Surveying and Geomatics Curricula in Nigerian Universities – The Professional and Educational Challenges

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Key words: Curriculum, Education, Geomatics, Surveying, and Technology.

ABSTRACT

Today's technological advances are not only influencing the hardware and techniques for capturing survey data, but are presenting innovative means of communicating and presenting information. For Surveying Curricula to remain relevant in this dispensation, it must ensure that this new advances are fully harnessed such that its graduates are better prepared to assume a wider array of surveying roles than are geographers, city planners, civil engineers and computer programmers. However, in many of the third world countries, lack of resources, high level of illiteracy, un-trainable professionals, lack of awareness among the college youths, etc. have all conspired to frustrate the emergent of Geomatics engineering curricula in the universities.

Assistance, such as; – recruitment, scholarship support, equipment loans/purchase, funding/donations, student holiday jobs, and permanent jobs after graduation – necessary to encourage the successful implementation of geoinformation sciences in the universities are almost non-existent. Nigeria presents an illustrative example of this phenomenon. This paper also highlights some of the professional and educational challenges facing the integration of Geo-Information technology into the Surveying Curricula of Nigerian Universities.

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1. INTRODUCTION

Due to advances in computer and space technologies, surveying and mapping have been totally revolutionized. Conventional methods and instruments in surveying and mapping have been transformed to analytical and full digital. The surveyor now has at his disposal, the use of geo-information technology tools to perform his professional duties in a more efficient and effective way. Thus, the nomenclature too is changing, instead of Surveying; the surveyor now talks of geoinformatics or geomatics - the two words generally meaning the same thing. Likewise, more innovative means of communicating and presenting the information are surfacing; surveying curriculum in the institute of higher learning are fast changing to meet up with the challenges of the time.

The most efficient way to approach an educational programme for any discipline is from the perspective of the prospective beneficiaries of such efforts. We must ask: how will prospective students (ultimately graduates) of a geomatics engineering or related programme be best served? The primary responsibility of such education must be to prepare graduates for a role in the competitive market place. The result must ensure that geomatics engineering graduates are better prepared to assume a wider array of surveying roles than are geographers, computer programmers, city planners and civil engineers. Moreover, they should possess the knowledge of every link and data flow in the geoinformation process (see Fig.1)

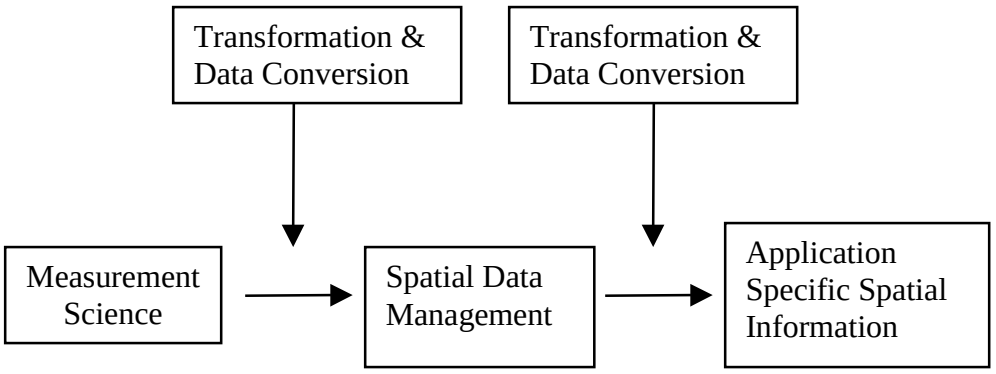

Figure 1: Geoinformation Process

2. TECHNOLOGICAL TRENDS IN SURVEYING

The technological advances that are transforming the traditional surveying activities include the global positioning system (GPS) receivers and computers. Both are impacting surveying operation and education by creating new opportunities for surveying organizations and researches in related and other fields.

The GPS receiver is currently one of the preferred equipment for surveying activities involving large areas. The technology is used in (Derby, 2000),

- Control surveys for mapping extensive areas
- Kinematic GPS for the mapping of existing features such as road centerlines in heavily used roads and urban centres.
- Mapping of existing features for geographic information systems
- Hydrographic surveys
- Airborne GPS to provide photo controls for photgrammetric mapping.
- Researches in robotics, space exploration, expert systems, telecommunications, missile guidance systems, etc.

