A New Era for Industrial Mathematics in Spain

Taking a proactive approach

When we speak of the transfer of knowledge and technology to industry, the current state of Mathematics in Spain does not differ greatly from the overall situation observed at an European level. Over the course of recent years numerous studies[1] have been carried out proving that, although mathematics is an essential tool to enhance industrial innovation, there still remains a long road ahead to bring mathematical technology together with business and harmonise relations between the two realms. In many cases, whether due to lack of time, motivation or experience, mathematics researchers rarely include knowledge transfer among their main priorities. It is also difficult for companies to fully perceive the value that may be added by the involvement of mathematicians in meeting industry needs, the fact being that the business world is rarely aware of possible improvements that could be brought about through collaborating with mathematicians. In early 2010 a leading group of Spanish mathematicians found themselves confronted with this situation and decided to take on the challenge of sourcing an innovative solution, proposing a new way to drive forward mathematical knowledge transfer, one in which the role of the researchers would be fully proactive.

They were not, however, starting from scratch. Since 2007 they had been promoting mathematical knowledge transfer through the Ingenio Mathematica (i-MATH)[2] Project's 'Consulting Platform'. The outcome of this groundwork had been the development of a broad spectrum of activities associated with knowledge transfer, such as the first ever mapping of the total available supply of mathematical technology in Spain[3], along with the Transmath Demand Map, analysing the results of a survey consulting more than 7,000 Spanish companies on their level of knowledge, use of, and demand for mathematical technology [4].

Subsequently, in April 2010, the 54 research groups that formed the project's 'Consulting Platform' came together at the 'i-Math Consulting Workshop: Present and Future' to debate achievements so far and to work on actions for the future. They proposed a major change in the joint activity carried out by the Platform, and approved the 'i-MATH Project Plan for Technological Knowledge Transfer', which included three strategic objectives to be achieved within two years through a total of thirteen shared actions. Amongst these were ambitious targets such as the creation of a Spanish Network for Industrial Mathematics, the dissemination of a catalogue of services supplied by almost 500 Spanish researchers [5], and the compilation of innovative solutions implemented with the use of mathematical technology, organised into their respective industrial sectors [3]. The Plan for Technological Knowledge Transfer involved the joint collaboration of all the participating research groups and thus gave significant impetus to the increasing activity in knowledge transfer of the i-MATH project, creating a favourable environment for mathematical-industrial interaction among the Spanish mathematics community.

Bringing mathematics closer to industry

Among the actions promoted from within the 'Plan for Knowledge Transfer' three stand out as being more directly aimed at consolidating relations with industry:

Establishing contacts with businesses. The lack of knowledge within the industrial sector about the possibilities offered by mathematical technology is a major hurdle to be overcome, and one where a proactive attitude on the part of mathematicians is essential. This has been tackled from within the 'i-MATH Knowledge Transfer Plan' through an ambitious partnership building programme, which included the identification of relevant companies, locating the best contact point within those companies, the diffusion of capabilities and mathematical technical expertise available from research groups, personalised visits in order to detect problems or needs within companies, and subsequent monitoring and quality control of the relationships established. A total of 561 points of contact were established between November 2010 and March 2012 within a range of different industrial entities, and 134 meetings held in person with companies or organisations from diverse sectors of economic activity throughout Spain. These opportunities for contact, which were widely taken up within industry, have resulted in the identification of more than 40 new needs or challenges in companies to be resolved through the application of mathematical or statistical techniques. The success achieved through this programme of visits, which actively continues through the i-MATH project, has corroborated the importance of taking the initiative on behalf of the mathematics community in contacting and building relationships with companies.

'Meeting Spaces' with industry. This work has com-

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[1] For studies at the national level in Spain, see [3] and [4]. At the European level, see the main conclusions presented at the Forward Look Final Conference on Mathematics and Industry on 2nd December 2010, organised by the European Science Foundation, as well as other related studies referenced on the Forward Look website [1] and [2].

[2] Singular research project for the period 2006-2011 financed by the Ministry for Science and Education (now known as Ministerio de Economía y Competitividad) and co-financed - for knowledge transfer purposes - by the Xunta de Galicia (Galician Regional Government), The Galician Mathematics Network for Consulting & Computing, the Galician IT Centre for Supercomputing and all three Galician universities (see http://www.i-math.org/).

[3] See [6] and http://www.i-math.org/mapa_consulting/.

plemented the building of contacts with industry in opening up new channels for bringing the mathematics community ever closer, without the need for companies to make binding commitments. To achieve this, it was fundamental to motivate and help companies identify industrial challenges that could be shared with mathematics researchers at distinct events or 'meeting spaces', including consultation seminars or study groups, based on the style of the 'European Study Groups with Industry', mathematics-industry interactive forums, industry days, modelling weeks, industrial problem solving workshops in the Mathematical Engineering Masters course where the companies would play the principal role, or even the coordination of interdisciplinary working groups in order to solve specific problems. Through these initiatives, a total of 17 'meeting spaces' were organised between April 2010 and March 2012, in which 88 problems were presented by 80 different companies or industrial organisations. The 'spaces' have involved the participation of 126 technicians from companies and of more than 430 researchers from a range of fields, particularly from applied mathematics and statistics and operations research, paving the way for new collaborations, as well as strengthening already existing relationships.

Support in intellectual property registration and capitalising on the investigation's findings. In the majority of cases, the application of mathematical techniques and methods for the solving of industrial problems brings about the development of personalised software. It is common, however, that researchers develop software packages in the process of their research, even without the collaboration with industry, that in the long run are never transferred. The objective of this activity was to analyse these packages, identifying those which had the scope for being registered as intellectual property and transferred to a company, or put to use through the creation of new IT companies now emerging at the heart of universities. In total 21 software packages which met the criteria for being registered and transferred were identified. All received support oriented at their being applied, either through publication in the i-MATH software repository , with the objective of being diffused and shared at an international level, or through the support of professionally qualified technicians, specialists in the analysis and development of software for registration as intellectual property. They also received support in developing business plans and feasibility studies for the creation of new IT companies. The outcome was the preparation of 4 new software packages for registration, in areas as diverse as the simulation of geophysical flows, estimation of nonparametric models of regression, the numerical resolution of electromagnetic problems, and the simulation of 3D wind fields. Similarly, work has been undertaken on the creation of 3 new companies whose viability emerged as a result of the research carried out.

The future. Throughout this period the programme of activities outlined above and the intensive task of diffusion, awareness raising and relationship building carried out by the Consulting Platform, has generated new opportunities for collaboration, bringing the Spanish mathematics community closer to industry. Whatsmore, the impact which was achieved in industry increased exponentially as new relations with businesses were strengthened, and better levels of coordination attained, between the groups involved in the investigations. If this level of activity were maintained, a very positive future will be in store for mathematical knowledge transfer in Spain. Thus, as the i-MATH project has finished in April, the continuity of this programme has been guaranteed through the creation of new catalysts for the transfer of knowledge, such as the recently created Red Española Matemática-Industria (Spanish Mathematics-Industry Network) (www.math-in.net), that currently brings together 300 researchers and support staff, or the Instituto Tecnológico de Matemática Industrial (Technological Institute of Industrial Mathematics) (ITMATI), that was created in Galicia with the aim of becoming an international reference point for industrial mathematics. The development of such a coordinated framework is necessary for the maintenance and multiplication of the impact on industry, just as takes place in other similar existing networks around the world (MITACS in Canada, Industrial Mathematics KTN in the United Kingdom or MASCOS in Australia).

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