GEOMATIC EDUCATION IN MALAYSIA: TIME TO DO SOME REALIGNMENT

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ABSTRACT

This paper identifies GNSS education and training program under Geomatic field of study. GNSS education programs is evaluated vis-à-vis new-products. Data on Geomatic knowledge generation in the era of the GNSS derivatives over the 1975 – 2003 period are examined. The emerging trends and patterns; in particular for selected Asian nations will be dissected in detail. The knowledge indicator used in this study is the patent ownership against the background of emergence of new core technologies and innovations in the field of GNSS. Looking at the dismal performance of Geomatic professionals in terms of innovative activities in most part of Asian and Malaysia in particular, is it there is something that holding up these professionals from doing so? With our universities and numerous polytechnics offering Geomatic program, more is expected from them. Is it a problem of lack or inadequacy of skills? Or is it these professionals are too busy and being narrowly focused on doing something else?

1.0 INTRODUCTION

Global Navigation Satellite Systems (GNSS) are Radio navigation system that utilizes orbiting satellites as their reference stations. The USA's NAVSTAR Global Positioning System (GPS), and the Russia's GLONASS, are the two core GNSS systems currently in service. Galileo is the European Union's equivalence, which is planned to be in operation only in the year 2008. GNSS are used for a wide variety of applications by many different users. Besides the military, end users fall into several sectors. GNSS offers two main services, namely location-based. The main applications of GNSS are navigation on land, sea, air and space. With the advent of sophisticated carrier phase processing, surveying and mapping applications was developed. Other GNSS applications are timing and scientific. Domestic GNSS users vary within these applications, with surveying and mapping communities in the lead since the pre-GPS era. Navigation users on the other hand are emerging quite strongly. Education and training programs in GNSS is no doubt an important element in this emergence.

There seems to be numerous GNSS education and training programs around locally, with government's institutions and agencies taking the lead. Private industries such as GNSS vendors are also running specialized short courses, specifically hardware and software specific. Those taking the courses come from a huge variety of backgrounds - environmentalists, people working in local and central government, utility companies, the military and non-governmental organizations. And there seem to be about hundreds of different GNSS and related textbooks.

Yet, despite all this, GNSS education and training is astonishingly lacking behind and - in our view - is mostly stuck on historical tramlines. Since the emergence of GPS in the middle 1980's and lately GNSS, there has been a shortage of skills in its use at several levels. Most educators were of the view that the technical complexity of GNSS operations and their sophisticated implementation requirements made the design and development of GNSS difficult to understand.

2.0 BACKGROUND

In Malaysia, GNSS education and training programs appears under Geomatic field of study. Geomatic study primarily entered university curricula in the mid-1980s, although there are notable exceptions such as at the UTM which commenced its undergraduate program a decade before in the early 1970s.

Teaching of Geomatic through the 1990's continued to follow a largely conventional path with lectures on theory plus practical exercises using either the latest technology from the major vendors (such as Ashtech and Trimble) or more commonly through the use of more simplified PC-based, university-developed software products.

Since those early years, UTM, USM, UPM and UiTM have now established graduate programs in Geomatic, while individual service subjects have also been made widely available for students. However, there is now an increasing trend towards the recognition of Geomatic technology as a discipline in its own right, and complete programs are becoming available at the undergraduate and graduate level. Examples from UTM include: the Bachelor of Geomatic Engineering.

The current Geomatic undergraduate degree administered by the Department of Geomatics at the UTM is the Bachelor of Geomatic Engineering - a four-year professional course of study that meets the requirements of the Institution of Surveyors, Malaysia. The degree originally had its foundations in land surveying and mapping science, but in recent years has moved into the wider domain of Geomatic field. Nonetheless, it is still fundamentally a professional engineering degree structured around the requirements of the professional bodies and licensing authorities that accredit it.

However, the Geomatic engineering discipline has rapidly expanded over the last decade—to the extent that the geographic component of information technology has now become a major global growth area. Indeed, annual worldwide expenditure in this field (in terms of software, hardware, training and data) is estimated to grow tremendously. Thus, the demand for qualified graduates in this area is becoming more acute than ever before, and is certainly greater than the demand for graduates from the Department's mainstream professional engineering degree.

