Impact of Digital Technology and the Need for Ccurriculum Review in Surveying Education

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Key words: Digital Technology, Curriculum review and Surveying Education

SUMMARY

Digital technology such as computer technology, Global Positioning System (GPS) and Geographic Information System (GIS) has been having a tremendous impact on the field of surveying. This development has positively affected the scope, methods, speed of data acquisition, data management and the rate of delivery of the results (map and other map products) of data procesing. For instance, Surveyors were hitherto engaged in the act of analogue collection, processing, storage and retrieval of data and data products. Nowadays, the use of digital technology for the same tasks has gained more importance. This is because digital technology produces more accurate results and is more economical than the analogue method. In order to incorporate the challenges brought about by the advent of the digital technology, some survey training institutions/departments have modified or completely changed their names. Therefore, it is logical to observe that what used to be accepted as surveying curriculum in these institutions/departments has become inadequate. This has made the review of surveying curriculum a necessity in order to meet the demands of the current advancements in digital technology. This paper tries to address the impact of revolution brought by digital technology on surveying education. Also, it focuses on the need to review the current surveying curriculum to meet the technological advancement. Finally, it raises the need for concerted efforts to re-train old survey personnel at all levels, for appropriate capacity building, particularly in developing countries.

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1. INTRODUCTION

The advent of digital technology has influenced the practice of surveying all over the world. This has positively affected the scope, and methods of surveying, the volume and speed of data acquisition, and the processing, storage, management and production of maps and allied products. With the advances in this technology, the definition of surveying, as the science and technology of taking measurements on, above and/or under the surface of the earth and the representation of the measurements on paper in form of a map or plan, has been modified. In Grum (1998) and Nwilo et al (2000), surveying is referred to as geomatics, which is defined as the science of acquisition, management, modeling, analysis and representation of spatial data with specific consideration to problems related to spatial planning, land use/land development and environmental issues. Advances in digital technology have occasioned broadening of training programs for data acquisition in surveying profession all over the world. Data, hitherto acquired with analogue instruments such as theodolites, levels, stereoplotters etc. are now acquired with ease using digital instruments such as GPS, digital photogrammetric instruments, etc. Availability of very fast computers with large memories and improvement in communication technology now make the production of maps and other map information possible using GIS applications. These developments have made many surveying institutions training manpower in surveying and practicing surveyors all over the world to change or contemplate changing their names to reflect the technological advancement. Currently, there is a campaign for the change of names of surveying institutions/departments in Nigeria. In fact, a number of surveying departments in private and public organizations have changed their names to either geomatics engineering or surveying and geoinformatics. For instance, the department of surveying in Ahmadu Bello University, Zaria is now named department of geomatic engineering. Also, the departments of surveying in University of Lagos, University of Nigeria, Enugu campus, Federal University of Technology, Yola, Abubakar Tafawa Balewa University, Bauchi and Federal school of surveying, Oyo have changed their names to the departments of surveying and geoinformatics.

The training curriculum for surveyors was geared towards producing surveyors for mapping and general land surveying practices. At that time, the duties of surveyors consisted solely of spatial data acquisition and production of plans/maps using analogue methods. This was deeply rooted in the fundamental principles of land surveying, astronomy, geodesy, photogrammetry, hydrography, mathematics and physics. Nowadays, apart from producing paper maps/plans, surveyors produce their information in digital formats rooted in digital technology. That is, the information produced can now be handled in a large database incorporated in a GIS environment. This has necessitated the need to review the old training curriculum, which was based on analogue method, in order to reflect the current

technological advancement in surveying profession. This is being done all over the world. In Nigeria, for example, all the surveying departments mentioned above have reviewed their curriculum to reflect the current digital technology. Some Polytechnics and colleges of technology are also doing the same. However, some institutions/organizations are still in doubt of what to do while others have not fully realized the need for the change. This might not be unconnected with the lack of awareness of the benefits offered by the digital technology in surveying and mapping. Therefore, it is the objective of this paper to discuss the impact of digital technology in surveying education. The need for the dynamic review of surveying curriculum to reflect the technological advancement is also highlighted.

2. DIGITAL REVOLUTION

Digital Revolution is a term that best describes the effects of a rapid drop in cost and rapid expansion of power of digital devices such as computers and telecommunication systems. It includes changes in technology and society, and is often specifically used to refer to the events that follow, as these technologies are widely adopted.

Digital technology was invented in the last half of the 20th century and became economical for widespread adoption after the invention of the Personal Computer. Underlying the revolution of the digital technology is the development of the digital electronic computer, the personal computer, usually referred to as microprocessors with its steadily increasing performance, which enabled computer technology to be embedded into a huge range of objects such as cameras, music players, surveying measuring instruments, surveying data processing instruments etc. Equally important is the development of transmission technologies including computer networking, internet and digital broadcasting systems.

