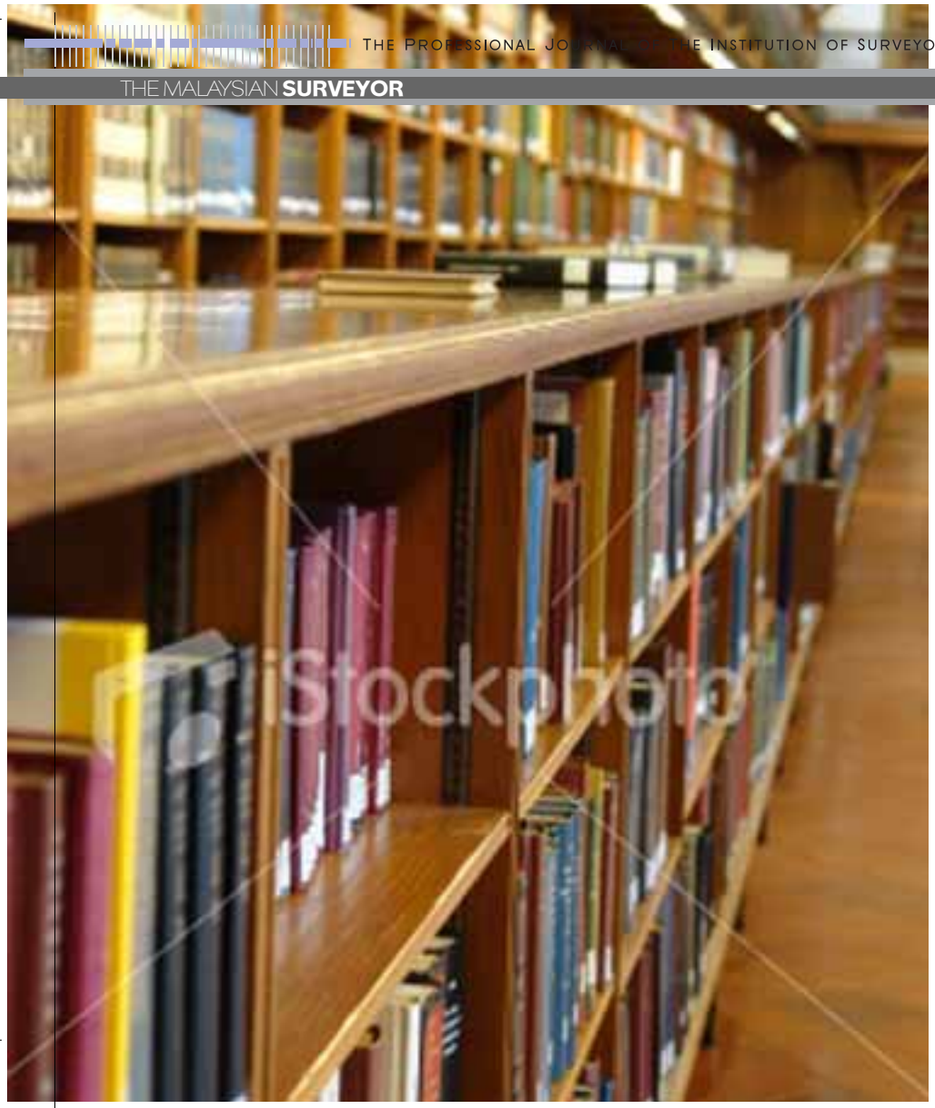

Who has not listened to colleagues speaking enthusiastically, if not idealistically, about their surveying programmes? Who has not learned at conversations during coffee breaks about the many troubling concerns such speakers often have? Examples include: What is the appropriate position of a surveying programme in academia? Is there a need for a doctoral programme? How do university administrators perceive surveying programmes in comparison to other programmes? Should surveying be administratively independent? Is programme closure due to lack of students more than just a foggy threat? Alternatively, is the teaching load so overwhelming that there is no time left to develop research?

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INDIVIDUALISED AND ITERATIVE GPS EDUCATION

Scanning 30 years of involvement in surveying education in the U.S.A. the questions above seem to have longevity if not a flair of permanency. It makes me think that the time has come to consider abandoning the legacy approach to surveying education and to explore new frontiers. The new approach should be inexpensive, have a national and even international reach, boast an academic quality that is second to none, and be a resource to practicing surveyors and engineers. In short, port the programme to the Internet, fully integrate multimedia technology, offer an iterative learning strategy and focus on individuals.

GPS-GAP

GPS-GAP (GPS- Geodesy Application Program) is such an attempt to explore new frontiers. A graduate course on GPS, introduced in 1982 at the University of Maine, was merged with other existing courses and redesigned into 11 one-credit hour units. The multimedia conversion was a major effort that stretched over more than two years. The resulting courses integrate the lectures, the textbook, numerical examples, quizzes and the communication strategy very tightly and are optimal for e-learning. See www.gnss.umaine.edu for details.

