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Integrating Modern Surveying Tools with the Project Team

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PRESENTATION OUTLINE

- INTRODUCTION
- AIM AND OBJECTIVES OF THE PAPER
- MODERN SURVEYING TOOLS (MST)
- THE PROJECT TEAM (PT)
- STRATEGIES FOR INTEGRATING MST WITH PT
- BENEFITS OF THE INTEGRATION
- CONCLUSIONS

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INTRODUCTION

- Over the years, as the global economies and populations grew, surveyors kept up with the increased demands for broader knowledge and higher accuracy and effective professional service delivery across the globe.

- Remarkably, in the past two decades, the developments in surveying tools and applications, and information and communication technology (ICT) have completely changed the landscape of surveying solutions and practice across the globe; thereby creating a total departure from the conventional tedious field measurements and data handling to a highly robust and user-friendly digital data collection, storage, processing, integration and management approach.

Introduction (Cont..)

- However, in Nigeria, *most civil, construction and environmental engineering projects have operationally regarded and treated surveying tools and professionals as mere auxiliary data providers, hence placed outside the box of project teams and implementation strategies.*

- The consequences of this subtle exclusion have been evident in sub-standard project deliveries and short lifespan of infrastructure, across the country.

- *The fact that, all projects initiated by man starts and ends on the earth surface or subsurface suggests that, the lifespan and functionalities of the infrastructure so placed is a function of the physical stability and spatial balance of its host (the earth).*

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AIM AND OBJECTIVES OF THE PAPER

Therefore, this paper seeks to establish the need for the integration of modern surveying tools with the civil and environmental engineering project teams for rapid and effective project delivery in Nigeria.

The **Objectives** are to:

i. Identify key modern surveying tools for rapid project delivery in Nigeria
ii. Justify the need for project teams in the modern project tasks and solutions
iii. Establish the need for modern project team to integrate modern surveying tools in Nigeria
iv. Recommend strategies to adopt in the proposed integration.

MODERN SURVEYING TOOLS

❑ Some key modern surveying tools required for rapid project delivery identified and briefly illustrated in this paper include:

1. ***Location-Based Information System (LBIS) with GNSS;***
2. **GNSS-Activated Construction Machines;**
3. ***Electronic Total Station (SmartStation/Pole) and Electronic Theodolite***
4. ***Hydrographic Charting Vessel;***
5. ***GNSS Real Time Kinematics (RTK) Observations of Positions of Interest and Project Site Mapping;***
6. ***New Aerial Sensors and Solutions with UAV and LiDAR;***
7. ***Geospatial Information Systems (GIS);***
8. ***Terrestrial Scanning Tool for As-Built Surveying;***
9. ***Core Wall Control Survey System (CWCS).***

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1. Location-Based Information System (LBIS) with GNSS

In Nigeria, the Office of the Surveyor General of the Federation (OSGoF) has installed about **15** permanent Global Navigation Satellite System (GNSS) Continuously Operating Reference Stations (CORS) to provide the framework for positioning and geospatial data for:

- *African Reference Frame (AFREF) Project,*
- *The ongoing Land Reform Initiative in Nigeria,*
- *Surveying , Mapping and Navigation;*
- *Engineering and Urban development projects, etc.*

Figure 1: State-of the Art GNSS CORS Infrastructure in Nigeria (Ojigi et al, 2011)

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Today, field crews use GNSS and Electronic Surveying tools to capture Cadastral and Land information. In rural areas, handheld Global Positioning System (GPS) receivers measure property and ownership boundaries to an accuracy of 20-30 cm. For property in higher-value urban areas, survey-grade GNSS receivers collect data to centimeter precision.

Fig.2a: Trimble Integrated surveying combines robotic total station with RTK GNSS for Jebba Bridge Monitoring, Nigeria

2. GNSS-Activated Construction Machines

- Figure 2b is a GNSS-Activate machine control system, and with this tool the surveyor's function has radically changed to supporting construction through planning processes, creation and verification of the digital terrain and design models used by the heavy machines, and geo-data management.

- At the construction site the surveyor’s additional activities include work to ensure that machines accurately create the desired design, managing on-site communications, monitoring individual machine performance, and providing input into the project's building information model (BIM).