In addition to the technological advances through GPS, computer-dependent technologies are also expanding the career opportunities and training of surveyors. Some of these emerging technologies involve Geographic Information Systems (GIS), Softcopy/Digital Photogrammetry and Remote Sensing systems applications - image processing and analysis. For instance, GIS has become the preferred tools for analyzing spatially referenced data. These valuable analytical and decision support tools are used in a wide range of public and private enterprises to explain events, predict outcomes, and develop strategies for managing resources.

With development in digital photogrammetry and remote sensing, multiple layers of images in digital format can be extracted and processed simultaneously, and the required information generated and transmitted in the appropriate format for dissemination. The modern equipment enables automation of the photogrammetic measurement and feature interpretation processes in a digital environment.

Apart from enabling aerial triangulation, orthophotos, digital terrain modeling (DTM); advances in digital photogrammetry has enabled easy interaction with GIS database, with digital images, especially color photographs from softcopy photogrammetry as input data for GIS displays and related presentations.

2.1 Implications for surveying education and practice

Obviously, the central tool in geoinformatics or geomatics is the geographic (or geospatial) information system (GIS). Apart from the establishment of national geodetic framework - which also serves at framework for GIS applications, the other aspects of surveying and mapping activities are now subsumed in GIS applications whose instrumentation and methods is fast becoming a “black” box.

Surveyors must therefore be necessarily well prepared to face the challenges of the next millennium as astute producers and managers of geospatial information. This requires thorough knowledge of GIS technology, awareness of the many sources of data for input to a GIS, and an understanding of the way in which the data can be handled and analyzed to solve problems associated with management of land and water resources. This calls for the combination of traditional skills with those of new technology and spatial data handling skills.

From the foregoing, it is obvious that additional activities have been added to the mandate of a surveyor. Apart from being computer literate, he must be good in information technology in order to be relevant in the 21st century.

According to Brimicombe (1998), the result of a survey has identified that employer now look for three main attributes in survey recruits.

(i) They must be adaptive: get up to speed quickly.
(ii) They must be adaptable: respond positively to change with ability to learn and apply new knowledge and skills.
(iii) They must be transformative: should be able to anticipate and lead change, help their organization's transformation process.

These attributes can be achieved only through a curriculum that is adaptive to changes. This means that appropriate education and training schemes must be immediately put in place in order not to be left behind. Moreover, as tertiary education worldwide comes under serious financial pressure, to remain relevant, the discipline of surveying must continue to move with the needs of the society and technological advancement.
Our curricular must be modular and flexible in order to be able to quickly adapt to the changing boundary conditions set by technological advancement and development of the profession (Grun, 1998).

Like the profession itself, our education should increasingly focus on the global market place rather than on the national/local scene so that, just like the mapping systems, the products (i.e. the practitioners) will also be on the move.

3. CURRICULUM FOR GEOMATICS ENGINEERING PROGRAMME

Although data acquisition procedure is fast becoming a 'black box', reducing the required knowledge to knowing which buttons to press and the teaching of this through particular applications, the need for a fundamental understanding of data quality is recognized by survey teachers. However, the understanding of data quality in turn depends on understanding the underlying algorithms used to create or capture and process the data. (Dale, 1999).

It is essential that Geomatics education should be strong at conceptual level so that the graduates of the course can be versed not only in the use of GIS package but also in GIS development. Evidently, a modern surveyor should be well trained in the three subsystems of GIS (see figure 2). With data acquisition fast becoming a "black box", geomatics education

needs to concentrate more on spatial data analysis, applying more rigorous mathematics and spatial statistics.
Thus, apart from the traditional branches of mathematics studied in surveying, new areas of geomatics especially aspects of spatial reasoning, such as spatial data modeling also require strong mathematical foundation in such areas as set theory, fuzzy set and fuzzy logic, graph theory, simplexes and complexes, topology, etc.
From the foregoing, four broad specialized areas, all in the digital domain can be identified as vital subject areas required in a meaningful geomatics education (Kufoniyi, 1999)

