

BACK TO NATURE

The Biowall returns clean air to commercial spaces.

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Dr. Alan Darlington, an adjunct biology professor and research scientist from the University of Guelph, stands proudly beside his booth at IDEX/NEOCON 2003, Toronto's fashionable interior design show. Darlington never thought his career as a world expert in air filtration would lead him here. But, as President and CEO of the two-year-old company, Air Quality Solutions (AQS), he has a product that fits right into interior design's new thinking about greening the corporate landscape. The product is a botanical biofilter, or Biowall, modeled on the principles of nature. The technology has transferred well from the laboratory to the market, although Darlington's business model is still evolving.

Designing Better Air

Air Quality Solutions was incorporated in 2001 as a research-based firm with a primary business focus of providing alternative methods to maintain indoor air quality. The technology that AQS is initially marketing as a modular botanical biofilter can be used as an alternative or a supplement to an existing ventilation system. Instead of introducing outdoor air to replace stale indoor

air, the AQS biofilter rejuvenates or cleans the indoor air so that it can be re-circulated and used over and over again. Because the air does not have to be conditioned for temperature (that is, heated or cooled), this product has the potential to save energy and reduce energy costs for its users, as well as reducing greenhouse gas emissions to the environment.

Botanical biofiltration of indoor air is

based on the principles of *phytoremediation*, which uses the natural ability of plants to break down and/or absorb pollutants.

The operation of a biofilter is quite simple. Fans draw air from the surrounding space into a wet, typically moss-covered biomass plenum, or layer, that makes up the vertical surface of the biofilter. Each biofilter is composed of three separate plena. The flow rate of each can be controlled separately by independent fan systems. As the air-borne contaminants flow over the wet biomass, the material partitions itself from the air and into the aqueous phase. Green plants cover the wet biomass. Although the plants are involved in the removal of some pollutants (eg. carbon dioxide), most of the degradation is microbial in origin.

Balancing Life Forms

The prototype for the biofilter or "Breathing Wall System" dates back to the Canada Life Environmental Room Project started in 1994. Darlington was one of the principal researchers in the project which installed an early version of an indoor air biofilter in a conference room of the Canada Life Building in Toronto. In a four week test period, researchers, including Alan Darlington, subjected the Breathing Wall to high levels of three volatile organic compounds (VOC's) that are common indoor air pollutants: formaldehyde, toluene, and trichloroethylene. The system easily removed all the formaldehyde, almost all the toluene and variable amounts of the trichloroethylene.

As Alan Darlington notes, "Overall, the system is performing well. The key to success is finding the right balance of life forms for each installation. This is one of the main challenges from a design perspective. Once that is achieved, a system like this will take care of itself."

"Ninety percent of the plants we use are standard horticultural products," explains Darlington. A variety of plants are selected because, for example, if only orchids were used, and the unit contracted an orchid disease, the system could be threatened. So far the plants used by AQS are sourced from suppliers, but Darlington hopes to grow his own in future.

Vertical Hydroponics

To date, the primary market driver for AQS has been the public concern about indoor air quality (see sidebar p. 19). AQS's marketing efforts, therefore, have focused on the firm's ability to deliver good quality air and maintain a healthy indoor environment. AQS's marketing of the botanical biofilter has also highlighted its aesthetic



A cross-section of the biofilter by Air Quality Solutions.

benefits. As Alan Darlington explains, "Most people like plants and, in terms of price, a biofilter system is comparable with other forms of indoor landscaping for commercial space. This is a value added product. The biofilter allows (people) to rationalize the presence of plants in an office environment."

Think of the system as vertical hydroponics. Each Biowall is customized to the client's specific needs and environment. So far, most installations have been for large institutional buildings or condominiums where a maintenance service is offered as well.

The largest installation that the company has undertaken so far is a dramatic Biowall for the atrium of the new University of Guelph-Humber building on Humber College Boulevard in Toronto (see p.17). Guelph-Humber is an innovative new educational initiative which builds on the combined strengths of two established Ontario academic institutions, the University of Guelph and Humber College. Since the site for the new venture is adjacent to the Humber College campus, the faculty were seeking a way to represent the academic and research credentials of Guelph in the new facility. As a product of Guelph research, Alan Darlington's Biowall was the perfect icon to install. In this case, the product will not only function as an environmental test case and indoor air purifier for this state-of-the-art institutional facility, but it will also serve to remind the building's occupants and visitors of the University of Guelph's stellar role in academic research and the commercialization of innovation.

