Facing the Challenge of the Shrinking, Aging Surveying Profession

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Key words: professional profile, aging profession, surveying education institutions, future directions

SUMMARY
During the past two decades the surveying profession across the globe has undertaken monumental changes, including the fundamentals of measurement with all digital equipment, digital data collection, software based data analysis and product design, and producing digital products for our clients. Surveyors have kept up with the information revolution and played a key role in the move towards global geospatial awareness. Our productivity and efficiency has increased. Data on the profession shows that we are getting older and fewer in number to a point where we are now concerned about the shortage of surveying expertise in the near future. This paper looks at examples of the age profile of the profession, the closing of key university programs, and the concerns of educating our next generation of surveyors.

RESUMEN
Durante los dos décadas pasadas la profesión de agrimensura ha cambiado enormamente, incluyendo cambios en los fundaciones de mensura con varios equipo digital; la captura de datos digitales; software para el análisis de datos y el diseño de productos; y el desarrollo de productos digitales para nuestros clientes. Los agrimensores ha mantenida corriente con la revolución informática y jugado un rol clave en el movimiento hasta una conocimiento geo-espacial al nivel global. Nuestra productividad y eficiencia ha mejorado. Datos sobre la profesión indica que estamos envejecimiento y disminuyendo, hasta el punto que tenemos preocupación sobre el escasez de pericia en agrimensura en el futuro próximo. Este artículo investiga ejemplos del perfil de edad de la profesión, la cierra de programas universitarios, y la preocupación sobre la educación de la próxima generación de agrimensores.

RÉSUMÉ
Durant les vingts dernières années, la profession de Géomètre à travers le monde a entrepris des changements monumentaux, notamment dans les principes fondamentaux de la mesure, grâce aux technologies numériques : collecte de données numériques ; logiciel d'analyse de données et de conception ; et création de produits numériques pour nos clients. Les Géomètres ont suivi la révolution de l'information et ont joué un rôle clé dans le mouvement de sensibilisation géospatiale globale. Notre productivité et notre efficacité ont augmenté. Les données sur la profession laissent cependant apparaître un vieillissement et une diminution croissante des effectifs, à tel point que nous sommes désormais préoccupés par une possible pénurie de travaux d'expertise, et ce dans un avenir proche. Cet article étudie des échantillons de la profession correspondant au profil type d'âge, la fermeture de programmes universitaires clés, et les inquiétudes liées à l'éducation des futurs générations de Géomètres.

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1. INTRODUCTION

In this paper we analyze changes to the surveying profession over the last twenty years and highlight some concerns about the next ten years. We attempt to address the following questions: What has changed in two decades, where are we now, and what are the challenges in the near future? Two particular aspects of the profession are looked at in detail: a) The current age profile of the profession, and b) the health of academic programs supplying the next generation of professional personnel.

In 1990 satellite navigation and positioning was just coming online with the launching of the full constellation of the U.S. Global Positioning System (GPS) satellites. GPS receiver technology and software was being developed at a furious pace with markets for receivers being opened up by those organizations that could afford the very high development and startup costs.

At the same time, personal computers were well established, though also relatively expensive in comparison with today's prices. Software that aided the surveying profession, such as automated drafting and field data adjustment software, was becoming easier to use and entering mainstream professional survey practice.

By 1990, digital sensors had replaced all optical analog measurement systems used to measure precise locations of objects on or near the earth's surface, being the core of the surveying professions primary data source. Hand held data loggers supplemented the surveyor's field book. Field to finish data streaming with automated checking rapidly replaced hand calculator computations. Drafting skills transformed from penmanship to AutoCad, with operators running faster and faster desktop computers with low cost multi-coloured digital plotters.

In the last two decades Geographic Information Systems (GIS) and digital mapping have made huge strides in capabilities and usability, resulting in the rapid introduction of these technologies into mainstream business and government institutions looking for efficient ways to manage spatially related infrastructure and information. With the growth of the GIS industry, the demand for accurate digital geospatial data has increased, adding to the services that the surveying profession could provide these new GIS savvy clients.

These changes are all well documented and have all made their way into the quiver of technologies that the surveying education institutions teach, aimed at both survey technicians and surveying professionals.

2. GEOMATICS/SURVEYING PROFESSION

For the past two decades the authors have been full-time academics in the United States and directly involved in the education of young surveying professionals while being actively engaged with the surveying profession. During this academic tenure, the authors have witnessed the rapid change in technology embraced by the surveying profession along with a rapid increase in efficiency of the profession in turning out surveying products. The figures below support the notion that these increases in efficiency resulted in a reduction in the number of personnel needed to produce an equivalent amount of surveying output that the old pre-GPS analog measuring instruments required.