Today there are only few government organizations that do not utilize satellite-positioning technology in some way for managing their data and assets, and for aiding many of their strategic decisions. Furthermore, GNSS is now accepted as a mainstream technology within local government and utilities, particularly for managing infrastructure, and these systems are also a key tool for the majority of environmental and natural resource management agencies.

While the B. Sc. Geomatic Engineering degree has moved a long way towards helping to meet the shortfall in human capital in the GNSS industry, it is still constrained by its need to serve the land surveying and engineering professions, yet the rapidly growing locational information industry is continuing to demand at a greater heights.

3.0 GNSS EDUCATION

Generally, what is required in programs of GNSS education are topics covering understanding of the GNSS system, its capability and limitations, extent of applications, and other associated or related topics. These could be achieved through taught modules as well as hands-on sessions (Walter, 2002 and Merry, 2002).

Within the understanding of the GNSS systems, discussions could be made on the system architecture and working principles, hardware and operations. For example, users should understand that GNSS are radio navigation systems which uses satellites to transmit the navigation signals to its users. The satellites however are passive devices. It only re-transmitting back whatever information uploaded to its memory. The system is actually governed by a network of Ground Control Stations which maintains and defined the reference datum, as well as tracking the satellites to determine its orbital motion. The users on the other hand requires a suitable receiver to receive signals from the satellites to obtained its services. GNSS offers at least three services, namely location-based services (LBS), precise timing and military/scientific. For the LBS, users need to receive at least signal from four satellites and using a triliteration formula within the receiver's firmware, to compute its position with respect to the reference datum of specific system. For the precise timing applications, a single satellite is what is needed to give time accurate to about a millisecond. Signals of GNSS could also be used for scientific purposes, such as for the monitoring of the Total electron Content (TEC) of the atmosphere (Walter, 2003).

Users also need to know capabilities and limitations of GNSS. On a basic mode user operation, GNSS could give positioning accuracy to within several tenths of meters and height determinations to about three times as worse. On a differential mode (D-GNSS), a significant improvement could be achieved, with positioning accuracy to 2-3 meters only and height to about 5-7 meters. With the use of carrier-phase data of the transmitted signals, a more sophisticated receiver as well as rigorous data processing algorithm, user could determine their position up to couple centimeters and height to about several centimeters. Limitations to GNSS services are mainly things that interrupts the operation of its system, such as the delay in the propagation path of the signal caused by the atmosphere, signal blockage such as by dense tree foliage and structures such as building walls and tunnels. For sure, GNSS signals could not travels in water. GNSS need a reasonable area of open sky, to enable the receiver receiving its signal. GNSS signals could also be interrupted by other signal transmissions from such as radio and cellular services tower.

Users have to be aware that at least two of the existing GNSS, namely the GPS and GLONASS are military navigation system, hence having a dual-service signals, military and civilian. By this virtue, military usage of these systems takes precedent over the civilian usage. By default also, military services is of several fold better than the civilian services.

3.0 GNSS EDUCATION PROGRAMS IN MALAYSIA

GNSS education and training programs in Malaysia can be grouped into formal education programs, short-courses and other programs.

3.1 Formal GNSS Education Programs

Formal GNSS education programs are carried out through taught course and research, leading to an academic award.

Universiti Teknologi Malaysia (UTM) is probably the only local university offering taught courses in GNSS. Masters in Science (Satellite Navigation) contains subjects such as Navstar GPS, GPS Navigation, Navigation Systems, and Intelligent Transportation System. While Masters in Science (Satellite Surveying) contains subjects of GPS Surveying, GPS Geodesy, GPS Navigation, and GPS Applications in Surveying and GIS. Two other programs, Masters in Science (Geomatic Engineering) and Masters in Science (Hydrographis Surveying) contain a couple of GNSS related subjects (FKSG, 2003).

UTM is also teaching several GNSS subjects in their Bachelor Degree of Geomatic Engineering, namely GPS Surveying, Satellite Navigation, and Hydrographic Positioning Systems. Post Graduate program through research works related to GNSS are also offered in areas of Satellite Navigation, Satellite Surveying, Geomatic Engineering, Hydrographic Surveying.

