CONSTRUCTAL DESIGN OF POROUS AND COMPLEX FLOW STRUCTURES

September 21-23, 2005

Memorial University of Newfoundland

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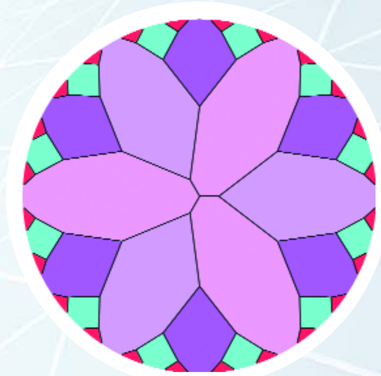
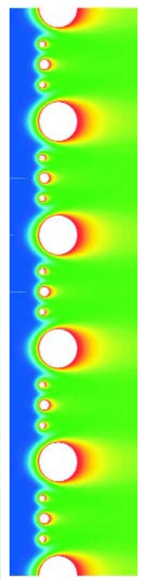
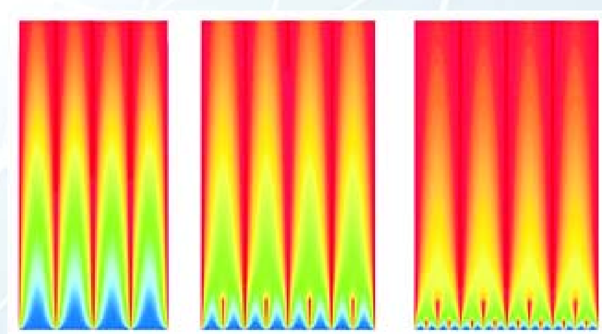
ABOUT THE COURSE

The course deals with the design and analysis of porous and complex flow structures found in engineering systems. Using novel methods of analysis such as constructal theory, engineers and researchers will learn how to design optimal systems for fluid collection, distribution and energy transfer. The course is the first of its kind to be offered in Canada. Lead by internationally renowned researchers, the course is diverse in topics that include: geophysical applications, fluid collection and distribution networks, multi-scale design, compact heat exchangers, process intensification, and sustainable design of energy systems.







KEY AREAS:

Porous media/process intensification/energy systems/complex flow structures/micro-systems.

WHO SHOULD ATTEND:

Mechanical engineers, petroleum engineers, civil engineers, environmental engineers, earth scientists, and applied mathematicians.

WHERE:

Faculty of Engineering and Applied Science
Memorial University of Newfoundland
St. John's, Newfoundland, Canada.

WHEN:

September 21-23, 2005.
Pre-registration is required by Aug. 15, 2005

PROGRAM

DAY ONE

Introduction to Constructal Theory (Bejan)

Constructal theory is the thought that flow structures change in time such that they provide greater flow access (less resistance). Imperfections (resistances) cannot be eliminated. They can be distributed optimally, and from this process springs the drawing—the design. Examples from geophysics, physiology and engineering show how flow systems acquire flow architecture, and how this architecture endows the system with performance and persistence in time (survival).

Flow Structures and Distribution – I (Lorente)

The basic idea is that flow systems derive their structure and geographic distribution from the maximization of performance in a global sense, while under the influence of constraints. The architecture of the flow system is the result of the minimization of imperfections or the optimal distribution of imperfections.

LUNCH

Flow Structures and Distribution – II (Lorente)

We illustrate the preceding ideas through examples such as how to design a tree-shaped flow path with minimum overall resistance between one point (O) and many points situated equidistantly on a circle centered at O. A complete optimization of the flow structure is proposed, and compared to a less expensive method.

Internal Flows in Complex Geometry (Muzychka)

Internal flows occur in a variety of complex shaped channels. Through an appropriate choice of length scale, the performance of complex systems can easily be predicted using a small number of equations which are independent of passage shape. These modeling equations demonstrate the universality of transport processes, even in the most complex flow systems.

DAY TWO

Generating Optimal Internal Structure (Bejan)

Convective structures such as heat exchangers and cooled electronics owe their imperfection to resistances to heat and fluid flow. By balancing these two resistances to minimize their global effect, one deduces the optimal multiple scales for spacings for channels, fin dimensions and frequencies of periodic flows.

Workshop-Flow Systems (All)

LUNCH

Multi-Objective Design (Lorente)

The system architecture is the result of a combination of constraints. The first example is the fundamental problem of distributing over a fixed area a supply of hot water as uniformly and at the highest temperature possible, which is a combination of two problems: heat transfer and fluid mechanics. Another example is the design of insulating walls with prescribed strength and air cavities where the thermal and mechanical objectives are competing objectives.

