific areas. The raised modular floor is used to distribute the conditioned and filtered air throughout the space. A series of air terminal units, replacing 600x600 mm floor panels (see *Figure 2*), provide the environmental control required by each occupant (see *Figure 3*), and in case of changes in layout they can be simply unplugged and relocated as required.

About the Author

Alberto Caporali leads the Schneider Electric Access Floor and UFAD solutions. Based out of Conselve, Italy where the access floor factory is located, he has 20 years of experience in automation, energy efficiency and project management. He works towards tight collaboration among final user, consultant, HR manager, architect, engineering team and technical partners.

Pankaj Pathak is an M. Tech from IIT Bombay with specialization in air conditioning. He has about two decades of industry experience in HVAC. Currently he is handling Cooling Application Engineering for Asia-Pacific and Japan region for Schneider Electric.

Figure 2: Air terminal units replace floor panels

Figure 3: Individual environmental control for each occupant

Advantages of UFAD

Lower Slab-to-Slab Height

The slab-to-slab height of the floors is reduced due to the fact that the sum of the raised floor height and the minimum false ceiling depth with a UFAD system is about 25% less than the height of a conventional false ceiling with overhead AC air distribution ducts. This allows additional floors within the same building height, or a lower building height for a given number of floors. Either way, it serves the interest of the building owner and investors.

Efficient Air Management – Energy Saving

Compared to traditional overhead air distribution, UFAD systems use air more efficiently and only where needed (see *Figure 4*). Occupants are interested in a comfortable environment only within the occupancy zone, which is up to 7ft in height. They are not interested in room conditions at the top of the room. In a modern space of about 9ft height, a UFAD system takes care of 70-75% of the vertical space, while the remaining 25-30% does not need temperature control. This ratio becomes more pronounced in case of high ceiling spaces like auditoriums, receptions, control rooms and retail spaces. An overhead air distribution system in a space of 20ft height cools three times more volume than a UFAD system. Moreover, the traditional overhead air distribution needs

Figure 4: UFAD brings about efficient air management

high capacity and air speed to reach the occupants furthest from the air discharge, often resulting in uncomfortable cold air drafts hitting the occupants' neck and shoulders. In addition, in a traditional overhead system, part of the cooled air blown from the diffusers is immediately sucked back into the return system and never reaches the occupants. This is an additional waste of energy that is avoided in a UFAD system.

Case Study

Efficient air management in a UFAD system allows downsizing the equipment and its efficient use. *Table 1* shows the real case study of a building in Korea.

In the UFAD solution, the design thermal load has been reduced up to 19% with the consequent downsize of cooling units. Design temperatures are higher than in the traditional approach, and combined with lesser volume, this has allowed 21% energy saving keeping the same room temperature.

Thus, UFAD design approach allows a benefit both in capex and opex for an overall improvement in total cost of ownership (TCO) compared to traditional design guidelines.

Better Air Quality

What makes UFAD technology particularly attractive is that these significant savings are achieved with improved occupant comfort. In fact, the slow speed of air moving from the floor to the ceiling follows the natural convection flow of body and computer heat, taking away pollution, carbon dioxide, humidity and heat. The result is clean air with no perception of uncomfortable cold drafts on the body. A good and healthy working environment improves people productivity and work satisfaction and results in positive behavior – parameters that HR directors value. Energy saving and higher comfort earn higher LEED points, too.

Space Flexibility

An important parameter in addition to energy saving and comfort is space flexibility. Unlike an overhead system where air ducts have a fixed footprint, any change in a UFAD system is possible with minimum effort and cost, by just moving either the air diffuser or the ventilation tile to a different position (see *Figure 5*). There are no limits in redesigning the space, moving people, reorganizing or even partitioning the space for different renting

