DEFENCE RESEARCHER Journal

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DEFENCE RESEARCH AND DEVELOPMENT BUREAU

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THE TEAM

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Editorial Board members

VISION

To be an internationally recognized research and development centre capable of meeting Nigeria's defence and security needs, while leveraging on the expertise of the indigenous and international partners"

MISSION

To provide strategic direction for self-reliance in defence and security needs through research and development

Goodwill message from

The Chief Of Defence Staff

General AG OLONISAKIN NAM CMH psc(+) fwc

I am most delighted to make a few remarks on this inaugural edition of the Defence Research Journal. On July 13, 2015 the President, Commander-in-Chief of the Armed Forces of the Federal Republic of Nigeria, Muhammadu Buhari appointed me as Nigeria's 16th Chief of Defence Staff.

In line with Mr President's directive, I charted a vision for the Armed Forces which is "To ensure a well motivated, manned, trained and equipped Armed Forces that is responsive to National Security commitments". It is therefore noteworthy to state that the reinvigorated proactive approach of the Armed Forces towards national development has improved the capacity, responsiveness and efficiency of the Force for better performance.

It is in line with this vision that the desire to become self-reliant through Research and Development (R&D) was conceptualised, hence the Department of Research and Development was upgraded into the Defence Research and Development Bureau for better efficiency.

Consequently, a Director General was appointed and given the mandate to coordinate and give strategic guidance to all research efforts of the Armed Forces. He is also mandated to monitor developments in equipment and weapons systems technology, collate data on various equipment holdings of the Armed Forces and also liaise with indigenous and foreign organizations with a view to building capacity for the Armed Forces.

Furthermore, the Bureau is also mandated to formulate policies, monitor training programmes as well as organize joint annual R&D seminars, conferences, competitions and exhibitions. Having mandated the Director General, it is hoped that he would take the Bureau to a great level before the expiration of his tenure. I wish to assure the members of the Armed Forces and the country of my resolve and commitment to project Research and Development of the Armed Forces of Nigeria to greater heights.

Finally, I want to commend the Editorial Team of the Defence Researcher Journal for a job well done. It is my wish that the information contained in this journal will continue to be useful to both members of the Armed Forces, researchers and the general public in understanding the activities of the Armed Forces in the area of Research and Development. I wish to also assure everyone that the military remains committed to the defence of the territorial integrity of Nigeria as enshrined in the constitution. Thank you and long live the Federal Republic of Nigeria.

Goodwill message from
The Chief Of Army Staff

LIEUTENANT GENERAL TUKUR BURATAI NAM OOM [BR] GSS psc[+] NDC [BD] FCMH FNIIAM BA [Hons] MA MPhil

FOR THE MAIDEN EDITION OF THE DEFENCE RESEARCH AND DEVELOPMENT BUREAU JOURNAL

I am highly delighted to felicitate with the Chief of Defence Staff (CDS) on the maiden edition of Defence Research and Development Bureau (DRDB) journal titled "Defence Researcher". This publication is coming at the right time when the current security challenges have placed enormous burden on the Armed Forces of Nigeria in internal security operations across the nation. The NA in particular has been faced with challenges on some of the equipment operated in the North East and other theatres of operation as result of lack of spares. Since the journal is so designed to articulate ideas, provide a comprehensive source of current research information, it would go a long way in providing workable solutions to the equipment maintenance challenges and possible improvisation of spares that would tackle equipment breakdown.

LIEUTENANT GENERAL TY BURATAI
CHIEF OF ARMY STAFF

Research and Development (R&D) in the developing nations of the world has been relegated to the background due to poor funding. Research Institutions in the military have not fared better as they would have been able to address the challenges the military is facing in equipment technological breakthrough. However, in the developed nations, R&D expenditure tends to represent major component of total government spending. Historically, development technology has often been linked with the military and war. Therefore, the production of this journal would encourage intellectuals in the military to contribute their quota on research on Counter Improvised Explosive Devices in conjunction with the academia. There is the need to delve into the research of local production of de-mining equipment that would help in the protection of troops in the war against terror in all theatre of operations in the country.