Universiti Putra Malaysia (UPM) teaches subject of Satellite Surveying in their Bachelor of Civil Engineering as well as subject of GPS in their Masters of Engineering (Remote Sensing and GIS) (Mansor, 2004). Universiti Teknologi Mara (UiTM) are teaching topics of GNSS in subjects such as Physical and Satellite

Geodesy, Geodetic Surveying, and Hydrography, under their Bachelor of Surveying Sciences and Geomatic, as well as subject of Geodetic Surveying under their Diploma of Geomatic Science program (Rosdi, 2004). Universiti Teknologi Petronas (UTP) teaches topics of GNSS in subject Geomatic under their Bachelor of Civil Engineering, while Akademi Laut Malaysia (ALAM) also teaches topics of GNSS in their subject of Electronic Navigation Aids (ENA) (Matori, 2004). Universiti Sains Malaysia (USM) is also teaching GNSS and related topics in their Bachelor of Civil Engineering program (W. Ismail, 2004).

3.2 Short-Courses

Institutions mentioned earlier under item 3.1 also from time to time offers short courses in GNSS and related topics. Apart from that Institut Tanah dan Ukur Negara (INSTUN), under the Jabatan Ukur dan Pemetaan Malaysia (JUPEM) also offers short courses in GNSS and related topics, which is mainly for their own staff in-house HRD programs. These courses are mainly focused on subjects or topics. The other parties that offers short-courses, which on the other hand focuses on instrumentations – hardwares and softwares – are GNSS related local vendors.

3.3 Other GNSS Education Programs

Local institutions also organize seminars and meetings on GNSS and related field. Such meetings are (just to mentioned several of them, for example);

1. UNOOSA The first regional workshop was held in Malaysia in August 2001 for countries in Asia and the Pacific
2. International Symposium and Exhibition on Geoinformation series, started 2002 - current
3. National Seminar on Geoinformation, started 1997 – 2001
4. National Seminar on GNSS Applications, started 2004.

4.0 THE NEW GEOMATIC & GNSS ERA

In this era of the so-called GNSS era, knowledge and innovation is considered as a crucial input in the industrialization and development of any nations. The GNSS economy is strongly influenced by the liberalization of international trade system worldwide where emphasis is given to competitiveness. With this scenario, the importance of knowledge as a factor determining the growth of nations is critically important. Malaysia, as a developing nation, sourced out its quest for high-tech knowledge from abroad, especially in the early stages of her development.

But the New Economy changed how businesses are conducted and the new rules of the game require speed, flexibility and innovation. A metal casting firm uses computer-aided manufacturing technology to cut cost, time and energy. A farmer who sows genetically altered seed and drives a tractor navigate by the GPS satellites. Or a toy manufacturer that uses the Internet to take orders from customers all over around the world. The New Economy gives birth to industry giants such as the Apple Computers from Steve Job's and Steve Wozniak's garage and Dell Computers from the trunk of Michael Dell's car. A nation's economic success will increasingly be determined by how effectively they can spur technological innovation, entrepreneurship, education, specialized skills, and the transition of all organizations—public and private—from bureaucratic hierarchies to learning networks.

5.0 GENERAL TRENDS IN GEOMATIC KNOWLEDGE GENERATION

It is well known fact that the innovative activity which, is the primary source of knowledge generation, concentrated only in a number of developed nations. Within these developed nations, these activities are only concentrated and dominated by only a small number of corporations.

In developing nations, the primary mode of promoting technology advances is through technology acquisition. However, in this new era of economy, the focus is on innovation and the creation of new technology and higher value-added activities by increasing basic and applied research. Malaysia, for example in the early years of its development has placed its primary emphasis on technology acquisition. As its per capita income increases, Malaysia is putting in place major fundamental research & development programs in the public and private sectors in an attempt to attain world leadership in key areas.

Table 1 shows two indicators of innovative activity for key Asian nations. These two indicators cover both knowledge 'inputs' as well as 'output'. R&D expenditures are considered the 'input' indicator of the innovative activity. The knowledge output indicator considered in this study is patents obtained by inventors from different nations at the US Patent and Trademark Office over the past 25 years period (1975-2000). There are other forms of knowledge generation activities such as copyright and trade secret. However, because patenting is the primary form of intellectual property protection, patent data are considered to be the most available, objective and qualitative measure of knowledge output. Thus, a nation's patenting activity is an indicator of the strength of its research enterprise and technological strengths, both overall and in particular fields of technology.