The digital revolution transformed technology that was previously largely analogue into digital which has a binary representation of ones and zeros. By doing this, it became possible to make multiple generated copies results obtained from surveying activities that are as faithful as the original copy. In digital communications, for example, repeating hardware is able to amplify the digital signal and pass it on with no loss of information in the signal. The economic impact of the digital revolution has been very great. That is, without the Internet, for example, globalisation and outcourcing would not be as viable as they are today. The cell phone has had a large, measurable impact on the productivity of people since late 1990s. As the revolution moves forward, virtually every aspect of life is captured and stored in some digital form (Wikipedia, 2005).

The advancement in computing technology which resulted in the development of high-speed computers with large memories, together with the need by surveyors and other professionals to store, manage and retrieve geo-referenced data has quickly led to the changing pattern in survey training. Furthermore, there is the tremendous impact that advances in technology, modern instrumentation and techniques have had on many professions, especially the surveying profession. Though most of the traditional surveying courses are still being offered in the Universities and Polytechnics, new courses like Principles of Geoinformation systems, Digital mapping, Digital coastal management, GIS tools and applications, etc. have now been

introduced to reflect the dynamic digital revolution in surveying education (Fajemirokun et al, 2002).

3. CHANGING TREND IN THE SURVEYING PROFESSION

Terrestrial surveys with a much older history had been the basis for determining the size and shape of the earth and establishing country and continent wide reference networks. But only densely populated countries, small in area were able to build an area-coverage of accurate maps by terrestrial plane table surveys (Konecny, 2002).

In recent times, the discipline of surveying had experienced tremendous growth. Since about 1960, a revolution has been taking place in surveying and mapping technology: angular and distance measurements are being obtained using electronic theodolites and distance measuring equipments respectively, the use of GPS and Total Station instruments is gradually taking over the determination of the distances, angles and coordinates of various points of the earth's surface, electronic computers are being used to carryout survey computations and to statistically analyze large sets of data and results, photogrammetry has become a digital discipline which competes in accuracy with ground surveys, the use of satellites for earth observations has made remote sensing an indispensible tool for mapping, cartography which relied on tedious manual graphic work has made way for computer graphic while geographic information system has now allowed for the use of spatially oriented data in databases for the management of global, regional and local problems.

Geo Information Technology (GIT), also known as Geoinformatics is a more recent terminology that has evolved within the past three decades. It is one of the products of the digital revolution, and a product of the marriage between the Geosciences (Geo) and Information Technology often referred to as Informatics (Ayeni, 1999). Many branches of the Geosciences such as surveying, geodesy, photogrammetry and remote sensing use various types of sensors to measure and capture spatial data, and these in turn are computer processed. The processed data can then be stored, edited, analysed, manipulated, interpreted, updated, displayed and made available to a wide range of applications, within the context of Geographical Information Systems (GIS).

GIS, which is also called Geospatial Information System is a system of computer hardware and software for capturing, storing, retrieving, analysing, manipulating and displaying spatially referenced data. Its essential features are the existence of a spatial database management system and spatial analysis capability. The common ground for GIT and Surveying is the GIS with the capability for attribute data linkage with geo-referenced data. Therefore, the training of survey personnel must recognize the need to incorporate aspects of geoinformatics in a new curriculum so that newly produced professional surveyors can be appropriately repositioned to take full advantages of geoinformation technology.

GIS, geoinformatics, remote sensing techniques and digital mapping methods have become increasingly popular. Indeed, they represent the trend and the direction of growth of the science of surveying with emphasis shifting from mere data acquisition and presentation, to

the inclusion of data storage, retrieval, manipulation and management (Fajemirokun and Badejo, 2004).

Geomatics or Geo-informatics or Geoinformation has emerged as a new integrated academic discipline. Geomatics, composed of the disciplines of geopositioning, mapping and the management of spatially oriented data by means of computers, has recently evolved as a new discipline from the integration of surveys and mapping (geodetic engineering) curricula, merged with the subjects of remote sensing and geographic information system. It has become open to value added applications in many other disciplines using spatially referenced data (Konecny, 2002). Geomatics addresses the subjects of geodetic reference system, global positioning system, geographic information system, photogrammetry, remote sensing and cartography, as well as traditional land surveying. It relies on theories of mathematics, physics, chemistry, astronomy, physical geodesy, and satellite technology. It uses the tools of data base management, computer graphics, and artificial intelligence. Its application is in topographic and thematic mapping and spatial data management for a number of uses such as agriculture, military, transportation e. t. c.