The courses can, optionally, be taken either for credit towards an academic degree, or through the Division of Lifelong Learning earning continuing education credits. The latter option offers great flexibility as to fee, timing, and grading; the student selects when to start a course, chooses the most convenient study times, and proceeds at a pace that fits his/her needs.

Location-independency as to instructor and student is achieved by merely using the Internet. The student needs a browser and a broadband Internet connection. The WebCT implementation of GPS-GAP is available continuously, day and night, every day of the year.

Individualised instruction, i.e. class room size is one, becomes possible because of free computer-to-computer calls. The faculty's office resembles a miniature multi-media studio, containing all the hardware and software to run and maintain the courses. In case of consultation, the student and the instructor sit at their respective computers and view the same PowerPoint page, Mathcad worksheet, textbook page, or listen to the same

audio. In this way, efficient and effective location-independent and individualised instruction can be realised.

Iterative learning is implied through the student's ability to repeatedly view all the material, in particular the quiz questions. The quiz questions are a very important part of the iterative GPS-GAP learning strategy and are made available at the beginning of the course. The mathematical derivations, final expressions, numerical considerations, theoretical concepts, figures, Mathcad source code, rules of thumb and so on, are subjects of quiz questions. The questions are presented in the form of graphical images which make it possible to create powerful composites, e.g. combining equations and figures, equations and text, and equations and Mathcad code.

The iterative learning strategy works as follows: the student first listens to the lecture and the Mathcad implementation, experiments with Mathcad solutions which are available from the dedicated server, and studies the quiz questions. If the student does not feel ready to take the quiz he/she can listen to the lecture again, study the quiz questions once more, and repeat this cycle until comfortable taking the quiz. This iterative approach assures that the student does not overlook the mathematical detail and other finer points presented in the lecture, because the quiz questions are a subtle reminder of the detail that has been missed. Should these iterations not converge then the student can contact the instructor for final clarification.

As to the content of GPS-GAP, the depth of coverage reflects a mathematic, geodetic, and algorithmic completeness which one expects from college-level courses. Mathcad is extensively used to experience both the mathematical and numerical elements. Indeed, because it

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can be learned "on-the-fly", Mathcad has become a major pillar in the GPS-GAP learning strategy.

Because GPS-GAP addresses all accuracy levels in positioning, there is a major emphasis on physics (plate tectonic motions, solid earth tides, ocean loading, polar motion, reference frames, geodetic datums, tropospheric and ionospheric properties, signal multipath). In addition to dealing with the GPS satellite signals, material is provided on the GPS modernisation, the re-vitalised GLONASS system and the forthcoming European Galileo and Chinese COMPASS systems.

Baseline vectors or point positions are considered derived quantities, we therefore develop all algorithms needed to compute them, starting with raw carrier phase and pseudorange observables. All necessary software has been developed at the University of Maine, is written in Mathcad, and is available to the student. It includes functions for adjustments, precise point positioning, ambiguity fixing (LAMBDA), conformal mapping, etc. Data sets are obtained from public databases or generated by in-house receivers. This approach makes the courses receiver-hardware independent and vendor-neutral.

Because an enormous effort was made to tightly integrate all course components, in particular the lectures and the quiz questions, a student typically does not often contact the instructors. It is therefore possible to offer all 11 courses continuously without being inundated with questions.

Building on GPS-GAP

Universities have long recognised the utility of the Internet, offering complete degrees online. However, the expressed focus on individualised and iterative learning in GPS-GAP is unique. Hopefully, it holds the key to reaching a national and even international audience of regular students as well as practicing surveyors and engineers.

Colleagues often express scepticism about online courses, plainly claiming that "their course can not be taught online". It is understandable that an instructor attempts to cover 100% of the material deemed necessary, even though some of it might be very subjective and of questionable value. A 90% solution that is available online to a large national audience might be more desirable rather than the 100% solution that does not reach beyond the traditional classroom walls.

Another argument against online courses is the need for hands-on experiences in laboratories. One can, however, readily imagine that online students from across the country to meet at the same location for an extended period of say 4-6 weeks, to conduct projects. Such a concentration of laboratory work would make a cap-stone like approach possible where material from all relevant lectures (and courses) is integrated into a major project.

The extended presence at one location would go a long way towards remedying the "lack of socialising experience" which other sceptics of online programmes worry about, and also provide ample opportunities for students to learn from each other.

Summary

The persistent difficulties surveying and mapping programmes have had with mainstream university curricula and degree offerings is well recognised. Tailoring and offering, perhaps collaboratively, a low-cost but high-quality programme of national reach that embraces multimedia and Internet technology seems to be the timely thing to do. Understaffed and otherwise struggling programmes might be terminated in the process or assigned a laboratory role. One can readily envision a collection of courses, maintained by instructors whose home base is dispersed around the world, which feeds an undergraduate and/or graduate degree programme of the highest quality. Issues in administering such a programme could certainly be solved. In addition, and importantly, the courses would be available to practicing surveyors and engineers, i.e. location-independent, individualised and iteratively.

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