EDUCATIONAL INTERFACES BETWEEN MATHEMATICS AND INDUSTRY

The International Commission on Mathematical Instruction (ICMI) and the International Council for Industrial and Applied Mathematics (ICIAM) are jointly launching the EIMI Study as part of the series of ICMI Studies. It will seek to better understand the connections between innovation, science and mathematics and to offer ideas and suggestions on how education and training can contribute to enhancing both individual and societal developments. The Study will examine the implications for education at the intersection of these two communities of practice – industrialists and mathematicians. We wish to emphasise that there should be a balance between the perceived needs of industry for relevant mathematics education and the needs of learners for lifelong and broad education in a globalised environment. The Study aims at broadening the awareness: of the integral role of mathematics in society; of industry with respect to what mathematics can and cannot realistically achieve; of industry with respect to what school and university graduates can and cannot do realistically in terms of mathematics; and of mathematics teachers and educators with regard to industrial practices and needs with respect to education. The Study also aims: to enhance the appropriate usage of mathematics in society and industry; to attract and retain more students, encouraging them to continue their mathematical education at all levels; and to improve mathematics curricula at all levels of education. To achieve these aims, ten content areas, each one with several questions, are suggested:

1. The Role of Mathematics – Visibility & Black Boxes. People are rarely aware of the importance of mathematics in modern technologies. The use of mathematics in modern society should be more visible questioning: How can mathematics, especially industrial mathematics, be made more visible to the public at large? — How can mathematics be made more appealing and exciting to students and the professionals in industry? — How can mathematics serve a progressive rather than a restrictive role in education and training for the workplace? — To what extent is it necessary or desirable to describe the inner workings of black boxes? What are the social implications of not explaining the inner workings of black boxes?

2. Examples of Use of Technology and Mathematics. Modern workplaces are characterised by the use of different types of technology including Mathematics in fields as diverse as the chemical industry, oil exploration, medical imaging, micro- and nanoelectronics, logistics & transportation, finance, information security, and communications and entertainment. What are insightful examples of the role of technology in showing and/or hiding mathematics in the workplace? — Does the existence of special types of technology and the hiding of mathematics from the view of the user imply a change in the mathematical demands on the user? How? — Do old competencies like estimation of results and reading of different scales become obsolete when using modern technology? Or, do they become more important? — What are the social and political consequences of the 'crystallising' and 'hiding' of mathematics in black boxes?

3. Communication and Collaboration. In the workplace, mathematics is seldom undertaken as an individual activity. Mathematical work, mostly on modelling and problem solving, is almost always a group activity and frequently the groups involved are made up of individuals with diverse expertise and expectations: How to identify which societal and/or industrial problems should be worked on? — How to better communicate within multi-disciplinary working groups? — How to communicate the underlying mathematics to the problem owners and/or general public? — How to achieve greater quantitative literacy among school leavers, workers, and the general population?

4. The teaching and learning of Industrial Mathematics – Making Industrial Mathematics more visible. Who decides what will be explained and to whom? — How to decide the level of explanation for various groups? — How to organise teaching and learning in order to make industrial mathematics visible – if this is wanted/necessary? — How much is it appropriate to explain for educational purposes in order to generate interest and excitement without overwhelming the learner?

5. Using Technology and Learning with Technology: Modelling & Simulation. Using a new technology usually requires special efforts to become acquainted with it, to develop routines and practice. This can be an obstacle to switching to a more modern technology as long as the older one still "does the job". On the other hand, change and innovation are necessary in industry. How should one decide on the level of detailed mathematics expected to be taught/learned in a given vocational black box situation? — How can mathematics help the transfer of technological procedures and/or solutions between different fields of industry? — What criteria should be used to judge the appropriateness of simulation in the teaching & learning of industry related practice? — How can one compensate for the "standardising effects" of any technology that is in widespread use?

6. Teaching and Learning for Communication and Collaboration. Communication and collaboration form an integral and important part of the industrial use of mathematics. Because of their importance in industry, it is desirable to have these skills taught and learned in all parts of education and training, questioning: What communication skills are specific to mathematics? — Are there specific skills for use in relation to industrial mathematics? — How do we teach mathematics as a second language?

7. Curriculum and Syllabus Issues. A partnership between mathematics and industry requires adjustments of the mathematics curriculum. This can also impact the teaching of mathematics in general, questioning: What are the (dis)advantages of identifying a core curriculum of mathematics for industry within the general mathematical curriculum at various levels and for various professions? — What are useful ways to introduce mathematics for industry into vocational education? — What are the (dis)advantages of creating specific courses on mathematics for industry vs. including the topic in the standard mathematical courses at various levels? — What are the (dis)advantages of treating mathematics for industry as an interdisciplinary activity or as part of the traditional mathematics syllabus?

8. Teacher Training. Teachers must be trained in new mathematical content, pedagogy and assessment and to recognise the presence of mathematics in society and industry. What level of understanding of this new content in relation to EIMI is appropriate for each grade level? — What are good practices that support this new direction in teacher training? — How to implement these changes in an efficient way?

9. Good Practices & Lessons to be Learned. In all sectors of education there are examples of good practice in relation to the Study. This Study would like to collect good examples of how to integrate industry into the educational process. Lessons to be learned from failures are of the same interest as those from successes.

10. Research and Documentation. National and trans-national documentation is widely missing in the field of mathematics and industry. Suggestions and contributions describing existing and future research and documentation of activities in the field of Educational Interfaces between Mathematics and Industry will be most welcome.

The ICMI/ICIAM joint Study on Educational Interfaces between Mathematics and Industry is designed to enable researchers and practitioners around the world to share research, theoretical work, projects descriptions, experiences and analyses. It consists of two main components: the Study Conference and the Study Volume.

1. The **Study Conference** will be held at the Fundação Calouste Gulbenkian in Lisbon, Portugal, on April 19-23, 2010. Participation will be by invitation only, based on a submitted contribution. Proposed contributions will be reviewed and selections made according to the potential to contribute to the advancement of the Study, with explicit links to the themes and approaches outlined in this Discussion Document. The Local Organising Committee is composed by Adérito Araújo (University of Coimbra), Assis Azevedo (University of Minho and CIM), António Fernandes (Technical University of Lisbon) and José Francisco Rodrigues (University of Lisbon and CIM).

2. The **Study Volume**, a post-conference publication, will appear in the New ICMI Study Series (NISS), published by Springer. Acceptance of a paper for the Conference does not ensure automatic inclusion in this book. A report on the Study will be presented during the 7th International Congress on Industrial and Applied Mathematics (ICIAM 2011, to be held on July 18-22, 2011, in Vancouver, Canada), as well as at the 12th International Congress on Mathematical Education (ICME-12), to be held in Seoul, Korea, on July 8-15, 2012.

The deadline for proposals of contributions to the study conference and to the study volume is **October 15, 2009** and should be done through the Study website http://www.cim.pt/eimi/

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