Aerial photographic interpretation became an important link between photogrammetry as a primary discipline for mapping to a great number of disciplines to collect thematic content. It was the satellite imaging, starting with the American Landsat program in 1972, that integrated the multidisciplinary uses of remote sensing with those of photogrammetric mapping. The integration of photogrammetry and remote sensing was a wise move to overcome the various geo-referencing problems.

There was yet another integration effort needed. This arose from the introduction of computer graphics into map production. While photogrammetry and remote sensing were principal tools to acquire map content, the management of the data by geographic information systems, and the analysis and visualisation of the data today forms an indispensable part of the geoinformation process. It does not make sense anymore to consider topographic and thematic mapping by photogrammetry and remote sensing separate from geographic information systems. The tedious and costly local terrestrial survey methods have been augmented and surpassed by GPS positioning using navigational satellites. While in the analogue mapping era, the geoinformation process could be separated into individual disciplines, such as surveying, geodesy, photogrammetry, remote sensing, and cartography, different data acquisition methods such as terrestrial GPS-surveys, aerial photogrammetry, satellite photogrammetry, laser scanning, photo-interpretation, and digital processing of remotely sensed images now compete in quality and cost. Their application must be geared to the respective global, regional and local tasks (Konecny, 2002).

4. THE NEED FOR CURRICULUM REVIEW

Training of surveyors is normally offered at three main levels. These are at the Universities, Colleges of Technology/Polytechnics and the Technical Colleges. These institutions train professionals, technologists and technicians respectively. Some low-level manpower may also be produced by way of apprenticeship and on the job training, particularly in developing

countries (Fajemirokun et al, 2002). In Nigeria, for instance, ten universities offer surveying at the professional level, sixteen polytechnics, one monotechnic and one College of Technology offer training at technician level, while four of these institutions run the Higher National Diploma programmes at the Technologist level (Fajemirokun and Badejo, 2004). The curricular approved by the National Board for Technical Education (NBTE) is used by all Polytechnics, Colleges of technology and similar institutions to train survey technicians and technologists while the National Universities Commission (NUC) is charged with the responsibility of accrediting Universities running the professional programmes. The curricular at the universities differ slightly, but, all are expected to be above stipulated Minimum Academic Standards

Initially, the training offered in the various institutions was geared towards training in the field of land surveying. The advent of large memory personal computers and the need to acquire, store, manage and retrieve geo-referenced data led to the changing pattern of survey training. Production of maps can now be achieved almost in real time. By these developments, there is a change of emphasis from land surveying to Geomatics which has brought about the integration of the traditional land surveying techniques and applications with the modern methods of Global Positioning System (GPS), Remote Sensing and Geographic Information System. Due to this change of emphasis, the training of surveyors needs to be modified to meet the training needs of geomatics education (Fajemirokun et al, 2002). In other words, it has become rather imperative for survey institutions and departments to review their programmes in order to align their curricula with the dynamic technological developments in surveying education and allied fields. Surveying departments in developed countries have already led the way. Their surveying curricula have been, or appropriately reviewed. In many cases, survey departments have had to change their names to Geomatics Engineering, Geoinformatics, Surveying and Geoinformatics etc, as the case may be, in order to reflect the new orientation to digital technology. The surveying and mapping industries in developing countries, where Nigeria belongs, are also now taking steps to follow their counterparts in the developed countries. This is because opportunities presented by modern survey and mapping techniques, offered through digital technology, have made surveying and mapping products attractive to decision makers and this has recently led to the interest in adequate funding of the survey industries in these countries (Fajemirokun and Badejo, 2004). As a result, surveyors must of necessity, become familiar with, and be proficient in the new techniques, so as to remain relevant and productive. Indeed, the task of training new surveyors to face the challenges of the new digital technology must include the re-training of already qualified personnel that have already qualified.

In Nigeria, many institutions at the University, College of Technology and Polytechnic levels are now modifying their curricula to reflect the new dispensation. It has become very important for every surveying institution in the country to change or modify their curricula in order to produce the needed manpower to meet the current needs in the private and public sectors. Many professionals in allied fields like engineering, sciences and social sciences and even in education and business administration is now embracing Geomatics. The higher institutions offering surveying are further saddled with the task of developing new curricula to train surveyors and professionals from other fields of study.

In fashioning out new curricula for training the new generation surveyors, a critical look at employers' needs becomes very important. According to Brimicombe (1998), the result of a survey has identified that employers now look for three main attributes in newly trained survey personnel. Such newly trained personnel must be (i) adaptive (i.e. get up to speed quickly), (ii) adaptable (so as to respond positively to change with ability to learn and apply new knowledge and skills), and (iii) transformative (i.e. they should be able to anticipate change, lead change and help their organisation to transform for better results).

