

**NCR101 Committee on Controlled Environment Technology and Use
2003 Annual Meeting
University of Guelph, Controlled Environment Systems Research Facility
Guelph, Ontario, Canada, April 26 – 29, 2003**

Station Report

**Greenhouse Engineering
Division of Alex Turkewitsch, P.Eng. Ltd.**

Company Profile

Greenhouse Engineering is a Canadian company specializing in engineering services for commercial, institutional, and research greenhouse facilities. Greenhouse Engineering offers services ranging from planning, feasibility studies, greenhouse and growth facility specialist consulting, and design/build systems.

Our international client list includes architects, greenhouse operators, manufacturers, institutions, governments, research organizations, universities, and bio-technology companies. We design a wide variety of greenhouse facilities, ranging from plant production blocks, garden centers, shade houses and lath houses, compartmentalized research greenhouses, conservatories and custom structures. Growth chamber facility design, including facility layout, service requirements, automated irrigation systems and containment considerations is also offered.

Our professional design services include structure and cladding, mechanical, electrical and control systems, lighting, shading, cooling, fogging, irrigation, and mechanization. Greenhouse Engineering is also called upon to perform inspections, project management, and engineering evaluations.

The Year in Review

Highlights of 2002 entail the successful completion of several research greenhouse projects, including the University of Toronto rooftop research greenhouse facility for the Department of Botany, the University of Texas field research station at the College of Natural Sciences in Austin, TX, and the Biology Department Greenhouse and Growth Chamber facility at York University, in Toronto.

Ongoing projects are the extensive renovations and updates at the McGill University Phytotron, University of Guelph New Science Complex (rooftop research greenhouse and growth chamber facility), University of Pennsylvania Life Sciences Quad (new rooftop research greenhouses and temporary greenhouse facilities for the transition period), University of Florida at Gainesville (new science building rooftop greenhouses and growth chamber facilities), the new Science Building at the University of California at Davis CA (rooftop greenhouse facility), Washington College new Biology Department greenhouse in MD and the relocation of the historic conservatory from its original 1932 site at the University of Toronto to the City of Toronto park at Allan Gardens.

New Trends in Research Greenhouses and Controlled Environment Facilities

New terminology, new requirements, new ways of thinking and new challenges to the design community have become increasingly apparent during 2002. Some of the new terms are: "molecular farming", "containment" and its complement, "exclusion", "uniformity and repeatability". These are obviously not new terms, but have gained new meaning and weight. The new requirements go hand-in-hand with the new terms – better control of temperature, humidity, CO₂, light and light quality, nutrients – better containment and/or exclusion of pests, contaminants, plant material and unwanted or unexpected visitors and improved uniformity in space and time of controlled parameters.

Molecular farming using greenhouses and other controlled environments for plant growth remains an intriguing but seminal business. There are some big opportunities here but also challenges. This field will develop over the next decade, at best.

Containment and exclusion are a part of the molecular farming task but also important in research greenhouses in general. Since the greenhouse is both the containment (or exclusion) barrier as well as the building envelope, it poses unique challenges when considering wind loads on the various surfaces, pressure differentials in link houses,

corridors and vestibules and use of natural ventilation techniques such as ridge and side vents, swamp coolers, fan and pad cooling systems and positive pressure ventilation fans. Other situations where containment or exclusion are required involve spaces within buildings that are buffered from the immediate weather conditions. With greenhouses, there is only the thin skin of glass or polymer that separates the controlled space from the great outdoors.

Similar challenges arise when we try to improve uniformity and repeatability of the environment within the greenhouse, due to the intimate coupling of the greenhouse environment with the changeable external weather conditions. Terms such as "turn down ratio" and "response time constant" are used when describing control of heating systems, environmental zone sensors, fog humidification systems, cooling systems and other controlled environment parameters. These parameters are driven to extremes when the equipment is asked to compensate for rapidly and widely varying external conditions.

Controlled environment facilities are being designed to suit the purpose as opposed to being intended for general use. Isolation suites, located at the extremities of the facility to reduce passing traffic, air conditioned zones, high light compartments, substrate controlled zones are some of the design challenges we have tackled in the past year. We anticipate this trend to specialization to increase in the coming years.

Cooperative Alliances

Over the past two years, Greenhouse Engineering has developed alliances with two consulting firms in complementary and related fields of practice. One of these is Montgomery Smith Inc., of Burlington, KY, headed by Jim Smith. Jim works extensively for conservatories, arboreta, botanical gardens, providing full scope design services, building evaluations, planning and advice for restorations. Our companies have collaborated on four projects over the past two years. We have also conducted four design projects in the past two years with CEA Technologies International, of Aylmer, Ontario, with agronomist Ron Evans. Ron is experienced with feasibility studies, economic analyses of greenhouse crop production systems, specialized growing systems and greenhouse technology.

Greenhouse Engineering has also been engaged over the past two years with Controlled Environments Ltd. in the development of their new CRG research greenhouse. This is a highly controlled, modular greenhouse structure that bears similarities to growth chambers in its controlled environment parameters of temperature, humidity and light in particular and the aerial and substrate environment in general. This, while being at heart a greenhouse, with the height and breadth, a shade system, overhead mobile lighting canopy, glass glazed exterior walls, aisles and corridors that distinguish this building type. We are proud to be an ongoing member of the design team, involved in the design and implementation of the structure, the shade system, the benches, the light support canopy and in contributing to the integrated design concept in general.

Next Year

If ongoing projects are any indication, research greenhouses will again pose increasing demands on us as engineers and consultants, to balance cost constraints with more stringent performance criteria. We see the balance swinging to improved performance in lieu of more space in many instances and, as such, the unit costs of research greenhouses continue to climb. As the greenhouse component of a new science building or biological research facility is typically very small, it is critical that the design task, the budget and the will on the part of all of the stakeholders take into consideration the unique and changeable nature of greenhouse engineering.

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Alex Turkewitsch, P.Eng. Ltd.

Alex Turkewitsch, P.Eng.
Mobile: (416) 318 5130

86 Glenview Avenue, Toronto, Ontario M4R 1P8, Canada
Tel: (416) 489 3816 Fax: (416) 481 3883
Alex@GreenhouseEngineering.com