The table reveals that an extreme form of knowledge generation concentration with just three nations of Asia, which account for the bulk of all innovative activities in Asia. This top three nation's of Asia, that is Japan, Taiwan and South Korea account for as much as 80% of Asia resources spent on R&D activity annually. In terms of knowledge output, the same top three nations have the most number of patents issued. They account nearly 98% of the knowledge output in terms of patents taken out in the US. Hence, the concentration in terms of knowledge output is even more uneven than for the knowledge inputs. But the obvious trend is that the control over knowledge is directly related to the amount of fund allocated to its R&D. Malaysia for example, allocated only 0.20% of its GDP for R&D purposes and this is reflected in the number of patents awarded for the past 25 year period, which amounted to only a meager 384 patents. The trend shows that Japan is way ahead in their innovation activities with a total of 426, 702 patents issued to them.

Besides the patenting activity defined by a nation of the inventor in all type of sectors, trends were also analyzed by the number of patents issued that are related to the Geomatic field. Keywords related to this field such as GPS, GNSS, mapping, remote sensing, triangulation, spatial, and photogrammetry are among others that are used in the definition. Table 2 shows the number of patents produced for the Geomatic field for a period from 1982 to 2001.

Nation	GDP 1999 (US $Billion)	R&D Expenditure as % of GDP (1998)	US Patents Taken (1975-2000)
Japan	4,357.7	2.90	426,702
China	991.2	0.69	1393
South Korea	406.9	2.68	19,935
India	440.5	0.67	1127
Taiwan	288.6	1.98	31968
Indonesia	151.9	0.09	153
Thailand	125.3	0.17	238
Malaysia	78.9	0.20	384
Hong Kong	158.6	0.25	4316
Singapore	84.9	1.79	1406
Philippines	76.5	0.08	228

Table 1: General Trend in Knowledge Generation in Asia

Period/ Country	1982-1986	1987-1991	1992-1996	1997-2001	Total
Japan	3	7	117	108	235
China	2	10	1	1	14
South Korea	0	1	3	5	9
India	0	0	0	2	2
Taiwan	0	1	5	14	20
Indonesia	0	0	0	0	0
Thailand	0	0	0	0	0
Malaysia	0	0	0	0	0
Hong Kong	0	0	2	1	3
Singapore	0	0	2	1	3
Philippines	0	0	0	0	0
Others	413	667	1058	1018	3156

Table 2: Number of Patents Produced for the Geomatic Field

Table 2 shows that Japan still leads in their patenting activities with a total of 235 Geomatic patents issued for the 20-year period. And this is followed by South Korea, Taiwan and China. Out of the total 3442 Geomatic patents issued by the U.S. Patent and Trademark Office, only 286 or 8% originates from the Asian countries. The remainder of the 92% of the patents mostly originates either from North America or Europe. The numbers shows that there is lack of innovative activities amongst the Geomatic professionals in the Asian region compared to their North American or European counterparts. What is more disturbing is that Malaysia, which boasted four higher education institutions (UTM, UPM, UiTM and USM) that offered Geomatic program does not possessed a single patent in the Geomatic sector. Ironically Singapore, which the number of Geomatic professionals is far less than that of Malaysia has already produced three patents that are related to the Geomatic sector.

To make a definitive comparison on the innovation activities of Geomatic sector to other sectors, data for five different sectors are compiled and tabulated for selected Asian nations. The sectors concerned are Advanced Materials, Automotive, Health, ICT and Transport. Table 3 shows the patents count of major Asian nations. The table is based on the indicators computed for the same four five-year periods: 1982-1986, 1987-1991, 1992-1996 and 1997-2001.