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GNSS Data communication scheme with the Bulldozer

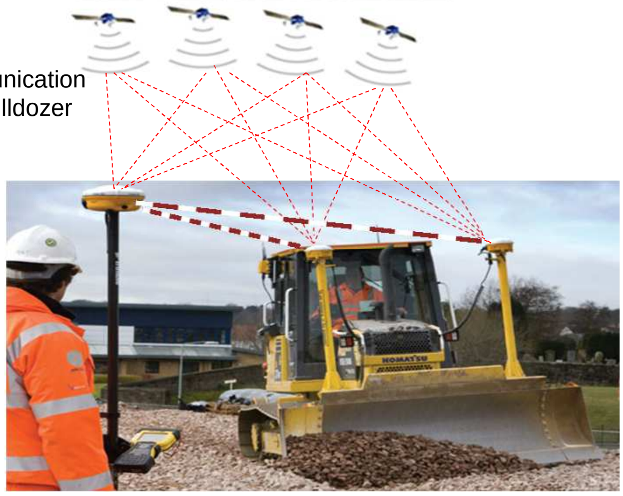

Figure 2b: GNSS-Activated Leveling Bulldozers (Source: modified after www.trimble.com)

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3. Electronic Total Station (SmartStation/Pole) and Electronic Theodolite

- Surveying by ***SmartStation*** and ***SmartPole*** have revolutionalised spatial mapping; such that, with *SmartStation* the entire survey is carried out by and controlled from the **Total Station**. While with ***SmartPole*** (Fig. 3b) the entire survey is carried out by and controlled from the pole.

- The ***SmartPole*** provides total flexibility, hence whichever system that is used (including fig. 3a), the time saving, speed of work, cost-effectiveness, and increased profits are ensured.

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Figure 3a: Electronic Total Station, Theodolite and Laser Levels for Precise Engineering Surveys

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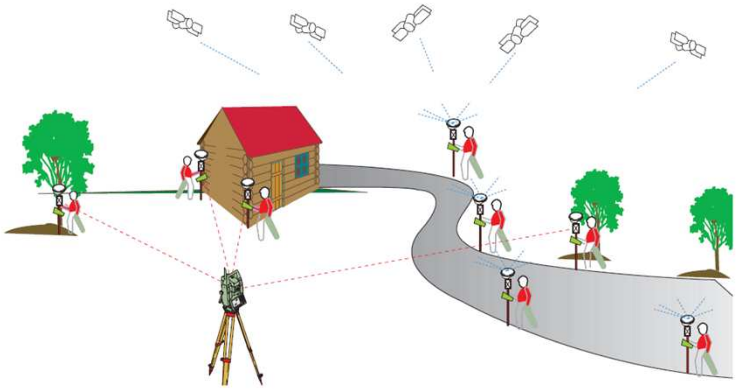

Figure 3b: An Illustration of Surveying with SmartPole [Source: Leica Geosystem (n.d)]

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4. Hydrographic Charting Vessel

- Tools of modern hydrographic surveying now include modern multi-beam sounders, the Global Navigation Satellite System-based Positioning System, and other devices (fig. 4).
- The vessel has communication facilities for data dissemination to central hydrographic data repositories. However, old methods using lead lines and triangulation can still come in handy where necessary.

Figure 4: Hydrographic Charting Vessel (http://www.hydrosurveys.net/surveys.htm)

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5. GNSS Real Time Kinematics (RTK) Observations of Positions of Interest and Project Site Mapping

- The errors in GNSS measurements for ***project site survey and mapping*** can be reduced and the position accuracy improved if measurements on the satellite signals are taken simultaneously at two stations and differenced (subtracted from each other-DGPS).

- One of the receivers is set up at a known point and is termed the reference; the other receiver is set up at an unknown point and is termed the rover (Fig. 5a).

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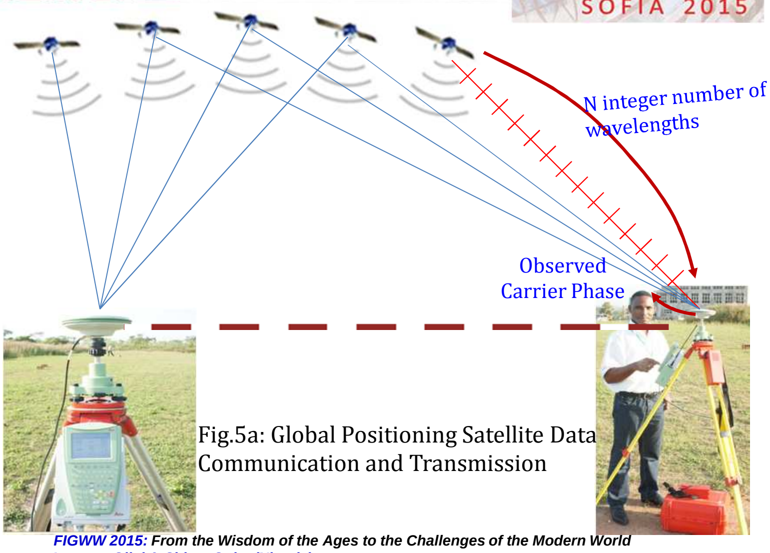

