Bioengineering:

New discipline at the forefront of discovery

By Alison Piper

Bioengineering is an emerging field where engineering practice and the biological sciences intersect—and where many new biotechnologies are developed and put to use. PEO is working to put it on the map as a distinct discipline of engineering.

Why is biotechnology receiving so much attention today? After all, we have used the biological processes of microorganisms for some 6000 years to make food products, such as bread and cheese. But during the 1960s and '70s, our understanding of biology reached a point where we could begin using cellular and molecular processes to solve problems and make products. Today, we know how to use cell culture technology to grow cells outside of living organisms, biosensors to identify and measure substances at extremely low concentrations, protein engineering technology to improve existing proteins and create new ones, and genetic modification technology to splice genes together.

These are just a few examples of the technologies comprising the "new biotechnology" of today—an area where business is booming. The world market for biotechnology is expected to reach $50 billion in annual sales by 2005. According to an Ernst & Young study, the Canadian biotech industry employs more than 11,000 people in over 200 firms. Its share of the world market is over $1 billion and growing.

A distinct discipline

Working on this new frontier alongside scientists, technologists and others are bioengineers. PEO recently began taking steps to recognize and define this rapidly evolving field as a distinct engineering discipline.

PEO's Bioengineering Task Group was set up in early 2000, to define the areas of practice that require the skills of a bioengineer, as well as the core body of knowledge and scopes of practice for those areas. The task group is defining what bioengineers need to know, and what they are doing with that knowledge that is within professional engineering practice, or should be.

John Runciman, PhD, P.Eng., an assistant professor at the University of Guelph's School of Engineering, who specializes in the orthopedics area of biomedical engineering, co-chairs the task group.

"Most of the people who now consider themselves to be bioengineers graduated from either mechanical, electrical or chemical engineering," says Runciman. "Yet, bioengineering is a complete area of study and distinct discipline. The time is right for PEO to define what bioengineering practice is and set up processes to regulate it—before the flock has left the barn and it becomes too late."

PEO Past President Peter DeVita, P.Eng., a member of the task group, echoes these concerns: "The Human Genome Project [which mapped the genetic blueprint of humans] has just been finished 25 years ahead of schedule. The Ontario government has committed to putting millions of dollars behind the development of biotechnology. And the forecast market for the industry is $8 billion for Ontario within this decade. If professional engineers want anything to say about this new area, we need to act now."

DeVita argues that, when new products are designed with predictable performance and for purposes useful for humans, such as food products or body part replacements, "we've gone beyond the discoveries of science, to the practice of engineering."

The task group also includes representatives of the Canadian Council of Professional Engineers, the University of Toronto's chemical engineering department and Robotics and Automation Lab, the University of Saskatchewan's agricultural and bioresource engineering department, the Bloorview MacMillan Centre in Toronto (which provides programs and conducts research involving the rehabilitation of children with disabilities) and the biotechnology industry. Experts from the University of Guelph's bioresource engineering and biochemical/food engineering departments have been invited to provide more input.

Setting the framework

To date, the task group has completed the bulk of its work and reached a consensus on what its recommendations to PEO Council should be. Scheduled to be presented to Council by August, its final report will include recommendations on the general education requirements of a bioengineer, as well as proposed course requirements for accredited undergraduate degree programs in the three areas of bioengineering practice biochemical/food, bioresource and biomedical engineering. The document will also include detailed scopes of practice and core bodies of knowledge for the three areas.

Currently, there are no undergraduate degree programs in bioengineering, as the task group has defined the term. There are a handful of specialization options offered within more traditional engineering programs at Canadian universities that cover most of the academic requirements proposed by the task group. These include options in biomedical and bioprocess engineering at the University of Guelph, biomedical and food process engineering at the University of Toronto, and agricultural and bioresource engineering at the University of Saskatchewan.

The task group used these programs as a starting point to develop proposed course requirements for accredited bioengineering programs—eventually agreeing on course lists that would be flexible enough to be relevant to all practitioners, regardless of their area of specialization.

Runciman stresses that accredited undergraduate degree programs that prepare bioengineers to work in the field will be needed, to see the discipline come into its own. He says he hopes the task group's report becomes a framework for setting up accredited programs in bioengineering, and for the academic review of PEO licence applicants working in the bioengineering field who are not graduates of accredited engineering programs.

The road ahead

DeVita notes that the task group's work is the first step in a long process involving several players. "PEO is at the centre of these activities, as it moves to establish licence requirements for a new area of practice, but PEO can't do this alone," he says. For example, engineering faculty need to agree to teach new, bioengineering programs. And PEO needs to work with the Canadian Engineering Accreditation Board, other professional engineering associations and engineering schools to develop national criteria for the accreditation of bioengineering degree programs.

There is also the issue of establishing, in law, where professional engineers must be involved in bioengineering. "We will need to work with the Ontario government to establish demand-side legislation, to ensure that only properly qualified people take responsibility for this work," DeVita says. This process would see PEO work with provincial ministries to draft new legislation specifying the types of bioengineering work for which professional engineers must be responsible in the public interest.

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Bioengineering defined

One of the task group's first jobs was to define bioengineering in concise terms, despite its complex, rapidly evolving nature. It has defined bioengineering as an umbrella term meaning "the integration of engineering science and the biological sciences for the benefit of society." As defined by the task group, bioengineering has three branches:

- **biochemical/food engineering**—the branch as applied to chemical products and services and food products;
- **bioresource engineering**—the branch that deals with engineering design and analysis to develop processes, machines and systems that influence, control or use biological materials and organisms for the benefit of society;
- **biomedical engineering**—the branch that deals with health, medicine and human factors.

Bioengineering Task Group

Co-chairs

- Argyrios Margaritis, PhD, P.Eng., chemical and biochemical engineering professor, University of Western Ontario
- John Runciman, PhD, P.Eng., assistant professor, School of Engineering, University of Guelph

Other members

- Walter Bilanski, PhD, P.Eng., professor emeritus of agricultural engineering, University of Guelph
- Katherine Crewe, P.Eng., vice president, R&D and operations, Medstent Inc.
- Peter DeVita, P.Eng., PEO Past President, and president, DeVita Associates
- Levente L. Diosady, PhD, P.Eng., professor of food engineering, Department of Chemical Engineering, University of Toronto
- Bruno DiStefano, P.Eng., president, Nuptek Systems Ltd.
- Monique Frize, PhD, P.Eng., professor, systems and computer engineering, Carleton University; professor, School of Information Technology and Engineering, University of Ottawa; holder, Natural Sciences and Engineering Research Council/Nortel Joint Chair for Women in Science and Engineering (Ontario)
- R. Lal Kushwaha, PhD, P.Eng., professor, machinery systems, Agricultural and Bioresource Engineering Department, University of Saskatchewan
- Begonia Lojk, P.Eng., Canadian Council of Professional Engineers
- Joseph E. Molto, PhD, director, Paleo-DNA Laboratory, Lakehead University
- Stephen Naumann, PhD, P.Eng., director, Rehabilitation Engineering Department, Bloorview MacMillan Centre
- Max Perera, MASc, MBA, P.Eng., PEO Councillor
- Michael Sefton, ScD, P.Eng., director, Institute of Biomaterials and Biomedical Engineering, University of Toronto
- Ady Solomon, PhD, P.Eng., Robotics and Automation Lab, Department of Mechanical and Industrial Engineering, University of Toronto