"The living wall not only represents the University of Guelph's rural roots in an urban setting," explains Guelph-Humber Vice Provost, Michael Nightingale, it also highlights the kind of leading-edge research being conducted at Guelph."

Product Focus

AQS's commitment to sustainability is also reflected in a lean business structure. A small staff work on R&D, business development, marketing and the technology of indoor air quality management (the AQS core competencies) in house. Ancillary functions like financial and legal services are handled off-site at a lower overall cost to the company. AQS has no factory, and no warehouse of standing inventory. Each biofilter is designed to meet the air quality needs and the aesthetic expectations of the client. Alan Darlington estimates that

seventy per cent of his time is devoted to product design, including associated research.

Applications

The Contained Environment Systems Research Centre at the University of Guelph has been a world leader in exploring and developing the applications of botanical biofiltration to air systems and has worked closely with NASA in researching the continuous recycling and cleaning of air for aerospace applications.

At the heart of Alan Darlington's research and all the applied technologies involving botanical biofiltration is the fact that living plants carry out many chemical reactions energized by sunlight which can metabolize or mineralize inorganic and organic molecules. They are further assisted in the process by microorganisms and bacteria present with the plants. The notion of using plants to filter or clean soil, water and air is simply a process that occurs naturally every day. Following nature's lead in this way has been referred to as biomimicry by author Janine Benyus in her seminal book, *Biomimicry: Innovation Inspired by Nature*.

To date, the applications for the AQS Biowall have been mostly limited to commercial facilities and large condominiums that can afford the installation and maintenance costs. But, what kind of plants does Dr. Darlington recommend to remove air pollutants in the home?

"The type of plant doesn't really matter," he says cryptically, "because it's the soil and the pot that do most of the work."

Healthy Returns

Air Quality Solutions Ltd. has adopted a business model not unlike that described in the principles of Natural Capitalism: what is good for the environment is, ultimately, good for the company's bottom line. The linkages between indoor air quality and health care costs are becoming clearer, and the need for alternatives to reduce greenhouse gas emissions is becoming more urgent. And so the demand for the expertise and the products being conceived by research-focused entrepreneurs like Alan Darlington and his staff will continue to grow both in Canada and abroad. As a corporate entity, AQS is primed for success in the global economy of the 21st century. ●

Sick Building Syndrome

North Americans spend approximately 90% of their time indoors. Indoor air can have, on average, 2 to 5 times, but as much as 100 times the concentration of air contaminants as outdoor air. In fact, indoor air quality has become such a concern that the United States Environmental Protection Agency (USEPA) has declared it one of its top five public health concerns. (USEPA, 1994)

Recent U.S. studies have clearly linked worker productivity to indoor environmental quality. Studies documenting the impacts of Sick Building Syndrome (SBS) and Building-Related Illnesses have clearly shown the economic costs associated with not maintaining indoor environmental quality, specifically, indoor air quality. The USEPA estimates that in the U.S. each year indoor air pollution is responsible for over \$1 billion in medical care for major illnesses, \$4.7 to \$5.4 billion in productivity losses associated with major illnesses, and as much as \$60 billion in productivity losses on the job from increased leave times. (USEPA, 1994) This has fuelled a growing market demand for healthier indoor air, to which developers, builders, building owners and managers, and manufacturers are now beginning to respond.

How is the quality of indoor air maintained? Traditional ventilation systems in buildings utilize "dilution" as the principle method to maintain indoor air quality. Stale indoor air is vented outside and replaced by imported outdoor air. The problem in congested urban centres is that the outdoor air may be of poorer quality than the indoor air. In that case, the ventilation system is simply exchanging one pollutant for another. Also, before it is circulated, outdoor air needs to be "conditioned"; either heated, or cooled or humidified. This process is energy-intensive, with conventional ventilation systems accounting for 60% or more of a building's total energy demand. Since the energy crisis of the early 1970's, buildings have been more tightly sealed to reduce energy leakages. This can cause a build-up of indoor air pollutants, thereby exacerbating indoor air quality problems. Conventional ventilation systems, in many cases, are no longer cost-effective, and are not environmentally sustainable.