(1) Spatial data acquisition (instrumentation and methods)
   (a) Computer - aided surveying (land and hydrographic)
   (b) Analytical and Digital Photogrammetry
   (c) Remote sensing
   (d) Digital Cartography: conversion of analogue map and other geospatial data into digital form by scanning and/or digitizing methods.
   (e) Attribute data collection methods (e.g. social survey)

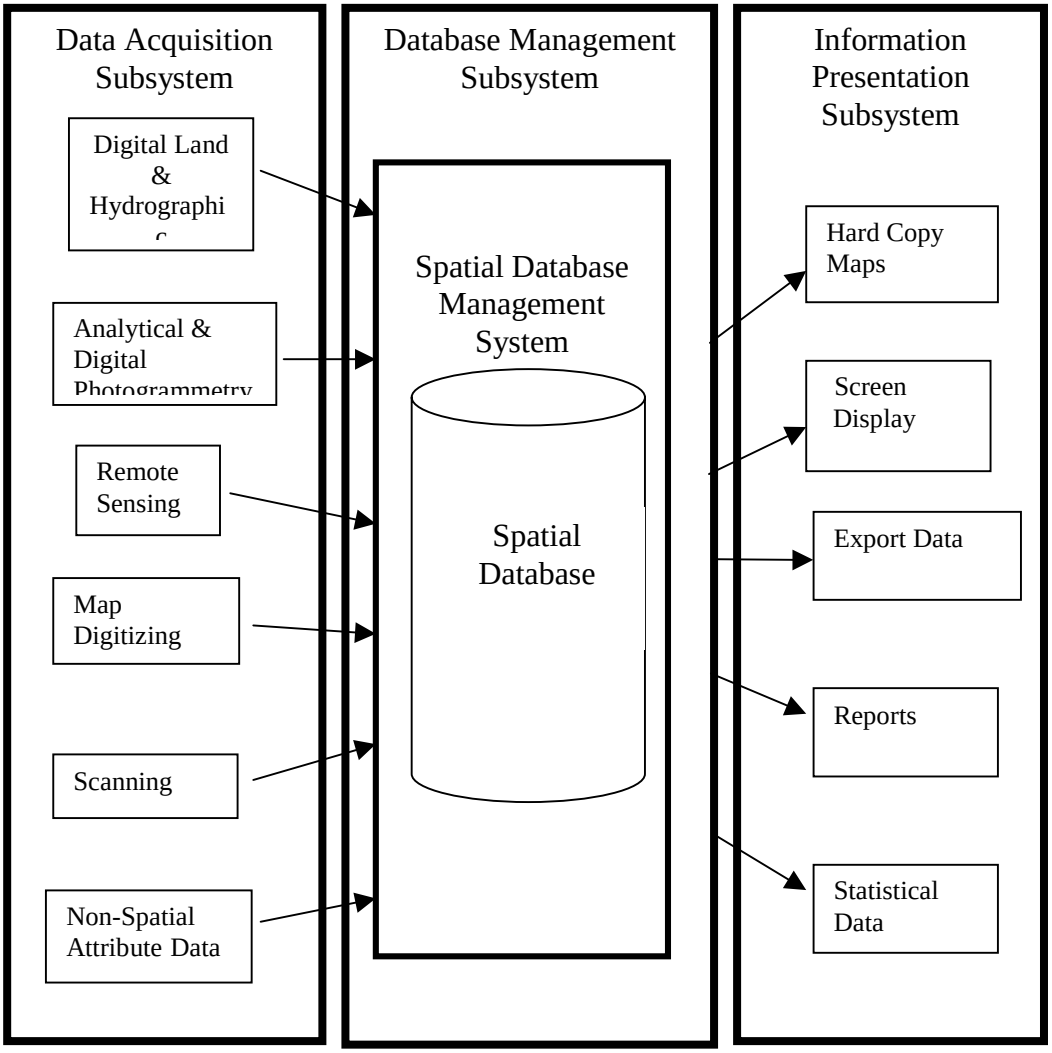

Fig. 2 GIS Subsystem

(2) Spatial data management (instrumentation and methods):
Requires the knowledge of,
- Database design and creation
- Database management systems
- Data transfer and exchange
- Spatial query development,
- Spatial statistics, etc.

(c) Cartography and Geoinformation Visualization: dealing with data formats and information presentation.

