To begin, why is there a need for the use of mathematical models in industry and other sectors to be promoted and supported? How does the European Consortium for Mathematics in Industry (ECMI) deliver this backing?

HO: Maths underpins our understanding of almost all ‘industrial’ processes including social science (we regard ‘industry’ as a broad term, using the EU definition: ‘any activity of social or economic value’). The aims of ECMI are to introduce academic mathematicians to real problems and to convince industry that they need mathematics and mathematicians.

The main mechanisms used are European Study Groups with Industry (ESGI) and workshops where industrial scientists can meet informally with mathematicians to brainstorm their problems. We support a number of Special Interest Groups in topics ranging from weather prediction to digital factories. These groups act as a focal point for researchers from all over Europe and can lead to EU funded proposals.

We also collect case studies and hold a regular research conference. An important part of ECMI’s mission is to educate the next generation of industrial mathematicians. Hence, the ECMI
One problem with applying for EU funding is that there is no heading for mathematics in most calls. ECMI has been working with the European Mathematical Society to establish ‘Modelling, Simulation and Optimisation’ as a Key Enabling Technology in EU Framework Programmes.

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**SOB:** The industrial mathematics philosophy arguably follows in the footsteps of the likes of Newton who was mostly motivated by real problems. But many mathematicians only wish to deal with problems that arise from mathematics itself, and this is often the view of the mathematician presented to the public.

**Could you offer a couple of brief examples where ECMI members have implemented mathematical models to solve problems in particularly innovative ways?**

**HO:** There was a problem from a small company about improving the design of a milking machine and when to switch off the irregular flow of milk from a cow. A mathematical model showed that a simple control device could solve this issue and this was quickly implemented and found to be effective.

**SOB:** Guinness in Dublin came to an ESGI with the problem of trying to understand how the widget in a can of Guinness works. A simple mathematical model was developed to show how widgets influence the nucleation of bubbles (which form the ‘head’) and alternatives were suggested.

**In your view, why is there a continuing loss of women from mathematics, particularly at the higher levels of research and teaching? Is ECMI active in addressing this deficit?**

**HO:** The number of women in industrial mathematics (and in biological applications) is well above the average for mathematics as a whole. Over 33 per cent of the ECMI Education committee’s members are women – a very positive message to students.

**With funding programmes across Europe, including Horizon 2020, encouraging open access publication through rules or enticements, what will be the repercussions of the inevitable move to open access on mathematics?**

**HO:** ECMI supports open access through the Springer journal *Mathematics in Industry*, which we sponsor. Mathematics usually comes at the predevelopment stage and is also supremely transferrable (from one application to another). Therefore, open access can only help in such a transfer. Companies are discovering the advantages of the open discussion that is an essential part of our ESGIs and are beginning to realise that they may learn more than they lose in such situations.

**SOB:** It is not well appreciated how transferrable applied mathematics can be. One mathematical problem may correspond to many different applications. For example, the equations that describe oil dripping from the underside of a machine component are closely related to the famous Black-Scholes equation of option pricing.

**With the influence of mathematics papers often being hard to define and sometimes taking decades to be fully realised, how can their impact be sensibly assessed by funders, policy makers, peers, etc.? Should new metrics be considered beyond peer review, journal impact factor and citations?**

**HO:** The recent trend towards using nonstandard metrics such as ‘impact’ is helpful to applied mathematicians, though more emphasis should be placed on interdisciplinary modelling skills. But one cannot rely on metrics alone to assess research work in any area.

**SOB:** New metrics could be introduced based on satisfaction ratings of industrial collaborators.

**What are ECMI’s plans for the next few years? How would you like to see the relationship between mathematics and industry evolve?**

**HO:** We are developing better lines of communication using open innovation and modern computational concepts so that we can share expertise and avoid duplication. ECMI is at the heart of a new COST Network for Mathematics in Industry (MI-NET) which will help to develop these links and spread the use of mathematics in industry further across Europe and the rest of the world.

**SOB:** ECMI is striving to get its message across that mathematics really can help industry, which is why we are seeking to strengthen our links with similar networks in the US and Asia.

**www.ecmiindmath.org**