Compact Heat Exchangers (Muzychka)

Compact heat exchangers are utilized in numerous process and electronics cooling applications. Optimal design of these systems is determined by means of the selection of the optimal internal geometry for a specific flow or given a fixed geometry the best flow is chosen.

DAY THREE

Workshop-Energy Systems (All)

Thermodynamic Design (Bejan)

More flow access means less resistance to currents (fluid, heat, electricity) and less thermodynamic imperfection. Examples from power generation, refrigeration, storage and solar energy will show how the optimal distributing of imperfections generates the configurations of energy systems.

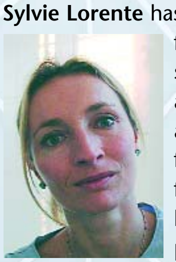
Thermodynamic Design of Compact Heat Exchangers (Muzychka)

Thermodynamic design issues of compact heat exchangers are discussed. Optimal passage, internal geometry, and flow conditions are obtained through the entropy generation minimization method.

CLOSING

ABOUT THE INSTRUCTORS

Adrian Bejan joined Duke University (Durham, NC) in 1984 and is J.A. Jones distinguished professor of mechanical engineering. Bejan's research covers a wide range of topics in thermal sciences and engineering including entropy generation minimization, energy analysis, convection heat and mass transfer, convection in porous media, solar energy conversion, cryogenics, aircraft systems design and the optimal geometry of electronics packages. Most recently, he formulated the constructal theory of organization in nature. For the last eight years, Bejan and his co-workers have devoted significant effort on the development of constructal theory. Bejan has postulated the constructal law as the underlying principle, the foundation from which self-organization and self-optimization phenomena can be deduced. Bejan is ranked among the 100 most cited authors in all of engineering by the Institute for Scientific Information. He is the author of 17 books and over 400 journal articles and has received numerous awards. An ASME Fellow, Bejan earned his bachelor's, master's and doctoral degrees in mechanical engineering at the Massachusetts Institute of Technology, Cambridge, in 1971, 1972 and 1975, respectively. He holds 14 honorary doctorates.



Sylvie Lorente has developed and taught courses on urban hydraulics, fluid mechanics, properties of materials, building energy system design, ionic transport through porous media and optimization of complex flow structures at INSA and at international summer schools. Her research focuses on the durability of materials, ionic transport, fundamental heat and mass transfer, energy flows in buildings and optimization of fluid flow networks. She proposed to apply the constructal law to the design of urban hydraulics networks. At a much smaller scale she studied the optimization of fluid flow dendritic structures with applications to the cooling of electronics. She is the author of 40 journal articles and a new book, *Porous and Complex Flow Structures in Modern Technologies* (Springer, 2004). Her honours include the Edward F. Obert Award at ASME 2004, first place in the 2003 competition for the prize of the Federation Nationale des Travaux Publics, France, and first place in the 1993 competition for equipment funding from the Energy Commission of the Regional Council of the Midi-Pyrenees, France. Dr. Lorente earned her bachelor's and master's degrees, and her doctorate in civil engineering at INSA in 1992 and 1996, respectively.

Yuri Muzychka has taught and developed courses related to heat transfer, fluid dynamics, and mechanical equipment and systems. His research focus is on the development of robust models for characterizing transport phenomena using fundamental theory and validated using experimental and/or numerical results. His current research focuses on the modeling of complex fluid dynamics and heat transfer problems in internal flows. These include transport in porous media, compact heat exchangers, two phase flow in oil and gas operations, micro-channel flows, and non-Newtonian flows. He also undertakes applied research in electronics packaging and thermal design/optimization of energy systems. He is the author of over 35 papers in refereed journals and conference proceedings. He is a registered professional engineer with Professional Engineers of Ontario and Professional Engineers and Geoscientists of Newfoundland and Labrador, and is a member of the American Institute for Aeronautics and Astronautics (AIAA) and the American Society of Mechanical Engineers (ASME). Dr. Muzychka received his bachelor's degree from Memorial University (1993) and his master's and doctorate from the University of Waterloo (1995, 1999), all in mechanical engineering. In 2004, he was the recipient of the Petro-Canada Young Innovator Award.

COURSE FEES (Canadian Dollars):

Industry:	**$600**
Academic:	**$600**
Student:	**$175**

Enrollment is limited. Pre-registration is required.

FOR MORE INFORMATION CONTACT:

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Fee includes all course materials and is tax deductible. Payment method (prepayment and pre-registration required by August 15, 2005): Cheque, Purchase order, Visa, Mastercard.