The CDS in the last 2 years has provided purposeful leadership in managing the affairs of the Armed Forces of Nigeria. He has personally intervened at critical moments towards efficient management of operations in all theaters and particularly of note is the CDS personal donation of some Ground – to- Air (GTA) Radio Communication sets to troops in the North East theatre of operation to enhance operational efficiency and effectiveness in the areas of command and control. It is not surprising that the CDS has taken another giant stride at re-positioning the DRDB towards meeting the research and development needs of the Armed Forces of Nigeria in particular and the Nation in general. I foresee a brighter future for Research and Development in the military if the production of subsequent journals are sustained.

On behalf of the officers and soldiers of the Nigerian Army I wish to congratulate the CDS, DG DRDB, the members of the DRDB Editorial Board, officers and men of the Bureau for the noble idea that would steer the path of meaningful research in the Nigerian Armed Forces. I encourage individual officers and soldiers of the Armed Forces of Nigeria, the R & B institutions to make informed contributions to this journal. I am to prescribe this journal to Nigerians for reading to update their knowledge on the Armed Forces R&B efforts. Wishing you all happy reading and God Bless.

Goodwill message from the

CHIEF OF NAVAL STAFF, VICE ADMIRAL IE IBAS GSS AM psc(+) ndc Msc

ON THE OCCASION OF THE LAUNCHING OF THE MAIDEN EDITION OF THE JOURNAL "DEFENCE RESEARCHER"

It gives me great pleasure to rejoice with the CDS and the entire Defence community on the production of the maiden edition of the "Defence Researcher". It is a fundamental truth that research and development are the cornerstones of organisational efficiency. For any organisation to remain relevant in this modern age, due attention must of necessity be accorded research and development. This is even more imperative in the Armed Forces where the changing complexion of modern warfare demands continued efforts on research and development. I therefore commend the CDS and the DHQ for initiating this publication, which should also drive transformation in the Armed Forces and provide platform for regular review of relevant innovations and breakthroughs.

Vice Admiral IE IBAS GSS AM psc(+) ndc MSc
CHIEF OF THE NAVAL STAFF

As the Journal makes its debut, I charge the Editorial Board to remain focused on making it an engaging package for the productive discourse of research and development issues. It is expected that you will work assiduously to sustain not only the publication, but the ideal behind its introduction, particularly as a publication devoted to publishing contemporary issues in military research, development and production.

Once again, I congratulate the Editorial Board of this maiden edition for a very promising outing and hope that the journal will not falter but will grow from strength to strength, surpassing the expectation of its readership for each published edition. In this endeavour, I wish you fair winds and God's speed. 'ONWARD TOGETHER'.

Goodwill message from the

CHIEF OF THE AIR STAFF, AIR MARSHAL SB Abubkar DFS GSS psc (+) fcw fdc (+) Msc

It is with profound joy that I congratulate the Chief of Defence Staff, General AG Olonisakin on the occasion of the successful publication of the maiden edition of 'Defence Research and Development Bureau Quarterly Journal'. The publication would, no doubt, contribute immensely to the sensitization of the military community on the importance of research and development. It would educate, inform and enlighten the wider Nigerian society about research findings by members of the Armed Forces of Nigeria. Furthermore, the publication would bridge the existing gap between research findings and the lack of awareness of these findings by the wider society.

Air Marshal SB Abubkar DFS GSS psc (+) fcw fdc (+) Msc
Chief of the Air Staff

Let me, therefore, on behalf of officers, Airmen/Airwomen and civilian staff of the Nigerian Air Force, congratulate the Chief of Defence Staff and indeed all members of the Armed Forces for the publication of this educational journal. I wish the Chief of Defence Staff and the editorial team more successes as we look forward to subsequent editions of this magazine.