In order to document the changes to the profession during the adoption of the new technologies data on the age profile of the profession was collected to observe the change in demographics of the profession over time. Data from the State of Texas in the United States was primarily used to track these changes with some data coming from Florida and the State of New South Wales, Australia.

2.1 Texas

In 1990 there were 3494 Registered Professional Land Surveyors in Texas (Texas Board of Professional Land Surveying 2000-2010). By 2000 the total number had decreased to 2877. The year 2000 was the first year that the age profile of the Texas surveyors was analyzed. The results appear in Figure 1.

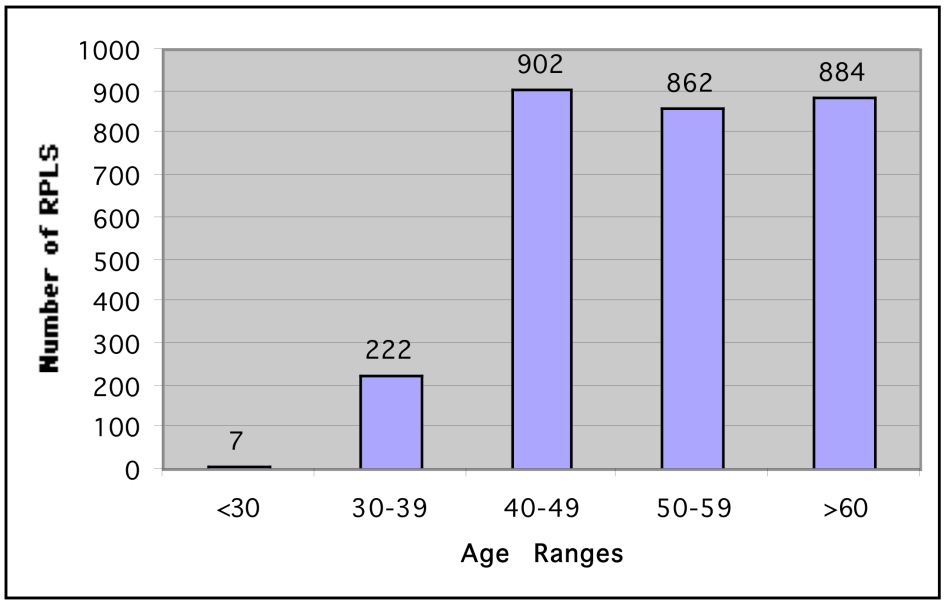

Figure 1. Registered Professional Land Surveyors – Texas 2000
(n = 2877)

The number of surveyors in Texas reduced by 17.7% over the decade of the 1990s . This in contrast to the huge increases in economic activity in Texas with the run up of the Dot.Com asset price bubble in the equities markets that ended in 2000.

The last decade has seen a further, if not so quite dramatic, reduction in the number of surveyors in Texas. The total number of surveyors for the start of 2010 is 2588, down another 10.0% from 2000.

