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“Mathematical Techniques For Industrial Problems”

Re: Mathematics in Industry Workshop

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Thank you for the invitation to open the 20th Workshop on Industrial Mathematics, for Australasia, and the first of these to be held in New Zealand. May I firstly thank The University of Auckland for providing the venue, then acknowledge the passion and drive of Professor Graeme Wake and the organizing committee for making it happen. Can I also acknowledge those who are attending today, on a public holiday at that. It says something of your commitment that you are here, and thank you for that.

Universities it is often said are ivory towers, and mathematicians are sometimes regarded as the epitome of those who inhabit them. Thus the thought that mathematicians from universities might engage with potentially useful issues such as those thrown up by industry is, at first blush, quaint. Indeed, in my own field of chemistry in the 1950s and 60s the more arcane the branch, especially if it happened to be practised at Oxford or Cambridge, the higher was its academic standing. What got lost in this Colonial transfer of prestige was the reality that the specific chemistry had very mundane origins. Thus the chemistry of what in my day was called natural products and had migrated to lofty academic heights was triggered near the start of the twentieth century by the drive for better chemical dyes, better explosives, and better pharmaceutical remedies. This dominance precluded the study of topics, which were just as chemically challenging, and of more practical value for New Zealand. To some extent that was remedied in the 1970s when a group of chemists and biochemists at Massey University chose to study protein chemistry with a view to enhancing the meat, wool, and dairy industry. The result some thirty years later has been not only increased value added to these industries but also effectively three Centres of Research Excellence, one at The University of Auckland which includes Professor Ted Baker (a protein chemist) and Professor Peter Hunter (a biomedical engineer) and embraces molecular biodiversity, one at Victoria University of Wellington headed by Professor Paul Callaghan, a fellow of the Royal Society of London which embraces new materials and nano technology, and one at Massey University which involves the mathematician Professor Michael Hendy and embraces molecular evolution. So, today, in tackling real problems you are giving yourself the opportunity to break new mathematical ground and who knows, perhaps as a result a new centre of research excellence will be born!

Over the vacation I have had the chance to read a series of essays on the use of mathematics in modern science. They have been edited by Grahame Farmelo, an Associate Professor of Physics at Northeastern University and have been published by Granta under the title “It Must Be Beautiful” Great Equations of Modern Science. I will not bore you with too much detail but they include essays on all the old favourites of theoretical physics, one on information theory, one on chemical reactions in the stratosphere, and two on population biology. One of those was by Lord May who made the point that from Newton until recently, the major mathematical tool used in Science was differential equations. These he pointed out, were particularly successful in theoretical physics because that discipline was capable of reducing itself to a few basics, all of which were amenable to such an approach. One has, of course, seen the power of these equations beyond that domain, for example, in engineering and chemical bonding and reactivity. I know, for instance, something of Professor Wake's work on spontaneous equation of wool, and I am sure that they will be again to the fore today. But May's essay notes that the algorithms devised to account for what has come to be called chaos theory are not of this domain and, where change occurs in discrete jumps rather than smoothly, to use his terms, this has proved to be a better approach for certain biological phenomenon such as predator-prey relationships. Incidentally, a chance meeting and over-dinner conversation with Dr Chris King, a mathematician at Auckland University, introduced me to a possible way to look at chemical bonding from a chaotic viewpoint which seemed to have considerable merit when compared to the currently used differential equation approach of Wave Mechanics.

The second essay involving mathematics and biology was by John Maynard Smith, and was about the application of game theory to evolution. In that essay, Smith makes the point that in contrast to the physical world, the biological world consists of a host of complex events incapable of separation because of their interdependence with respect to time and space. In such circumstances, he argues (though Professor Hunter who has devised algorithms that simulate soft tissue behaviour and span several orders of magnitude with respect to time and space may not agree), that mathematics in biology can only provide a "big-picture view". That said he shows that the mathematical technique he uses, can produce some far reaching and very powerful insights.

The point I am trying to make is that mathematicians have now designed an armory of techniques that have proved extraordinarily helpful in scientific areas. Just as we have seen that different approaches reveal different truths in the physical and biological worlds, so, we might expect the same as we move into industry. So problems associated with manufacturing, lining up as they might, with problems in engineering, might be first approached via differential equations. But problems associated with the business side of industry, financial and human management, for instance might require another. Thus, at the Albany Campus of Massey University, for instance, the post-graduate Finance papers are heavily dependent on our post-graduate statistic courses and make up the bulk of those large numbers of students. By way of contrast, there is little mathematics involved in post-graduate management courses, and given that it contains complexities similar to the biological world in that it involves large numbers of complex, time-dependent interactions, one wonders whether game theory could provide useful insights in this and other disciplines that have a high social interaction content. Auckland's Vice-Chancellor Dr John Hood has rather controversially publicly lamented the absence of a world-class business college in New Zealand. Whether or not he is correct, I firmly believe that the first to put all of there offerings on a firm mathematical foundation will be the first to enable a better understanding of business practice.

But that’s enough from a lapsed physical chemist whose major academic pursuit involved mathematics no more demanding than y=mx+c. The time has now come to tackle the real problems before you and make use of the considerable mathematical talent that is gathered here today. I am sure that over the years these problems will broaden in scope as will the mathematical armory to attack them. Congratulations to the organizers, and all the best for what I hope turns out to be an interesting and enjoyable week.

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