Industrial Mathematics: 'On the Crest of a Wave'

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The quote above comes from Professor John Ockendon FRS, Founding Director of the Oxford Centre for Collaborative Applied Mathematics (OCCAM) which was formally launched in mid-2009, having earlier received major support from Saudi Arabian based funders (King Abdullah University of Science and Technology). John made this very apt statement in his opening remarks at the European Conference in Industrial and Applied Mathematics in London in 2008.

The recent growth of activity in industrial mathematics (and statistics) world-wide is really remarkable, with a wide variety of degree programs, study groups, consulting frameworks and the like in existence. These activities frequently overlap and are adapted to take on board the local circumstances. Europe and North America clearly lead in terms of the scale of activity, but there are flourishing and developing activities here and in our South-East and Northern Asian neighbours. Our own ANZIAM Mathematics-in-Industry Study Group (MISG) continues to flourish and moves around the region at about three-yearly intervals. In 2010 it moved from the University of Wollongong to RMIT University in Melbourne. The very successful 2010 MISG was held in early February under a team ably led by Associate Professor John Shepherd of RMIT.

You may ask 'Why is this happening now?' Perhaps it is another timely thrust towards applications driven by the demands of technology, often encouraged by governments who see this as a key underpinning framework for advancement in a highly technical world. Whatever it is, there are a lot of opportunities for us in our own contexts.

Over 2007–2009 the Global Science Forum (GSF) of the Organisation for Economic Cooperative Development (OECD) conducted a major review of industrial mathematics world-wide. Both Australia and New Zealand are, of course, member countries of the OECD. The first report followed a year after an initial gathering was held in Germany in early 2007 (which was attended by Professor Tim Marchant from the University of Wollongong).

The OECD report is an excellent overview document. It makes the point that industrial innovation is increasingly based on the results and techniques of scientific research, and that this research is both underpinned and driven by mathematics.

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This is justified by the initial presentations at the 2007 conference. The report goes on to say that:

> Given the increasingly intimate connection between innovation, science and mathematics, it is natural to inquire whether the interface between all these three activities is functioning in an optimal way

and, I add, how they can be improved.

The report concludes that, while many industrial problems have a significant mathematical component and the intellectual challenges they pose often fall within topical areas of current research in the mathematical sciences, industrial problems also often extend well beyond the 'envelope of classical topics in mathematics'. I note that generally 'industry' should be interpreted broadly and extends into the biological, medical, agricultural, social, and financial areas, as well as the traditional areas of engineering and the physical sciences. It is noted that increasingly stronger links between mathematics and industry will be 'both beneficial to the partners and to national economies'. These links will inspire new mathematics and enhance the competitive advantage of companies. There are specific recommendations made under the headings:

- *Mathematics for Industrial Innovation* — options canvassed include the creation of Interdisciplinary Research Centres, special positions in industrial mathematics, the scheduling of workshops (like our ANZIAM Study Group), and specialist workshops to highlight novel mathematical techniques relevant for industry.
- *Education and Training* — a revision of the traditional curriculum, both in content and approach, including provision of opportunities for secondary school teachers to engage in academic–industrial interactions.
- *Interface between Mathematics and Industry* — the formation of 'joint teams', positions for 'translators', web access for information about problems, methods, solutions, centres of excellence and available expertise, with networks of experts across institutional boundaries and the sharing of things like model agreements on intellectual property rights.
- *Academic Infrastructure* — to be changed to support interdisciplinary activities, rewards to be made for faculty involvement in outreach activities, the creation of faculty positions for researchers from industry (which would provide much-needed role models for students), and the maintenance of quality control of industrial mathematics projects.
- *Industry Infrastructure* — the need for the availability of positions in industry for qualified researchers (notwithstanding the different perspectives industry and researchers have in regard to the timescales involved), the willingness of industries to participate in workshop activities and the like, and the provision of industry support for the enhancement of mathematics in industry.
- *National and International Coordination* — this is happening, but a more collaborative (and less competitive) approach is needed to maintain critical mass, the sharing of expertise, and lessening of the wasteful duplication of effort.

This is a small overview of the whole report which can be found on the OECD website (see [1]).

It is acknowledged that Australia and New Zealand (through AMSI, ANZIAM, CSIRO, and elsewhere) have made some steps in this direction but much more should and could be done.

Following the publication of this first report, the GSF formed an 'Experts' Working Group' to review and report on the various mechanisms used to further activities in Industrial Mathematics around the world. The purpose of this was to provide a blueprint that groups interested in proceeding could follow. I was privileged to represent Australia and New Zealand on this small working party, thanks to a nomination by Australia. This second report looks across the countries of the OECD and gives representative descriptions of activities along the lines of those advocated in the first report. It does not pretend to be comprehensive and was of course dependent on input from the 'small' committee (of 22 people) from all around the world. But it is heartening to see that we are in fact moderately active in this important area in spite of the rather limited collaboration between institutions. I was particularly involved in advocating the need for 'publicity' on how it works in practice and the need for industrial leaders to become educated in the whole process (see Section II.7 of the second report [2]). This short article represents in part my reporting back to the community. For the report of the Experts' Group see [2]. It is an evolving document and is updated regularly as new activities are reported.

References

[1] *Report on Mathematics in Industry*. July 2008. Global Science Forum, Organisation for Economic Co-operation and Development, www.oecd.org/dataoecd/31/19/42617645.pdf.

[2] *Report on Mechanisms for Promoting Mathematics in Industry*. April 2009. Global Science Forum, Organisation for Economic Co-operation and Development. www.oecd.org/dataoecd/47/1/41019441.pdf.

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