(d) Geospatial information infrastructure and management: dealing with aspects such as spatial data standard, GIS policy, implementation issues, etc.

As stated earlier, relevant to each of the four broad areas are fundamental subjects such as mathematics (including set theory, graph theory and topology), computer science, artificial intelligence and expert system (See fig. 3)

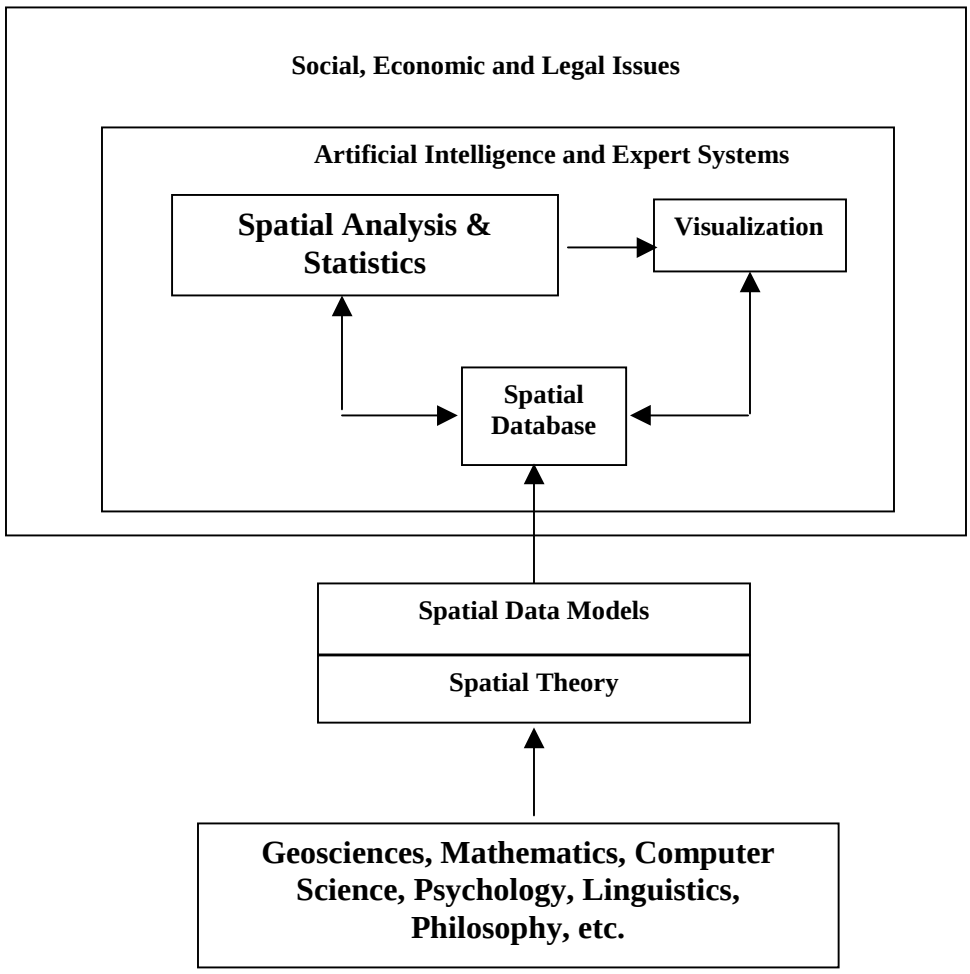

Fig. 3. Spatial Information & Supporting Knowledge

Therefore, it is necessary to design new surveying curricula which would address the four groups above as well as the fundamental subjects to be able to produce surveyors that can be referred to as Geomatics Engineers.

3.1 Geomatics Education in Nigerian Universities

Geomatics education in Nigeria is still at its infancy with limited number of academics knowledgeable in the discipline. Presently, out of the nine universities offering surveying courses in the country, only the University of Lagos's Department of Surveying & Geoinformatics have fully integrated geoinformatics technology into its curriculum.

For instance, there are at present 9 universities (out of 38), 17 Polytechnics (out of about 50), Federal School of Surveys (FSS) - a monotechnic, and a regional center for the Training of Aerial Surveys (RECTAS) offering various courses in Surveying in Nigeria. Of these, only 3 can boast of adequate facilities qualify for training students in Geomatics – The University of Lagos (UNILAG), FSS and RECTAS. Since the last two are non-degrees awarding institutions, it is certain that knowledgeable graduates in geomatics engineering are being produced at a very slow pace.