Fig.5a: Global Positioning Satellite Data Communication and Transmission

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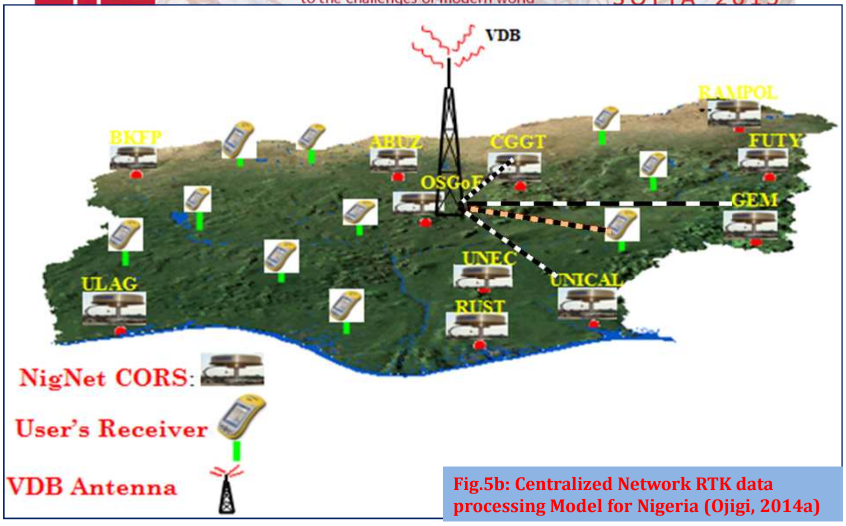

Fig.5b: Centralized Network RTK data processing Model for Nigeria (Ojigi, 2014a)

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6. New Aerial Sensors and Solutions with UAV and LiDAR

- Mobile mapping systems utilise video and LiDAR imaging combined with position data from GNSS and inertial systems (Fig.6a/b).

- Airborne systems continue to improve as well, with aerial cameras and scanners supported by positioning systems for navigation, flight management and georeferencing.

- The data from these high-speed, multi-sensor systems are fused and made available to GIS, design and other applications.

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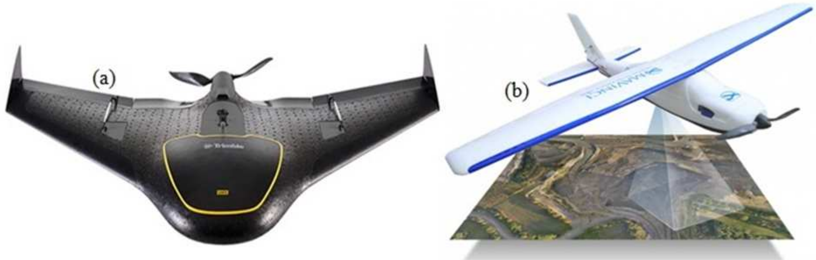

Figure 6: (a) UAV for Aerial Surveys (b) SIRIUS PRO Terrestrial Laser Scanner (http://www.geo-matching.com/products)

- For example, the ongoing railway project in Nigeria can use mobile mapping system to collect information on the condition of its track, signals and other assets and management strategies.

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7. Geospatial Information System (GIS)

- GIS presents business opportunities that include creating, populating and maintaining a GIS and using it to manage land information, cadastral data and other thematic information on the natural and built environment.

- Surveying and GIS tools are on the converging path, and providing a robust solution for construction and engineering project planning, design and implementation across the globe.

- Figures 7 and 8 provide typical geoinformatics tools and techniques project site information and management. The satellite imagery in Fig. 11 is a sample datasets are effective project site identification and mapping.