Table 1: Comparison of conventional and UFAD systems

				UFAD Design			Hypothesis for conventional design			
					Surface thermal load	Note	Specific thermal load	Surface	Themal load	Note
				Sqft	TR	design comparison with conventional design	TR	Sqft	TR	
				193750	323	-19%	Sqft / TR: 400 to 600	198465	397	According to Reliance info
	Item	Model	Specific power consumption kW	Nr	Total power consumption kW	Note	Specific power consumption kW	Nr	Total power consumption kW	Note
Cooling capacity	Booster	UTCT	0	1598	0			0		
	Cooling unit	TDCV2000A	29	8	232	Downflow units with 20Pa ESP. Chilled water in/out temp : 10/15°C. Supply air temp: 12-14°C. Room temp: 24°C/50%.	33	8	264	Upflow units with 100Pa ESP. Chilled water in/out temp : 8/14°C. Supply air temp: 11-12°C. Room temp: 24°C/50%.
	Cooling unit	TDCV2700A	35	17	595		44	17	748	
	Cooling unit	TDCV3400A	44	7	308		58	7	406	
	Chiller	BCWC	570	2	1140		710	2	1420	
Power consumption	Booster	UTCT	0.018	1598	29	3rd speed on 10		0		
	Cooling unit	TDCV2000A	0.5	8	4	Downflow units with 20Pa ESP. Chilled water in/out temp : 10/15°C. Supply air temp: 12-14°C. Room temp: 24°C/50%.	1	8	8	Upflow units with 100Pa ESP. Chilled water in/out temp : 8/14°C. Supply air temp: 11-12°C. Room temp: 24°C/50%.
	Cooling unit	TDCV2700A	0.5	17	9		1.2	17	20.4	
	Cooling unit	TDCV3400A	0.76	7	5		1.8	7	12.6	
	Chiller	BCWC	104	2	208	Chillers have not been provided by SE. Data refer to equivalent SE model: BCWC0630A	133	2	266	Chillers have not been provided by SE. Data refer to equivalent SE model (larger model): BCWC0950A
Power consumption		**total**			**255**				**307**	
		delta			**-21%**					
Annual saving with energy cost 0,1€/kW					**-45916**					

Notes: • *AHUs were not part of the scope of the project • Cooling tower and pumps are not included • Model numbers refer to Schneider Electric equipment*

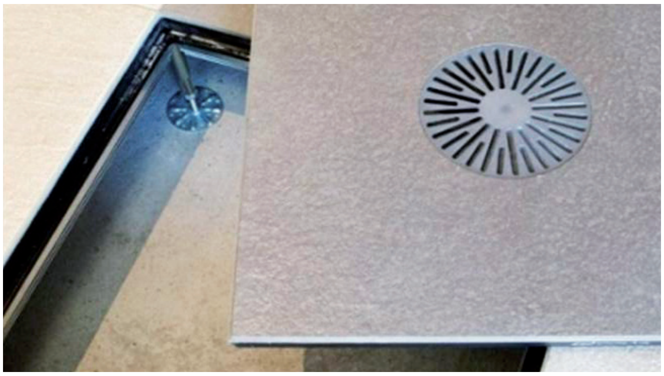

Figure 5: UFAD provides space flexibility

continued on page 64

continued from page 62

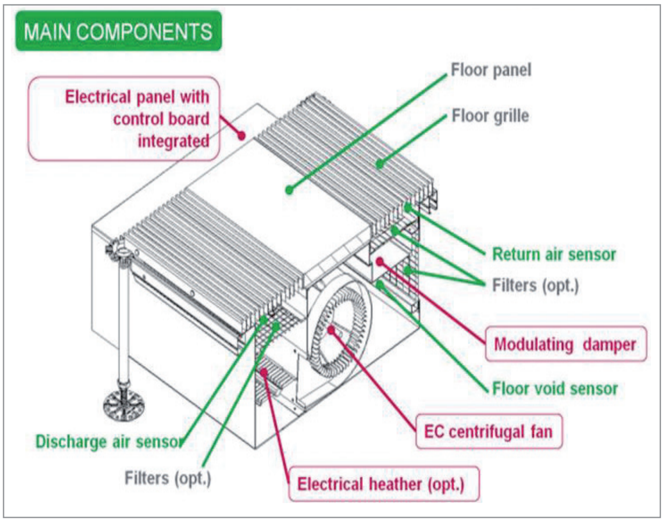

Figure 6: Independent perimeter cooling unit and its main components

polices. This enables an agile response to changing business dynamics.

Independent Temperature Control

UFAD makes it possible to design flexible systems, where different areas can be independently temperature-controlled. In comparison, overhead air distribution systems suffer the limitation of a fixed set temperature everywhere, resulting in most of the zones being too cold for occupant comfort and a huge waste of energy.

Independent Perimeter Cooling Units

Advanced UFAD systems have independent perimeter cooling units (see *Figure 6*), which enable temperature adjustment of individual zones using variable speed fan technology, three-way valve driven by a modulating servo-motor to control the cold and hot water and an advanced microprocessor control.

Conclusion

Developed in the 1980s in South Africa, Japan and Germany, UFAD is one of the most promising solutions that combines sustainability, comfort, energy saving and architectural requirements. UFAD is commonly acknowledged to bring capex and opex savings.