Workshop
"Industrial Mathematics and its Practice"

Sponsored by
Global Center of Excellence Program
“The Research and Training Center for New Development in Mathematics”
(Graduate School of Mathematical Sciences, The University of Tokyo)

Organizer: Professor Junjiro Noguchi, Hiroshi Matano, Yoshikazu Giga, Masahiro Yamamoto (The University of Tokyo)
Secretariat: Mika Marubishi

Objectives: Needless to say, mathematics can play essential roles in collaboration with various disciplines and fields such as engineering and physical sciences as well as the industry. The essence of mathematics is the abstract character and the universality. Nowadays, many important problems need interdisciplinary and international team efforts, where mathematics can provide a fundamental language when we will discuss issues thoroughly.

By such capability which only mathematics can offer among natural sciences, one can greatly expect that the suitable organization of activities of the industrial mathematics may yield innovations in the technology. In a bilateral way, the industrial mathematics may inspire graduate students by posing new problems which are mathematically meaningful as well as important from perspectives over the real world and consequently the mathematical activities in academia may become more active.

At this workshop, we will discuss the effective means of the industrial mathematics, and exploit realistic ways which are productive from the both viewpoints of the academia and the industry.

In China and European countries, activities of the industrial mathematics have already functioned well. We plan 5 talks concerning case studies on industrial mathematics and applicable mathematics to industrial demands. The talks may give general recipes for the promotion of industrial mathematics and reflect specific situations in Japan, China and Germany. We believe that with this wide views, we could provide the way for promoting the industrial mathematics among graduate students and enrich and enhance their careers.

Moreover we organize a panel discussions with panelists from Germany, France, Russia and China and discuss how to promote the industrial mathematics to the younger.

Date; February 23 (Monday) - February 24, 2009

Location: Room 056, Graduate School of Mathematical Sciences, The University of Tokyo
Access: http://www.ms.u-tokyo.ac.jp/access_e/index_e.html

February 23 (Monday)

13:00-13:05 Opening

13:05-13:50 M. Yamamoto (The University of Tokyo):
"Practice of Industrial Mathematics: Combination of Theories and Applications to the Real-world"

14:00-14:50 Y. Tan (Fudan University, Shanghai):
"Study Group and Mathematical Problems in Industry"

15:00-15:30 Coffee Break

15:30-16:20 D. Hoemberg (Technical University of Berlin, Weierstrass Institute for Applied Analysis and Stochastics, Berlin):
"Coupling of Process, Machine, and Work-piece in Production Processes -- a Challenge for Industrial Mathematics"

16:30-17:45 Panel Discussions
Panelists: Y. Tan (Fudan University, Shanghai),
T. Tang (Hong Kong Baptist University),
D. Hoemberg (Technical University of Berlin),
B. Miara (Ecole Superieure d'Ingenieurs en Electrotechnique et Electronique, Paris),
V.G. Romanov (Sobolev Institute of Mathematics, Novosibirsk),
Moderator: M. Yamamoto

February 24 (Tuesday)

10:00-10:50 T. Tang (Hong Kong Baptist University):
"Convergence Analysis for Numerical Methods to Stochastic Hyperbolic Equations"

11:00-11:50 J. Cheng (Fudan University):
TBA

11:00-12:00 Closing

Profiles:

Professor Yongji Tan

Professor of Fudan University, Vice president of Chinese Society of Industrial and Applied Mathematics（CSIAM）and President of Shanghai SIAM.

He has experiences of 40 years to cooperate with industry and to solve industrial mathematical problems. He has solved the mathematical problems of continuous casting and monitoring corrosion of blast furnace for Bao Steel, micro-sphere focus well-logging and spontaneous well-logging for Daqing Oil Field and Jianghan Oil Field and mathematical problems of the engine design for Shanghai Engine Institute.

Moreover he has made substantial contribution as a main member of a joint research project by Graduate School of Mathematical Sciences of The University of Tokyo and Nippon Steel Corporation, Japan.

Professor Jin Cheng

Professor of Fudan University.

He is a core researcher in applied mathematics in China. In China he is main organizers for joint research projects not only at Fudan University but also at Institute of Geophysics of China Eearthquake Administration and School of Electronical Engineering & Automata of Tianjin University. His international activities are remarkable and he has won the award for younger researchers by The International Society for Analysis, its Applications and Computation and many awards in China.

He has stayed in many countries such as France, Austria and Germany as guest researchers and especially in Japan he has rich experiences of long stays at The University of Tokyo, Kyoto University, Gunma University and is familiar with situations of Japanese mathematics. Since 2000, he has made remarkable realistic contribution in the industrial mathematics as a main member of several research projects with Graduate School of Mathematical Sciences of The University of Tokyo, Nippon Steel Corporation and The New Energy and Industrial Technology Development Organization (NEDO: an incorporated administrative agency of Ministry of Economy, Trade and Industry, Japan).

