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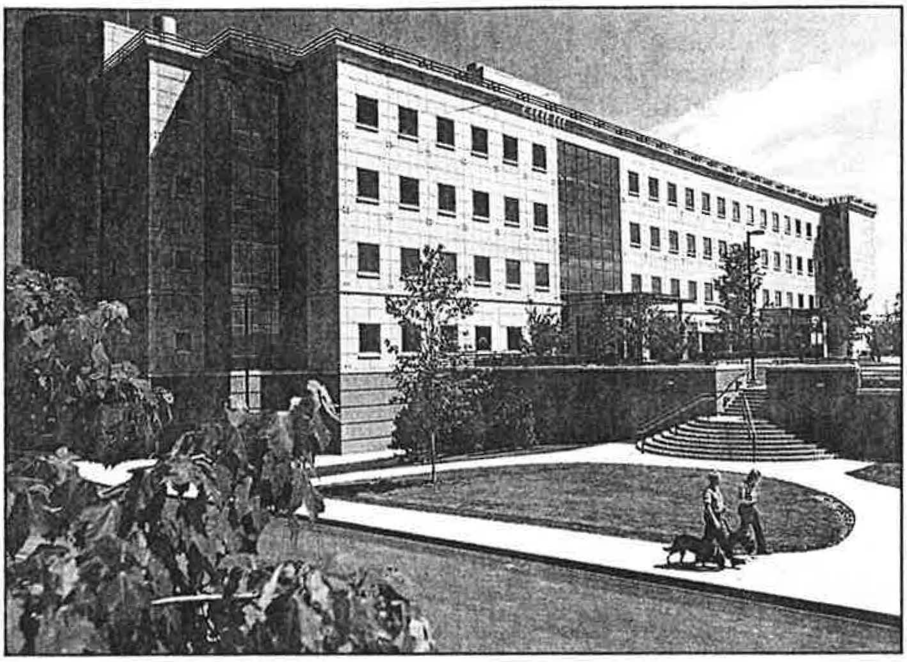

An exterior view of the Vet Medical Center at Cornell University.

Innovative Ventilation System For Animal Anatomy Laboratory

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A unique ventilation system was designed and built to reduce formaldehyde fumes in the large animal anatomy lab at the Vet Medical Center at Cornell University. The laboratory includes four rooms totaling 5,500 ft^2 (5 110 m^2). The main room has 2,300 ft^2 (214 m^2) and houses the laboratory where up to 60 students dissect as many as 12 horses at a time. Other rooms are a cold storage locker, an animal preparation room and a smaller lab for specialized instruction.

The large animal anatomy laboratory has a history of air quality complaints despite a fairly high ventilation rate of over 10 air changes/hour. The horses are embalmed, creating a volumous source of formaldehyde and phenol vapors. Budget constraints and increasingly stringent exposure limits for formaldehyde presented a great challenge to design a ventilation system that yields acceptable air quality. The design solution included two innovative elements: air-to-air heat recovery, and focused ventilation.

Design Solution

Typically, air quality in a laboratory environment is maintained by containment of hazardous fumes. Gases generated by laboratory processes are collected in exhaust hoods and canopies, and removed from the room. When a process is too large to enclose the source under a hood, then bulk ventilation must be used through the room so that the source, when diluted with ventilation air, results in a steady state concentration that is below acceptable limits. The negative side of this is the cost of energy to heat and cool this outside air, and the drafts caused by introducing this rate of air

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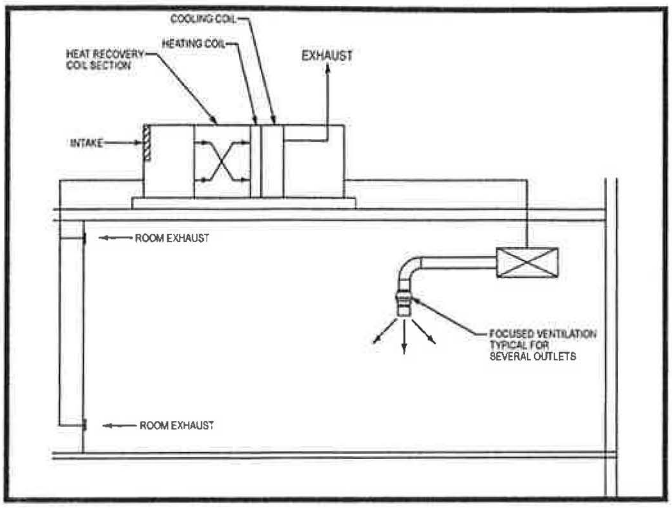
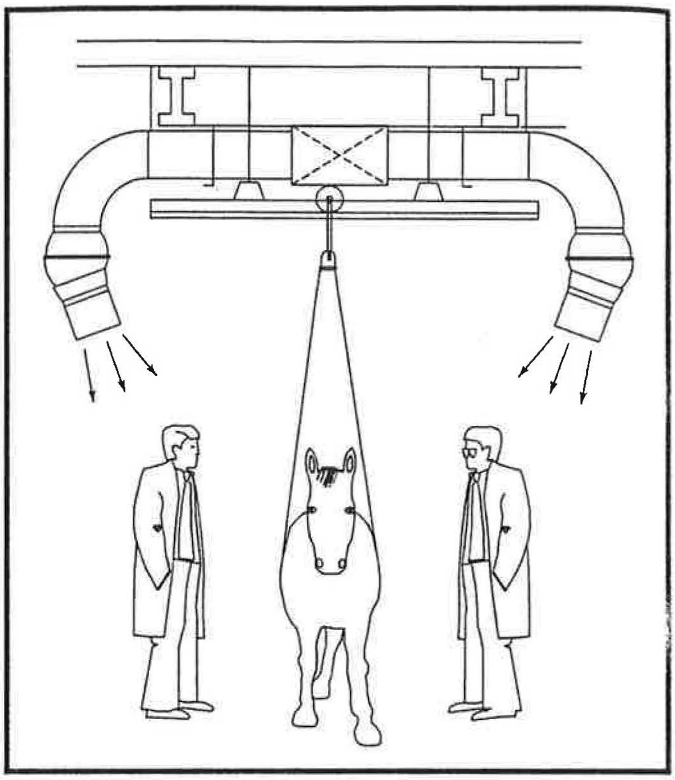


Systems incorporates two innovative elements: Air-to-air heat recovery, and focused ventilation.