From The Desk Of the Director General Defence Research and Development Bureau

AVM Onyemaechi Jomo Osahor

GSS psc(+) fdc B.Engr MSc MNSE FIEAN, Director General Defence Research And Devt Bureau

The transformation of the Department of Research and Development into a Bureau completed the process of re-engineering of this vital arm of the Defence Headquarters in line with global best practices. It was indeed heralded with a lot of enthusiasm as it sets Research and Development (R&D) on a new pedestal. Thanks to the resilience and commitment of a visionary leader, the current Chief of Defence Staff, Gen AG Olonisakin that midwifed the entire process of integrating the entire R&D efforts of the Armed Forces of Nigeria (AFN) in collaboration with viable partners through the creation of a Bureau. The long term vision is the transformation of the integrated system into a Military Industrial Complex (MIC) capable of meeting the defence and security needs of the AFN and the country at large.

The motivation has been that "if it can be done anywhere in the world, it can be done in Nigeria". It is with this 'we-cán-do-it' spirit that on assumption of duty as the Director General of the Defence Research and Development Bureau (DRDB) on 14 July 2017 that series of activities were embarked upon to actualize the total transformation of the Department to a Bureau of international standard. My resolve to chart the much needed strategic direction for the Bureau while leveraging on the modest efforts of my predecessor led to several in-house conferences with staff which marshalled out the vision and mission of the Bureau. Accordingly, the Bureau's vision is "to be an internationally recognised R&D centre capable of meeting Nigerian's Defence and security needs while leveraging on the Expertise of indigenous and international partners". Similarly, the mission statement of the Bureau is to "to Provide strategic direction for Self-reliance in defence and security needs through research and development". To this end, the draft Bill for the Bureau was painstakingly drafted for consideration by the National Assembly (NASS). Additionally, the Bureau also reviewed its administrative structure to accommodate civilian staff.

Within this period, the bureau in collaboration with some partners rolled out some cutting edge technologies aimed at enhancing the operation of the AFN. As part of the effort to place the Bureau on a global stage, a quarterly journal was also launched to showcase military efforts in R&D and innovations amongst others. The quarterly journal titled "Defence Researcher" is billed to hit the news stand with its maiden publication in the second quarter of 2018.

Most assuredly, DRDB is working assiduously to lay solid foundation for R&D in collaboration with both indigenous and foreign partners to provide substantially the defence and security needs of the AFN. Let me seize this opportunity to appreciate the commitment of the editorial board and the news crew towards the publication of the maiden edition of the Bureau's journal. Finally, to the entire management team and staff of the Bureau, I enjoin you to remain resolute as we chart the course of excellence in DRDB.

From the Editor-in-Chief

Brig Gen EC Ekwesi

It is with great honour and privilege to be a member of the conceptualization of the Defence Researcher, a quarterly journal published by Defence Research and Development Bureau (DBRD) of the Armed Forces of Nigeria (AFN). As one of the thrusts of the Bureau, the Journal is packaged to bring to light various research and development efforts of our Centres and institutions in the AFN in collaboration with other public and private institutions and organisations. I am most delighted that this maiden edition is hitting the news stand at no better time than now that our nation is looking inward in terms of promotion of science and technology as contained in the Presidential Executive Order 5 of 2018.

Over the years, the AFN have recorded some modest achievements and innovations in the field of defence and security through robust research and development. However not much has been done to harmonize, document and publish these efforts under a common platform in line with global best practices. This prompted the birth of the Defence Researcher to coordinate and harness these efforts for publication. It is also to promote and showcase competences in science and technology in line with CDS strategic vision for the AFN which is to source for her defence needs through local production and gradually but eventually attain self-reliance in defence production.

Since its establishment, the DRDB has witnessed a flurry of activities aimed at bringing all relevant stakeholders on board. The Bureau visited various military and public institutions as well as private organisations and held strategic discussions with their leadership. These activities were extensively covered in this first edition of the Defence Researcher. Some of the institutions visited by the Bureau include Defence Industry Corporation of Nigeria, Centre for Er ergy Research and Training, Federal Institute for Industrial Research Oshodi and Centre for Energy Research and Development. The indigenous companies visited include Proforce Limited, Erisco Foods Nigerian Limited, Innoson Motors and SUNUP amongst others. This Edition also emphasizes the strategic vision and objective of the Bureau as underscored by the Director General during his interaction with the Editorial Board members. He reiterated the resolve of the Bureau to relentlessly pursue self-reliance in the production and manufacture of defence needs of the AFN through integrated approach in research and development. The Journal also captures some of the R&D efforts in the Army, Navy and Airforce.