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Figure 7: Features of GIS for Rapid Project Delivery (Ojigi, 2014b)

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Figure 8: Rapid Survey Data Collection Tools (Ojigi, 2014b)

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8 .Terrestrial Scanning Tool for As-Built Surveying

❑Terrestrial Laser Scanners (Fig.9) are used for survey and investigations in the following areas amongst others:

- *As-built and engineering surveying*
- *Geology and Mining;*
- *Architecture;*
- *Heritage/archaeology,*
- *Plant design engineering,*
- *3D city modelling.*
- *Reconnaissance and Construction*
- *Facility management,*
- *Simulation and defense, etc.*

❑Key distinguishable features of this survey tool include *echo digitization, online waveform processing, multiple target capability, stand-alone data acquisition, HMI-interface, integrated GPS receiver; laser plummet; inclination sensors, and compact*. The scanned data products by this terrestrial laser scanner (TLS) are in JPEG, TIFF, or RAW formats. Figure 9 shows two varieties of TLS

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Figure 9a: Leica ScanStation C10

Figure 9b: RIEGL VZ-1000 Terrestrial Laser Scanner

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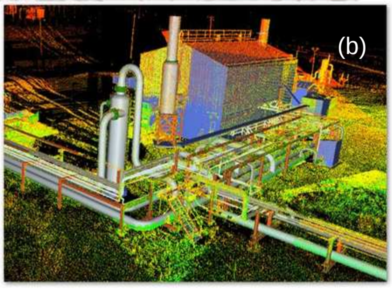

Fig. 10: *Scanned data products from Leica ScanStation* **C10** **(***Source: Leica Geosystem)*

- Application of 3D Laser Scanning allowed for the collection of ***very large amounts of data in a short time***, without any interruption to production process (figures10a, b and c)

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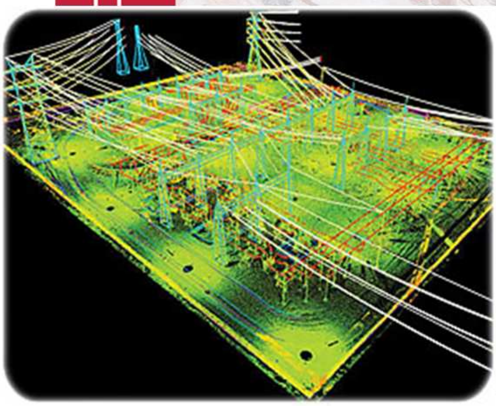

Fig. 11: Laser Scanned data of Power Station Infrastructure using Leica C10

LiDAR data is post-processed to create a three-dimensional model of the facility that is unprecedented in its detail and accuracy.

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9. Core Wall Control Survey System (CWCS)

- With Advances in technology, considerable interest have been generated in the construction of super high-rise and iconic buildings all across the cities (e.g. Abuja, Lagos, Port-Harcourt, etc) of Nigeria, whose monitoring with conventional surveying tools may be challenging.
- The on-going World Trade Centre building in Central Business District (CBD), Federal Capital City (FCC) Abuja, Nigeria is a good example (fig. 12b).
- Modern surveying tools such as the Core Wall Control Survey System (CWCS) (Fig.12a), developed and tested by Leica Geo-systems provides a unique solution.
- The Core Wall Control Survey System uses networked GNSS sensors combined with high precision inclination sensors and total stations to deliver precise and reliable coordinates that are referenced to the design frame, and ellipsoids/projections that are not influenced by building movements.

Fig. 12a: Monitoring Vertical Towers with Core Wall Control Survey System (CWCS) (Source: van Cranenbroeck (n.d))

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Figure 12b: Abuja World Trade Centre *(Under Construction)*, Central Business District (CBD), Federal Capital City (FCC), Phase 1, Abuja, Nigeria

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THE PROJECT TEAM

A project team could be described as a group of professionals with relevant expertise who have been tasked with collectively completing a project. *Attempts to belittle or denigrate the tasks of some team members in a project team often lead to sub-standard project completion and delivery.*

Examples of projects that require Project Team:
- *Road and rail construction,*
- *Mass housing project,*
- *Drainages and flood control,*
- *Dams and bridges,*
- *Dredging and pipeline,*
- *Stadia and parks,*
- *Telecommunication and power transmission projects,*
- *Jetties/harbor and ports,*
- *Underground tunneling and mining of solid minerals, Exploration and exploitation of oil and gas, etc*

Figure 13: Project Team Thinking Together

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The Need for a Balanced Project Team

A robust project team is needed for the following reasons amongst others.

