Australian Mathematical Society Inc.

Submission to the Senate Inquiry into Higher Education

Prepared by:
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1. PREAMBLE

``Mathematical Sciences in Australia: Looking for a Future'' (FASTS Occasional Paper #3, Jan Thomas, October 2000) identified serious difficulties facing the mathematical sciences in Australia. Although not currently documented in such detail, similar problems exist in quantitative disciplines generally especially where there exists a global shortage of expertise in areas seen as economically important.

These problems are

(a) A loss of very high level research expertise to overseas institutions and businesses.
(b) A dramatic fall over the last decade in the number of secondary students studying the more advanced mathematics subjects and a lack of appropriately qualified teachers.
(c) The lack of discipline specific targeted funding to support high level research activity essential to the innovation strategy proposed by the government.

(a) was covered in some detail in the FASTS paper. Not only were experienced researchers leaving but so were beginning researchers and very few were returning. The breadth and depth of post-graduate courses in the mathematical sciences in the USA was a particular attraction for some.

(b) was also discussed in the FASTS paper. The overall number of students studying mathematics in senior secondary school remains constant when compared with total year 12 enrolments but more students study vocationally oriented mathematics subjects. This may be partly in response to the dropping of pre-requisites by some universities. On the other hand the places in universities open to students with a sound quantitative background have expanded particularly in engineering, IT and finance.

Starting salaries for new mathematical sciences graduates have steadily risen as their number has declined. This has in turn made teaching a less attractive career so that there is now a feedback mechanism for reducing the number of well prepared secondary teachers, and hence students, even further.

Initiatives in areas facing similar shortages such as IT have been interventionist. For example there has been government funding for targeted training and publicity drives to make secondary students aware of the career opportunities. The AustMS has invested, and continues to invest, its resources in raising awareness of the importance of quantitative skills generally as well as targeting specific discipline areas. There has been little reciprocal support from government agencies.

(c) is concerned with research centres. The AustMS has for many years, along with other bodies such as the National Committee for Mathematics and the Australian Mathematical

Sciences Council, lobbied for changes to the ARC rules and the guidelines for CRCs to enable the creation of centres of the kind which operate so successfully elsewhere. The creation of centres has been adopted in the US and Europe for promoting interaction between mathematical scientists and other areas which use quantitative methods and to improve postgraduate education in all areas which exploit the mathematical sciences.

Examples of the establishment of large scale research centres are found in the Max Planck Institutes in Germany, the CNRS in France, National Institutes in Berkeley, Minnesota, Santa Fe and elsewhere in the U.S. and the Fields Institute in Canada.

There are many examples where such collaborative centres have successfully supported interaction between the mathematical sciences and other disciplines including the work on the epidemiology of AIDS. Equally however there have been fundamental advances in meteorology, oceanography, signal and image processing, population dynamics and ecology, the role of knots in DNA replication and the use of simulations in computational biology. These are just a few examples where dramatic outcomes have resulted from organised collaboration.

The loss of statistical expertise in the universities is of particular concern as university statisticians have had a pivotal role in supporting research across faculties, providing advice to those in the social sciences and business as well as to those more clearly connected with science.

2. THE 'MATHEMATISATION' OF SCIENCE AND TECHNOLOGY

2.1 The initiatives of the U.S. National Science Foundation.

The NSF has just added the mathematical sciences to its list of on-going funding initiatives. The others are Biocomplexity in the Environment, Information Technology Research, Nanoscale Science and Engineering and 21st Century Work Force. The mathematical sciences initiative will have ties to all of these. The initiative consists of three components:

- support for the fundamental research in the mathematical sciences,
- support of connections between the mathematical sciences and other disciplines, and
- mathematical sciences education.

It is no coincidence the problems identified in the FASTS paper are exactly the ones being targeted by the NSF through these initiatives. The driving force is the `mathematisation' of all areas of science and technology. In order for other disciplines to make effective use of mathematical, statistical and computational methods and ideas the mathematical sciences must themselves be strong and their links to other disciplines strongly developed.

In the US the problems have been similar to Australia's. A documented `fragile' state of the mathematical sciences, a decline in undergraduate and postgraduate students studying advanced mathematical methods, serious problems with secondary school mathematics, an unsustainable over-reliance on foreign mathematical talent and lagging support for research in the mathematical sciences. At the same time there has been a recognition of a `paradox' in mathematics and science education: there is a widening gap between the sophisticated knowledge base and uses of science on the one hand and the participation rate in mathematics, engineering and science at all levels of the educational system.