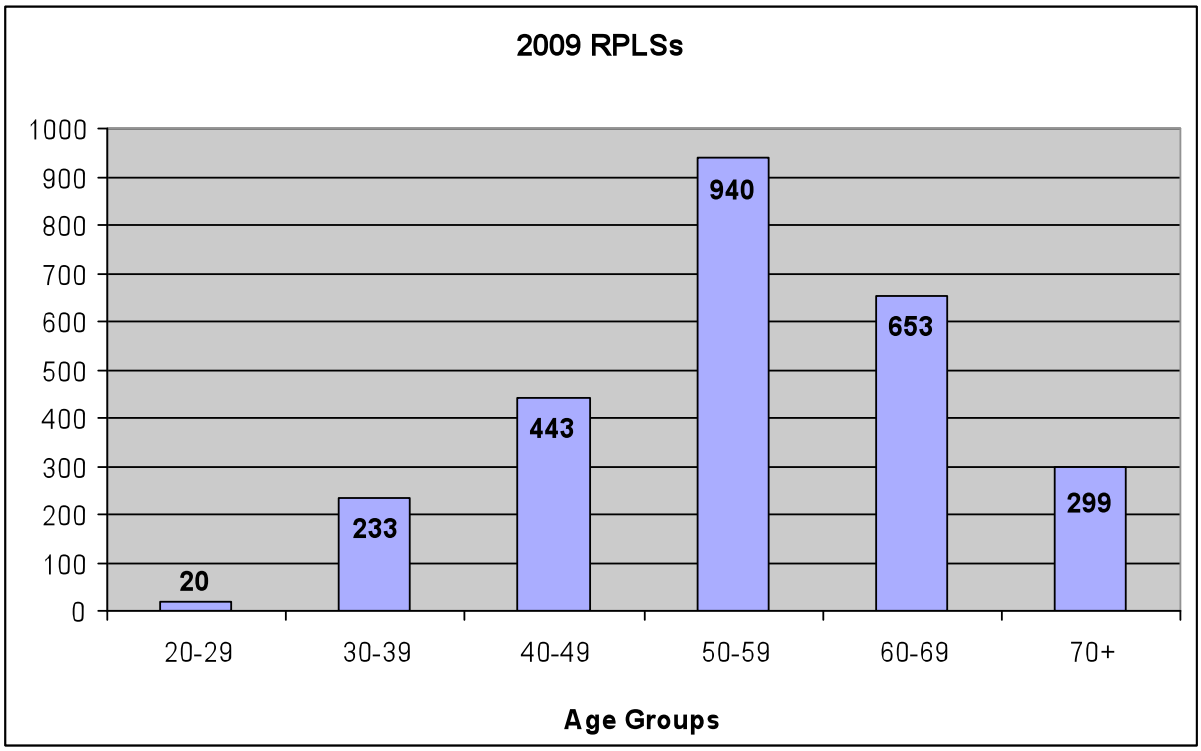

Figure 2. Registered Professional Land Surveyors - Texas
31st December 2009 - 1st January 2010
n=2588

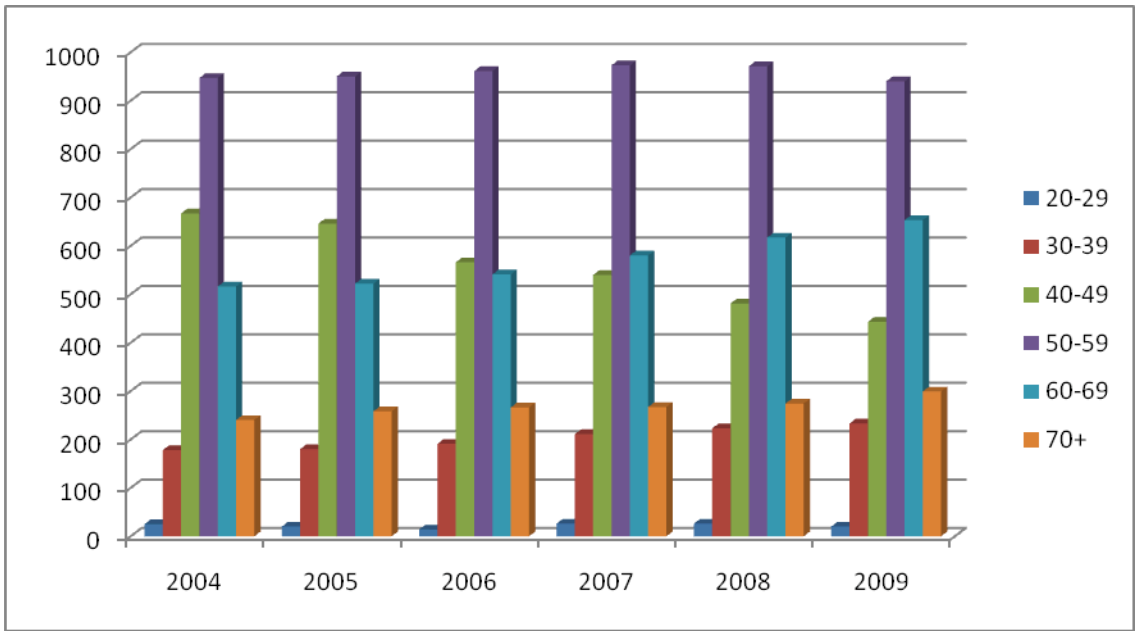

Figure 3. Changing Age Structure of Professional Surveyors in Texas (2004 – 2009)

The age structure for years 2004 to 2009 (shown in Figure 3) indicates that the 40's age group is decreasing the most significantly, a decrease of 224. The 50's age group has been the steadiest, decreasing by a mere 7 between 2004 and 2009. Both the 60's and above 70 age groups have shown a steady increase. Note that detail data not shown indictaes that about 20% of Texas surveyors are 65 or older, where 65 years is considered the retirement age (not compuslory) in the U.S.

Table 1 shows that the number of surveyors has leveled off over the last half of the decade, however, the average age of surveyors continues to creep upwards and the median age is increasing presently by one year every two years (from 53 years in 2000 to 56 years in 2010). The number of younger professionals entering the profession is insufficient to stabilize the aging trend of the profession. Note that the percentage of surveyors younger than forty years is smaller than the percentage of surveyors seventy years or older. Over the next 20 years over 70% of the current professional surveyors will likely retire as baby-boomers leave the workforce. At the current rate, the over 50 age group will only replace one-third of the number retiring.