Finally, I wish to appreciate members of the Editorial Board for working assiduously with me to ensure timely production of the Journal. I am optimistic that reading the Defence Researcher will be a rewarding experience for those eager to explore the world of innovations in defence related endeavours in the AFN. Thank you and please accept my best regards.

Defence Research and Development Bureau Technical Assessment Team Visit to OP Lafiya DOLE and OP DELTA SAFE

In line with the strategic vision of the Chief of Defence Staff, General AG Olonisakin to promote science and technology for self-reliance in defence needs of the Armed Forces of Nigeria (AFN), the Defence Headquarters Department of Research and Development was transformed and upgraded to a Bureau to drive this vision. One of the core mandates of the Bureau is to coordinate and encourage all research efforts of the AFN to meet international best practices. It is with this in mind that Defence Research and Development Bureau (DRDB) embarked on a series of collaborative efforts with indigenous and foreign partners to achieve her set goals. One of the immediate tasks of the Bureau is to resolve the problem of spare parts through indigenous research in order to resuscitate broken down vehicles and other equipment occasioned by the on-going military operations in some parts of the country especially in the northeast and south-south geopolitical zones.

Pursuant to this objective, the DG DRDB inaugurated technical committees that visited Operation LAFIYA DOLE and Operation DELTA SAFE from 13 to 17 February 2018 to conduct on-the-spot assessment of all the broken down equipment with the aim of finding urgent solutions to them in collaboration with strategic partners. The visit to Op LAFIYA DOLE was quite revealing as the Committee identified areas for short,

medium and long term interventions in repairs, fabrications and construction. The Team also observed that some vehicles such as MRAPs, Armoured Personal Carriers (APCs), Troop Carrying Vehicles (TCVs), Explosive Ordnance Disposal (EOD) and communication equipment require spares for urgent repairs. The aim is to address the dearth of equipment in the Theatre and also boost operational efficiency and effectiveness. Additionally, the challenge posed by Improvised Explosive Device (IED) which is often employed by insurgents against own troops was considered with a view to finding lasting solution to the menace. As a short term measure, the Team recommended closer collaboration between DRDB and Nigerian Army Special Vehicle Plant (NASVP) as well as Airforce Institute of Technology in dealing with the challenges.

DRDB team inspecting anti-aircraft gun during visit to OPS LAFIYA Dole

Similarly, the Committee that visited Op DELTA SAFE in South – South Nigeria, assessed the serviceability of some Gun Boats, Fast Assault Crafts (FAC), Off Shore Patrol Vessels and Ships. The observed challenges are also receiving attention as the DRDB has identified viable public and private companies, institutions as well as foreign companies with requisite competences in the areas of retrofitting, boat construction and repairs.

It is envisaged that in the coming weeks and months, the collaborative efforts by DRDB for increased availability of spare parts for operational equipment and platforms will begin to yield results. Moreso, the DRDB intends to engage in continuous liaison with formations and units in operations through appropriate channels to identify critical and urgent needs with a view to addressing them through research and development efforts.

Anti-Aircraft gun under repairs

OP Lafiya Dole vehicles under repairs

Director Development, DRDB Rear Admiral Odeh (middle) being, briefed by CO NNS Zaria during visit to Operation Delta Safe

Design and Analysis of Rigid Tow Bar for Nigerian Air Force Alpha Jet Aircraft

AVM Paul O Jemitola, Gp Capt Osichinaka C. Ubadike, Wg Cdr Godwin E Abbe & Sqn Ldr Okemini S Uguzo

ABSTRACT

This paper provides a case study on the structural integrity of a towing bar using finite element analysis (FEA). The overall design of the towing bar in terms of shape and material properties was subject to the original equipment manufacturers (OEM) design for the Alpha Jet aircraft. The simulation analysis was done for four different cases, where force was applied at four different angles; 0, 30, 45 and 60°. The results of the FEA simulations show that the maximum stress experienced on the towing bar reduced significantly when the load is applied at increasing angles. The computer simulated maximum stress is 450 N/mm2, which is 1.9 times less than the value specified in the aircraft's towing procedure. This investigation only shows the maximum force that can be applied to the specific towing bar and the behaviour of its structure during failure. Therefore, further experimental analysis should be conducted in order to reaffirm the findings from the simulation analysis.