Since the University of Lagos presents the only viable geomatics programme in the Nigeria Universities so far, the succeeding section highlights how the courses in its surveying curriculum were modified to integrate modern technologies for capturing, processing and managing survey information.

3.1.1 Geomatics Education At The University Of Lagos

The geomatics education at Unilag is domiciled in the Department of Surveying and Geoinformatics (formerly, Department of Surveying). The name was changed in January 1998 to reflect the new changes in its academic focus/orientation. As the Departmental prospectus explains, "The **Surveyor (and now *Geomatics Engineer*),** as defined and produced at the University of Lagos, is a **professional** and a **geoscientist** well equipped to provide spatial and other environmental information necessary for designing and planning of engineering works as well as in the location and exploitation of natural resources (Dept. of Surveying & Geoinformatics, 1999).

Areas affected by the modification include;

(1). Curriculum:
The Curriculum include subjects in Real Property Bordering Determination, Aerial and Digital mapping, Geodesy and Geodetic/Global Positioning Systems (GPS), Hydrographic/Oceanographic Surveying, Photogrammetry and Remote Sensing, Environmental and Resource Mapping, Project Management, Route Design and Construction Location, Digital Cartography, Land and Geographic Information Systems (LIS/GIS).

The new courses that have been added or modified at the undergraduate classes are presented in the Appendix.

(2). Teaching Facilities:
Laboratory facilities have been made available in efforts to prepare and empower the students to harness the benefits of the new opportunities that Geoinformation technology presents. In the last three years, substantial improvements have been made with regards to laboratory equipment. Apart from the Photogrammetry laboratory, the Department is currently running two other laboratories namely, Geoinformatics laboratory and Marine/Coastal Research laboratory. A range of Computers and GIS/image processing software have been acquired. Towards the end of year 2001, ESRI (USA), though Chevron (Nig) Limited endowed the department with the new ArcGIS 8 software and three branded computer stations. This is in addition to other similar software running in the laboratories. Examples are; Arcview GIS 3.1, MapInfo 4.0 professional, Atlas GIS, Idrisi for Windows, AutoCAD 14 and 2000, etc.

Other hardware facilities available apart from computers include Kern PG2 photogrammetric plotter, GPS Receivers, Hydrographic boat and accessories for coastal & oceanographic research, Digitizers, Plotters, Electronic theodolites, EDMs, etc.

(3). Staffing:
There are 12 academics currently engaged in the different fields of the profession at the department; four are professors, three are senior lecturers, a lecturer-I, two in lecturer II cadre, and two assistant lecturers. The younger lecturers are presently engaged in different spheres of research in geomatics engineering for their doctoral degrees.

(4). Student Enrollment:
Student enrollments particularly in the past 3 years have been quite encouraging. Parents and prospective students are very much eager to know what the programme entails as well as its relevance in today's world. A new **Master of Geoinformatics (Executive)** degree programme for graduates of related discipline was commenced in the 2000/2001 academic session as parts of efforts to introduce the emerging technology to other professions. This is apart from the regular postgraduate programmes leading to the awards of MSc, MPhil and PhD degrees at the department.

3.2 Challenges Facing the Programme

Whilst the developed nations of the world are grabbling with the task of engineering better options for marketing the new found love 'Geomatics Engineering' as a better replacement for the *passé* term 'Surveying', particularly to encourage the younger ones into the profession. The third world countries are busy battling with diverse problems threatening to swallow not just the name but also the profession itself. These problems are varied but mostly familiar, examples are the usual lack of capital and other poverty induced problems like illiteracy and inadequate/lack of facilities, limited opportunities, joblessness, unprepared ness to change (particularly by the older generation) – called the *untrainable* professionals, scarcity of knowledgeable academicians to train up the few interested graduating college youths, etc. These 'attributes' have conspired to provide the present difficult challenges facing the integration of Geoinformation technology into the surveying curricula of most third world universities.

