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It is now 8 years since I left Australia for Germany. Although I had always had vague thoughts of living and working in Europe for part of my life, the events at the university in Australia where I was the professor of mathematics precipitated my departure and more recent developments (as well as family and personal factors) have destroyed any desire or illusion of returning to Australia in any professional capacity. There are certainly major changes underway within the university sector all over the world, especially here in Europe, yet I find what has happened to mathematics in Australia particularly saddening and disappointing.

The problems facing mathematics in Australia now are surely not due to the lack of talent — the generation of Australian mathematicians born between the 1930s and 1960s has played and is still playing a major role internationally in mathematics, especially in statistics (though many no longer work in Australia). And the younger generation is no less talented as the PISA school statistics indicate, though little of this seems to flow on now to a higher level of studies.

I wish to make a number of comments and suggestions, which are not complete and are partly anecdotal – they are aimed more to draw attention to possible courses of action rather than to provide solutions. They are coloured by my own experiences at smaller universities where mathematics was always particularly vulnerable, even at the best of times.

The problems and attitudes now encountered in Australia (and elsewhere) are not really new, as the following comments made in the 1890s by the genial Norwegian mathematician Sophus Lie in connection with Norway indicate:

• *On the whole I have a strong impression that the general public do not fully comprehend that for two thousand years mathematics has been the cornerstone of all higher education, and above all, that it has been mathematics and the natural sciences which in our century have brought about great intellectual and material progress in various fields.*

• *These days science is near the centre of every serious forward step, and not least in material fields. This country, if it wants to enter world competition, must hold high the honour of science, and do this not only for the sake of advertisement, but also by deepening conciousness of science's real and ideal value.*

(Taken from the biography *The Mathematician Sophus Lie,* by Arild Stubhuag, Springer-Verlag, Berlin, 2002; pages 427 and 429, respectively.)

Mathematics outside universities: One can argue about just how much fundamental research a country needs and can afford to pay for (or afford not to pay for). But it is even clearer now than in Sophus Lie's days just how much mathematics and quantitative methods permeate every day life and the activities of industry throughout the world.

I am sure that submissions from Australian companies will confirm this with more convincing evidence than I am able to provide. My own evidence is essentially anecdotal, based on my close contact with the banking and finance sectors in Australia and Europe, in particular in Frankfurt — due mostly to the worktools developed in my books on stochastic numerics. Although German banks are cutting staff (mostly counter and administrative) drastically due to structural changes, they are actively recruiting mathematically trained personnel. This is partly because of the mathematical nature of many modern financial products as well as because of the demands of the Basel 2 agreement on risk assessment. I am frequently telephoned by personal managers and section leaders of banks in Frankfurt asking me to send them students for a praktikum. Most of my masters students here have a praktikum with a bank during their studies and have a job offer before or very soon after they graduate. Many mathematically well qualified people are finding similar jobs in Australian banks, indeed with preference over those without quantitative skills.

I also know from discussions with well qualified individuals in areas such as environmental science, engineering, medicine, economics etc, how they discover much too late how much mathematics and related quantitative skills they need in their work and how much they regret not having been taught (or forced to acquire) more in their undergraduate studies.

National interest: As far as I understand the situation, the Australia goverment's neoliberalist policies assume that market forces will eventually sort out the problems in Australian universities, but a lot of damage can occur (and is occuring!) in the mean time to the the underlying infrastructure, personnel and levels of skills, which cannot be simply switched on or off over night when needed again, or substituted for cheaply by a few carefully selected scientific immigrants (as a senior civil servant told me a decade ago when I was a member of the mathematics and physics panel of the Australian Research Council – surely a joke?).

Whatever the economic or political philosophy pursued by a country, I believe that a responsible government is obliged to take action to protect and advance matters of national interest. The past decade of decisions and actions by individual universities in Australia show that this cannot be left to market forces alone — there have been too many quick

fixes, too much pursuit of popular and easy courses, too much off-loading of harder study programs in the mathematical and physical sciences with lower enrolments, too much de-emphasis or elimination of service teaching of such scientific skills in other courses, and so on. Australian university Vice-Chancellors have shown that they cannot be relied on to take anything but a localized and short term view.

If the Australian government believes (which I sometimes doubt) that mathematics, engineering and the physical sciences have an important role to play in society and the economy, then it is its duty to act to ensure their continued viability. There are of course many ways in which this can be done – the excessive enthusiasm for intervention of German governments is probably not suitable for a neoliberal Australia, but policies in advancing national interest followed by US and UK governments surely are.

National Mathematics Centre: The recent founding of the Australian Mathematical Sciences Institute offers some hope for the survival and development of mathematics in Australia. I believe it should be actively funded by the Australian government, not as a small, elite and isolated research centre, but rather as a centre for coordinating and fostering mathematics in Australia.

Amongst other roles, I see it as a means through which many mathematicians employed in smaller universities and colleges with a heavy teaching commitment and limited research opportunities could have a life line to research activities and the possibility to teach graduate level courses on, say, secondment, as well as for providing postgraduate students at smaller institutions with a broader offering of higher level lecture courses and contacts.

Need for accreditation: Unlike in the past, one can no longer be sure what Australia students have actually studied in their undergraduate courses – one needs to look carefully at the university, the lecturers, and the individual syllabi. Moreover, the variation is now very large. In the past one could go to a top international university with a good Australian honours degree. Not so now. In fact, I know personally of two cases where students with Australian mathematics pass degrees in mathematics were exempted only from the first and first two semesters, respectively, of courses at a Dutch and a German university. Market forces may act and eliminate such problems in the long run, but that is little consolation for these particular students, who had no way of knowing otherwise.

I think there is now considerable need for the accreditation of all – not just mathematics – undergraduate degree courses in Australia, to ensure minimal standards are maintained and to allow potential students to know about this in advance.

Accreditation has been long a fact of life in American universities and colleges, and is now a necessity in Europe as European community countries all introduce a common structure of bachelors/masters degrees. Industry groups have had considerable input into the accreditation process in Germany and elsewhere in Europe, and should also have in Australia.

Accreditation will ensure more transparency and international standards. It will also pro-

vide an opportunity to ensure that essential if somewhat difficult or unpopular skills – in particular mathematical skills – are learned in undergraduate course in other disciplines and not avoided in order just to increase enrollments. In particular, such compulsory skills will need to be taught by specialists in the area such as mathematicians, and not just taught heuristically within other courses.

The American universities do not shy away from compulsory elementary mathematics courses in their degrees, even though they are often unpopular and students often pay high fees. Large amounts of service teaching have always been the bread and butter of mathematics departments in the USA, indeed in most other countries – it is necessity of life, and not an indication of failure as my former dean in Australia repeatedly told me. Service courses provide essential mathematical infrastructure in the country.

National scholarships in mathematics: More needs to be done to actively attract mathematically gifted school leavers to study mathematics at university, rather than what they may perceive to be a more financially lucrative field, e.g. business or law.

During the 1960s the ANU offered a number scholarships nationally for top mathematics students, many of whom are now leading mathematicians and statisticians in Australia and overseas.

The Australia government should be urged to introduce a similar scheme – with say a dozen or two new scholarships each year paying fees and a small living allowance. Double majors should be permitted if not actively encouraged. Industry could contribute funding too. This scheme should be administered through the Australian Mathematical Sciences Institute with the scholarships tenable only at those universities which pro-actively support mathematics and have a high accreditation score for their mathematics degree.

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