Keywords: Towing bar; finite element analysis; maximum stress; maximum deflection; towing angle.

Introduction

The induction of an additional variant of the Dassault-Dornier Alpha Jet aircraft into the Nigerian Air Force (NAF) inventory was a welcomed development. However, the dynamic application of today's air power in terms of the aircraft's deployment into various theatres of operation presents a dilemma which is encountered during ground handling operations. Before the Alpha Jet can take off to perform its mission, it must be towed from the maintenance shed to the hangar, from the hangar to the taxiway, etc. When towing an Alpha Jet aircraft, a towing bar is connected between the aircraft and vehicle. One end of the towing bar is fixed to the front wheel of the aircraft, while the other end is attached to the back of the vehicle. During operation, the structure of the towing bar is subjected to high stresses due to the high loads 2 applied. Also, the allowable angle for turning during the towing operation is from 0° to 60° (Manson, 2011).

Due to the high stress applied and the surface conditions of the forward operation airfi elds, the Alpha Jet towing bars hav e failed during operation in miss ion areas. Furthermore, becau

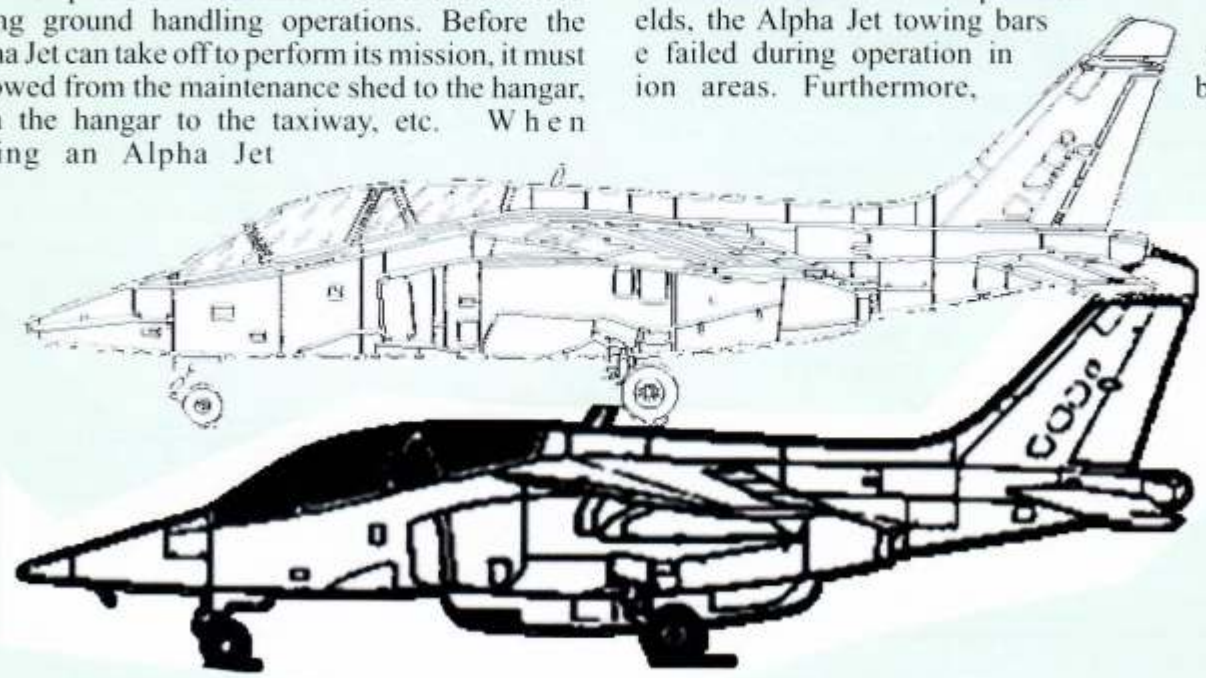


Figure 1 Difference in Alpha Jet Variants Nose Section Dimensions

se of differences in nose section dimensions as shown in Figure 1, some Alpha Jets have experienced mechanical damages. These occurred after impact loads from a towing bar connection exceeded design limits during sudden stops by the tow tractor. These damages include deformation of the aircraft pitot-static tube and structural deformation of the tow bar. It has been estimated that a single failure of this type could cost upwards of a million Naira. In some incidents, the aircraft overhangs the tow tractor, which has the potential to cause death or serious injury to the tow tractor operator, not to mention damage to and loss of operational capability for the aircraft.