	2004	***2005***	***2006***	***2007***	***2008***	***2009***
Total	2573	2576	2539	2597	2592	2588
Average	54.23	54.69	55.16	55.14	55.42	55.79
Median	54	54	55	55	56	56
65+	478	477	478	482	519	540
% 65+	18.6	18.5	18.8	18.6	20.0	20.9

Table 1. Change in Numbers of RPLS in Texas 2004-2009

2.2 Florida

Florida's economy depends heavily on the property market and tourism, both of which have been severely impacted in the latest global economic downturn. This crisis will affect student numbers and has already reduced the demand for surveying services and layoffs within surveying companies. No 'clean' age data is available for professional surveyors in Florida, but data is available for the number of new surveying licenses issued each year. This data is graphed for years 1976- 2009 in Figure 4. Since a high of 177 in 2001 it has dropped consistently down to 24 in 2009.

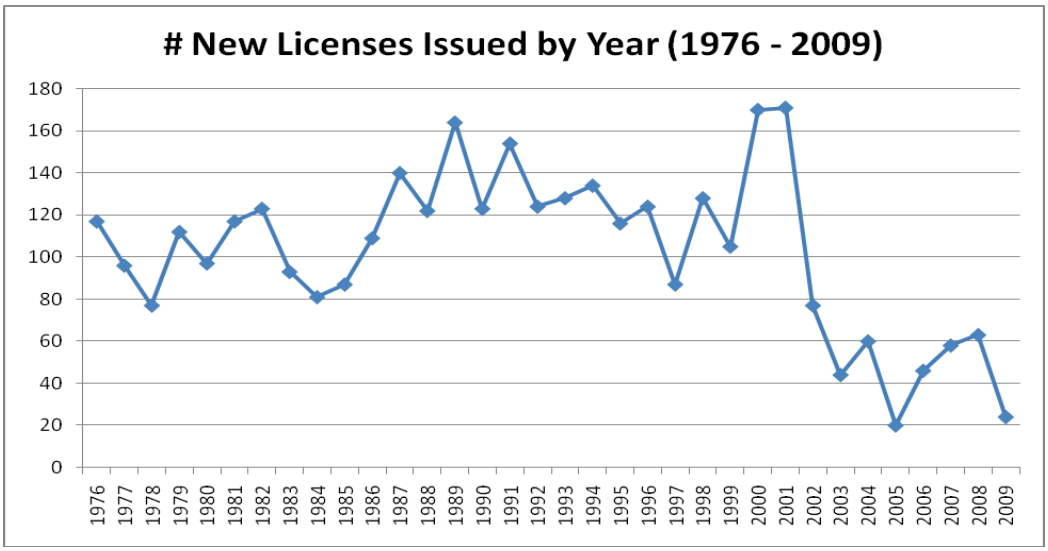

Figure 4. Changing Supply of Licensed Surveyors in Florida (FSMS 2010) (1976 – 2009)

Florida requires four years of experience after obtaining a degree which means there is some latency between graduation and licensing. However, it is clear from this graph that surveying services are, like Texas, being met largely by those who have been in the profession for some time.

2.3 New South Wales

The same trend appears in the number of surveyors in New South Wales, Australia. Data obtained in 2007 shows a similar trend to Texas (see Figure 5). One noticeable difference being the larger number (20 %) of surveyors younger than 40 and the small number (3.3%) over seventy years old. Figure 6 shows a similar trend to Texas in the total number of surveyors in New South Wales, leveling out at just below 1000 surveyors.

Overall, from 1991 to 2007 New South Wales surveyors declined in number by 38% while Texas saw a decline of 26% over the past two decades. The technological changes and

improved efficiencies discussed in the introduction have occured at the same time a decrease in the number of surveyors took place and during a period when the demand for surveying services has increased with increasing population and development. The market for real estate has certainly increased over the past two decades, which has also added to the demand for surveying services.

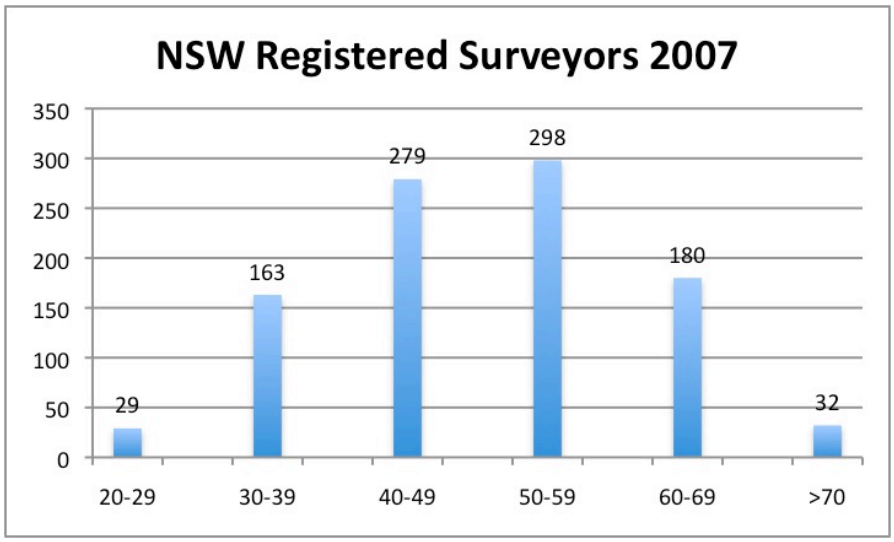

Figure 5 Registered Surveyors by Age Group – New South Wales - 2007 (n = 981) (NSW Board of Surveying and Spatial Information, 2007)