1. *When team members use their skills and knowledge together, the result is a stronger union that can fulfill its project mission;*
2. *People working together can sustain the enthusiasm and lend support needed to complete the work of each program.*
3. *Civil and environmental engineering in the face of ever dynamic development in science and technology are more complex; hence require comprehensive approach to delivering complete and effective results;*
4. *Need for interdisciplinary approach for multi-dimensional solutions is a key requirement in modern science and technology*
5. *If there must be speed and precision to a well thought out civil and environmental engineering project vision, many relevant hands and opinions are imperative ('the more, the merrier').*

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STRATEGIES FOR THE INTEGRATION OF MODERN SURVEYING TOOLS

(1) The efficient use of modern surveying tools such as Global Navigation Satellite System receivers, Mobile GIS and location based information system, Electronic Total Station and Terrestrial Laser Scanner, Laser Levels, 3-D Sounding Boats and Vessel, etc should be emphasized at the following stages of projects:

- i. *Pre-project surveys and mapping (for planning and design)*
- ii. *During-project surveys and mapping (monitoring)*
- iii. *Post-project surveys and mapping (As-built surveys in medium term)*
- iv. *Maintenance surveys and Geospatial Database Management (long-term).*

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(Strategies for Integration-Cont-----)

(2) Professional Surveyors should be among the project team alongside the Quantity Surveyor, Civil Engineer, Architect, etc. *This should discourage the implementation of the surveying contents in a project as a supplementary part of project(s), rather than being considered as one of the core components.*

(3) Time series spatial measurements and database on land information, geographic information, marine and hydrographic information, subsidence and ground deformation (x, y, z) should be adopted and integrated into the mode of project operations for sustainable project maintenance. Examples of deformation surveys should include the following:

- *The monitoring of ground deformations due to mining activities across Nigeria*
- *Withdrawal of oil or underground water,*
- *Construction of large reservoirs and engineering structures;*
- *The monitoring of accumulation of stress near active tectonic plate boundaries;*
- *Checking of the stability of large or complex structures (e.g. hydro-electric dams, stadium structure, high rise building, etc).*

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(Strategies for Integration-Cont-----)

4. Post collapse investigations by Project Team that acknowledges the applications of modern tools should be the new direction, rather than board of enquiries made up of politicians and non-technical experts.

5. The built environment professional must deliberately create a more inter-operable platform for interdisciplinary interactions and roles for effective delivery of projects in Nigeria.

6. Capacity building of members of the project team in moderate handling and use of key modern surveying tools in order for them to appreciate the requirements and need for employing such tools.

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Benefits of Integrating Modern Surveying Tools with the Project Team

The following benefits are accruable to effective integration of modern surveying tools in project implementations:

1. ***Improved accuracy in the job quantities (location based information) and delivery;***
2. ***Cost-effective and speedy delivery of project;***
3. ***Assurance of project quality and longevity***
4. ***Enhances professional collaboration and inter-disciplinary expertise***
5. ***Ensure consistency with the global best-practice in modern solutions to project implementation and delivery***
6. ***Support sustainable digital mapping and applications, and enterprise geospatial information system for project planning, design, implementation and delivery***

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CONCLUSIONS

- *The implications of the advances in ICT on surveying and mapping tools are innovations in informatics, computing, communications, software engineering, satellite sensing, spatial observation technologies, land information management and geospatial modelling techniques.*

- *As ICT advances, clients also become increasingly sophisticated; hence they expect and drive the surveyor and the entire project team to deliver higher levels of information, analysis and robust solutions.*

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CONCLUSIONS (Cont..)

- *On the other hand, the technological advances in acquiring and applying measurements enable the surveyors to perform as the geodata managers, and by selecting and blending techniques of geomatics and data management technologies, the surveyor can structure an optimal geospatial solution that will help the project team to deliver more professional and technical project results in Nigeria.*

- *In the light of the above, this paper has succinctly established the need for integrating modern surveying tools with the civil and environmental engineering project teams and also advanced some key strategies for such integration in order for cost-effective, qualitative and reliable deliverables in our national project tasks.*

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The Way Up is to Appreciate
One Another and Work
Together for the Common Goal
of the Project(s) in View

Thank You!

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