The table shows that Japan leads in all sectors in terms of the number of patents issued. But the technological capabilities of Korea and Taiwan are budding, with their growing strength most evident in the advanced materials and ICT sectors. In the transportation sector, Korea and Taiwan are showing steadily growing strength. On the other sides, three Asian nations of Malaysia, Hong Kong and Singapore do not have enough patenting activities in any of these five sectors to be identified as emerging competitors. Singapore for example allocated nearly 1.79 % of its GDP for R&D purposes and these percentage points is comparable to Korea or Taiwan, but still lags behind. The most probable reason for this trend is that these three nations lack what is called the indigenous R&D capability. For the most part, manufacturing and industrial development are currently supported by R&D done elsewhere.

Comparing the number of patents generated by Geomatic professionals with the other five sectors shows a very disturbing trend. Lets take Japan for example, leaders both in the number of Geomatic patents and number of all types of patents for Asian nation. For the 20-year period, Japan has produced a total of 235 patents related to Geomatic sector. Among the five sectors, transport shows the least number of patents produced that is 5213 patents. Therefore, when compared to the weakest link of the five sectors, Geomatic still pale behind considering the number of patents produced.

Even though Malaysia dose not produce a single patent in Geomatic field, but all the other five sectors have some form of innovative activities in terms of the number of patents. The problem of lack of innovative activity is not only confined to Malaysia alone, but also to all other Asian nations as shown both in Table 2 and 3. The lack of innovative activities it seems is not confined to a particular nation but to the Geomatic professionals itself.

6.0 CONCLUSIONS

Looking at the dismal performance of Geomatic professionals in terms of innovative activities in most part of Asian and Malaysia in particular, is it there is something that holding up these professionals from doing so? With our universities and numerous polytechnics offering Geomatic program, more is expected from them. Is it a problem of lack or inadequacy of skills? Or is it these professionals are too busy and being narrowly focused on doing something else?

Malaysian business are generally doing well, in large measure, as a result of our national investments in science and technology, and the innovation and competitiveness they yield. In this perpetual marathon that is global competition, now is the appropriate time to strengthen our effort into bringing the Geomatic field to greater heights. We must prepareourselves to seize new GNSS sector opportunities and create fertile ground for economic growth.

The world's GNSS sector is undergoing a fundamental transformation where revolutionary technological advances such as powerful personal computers; high-speed telecommunications and the Internet are the root cause of it. The sudden transformation of GNSS changed how Geomatic business is conducted and the new rules of the game require speed, flexibility and innovation. Geomatic studies need not be in the frenetic action of the cutting edge but revolves their organizing work around high technology. The Geomatic in the arena of GNSS derivatives holds vast potential for extending the technology-driven economic growth of a nation.

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Sector	**Advanced Material**					**Automotive**					**Health**					**ICT**					**Transport**					Total
Country	**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		**82-86**	**87-91**	**92-96**	**97-01**		
China	0	2	4	6	(12)	0	10	7	16	(33)	1	16	38	45	(100)	2	21	36	56	(115)	1	2	3	6	(12)	**272**
Hong Kong	0	1	1	1	(3)	1	2	3	3	(9)	1	4	12	17	(34)	7	7	26	32	(72)	1	1	2	3	(7)	**115**
India	0	2	6	6	(14)	0	0	3	4	(7)	11	15	57	65	(148)	1	4	41	49	(95)	0	0	3	9	(12)	**276**
Japan	46	1329	1862	3053	(6290)	2058	3754	3217	4326	(13355)	1497	2510	3008	3867	(10882)	7012	16208	25015	45924	(94159)	432	1215	1560	2006	(5213)	**129899**
Malaysia	0	0	0	1	(1)	1	0	0	2	(3)	0	0	2	2	(4)	2	4	10	15	(31)	0	0	2	4	(6)	**45**
Singapore	0	2	3	7	(12)	1	0	0	1	(2)	0	0	3	5	(8)	1	8	82	127	(218)	0	1	0	1	(2)	**242**
S. Korea	1	3	57	65	(126)	2	27	72	103	(204)	5	12	74	92	(183)	4	224	1629	3429	(5286)	0	7	38	65	(110)	**5549**
Taiwan	1	9	45	83	(138)	15	109	204	326	(654)	4	8	34	101	(147)	12	113	1007	1743	(2875)	1	22	39	47	(109)	**3923**

Note: Number in brackets is the total of each sector.

Table 3: Patent Counts of Other Sectors for Selected Asian Countries.