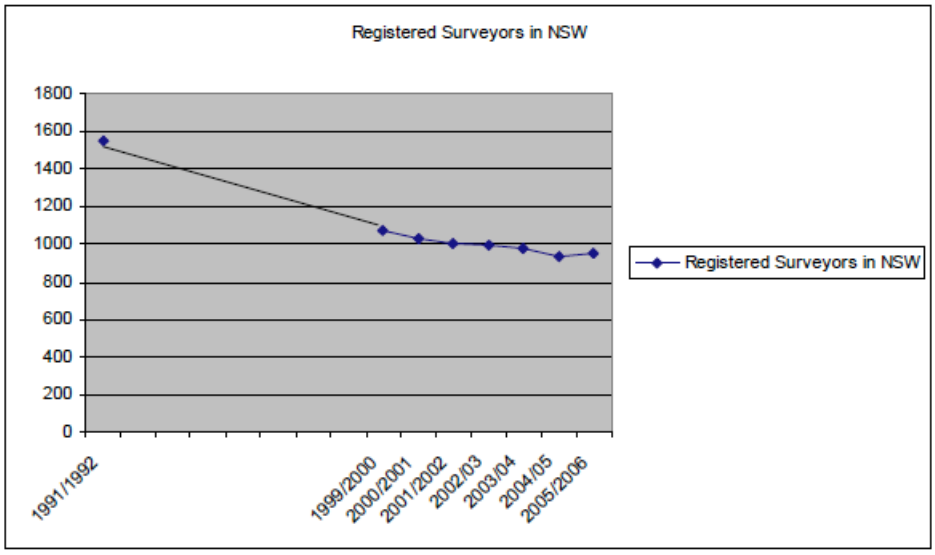

Figure 6. Total Number Registered Surveyors in New South Wales 1992 - 2006 (Blanchfield, and Elfick, 2006)

Economics would dictate that with a shrinking workforce and a continuously increasing demand for surveying services, the surveying profession should have displayed a remarkably robust increase in income. While we have seen increases in salaries offered to graduates entering the profession, the overall income levels of most of the surveying profession has not shown the expected increases acording to economic theory of supply and demand. It seems the surveying profession is charging less for their services as the value of real estate increases and the demand for services increases with the population.

It appears that the surveying profession charges for their time rather than the value of their services to their clients. Unlike other professions, for example engineering or architecture, who charge an ad valorum fee for service, surveyors tend to diminish their products value over time by charging hourly rates rather than ad valorum fees. Changing to ad valorum fees would greatly increase the income of the profession, which would in turn attract many more bright young minds to the profession.

3. PROFILE OF GEOMATICS AT US UNIVERSITIES[1]

3.1 University of Wisconsin (UW)

In the summer of 2006 the last three professors in the ”Surveying-option” program retired at the UW. This marked the end of an era as their retirement meant the end of a dedicated Geomatics program within the Department of Civil and Environmental Engineering at UW. This program had been whittled down over the years as a generation of surveying educators retired without being reploaced. The end of this program is especially significant to Geomatics in the US because of its huge contribution to the Geomatics teaching capacity in the country. By 1990 forty percent (40%) of all faculty at major Geomatics programs in the country had been educated through the surveying program at UW. This included faculty at programs in the Universities of Florida, UC-Fresno, Maine, Ohio State and Purdue.

Like other programs in the US, the UW Geomatics program had its own identity at the undergraduate level, but at the graduate level it was regarded as part of the civil and environmental engineering (CEE) program. With one exception, who served as chair of the department from 1986-1990, Geomatics faculty did not hold the leadership reigns of the CEE department. Beginning in the 1990s, the CEE began to systematically dismantle the Geomatics “program” by not refilling vacant positions that arose due to the retirement of the seven faculty members. Granted, there were several difficult budget years for the university and college, but the fact that not one of these positions was refilled is a clear indicator that Geomatics was, to put it mildly, not regarded as a priority area. Although there was no overt statement made, one can conclude that a policy decision was made in the 1990s to do away with Geomatics within CEE. This marginalization of Geomatics within Civil Engineering departments is not unique to the University of Wisconsin as will become evident in this paper.

