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Don't leave maths out of the equation

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THE Jan 23 issue of Business-Week ran a cover story entitled Math Will Rock Your World. It describes how mathematics has changed fundamentally the way business is done today - in advertising, insurance, communications and many other fields.

This transformation is also taking place outside business. From national security to finance to engineering design, mathematics - in partnership with computer science - has become an indispensable tool for nations, companies and industries to stay ahead, compete and succeed.

And it is not the use of high-school mathematics that has changed the landscape. The Google and Yahoo search engines are now almost household names for information retrieval on the Internet.

But perhaps less well-known is the fact that the creation of the search technology requires solving complex combinatorial problems using efficient algorithms as well as techniques from statistical modelling and data analysis. And a prerequisite to appreciating these subjects is a basic course in linear algebra, among other things.

A new major R&D initiative launched recently by the Government, in connection with the establishment of the National Research Foundation, is interactive and digital media. Perhaps the most important area, at least commercially, in this regard is computer animation.

Fundamental to a successful creation of computer animation, be it simulating fluid flows, fire, explosion, collision, in movies, computer games or elsewhere, is an understanding and creative use of computer graphics.

Computer graphics have advanced tremendously in recent years. To design a successful graphics engine that is the basic building block for computer games software in the Microsoft Xbox 360 or Sony Playstation 3, for example, a working knowledge of techniques in advanced computer graphics is essential.

The mathematical prerequisites for such an advanced course quite often include linear algebra, calculus of single and several variables, calculus of variations, and ordinary and partial differential equations, in addition to basic theory of probability and statistics, analysis of algorithms and, of course, C programming.

Advanced topics such as the level set method, differential geometry and wavelets are becoming important too. For example, the Navier-Stokes equation involving partial differential equations about incompressible fluids is a basic tool in simulation.

The convergence of mathematics, computational and computer science by way of computer animation is now very apparent.

In Singapore today, computer science as a subject of study has lost its shine. Many bright students shun mathematics and computer science in favour of other subjects.

Large numbers of junior college students at present view life sciences as their top choice of study in the university. Many have limited exposure to mathematics and computing in the university.

While there is no dispute about the importance of the life sciences to the nation's economy, it is important to see what Singapore stands to lose in its R&D capabilities without a sufficient number of talented youths in mathematics and computer science.

For example, while creative art design is indispensable to any work in interactive and digital media, an absence of world-class computer graphics research in Singapore means that it will have to depend on groundbreaking work achieved elsewhere for use by the local industry.

While this might have been acceptable in the past, a different set of agenda will have to be drawn up in view of the heavy investments that will go into the interactive and digital media initiative.

In Silicon Valley, in the United States, the close collaboration between Stanford's Graphics Research Laboratory and Lucasfilm's Industrial Light and Magic as well as Pixar is very striking.

Looking at the countries in the Asia-Pacific region, it is clear the kind of competition Singapore is up against.

The Association for Computing Machinery (ACM) is the world's leading professional organisation in computer science. The ACM Siggraph (Special Interest Group in Computer Graphics) conference is generally regarded to be the most prestigious conference in computer graphics. Papers presented at Siggraph very often translate into implementation by animation studios and game companies.

A look at the papers presented at the 2005 Siggraph (www.siggraph.org conference&p=papers) gives an indication of the level of industry and university participation in computer graphics research.

Several Asian research institutions and R&D companies did very well in the 2005 Siggraph conference, especially Microsoft Research Asia, which is based in Beijing, in collaboration with Qinghua University. Perhaps it will not be long before China develops an industry in interactive and digital media in a big way.

How can Singapore succeed in the face of this competition, especially when many others have had a headstart? A critical mass of R&D expertise in computer graphics and the applications of mathematics at Master's level or above, building on the existing strength, is necessary.

We have done well in international school mathematics competitions. This may serve as a foundation for rigorous training in the technical subjects that are critical for the R&D work to come later.

For a start, it means that students completing their A levels should learn something about the role of mathematics in the modern world, and the many exciting opportunities that are open, or opening up, to those well trained in the subject.

There will have to be a continued push in the university curriculum, emphasising the importance of thinking and understanding of the fundamentals over a formula-driven, more-is-better syllabus.

Changes are taking place elsewhere. For example, in recent years, enrolment in mathematics at the University of California, Berkeley, has gone up significantly, probably due to the rebirth of Silicon Valley after the dot.com bubble burst in 2000.

Graduates in mathematics at Imperial College London join Google in Europe. Mr Russell Hancock, president and chief executive officer of Joint Venture: Silicon Valley Network, said in a recent radio interview with National Public Radio in the US that Silicon Valley has reinvented itself. It is now 'all about research, design, prototyping and product development', and it has gone even higher-end than before.

At that level, the question of outsourcing of jobs does not arise. His advice to the young people coming out of high school is: 'Reading, writing and arithmetic.' A simple, age-old piece of advice that rings particularly true in the age of global competition.

But one has to appreciate that this will not be an easy task.

Euclid made the famous remark that 'there is no royal road to geometry'. In the global competition for excellence, perhaps 'geometry' should be replaced by 'R&D'.

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