Nozzles, similar in function to those found on airplanes, focus fresh air on the students who are working on the horse.

into a room. In the past, this anatomy lab has operated with ten air changes per hour, yet personal exposures were, at the worst, a factor of three above the desired limit. It would be impractical to increase the airflow through the room enough to mix these vapors to acceptable levels.

We also considered containment using exhaust canopies over the animals and determined this was not practical due to the size of the horses and the need to keep the room clear to see demonstrations in the front. In addition, canopies large enough to enclose a horse would require a tremendous ventilation rate to ensure proper containment of fumes. Flexibility is also an issue as the lab is used to dissect various large and small animals.

The solution was the use of focused ventilation by directing uncontaminated ventilation air directly on the student teams in the space. While concentrations of formaldehyde will be high in some parts of the room, air quality at the breathing zone of the students will be very good. Our solution was facilitated by the relatively fixed geometry of the room. All horses are suspended from an overhead track system and location of the horse during the lab session is known. A team of four students works on each side of the animal. Ventilation is supplied through an overhead duct system and the air outlets are adjustable "eyeballs" - similar in function to the air vents on airplanes. These vents are 6 in. (15 cm) in diameter, however, and are focused to cover the student team in fresh air. Air monitors outside the wash of the focused ventilation confirm that the bulk concentration of formaldehyde in the room is still high yet monitors worn by students during dissections show acceptable exposure that is lower than the general level in the room.

Energy Efficiency

This system is highly efficient compared to conventional ventilation for two reasons: 1) the scheme of focused ventilation allows outside airflows much lower than would be required for bulk dilution, 2) air that is used for ventilation is introduced through a heat recovery unit. As a result this system operates with 10% of the energy consumption of a conventional bulk ventilation system.

In the course of design, several other large veterinary schools were contacted. Most said that they also had air quality problems in their anatomy laboratories. The few that felt air quality was acceptable had new facilities and very high ventilation rates. Let's contrast these labs to the solution applied.

The conventional anatomy laboratory may have a bulk ventilation rate of 30-40 air changes/hour. In a climate with 7,000 heating degree days this represents a heating load of 1 million btu/ft^2/yr (11 360 000 kJ/m^2/yr). The proposed solution maintains acceptable student exposures with a bulk ventilation rate of only 12 air changes/hr. If outside air is introduced using a heat recovery unit with 75% effectiveness, the energy consumption is only 90,000 btu/ft^2/yr (1 022 400 kJ/m^2/yr) in the same climate.

Construction of the ventilation system to serve the large animal anatomy laboratory and four auxiliary rooms cost $90,000, and will cost about $1,000 per year to operate. An alternative system to ventilate the room through a bulk ventilation rate of 35 air changes would have cost about $150,000 to build and $12,000/year to operate, if it did not include heat recovery. The design solution resulted in a first cost savings of $60,000 and an annual savings of $11,000. For a 20-year system life and 5% internal rate of return (IRR), this solution has resulted in a present value of $180,000 in savings over a conventional system.

Indoor Air Quality

Formaldehyde is recognized as a problem agent in indoor air quality. In this lab, gallons of the formaldehyde/phenol solution drain from the animals and are available for evaporation. Prior to design and installation of this system, student exposures were monitored and found to be as high as 2.6 ppm averaged over a 2-hour lab period. This is significantly above current OSHA permissible exposure limits.

High student exposures prompted the university to consider several changes. The use of a single animal to be dissected by the professor, it was felt, would not provide the quality of training that future veterinarians needed. Personal protective equipment (PPE) was considered and rejected as it would require each student to be part of a monitoring program. It also was feared that students would avoid using the respirators.

It was apparent that the solution to this problem would need to be a combination of changes to laboratory practices and a creative ventilation system.

Several operational changes were implemented: concentration of the embalming fluid was reduced; animals were predrained before students entered; and more effort was made to keep the animals covered.

The combined result of these changes and focused ventilation was extraordinary. Exposures for students during the same operation a year later were less than .2 ppm. This was a 90% reduction in formaldehyde exposure among students. All exposures were measured in the breathing zones of the student in accordance with the OSHA 52 method for formaldehyde in which students wore powered filters for the two-hour lab period.

Summary

This ventilation system was placed in service in 1993 and has operated well through six semesters of teaching. Students' exposures to formaldehyde have been monitored each semster and the results have been a tremendous improvement.

There are only a handful of veterinary schools in the country, and the uses of this specific system are, limited. The concept of focused ventilation, however, has potential for many research and industrial applications. Many industrial operations use volatile contaminants that cannot be contained in hoods or under canopies. Similarly, in teaching it is common to demonstrate a process to a group of students who must be able to gather around and view the operation. In these instances and many others where containment of vapors is not practical, the concept of focused ventilation might provide an answer. ■

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