3.2 University of Florida

The University of Florida also faced challenges to its sustainability. Although housed in the Department of Civil Engineering for most of its life, the UF Geomatics Program has for many years offered its own undergraduate Geomatics degree. With changes in leadership at the college and department levels around 2002, resources from the department to the Geomatics Program (space, teaching assistants, secretary, budget, etc.) began to be reduced or removed completely. In an era when most engineering deans seem bent on moving their programs into the top ten rankings as defined by US News and World Report, programs that did not either secure large research grants or attract large numbers of PhD students (both important ranking factors) were not viewed favorably. Since Civil Engineering did not appear to be a top priority for the College of Engineering, and Geomatics was evidently not a high priority for the Department of Civil Engineering, the UF Geomatics program was doubly marginalized.

In a radical move, at least by most university standards, the Geomatics faculty began in 2003 to explore the option of transferring the entire program out of the College of Engineering. Their initial investigations identified the School of Forest Resources and Conservation (SFRC) in the College of Agriculture and Life Sciences (CALS) as the best option for the move given past collaboration with SFRC faculty and the affinity of surveying and forestry. Additionally, CALS is located in the land grant part of the university which means that its mission is oriented towards the public at large. This meant they were far more supportive of undergraduate education, particularly a program that led to licensing professionals. After a year of negotiations, in which they sought to transfer four faculty positions[2] from the College of Engineering to CALS, and, reached an agreement whereby two faculty positions were transferred and two were 'bought' from Engineering. In 2004 the Geomatics program moved to the SFRC. However, the undergraduate degree in Geomatics, and the coursework offered, have largely remained the same.

Like the Surveying program at the UW, administrators in engineering had effectively written off the Geomatics program and were slowly but surely dismantling it. However, within three years of moving to the SFRC the UF Geomatics program had doubled its faculty numbers, secured funding to a develop distance-ed capacity, and through supportive leadership increased its undergraduate numbers substantially. The significant support given by Florida Geomatics professionals in this endeavor should also be noted. This success story indicates that Geomatics can thrive at a major university provided it is housed within a supportive institutional unit.

3.3 Ohio State University (OSU)

Until about 1995 Geomatics at Ohio State University was taught through the Department of Geodetic Science and Surveying located in the College of Math and Physical Sciences. Besides Maine, OSU was the only stand-alone department in Geomatics at that time. However, this changed in 1995 when it lost its departmental status and was incorporated into the Department of Civil and Environmental Engineering (CEE). Unlike most of its

counterparts, OSU's Geomatics program did at least manage to retain some identity at the departmental level through renaming the department Civil and Environmental Engineering *and* Geodetic Science (CEEGS). However, it is now run as a program within the administrative structure of this department which falls under the College of Engineering.

In 2005 the geodesy faculty of the Geomatics Program were transferred to the Department of Geological Sciences (College of Mathematical and Physical Sciences) which subsequently was renamed the School of Earth Sciences, with Geodesy and Geospatial Science as one of the divisions within the School. This unit collaborates with the Geomatics faculty in CEEGS in offering graduate programs that specialize in geodesy, photogrammetry or mapping/GIS. Geomatics at OSU has therefore shifted from a cohesive program offered through a specific department to a program where geodesy has detached itself from the remainder of the program and established itself in a different unit within a different college.

3.4 University of Maine

In 2003 the University of Maine created a new niche for undergraduate Geomatics education by focusing on "technical, managerial, and policy issues associated with constructing and managing computer-based information systems for modern organizations."[3] In the process they jettisoned most of their conventional surveying offerings which had for many years provided the basic education for practicing surveyors in Maine and the northeastern US. In an effort to counter the backlash from the surveying profession, and continue to meet the demand for surveying education, the School of Engineering Technology agreed to house a more technically oriented surveying program where "the practical aspects rather than the theory of these disciplines are emphasized in the teaching."[4] This has also been described as a "terminal program," meaning there is no intention to expand to the graduate level (Greulich 2003: 120)

The end-result of these moves is that the Geomatics program at Maine has essentially separated into an undergraduate program – Surveying Engineering Technology - and a graduate program taught through the Department of Spatial Information Science and Engineering (within the College of Engineering). By focusing on the scientific aspects of spatial information, UM have set their program on a new trajectory which centers on GIS in its broadest definition. Institutionally, however, they have remained under the administration of the College of Engineering.