Herein lies the problems of the profession in this part of the world, bedeviled with growth problem that is resistant to change caused by uninterested professional, under equipped and understaffed institutions that are supposed to be the driving force behind this change phenomenon. Even then, the parlous economic state of the nation which has affected every segment of the economy still ensure that some of these few graduating youths remain jobless after the completion of their programme.

3.3 Future plans

The introduction of new geomatics curricula at the University of Lagos has broadened the needs of the larger geomatics profession, which includes, but goes beyond the surveying profession in Nigeria. Likewise, it is expected to increase the career potential of graduating students of the department. Companies hiring surveying/geomatics graduates from Unilag can because of these improvements in the curriculum, expect their new hires to perform better and be capable of assisting/supporting policy makers in decision-making situations by providing appropriate information at the appropriate time.

As a result, the department envisages future improvements, particularly in its hardware and software pools, in order to adequately prepare our graduates for a recession proof geomatics engineering career.

Areas of notable improvement in the near future will include: timely updates of curriculum to reflect changing needs of the society, acquisition of Digital Video Plotter (DVP) software for the digital photogrammetry class, more workstations (computer stations), image processing and analysis software for the photogrammetric/Remote sensing courses.

The increase in students' interest will also impact on the minimum matriculation examination score requirement for admission. This will further enhance the competitiveness of the programme at the university. In addition, Postgraduate researches will be boasted by increase in research facilities and creation of more conducive learning environment. The Department's Internet project when completed will provide additional opportunities for the academics and students to source information that would enhance their research works and learning process.

4. CONCLUSIONS

It is clear from the foregoing that the new changes requires new curriculum to update and teach emerging knowledge about these advances. For instance, the photogrammetrist of today needs to have sufficient knowledge about spatial accuracy of digital data, remote sensors, image processing and analysis and about GIS in order to correctly apply these emerging technologies. It therefore behooves the new GIS analyst, photogrammetrist, or image analyst to acquire additional knowledge beyond what is offered in traditional surveying education since the new graduate surveyor (*nay!* Geomatics Engineer), is expected to demonstrate adequate proficiency in the use of these new equipments, and data processing and analysis procedures, as well as become skilled in information management and presentation methods.

Again the growing availability of faster means of data acquisition will continue to lead to proliferation of spatial data of diverse sources, resolution and quality. This will lead to the growing need for those who understand spatial data integration issues, knowledgeable in the propagation of uncertainty in spatial data handling and analysis, can advise on supplementary data collection, know how to communicate spatial information, and have the skills to create and maintain key spatial data infrastructure.

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BIOGRAPHICAL NOTES

Adewale, O.S. (1966 -): Received his first degree in 1988 and in 1998, a master's degree in surveying both from the University of Lagos. He has over ten years of professional experience in engineering surveying, seismic survey data acquisition, GPS applications, Geographic Information Systems and Remote Sensing Data applications. He is presently an Assistant Lecturer at the Department of Surveying and Geoinformatics, University of Lagos, Nigeria. His research interest is in Spatial Information Systems, Digital Mapping and Remote Sensing.

APPENDIX

COURSE CODE	COUSE TITLE	COURSE UNITS
SVY 201	Basic Surveying II	3
SVY202	Engineering Surveying	3
SVY 210	Photogrammetry I	3
SVY 204	Remote Sensing I	3
SVY 206	Computer Application in Surveying I	2
SVY 305/306	Cadastral Surveying I/II	3
SVY 311	Hydrographic Surveying I	3
SVY 313	Principles of GIS I	3
SVY 312	Comp. Application in Surveying	3
SVY 314	Principles of GIS II	3
SVY 316	Digital Mapping I	2
CEG 304	Engineering Geology	3
SVY 413	Photogrammetry and Remote Sensing I	3
SVY 417	Digital Mapping II	2
SVY 501/502	Adjustment Comp. II/III	3
SVY 503	Special Studies in Digital Remote Sensing	3
SVY 517	Photogrammetry (& Remote Sensing II)	3
SVY 523	Introduction to Coastal Mapping and Management	2
SVY 525	GIS Tools & Applications	3
SVY 519	Mathematical Geodesy	2
SVY 516	Marine Surveying II	3
SVY 504	Special Studies in Analytical and Digital Photogrammetry	3
SVY 528	Close Range Photogrammetry	3