These attributes above can only be achieved through curricula that are adaptive to change. In other words, adequate training schemes must be put in place to meet up with the new demands in geomatics industry. In Nigeria, the National Board for Technical Education (NBTE) in collaboration with the Federal School of Surveying, Oyo, in March 1998, held a workshop to review the curricula for survey training in polytechnics and Colleges of Technology in the country. The new curricula brought in courses such as GIS, Environmental Management, Knowledge-based Systems, Digital Surveying and Internet Technology. Also, in line with the development in Colleges of Technology and Polytechnics, the National Universities Commission (NUC) has also directed all institutions offering surveying to modernise their curricula. This directive is being carried out appropriately. In Kufoniyi (1999), it was identified that there are four broad specializations in geomatics education. These are:

(i) Spatial data acquisition through computer-aided Surveying, analytical and digital photogrammetry, remote sensing, conversion of analogue map and other geospatial data into digital form using manual digitizing and scanning, and attribute data collection methods.

(ii) Spatial data management which requires knowledge of database design and creation, database management systems, data transfer and exchange, spatial query development, spatial statistics, e. t. c.

(iii) Cartography and geoinformation visualisation, dealing with data formats and information presentation.

(iv) Geospatial information infrastructure and management, dealing with aspects such as spatial standards, GIS policy, implementation issues.

The reviewed curricula being developed in Nigeria aim at covering the four broad-based areas of geomatics stated above in addition to the foundation disciplines of Mathematics and Physics, and the traditional surveying topics. For instance, the Department of Surveying and Geoinformatics, University of Lagos recently reviewed her curriculum, changing the training emphasis from surveying to geomatics. The new curriculum therefore aims at preparing students, in addition to their traditional roles as surveyors, for a new role as information managers, environmental and coastal management experts, remote sensing experts etc (Fajemirokun and Badejo, 2004). Some of the new courses introduced at the undergraduate

level include Computer Applications in Surveying, Principles of Geoinformation, Digital Mapping, Coastal Mapping and Management and GIS Tools and Applications. The new programme also incorporated the General Studies (GST) courses as stipulated by the University. Similar modifications have also been made to the department's programmes at the post graduate levels. For example, at the Masters and Doctoral degree programmes, some of the new courses introduced are Data Acquisition Systems, Advanced Concepts in Geoinformatics, Spatial Data Structures, GIS Implementation Strategies, Spatial Statistics, Policy Issues in GIS Implementation, Digital Cartography, Knowledge-based Systems and Environmental Management (Fajemirokun et al, 2002).

5. CONCLUSIONS

Digital Revolution has led to a rapid drop in cost and rapid expansion of power of digital devices such as computers and telecommunications. Digital technology and communications have revolutionised the practice of Surveying all over the world.

The task of surveying profession has been broadened from mere data gathering to include that of digital data processing and management. This has made what used to be acceptable as surveying curriculum inadequate. Therefore, the need to modernise surveying curricula in tertiary institutions has arisen in order to meet the demands of the technological advancements. In Nigeria, for instance, the National Universities Commission (NUC) has taken a bold step to direct all universities offering surveying to modernise their curricula in line with the technological development. Some Universities have already complied while others are in the process of reviewing their curricula in line with NUC directive. Similarly, the NBTE has given approval for the modernization of surveying curricula in Colleges of Technology and Polytechnics.

Periodic reviews of the academic programs and curricula in Universities and Polytechnic offering surveying are necessary if such programs are to keep abreast of the dynamic nature of the technological advancement. Such review is better appreciated as advances in computer hardware and software, digital and information technologies continue to improve the techniques of spatial data acquisition and processing in the surveying profession.

6. RECOMMENDATIONS

The importance of reviewing the survey curricula throughout the University and Polytechnic systems is so great that the choice to review or not should not be left with each surveying institution/department. Therefore, government regulatory bodies of surveying institutions/departments should continue to insist on the review of surveying programs in the Universities, Polytechnics and Colleges of Technology. That is, the bodies should formulate clear policies on surveying and geoinformatics education in line with advancements in surveying technology brought about by the digital revolution. These policies should clearly lay down minimum academic requirements and desired component parts of new curricula for all surveying departments in Universities, as well as in the Polytechnics and Colleges of Technology. An advantage of this is that it will encourage international and inter-institutional

exchange programmes for students undergoing survey training in Universities, Polytechnics and Colleges of Technology all over the world.

There is also the need to mount aggressive re-training programmes for surveying personnel at all levels, so as to build up appropriate human capacity for Geoinformation Technology. This further makes it imperative for all other stake holders in survey education to provide adequate funding for training and purchase of facilities for institutions offering surveying and geoinformatics. Survey institutions, on other hand, must look beyond government subventions for the funding of geomatics education. In other words, they should, for example, seek help from non-governmental agencies such as oil companies and other international organizations for funding surveying and geoinformatics education.

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