3.5 Purdue University

The Land Surveying and Geomatics Engineering 'program' at Purdue has traditionally been closely linked and administered through the Department of Civil Engineering. At Purdue, Geomatics is treated more like a specialization of civil engineering than as a separate program.[5] Students are encouraged to do an extra year beyond the BS in civil engineering in order to specialize in Geomatics. Current proposals at Purdue focus on developing an inter-disciplinary Masters degree in Geo-Sensing which would link to the various departments of engineering and beyond. This vision still retains an engineering-centric approach, although

the focus would be on remote sensing and photogrammetry. To achieve this, the Geomatics faculty have requested several new faculty lines which are still waiting for final approval by the dean of engineering.[6]

3.6 Texas A&M University – Corpus Christi

The program at Texas A&M Corpus Christi is built on the Geospatial Industry model and incorporates surveying education in the Bachelor of Science (BS) in Geographic Information Science and Master of Science (MS) in Geospatial Surveying Engineering. This program was designed in the early 1990s by a team of both surveyors and GIS experts. The philosophy of the program was to incorporate surveying education as an integral component of the geospatial sciences and offer an emphasis in geomatics (digital surveying and professional practise) as well as a GIS emphasis (with a focus on geospatial technologies and computer science). The BS program was implemented in 1995 and the MS was implemented in 2007.

The Texas A&M University-Corpus Christi has maintained an undergraduate student body of around 80 students and a post-graduate program of 30-40 students. The faculty has grown from 2 in 1995 to 6 in 2009. The program has produced 152 graduates from the BS program and 10 from the MS program. Of the 152 BS graduates, 112 or 74% have elected to pursue careers in the surveying profession with 38 now Registered Professional Land Surveyors. The lure of students to the program is the name and the focus on the geospatial industry rather than surveying, which is generally not on the minds of graduating high school leavers.

4. MAPPING THE FUTURE

The splitting of the original Surveying Engineering Department into two entities at UM and OSU appears to support the claim that there is an irreconcilable difference between the needs of an undergraduate Surveying/Geomatics program – designed to respond to the needs of a Surveying profession – and the research demands that typically drive faculty careers at major universities. The pessimistic conclusion implicit in such a claim is that conventional surveying (as reflected in current geomatics programs) is intellectually barren and research does not have a significant role to play in redefining its future role in society. It is revealing that under the new arrangement at UM the undergraduate entity providing education for future professional surveyors does not have departmental status and comprises half the number of faculty as the Department of Spatial Information Science and Engineering. This increasing divide between undergraduate and graduate programs is also evident at OSU, and Purdue.

While this division into separate undergraduate and graduate programs may be a rational restructuring within the broader university administrative structure, it presents one crucial dilemma for the future of surveying/Geomatics. Where will the professors of tomorrow come from if none of the students graduating from undergraduate Surveying/Geomatics programs move on to pursue graduate degrees? Will programs have to rely on practitioners with an undergraduate or at most a Masters degree,[7] or will the focus of Surveying/Geomatics shift to

spatial information science as the new core? This shift would require a radical change in the current Surveying/Geomatics paradigm in the US which is largely based on serving development and civil engineering activities. Many of us believed that the traditional paradigm would change with the advent of GIS, but surveyors in the US (and elsewhere) have been slow to adopt GIS as a bridge into the spatial information management world. Individual data products remain the key marketable resource with little recognition that these are part of a larger spatial infrastructure.

It is clear from graduate student interests that very few are interested in focusing on Surveying in its narrow definition. The profile of professors entering the Geomatics ranks today is very different than those that entered the ranks 10-20 years ago. In a recent (2006) search for a faculty member at one of the universities discussed in this paper, 42 applicants responded to a job description that was broadly defined, requiring applicants to have a specialization in any one of the several areas of Geomatics, but still be qualified to teach basic surveying courses. The profile of these applicants is summarized and compared with the 1990 profile of faculty at major Geomatics programs in the US in Table 2 below. In 2006 the only candidates with sufficient background in Surveying were from Asia, Africa or the Middle East. None of the 3 American-born applicants had any surveying background in 2006, while in 1990 most faculty had at least a Bachelors degree in surveying and 80% were born in the US.

1990 Profile	2006 Profile
• 80% American-born	• 5% American-born
• PhD in Photogrammetry, Cadastral Studies, Geodesy, GIS/LIS…	• 50% with a PhD in remote sensing
• Most had at least a BS in Surveying	• 80% with no surveying background

Table 2. Comparison of Geomatics Faculty Profiles – 1990 vs 2006

This comparison shows an increasing divide between the origin, discipline and qualifications of aspiring Geomatics professors and the demands and requirements of the surveying profession in the US. Faculty that are steeped in basic surveying with a specialization in one of the areas of Geomatics are just not available anymore. This calls for a change in direction or different roadmap, perhaps along the lines of programs such as those at UM and Texas A&M. Another direction would be more heavily into the sustainable development area, a topic that has been receiving increasing attention with various FIG forums. The new Sustainable Development Practice degree (Barnes et al 2010) at UF offers such an opportunity, although it is not part of the Geomatics Program.