The application of static or dynamic loads cause stresses in structural materials. The analysis of these stresses is an important engineering discipline referred to as stress analysis. This process is required for the study, design and manufacture of structural components under given or expected loads. At various phases of component design and manufacture, the structural behaviour and characteristics of a component can be predicted using stress analysis. This is achieved using complex equations followed by a validation process such a Finite Element Analysis (FEA)(Hibler, 2005).

FEA has become more important in aviation in recent years. Numerical solutions even for a very complicated stress problem can be obtained using this method (Roylance, 2001). The model of a structural design can be developed using Computer Aided Design (CAD) software for specific stress related results. A pre-processing operation converts the CAD model into a discretised form of mesh. The solid bodies of the material are discretised by FEA into small and finite volumes called the finite elements, where elasticity principles can be easily applied. A solver, containing various equations, then evaluates the mesh. Finally, a post-processing module interprets the results obtained from the solver (Zienkiewicz et al., 2005; Rao, 2010), to determine whether it can perform under the required specifications prior to construction or manufacturing. This paper provides a case study of a structural behaviour of the towing bar for the Alpha Jet aircraft using FEA. The objectives of the research were to:

a. Determine the maximum forces that can be applied to the towing bar at critical angles that have been identified for future reference of users.
b. Analyse the behaviour of the towing bar structure towards each loading conditions.

Modelling methodology

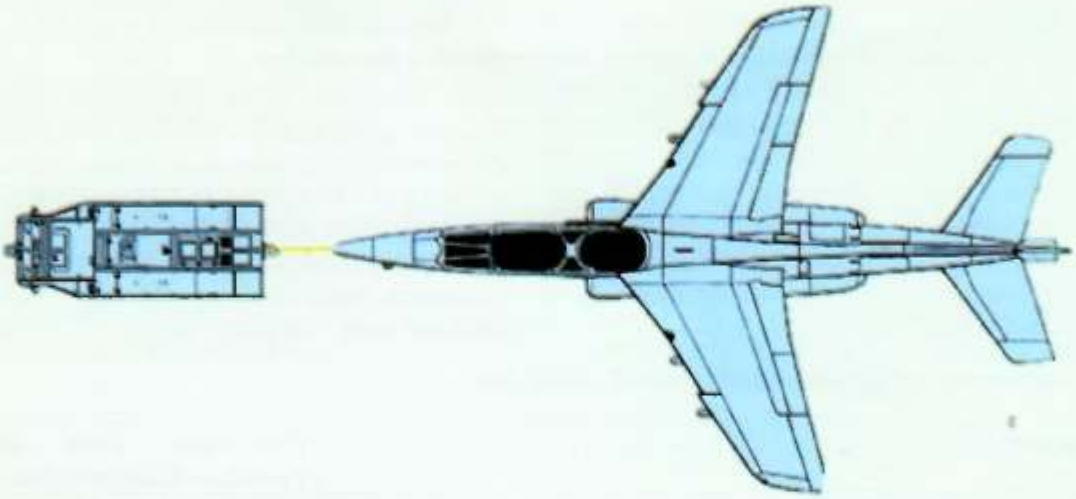
This work deals with conventional stress and finite element analysis of a rigid tow bar for recovery and positioning of the Alpha jet aircraft. In the present analysis, the focus is given on design modification and optimization of the existing design of the tow bar to withstand higher loads. Load distribution calculations are carried out by considering following 2 situations:

a. Tensile forces act on the tow bar when the tow vehicle begins to pull the aircraft.
b. Compressive forces act on the tow bar during braking by the tow vehicle to bring the aircraft to rest condition.

