14 July, 2006

Associate Professor Barry Hughes
Executive Director
Strategic Review of Mathematical Sciences

UNSW School of Mathematics and Statistics
Submission

In this submission, the School of Mathematics and Statistics at UNSW will argue that:

- A better funding model for the Mathematical Sciences is needed
- Mathematics should form a greater part of more university degrees than now
- Publicity is needed to encourage high school students into advanced mathematics.

The Mathematical Sciences at UNSW

Historically, the School of Mathematics at the University of New South Wales (now the School of Mathematics and Statistics) has been one of the biggest and strongest groups in the mathematical sciences in Australian universities. For many years, our academic staff numbered approximately 60, our successes in teaching were recognised by our colleagues in several faculties, particularly engineering and commerce, as well as by employers, particularly in areas such as finance, and our successes in research were recognised by funding bodies such as the Australian Research Council and by other measures, such as the 2002 ranking of Mathematics at UNSW as fourteenth in the world on the basis of the numbers of citations per paper.[1] We host one of the few Federation Fellows in the mathematical sciences (Professor Matthew England, a climate modeller), one of our members (Professor Ian Sloan) is the current president of ICIAM (International Council for Industrial and Applied Mathematics), and we played a leading role in hosting the 2003 ICIAM Congress in Sydney.

The School of Mathematics and Statistics at UNSW tries to be attuned to national needs. We offer undergraduate education in a wide variety of areas, including the biomedical applications of both mathematics and statistics, financial mathematics and statistics, and climate and oceanographic modelling, as well as in the more traditional areas of applied mathematics, pure mathematics and statistics. We are currently investigating the possible

[1] See http://www.sciencewatch.com/may-june2002/sw_may-june2002_page2.htm

development of courses in risk management. With our Master of Statistics program, we have been one of the largest providers of postgraduate statistics courses in Australia, and our postgraduate research program continues to be substantial (though there has been a gradual decline in enrolments for many years). In order to reinforce both teaching and research links, we have negotiated joint appointments with one of our schools of biological sciences (this arrangement has been recently cancelled due to a lack of funding in that school), with our school of public health (this position continues), and with a local medical research institute. In response to student and employer demands, we have introduced new undergraduate courses in biomathematics, in modelling, and in data management, and postgraduate degrees in mathematical finance and in biostatistics. We have changed the assessment processes in some of our courses to emphasize communication, project work and teamwork as well as traditional academic skills. Moreover, particularly through the Centre of Excellence in the Mathematics and Statistics of Complex Systems, in which we are a partner, we have been building our links with business, industry and government.

Recently, however, we have had some problems. Enrolments have dropped, in part because the university has enrolled fewer students in response to edicts from Canberra, but also in part due to changes in engineering degrees which have cut the amount of mathematics taken by engineering students. Our funding was inexplicably low in 2003 (and low in 2004), which has created a debt that is hampering our ability to respond to the challenges we face. As a result of all these changes, we expect that our academic staff numbers will be closer to 45 in the future. Third, UNSW abolished pre-requisites for engineering and science courses; these used to ensure that students arrived with a suitable mathematical background. This means that it now takes more effort to educate our students.

We are worried about the inadequate funding of mathematics. The costs of training a mathematician and statistician have increased over the last twenty years. Twenty years ago our computing laboratories had about fifty terminals for our undergraduates, who learnt programming languages such as FORTRAN and APL, but now we are trying to maintain a computing laboratory with about 150 seats, so that our students can learn to use a range of packages such as computer algebra (MAPLE), statistics (R), and data management (SAS), as well as standard numerical packages (Fortran and MATLAB), and learn to manage large data sets. While our costs have increased, computerisation has decreased the costs of training medicos, engineers and scientists, as simulations have replaced the real thing. But the relative funding for mathematics remains at the same low level as twenty-five years ago.

Our final concern is the teaching of Mathematics in high schools. Most teachers who are qualified to teach advanced high school mathematics to year 12 will retire within the next five to ten years, and fewer students in high school now take advanced courses. Further, the academic standards of high school mathematics have declined in most states, as state Departments of Education have distanced themselves from academic mathematicians in the preparation of syllabuses and relied on “education experts” with little knowledge of the subject; we are particularly concerned that NSW may be about to follow this trend, as there is a review of HSC mathematics underway. But even if the quality of the current syllabuses is maintained, the other trends mean that the number of our students who have been exposed to quality high school advanced mathematics is likely to decrease.

What do we need?

We submit that the Federal Government should review funding for the Mathematical Sciences. The costs of training mathematicians have increased relative to other disciplines, due to the increasing computerisation of our activities and the need to deal with less well trained students than in the past, but our funding has not risen. If we are better funded, then we will be able to continue to provide our students with good computer skills, to increase the number of courses in which our students work cooperatively on projects and acquire better communication skills, and develop courses with industry placements and with embedded lectures by industry practitioners; these will satisfy identified needs of employers of mathematical sciences graduates.

We argue that mathematics and statistics need to be a greater part of more degrees than now. For instance, biology (including the environmental and biomedical sciences) used to be seen as suited to those who are interested in science but not strong in mathematics. This perception is outdated. Technological advances in computing and instrumentation have led to an explosion of data from the biological disciplines. A sound training in the mathematical sciences will enable better exploitation of the potential of this data, through the construction of quantitative models that can be validated and calibrated. Mathematical and statistical training will also provide better quality data through better experimental design. Future research in the biological sciences will also demand new mathematical developments that would not be possible without high-level mathematical skills. Other areas where more mathematics courses in the programs of study would help train better graduates include engineering and commerce. An engineer who takes a mathematics course in which the examples come from several branches of engineering and from management is more flexible, and has more transferable knowledge, than one whose mathematical skills have been acquired through contextual teaching focussed on just one area. To be realistic, this may require a change in the way that the university distributes funding, as the current model encourages a “robber baron” mentality in both heads of schools and faculties.

We believe that mathematical scientists need to better publicise their achievements. There is a naive and fallacious belief, both in the university and in the general community, that “technology” has made mathematics obsolete. Many of the technological advances that are seen as being the result of better engineering and computing actually rely heavily on mathematical advances: for instance, mobile telephones require mathematics to locate the towers efficiently and to encode and decode the signal, and the increase in speed of optimisation to enable the efficient scheduling of international airline flights is due more to improved mathematics than to improved computing. If this erroneous belief could be countered, then more students would take advanced mathematics in high schools, which would lead to more students of the mathematical sciences in universities, and to Australia being able to fulfil the needs of business, government and industry for people with advanced mathematical and statistical skills.

Michael G Cowling