The proliferation of Surveying programs at smaller colleges in the US[8] provides one potential solution to educating future professional surveyors. However, these colleges do not have graduate programs in Surveying/Geomatics and therefore will not produce future Geomatics professors. In a provocative paper (see Greulich 2005; 2006) presented at the 20th Surveying

and Mapping Educators Conference, Hazelton (2005) suggested that the US surveying profession should look off-shore for a solution. Specifically, he outlined a scenario in which US surveyors limit their role to data collection and rely on the "more comprehensive and advanced" Geomatics skills of foreign professionals to complete the more challenging part of the job (p. 145). This is quite different than the usual off-shoring model in the US where simple, labor intensive tasks are out-sourced to countries like India where the labor costs are much lower. The latter is already occurring, for example, at local title insurance companies in where title evidence (deeds) are transferred off-shore and the chains of title developed remotely.

5. CONCLUSIONS

Clearly the traditional surveying academic programs of the 1960s, 1970s, and 1980s are not sustainable with the current numbers of students seeking entry into the surveying profession. Those high school leavers with the talent needed to excel in the surveying profession have many more career choices than were available twenty years ago. Professional surveying is a critical necessity for the real estate market to function. However, while this role will never dissappear, the profession is also an integral part of the wider geospatial industry. The surveying profession is slowly adjusting to the possibilities of a wider market for geospatial positioning services and a wider pool of potential talent that can grow a future workforce.

In this paper we have presented evidence of the shrinking and aging surveying profession. It shows clearly that the profession in the US is top-heavy – most of the members are over 50 and some of them over 70. This suggests that the surveying profession may reach a threshhold point where it can no longer supply sufficient qualified individuals to meet societal needs. The transformation in Geomatics educational institutions over the past 10-15 years shows no evidence of making up the losses from retirement. Perhaps most important to the future of Geomatics is the acute shortage of conventionally qualified professors and lecturers to teach the students who would become future professionals.

In spite of all of this negative evidence there are a number of innovative programs that demonstrate a way forward. Texas A&M University-Corpus Christi and Troy State University, Alabama, have embraced academic programs that marry professional surveying education to the wider geospatial industry. Students entering these programs have common courses in geospatial measurement and spatial modeling, then build on these skills to specialise in either GIS or surveying. While these programs are attracting students, recruiting qualified faculty with professional surveying qualifications at all geomatics programs remains a challenge. A challenge that the surveying profession and academia need to address in the near future.

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BIOGRAPHICAL NOTES

Gary Jeffress

Dr. Gary Jeffress is Professor of Geographic Information Science and Director of the Conrad Blucher Institute for Surveying and Science at Texas A&M University-Corpus Christi. Dr. Jeffress is Principal Investigator for the Texas Coastal Ocean Observation Network and the Texas Height Modernization program. He holds a Ph.D. in Surveying Engineering from the University of Maine (National Center for Geographic Information and Analysis), Master of Surveying Science and Bachelor of Surveying degrees from the University of New South Wales. Dr. Jeffress is a Registered Professional Land Surveyor in the State of Texas and past-president of the Texas Society of Professional Surveyors and past-president of the Geographic and Land Information Society. Dr. Jeffress currently sits on the Hydrographic Services Review Panel, and the Data Archiving and Access Requirements Working Group for the Scientific Advisory Board of the National Oceanic and Atmospheric Administration.

Dr. Jeffress was born in Sydney, Australia and has been a citizen of the United States since 2003. He has lived in Corpus Christi since 1990. He is married to Rhonda Bergey, MBA, CPA. He has two daughters, Laura 16, and Katie 14.

Grenville Barnes

Dr. Grenville Barnes is Associate Professor of Geomatics at the University of Florida. He received his early education at the University of Natal and completed his Ph.D. at the University of Wisconsin, Madison in 1988. His work has dealt with technical, institutional, legal and policy issues associated with cadastral surveying and property information systems in developing countries. He has worked as a researcher, consultant or educator in over twenty countries, primarily in Latin America, the Caribbean and Southern Africa. Grenville has published in a wide variety of professional journals in the US, Canada, South Africa, India, and Brazil. He currently serves as the Co-Director of the Masters in Sustainable Development Practice (MDP) Program at the University of Florida.

Dr. Barnes was born in South Africa, but has been based in the United States for the past 26 years and lived in Gainesville since 1993. He is married to Fiona Barnes, Ph.D., and they have a daughter, Sarah 18, and a son, Barrie 13, who have contributed a number of grey hairs to their parents.

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Endnotes

[1] This section and the next draw heavily on Barnes (2009)
[2] The fifth faculty elected to stay in Engineering
[3] http://ise.umaine.edu/
[4] http://www.umaine.edu/set/svt/Newsletters/News021029.pdf
[5] See https://engineering.purdue.edu/CE/Academics/Undergraduate/ (Feb 09)
[6] S. Johnson – personal communication, 2009
[7] Recent job advertisement at Troy State University and Alaska show this trend already exists.
[8] See .http://www.lsrp.com/colleges.pdf for a list of Colleges and Universities with Surveying/Geomatics Programs (Feb 2009)