

Amundson Lecture Series 2015

*The Department of Mathematics is honored to host a series of lectures by
Professor Olivier Pironneau in recognition of Professor Neal Amundson*



About the Speaker

Professor Olivier Pironneau's research interests include Fluid Mechanics, Electromagnetism, Optimal Design, Mathematical Finance, Numerical Analysis and Partial Differential Equations. He is the author of 8 books and more than 300 papers and the Advisor of more than thirty Ph.D. students. He is a member of **French Academy of Sciences** and was awarded the **Marcel Dassault Prize** by the French Academy of Sciences in 2000. He is also the recipient of the **Blaise Pascal Prize** of the Academy of Sciences (1983), the **Legion d'Honneur** (2009), and is an Associate member of the **Russian Academy of Sciences**. His group has developed the software named **FreeFEM** which is used by researchers worldwide for computation.

For more information on the speaker, visit:
<http://www.ann.jussieu.fr/pironneau/>

ABSTRACTS

In Search for Optimal Shapes with Mathematics and Computers

(General Lecture- SEC 204, 4:00 p.m.—5:00 p.m.)

There is an underlying assumption in sciences that once a system is understood it can be improved or controlled. However beyond a handful of parameters the human mind cannot find the optimum by trial, error and experience; one needs the help of computers and optimization algorithms.

Shape optimization may be hard to define mathematically because of conflicting criteria uncertainty in the data and topological problems, yet number of solutions are available. Optimal design has invaded almost all fields of engineering; it can be as different as the design of the door of a car, which makes the most pleasing noise when slammed to the identification of oil reservoir underground.

Calculus of variations and optimization theory provide mathematical tools leading to computational algorithms to optimize shapes. But there are still a number of unsolved issues related global versus local optimization, multiple scales, and convergence of numerical methods.

Computer science provides also an entirely different set of tools derived from machine learning, cellular automata and computational graphics. Many examples and solutions will be presented from airplane and car industries, acoustics, solar cells, fans, etc.

Contribution to Parameters Identification for Fluid-Structure Interaction Problems

(Seminar Lecture: SEC 206, 3:00 p.m.—4:00 p.m.)

Is it possible to recover the parameters of a fluid-structure system in interaction from images of the system? Is the system observable? What are the algorithms available for identification?

An important application is for hemodynamics and the identification of the blood rheology and the blood vessel's mechanical parameters from MRI images.

Our contribution to this field is the study of a reduced fluid-structure interaction algorithm for the Navier-Stokes equation coupled with a shell model. By using transpiration condition the model runs easily on a laptop computer. It has also been fully analyzed mathematically and shown to be well posed and stable after discretization.

Calculus of variations and control theory provides a framework to implement a 4D-var parameter identification algorithm. We will discuss the discretization schemes and the implementation with finite element methods and descent methods.

WiFi and mathematics **(Graduate Student Lecture- SEC 203, 1:30 p.m.—2:30 p.m.) *ROOM CHANGE**

WiFi is an electromagnetic signal similar to the one used by mobile phones. By computer simulation of Maxwell's equations, the intensity of the signal in a 3D scene can be computed and also compared with other electromagnetic signals, including common appliances like micro-wave ovens and TV sets. The implication of numerical methods in such simulations is high. There are also more exotic applications of mathematics to wifi, such as:

- Finding the plan of an apartment and where is its tenant from the quality of wifi reception of his mobile phone and inverse methods.
- Development of new technologies with focusing wifi signals using time reversal ideas.

We will also discuss the possibility to make such simulations on a laptop computer.