2.2 The Singapore initiative.

The Singapore government, in conjunction with the National University of Singapore has established a National Institute for the Mathematical Sciences. Its mission is to provide an international centre of excellence for mathematical research. The institute's programs will focus on fundamental issues in and applications of the mathematical sciences and will also promote interest in those fields and in multi-disciplinary research in Singapore and the region. (See http://www.siam.org/profops/01-01/nus.htm)

Australia is no longer providing the lead in the mathematical sciences in the region.

2.3 The Innovation Statement.

There are several glaring deficiencies in the Government's Innovation Statement. The initiatives in biotechnology and information technology are commendable but unlike those of the NSF they are not underpinned by support for the mathematical sciences or its connections with these areas. This is a serious deficiency because there is an already emerging shortage of trained researchers in the key area of bio-informatics and a chronic shortage of `cutting edge' IT graduates (those in the quantitative areas such as software engineering).

It seems unlikely that innovation in Australia will be particularly successful until the mathematical under-pinnings of science and technology are supported.

3. THE WAY FORWARD

Many commentators have referred to a policy vacuum in higher education. There is a clear aversion to an interventionist strategy that targets funding to high quality groups that enhance the innovation process. This aversion is not shared by small technology oriented countries such as Finland and Ireland who have been actively interventionist in higher education.

The AustMS supports 3 main initiatives.

3.1 National Mathematical Sciences Research Institute.

Re-invigorating the underlying research base in the mathematical sciences by implementing proposals for a national research institute using targeted ARC and other funding, including CRC funding. This would deviate significantly from the generic type of ARC funding support which is more specifically adapted to the experimental sciences and would involve changes to current CRC guidelines.

The Institute would be modelled along the lines of the Fields Institute in Canada. It would be a distributed system of nodes tying in with the regional concentrations of research strength, and promote the integration and interaction of mathematical, statistical and computational science with the application areas. It would be active in educational matters, working closely with DETYA and secondary and tertiary institutions.

3.2 Encouraging Greater Participation in the Mathematical Sciences.

Incentives in the form of scholarships, possibly by HECS exemptions or changes to the HECS scheme, to encourage students to undertake degrees in areas of national need are needed. On a broader scale there is urgent need for a mathematical awareness strategy to demonstrate to all students, and their parents, the value of mathematical knowledge in career options in diverse and varied settings.

But funding for mathematics, physical sciences and engineering in Universities must also be improved. Proper infrastructure funding for both undergraduate and postgraduate education is required. Access to higher education in mathematics is a laudable goal but only if it can be properly taught. Mathematics courses need small tutorials and adequate access to technology if relevant material is to be presented.

At the same time the innovation strategy of both parties has to look at fostering new industry so that opportunities exist within Australia for mathematical sciences graduates to work as mathematical scientists. The Institute proposed in 3.1 could lead to new Australian industry involving the provision of mathematical services to diverse customers around the world.

3.3 Ensuring Equitable Access to Mathematical Education.

Addressing issues of teacher supply and quality are important equity issues in access to the mathematical sciences. There must be retraining and other incentives to improve the supply of mathematics teachers.

The key issues are identified in `Radical Equations: Math Literacy and Civil Rights' by Robert P. Moses and Charles E. Cobb Jr. Moses notes that in today's world, economic access and full citizenship depend crucially on mathematical and science literacy, and that students without a good mathematical background are disadvantaged in the same way as the people who couldn't read and write in the Industrial Age.

The AustMS believes that there will be an emerging realisation by parents and the students themselves of the necessity of mathematical competence, and that this is related to quality teaching. They will demand the right to learn mathematics and will demand properly qualified teachers. The teacher shortfall is already impacting on remote schools and schools perceived as challenging and difficult places in which to teach.

CONCLUDING COMMENT

If there is to be innovation in science and technology in Australia the mathematisation of these areas must be recognised and the mathematical sciences base strengthened and improved. Above all the AustMS believes that governments, in this instance, should lead and not follow.

Contact details:

The Australian Mathematical Society would like to give evidence at one of the public hearings. The preferred city would be Melbourne as the dates and location are suitable to those who would be involved.

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