Professor Tao Tang

Professor at Hong Kong Baptist University and Director of Joint Research Institute for Applied Mathematics.

He is a distinguished researcher on numerical analysis with world-wide reputations and has won the international price "Leslie Fox Price" and many awards in China and Hong Kong. Joint Research Institute for Applied Mathematics is a collaborative institute with Beijing University and as director he is organizing and promoting research activities.

Professor Dr Dietmar Hoemberg

Professor at Technical University of Berlin and the leader of Research Group "Nonlinear Optimization and Inverse Problems" of Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany which engages in project-oriented researches in applied mathematics.

He is Scientist in Charge for the application area "Production" of DFG Research Center MATHEON - Mathematics for Key Technologies in Berlin.

His research interests are in industrial mathematics, especially in direct and inverse problems related to thermomechanics and phase transitions.

He is devoted to interdisciplinary research with partners from industry and engineering. Current projects deal with hot-rolling of multiphase steels, distortions due to heat treatments, laser and electron beam surface treatments and the stability of milling processes. Furthermore he is committed to an innovation programme in mathematical educations for engineers.

Abstracts of Talks:

M. Yamamoto: "Practice of Industrial Mathematics: Combination of Theories and Applications to the Real-world"

Abstract: On the basis of my experiences for 10 years in the industrial mathematics, I speak about the practice of the industrial mathematics aiming at fulfilling missions from the industry and emphasize that the practice should be beneficial both to the academia and the industry. I will discuss current situations around mathematical communities in Japan, and present two case studies in steel industries.

Y. Tan: "Study Group and Mathematical Problems in Industry"

Abstract: Study Group (Study Group with industry) started in 50's of the 20 century in Oxford University, England. Since it is efficient to solve industrial mathematical problems, it became a most popular way to solve industrial problems and had been widely held all over the world. Since 2000, seven Study Groups have been held in China (including Hong Kong).

Many industrial mathematical problems have been appeared in those Study Groups. Since academic people and industrial people are joining together for a whole week and discuss face to face, those problems can be understood well and the solution process can be shortened. In this talk, we will survey the industrial problems appeared in Chinese Study Groups and show solutions for blast furnace corrosion problem and dust and plume pollution problem in steel industry.

D. Hoemberg: "Coupling of Process, Machine, and Work-piece in Production Processes -- a Challenge for Industrial Mathematics"

Abstract: To remain competitive with low-wage countries, it is of vital importance for industrialised nations like Japan or Germany to maintain a high degree of automation in manufacturing. To achieve this goal, important challenges are the reduction of batch sizes, e.g., in automotive industry, the acceleration of ramp-up and down stages and the automatic reconfiguration of production processes. An important step in this direction is the study of interactions between machine, work-piece, and the process, which is carried out on the respective machine.

The traditional approach used to be a separate study of machine and process dynamics as well as material behaviour of the machined work-piece. However, for a refined and more precise simulation and control of complex production processes, it is important to take a holistic view and to study especially the coupling of these effects

We illustrate this approach in the case of a milling process. Here the productivity is limited by the occurrence of chatter caused by vibrations of cutter and work-piece. We model the machine dynamics in terms of a multi-body system, the work-piece is described as a linear thermo-elastic continuum. The coupling of both parts is realized by an empirical process model permitting an estimate of heat and coupling forces occurring during milling.

After a brief derivation of the governing equations emphasizing the coupling, we discuss the well-posedness of the resulting system. We show how the system can

be treated numerically, including the effect of material removal due to cutting. Numerical results confirm that process instabilities can be induced by the machine as well as by work-piece effects. The talk concludes with an outlook on further coupling effects between structure and process in manufacturing engineering.
This is a joint work with Krzysztof Chelminski (Warsaw University of Technology) and Oliver Rott (Weierstrass Institute for Applied Analysis and Stochastics, Berlin).

T. Tang: "Recent Development of Scientific Computation with Mesh Activity"

Abstract: In this talk, we shall discuss the idea of adaptive grid methods for solving partial differential equations. These methods involve the solution of the underlying PDE for the physical solution in conjunction with a so-called moving mesh PDE for the mesh itself. We also present an adaptive moving grid strategy for partial differential equations in two- and three-space dimensions. The algorithm automatically adjusts the size of the finite elements in the physical domain to resolve the relevant scales in multiscale physical systems while minimizing computational costs. Some subtle issues in the moving mesh scheme, in particular the solution interpolation from the old mesh to the new mesh and the choice of monitor functions, will be addressed. This talk will describe and review some recent developments of adaptive grid methods, especially their applications to computational fluid dynamics.

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