There are two main parts in this investigation, modelling the structure using CAD and analysing the structure using computer aided engineering (CAE). Using the dimensions given, the design of the towing bar is modelled using a CAD software, CATIA V5 R20. The generated model of the towing bar is then analysed using a CAE analysis software, ABAQUS V13.

Load Requirements

In considering the load requirements of the towing bar for the Alpha Jet, the provisions of MIL-STD-805B was referred to. This standard covers general design requirements for towing fittings and provisions which are an integral part of military aircraft equipped with a wheel-type landing gear. These towing bars are classified as medium duty universal tow bars based on the weight of its applicable aircraft. The load requirements placed on the design of the new tow bar system were the same as those utilized in the development of the



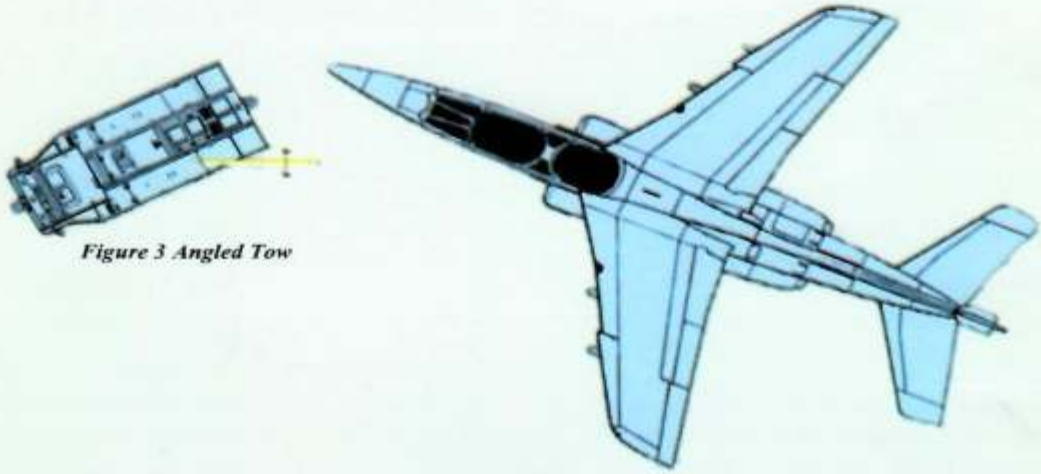
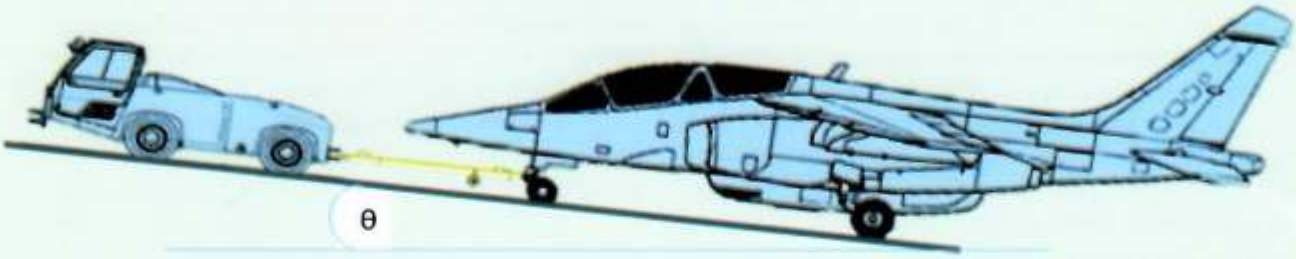
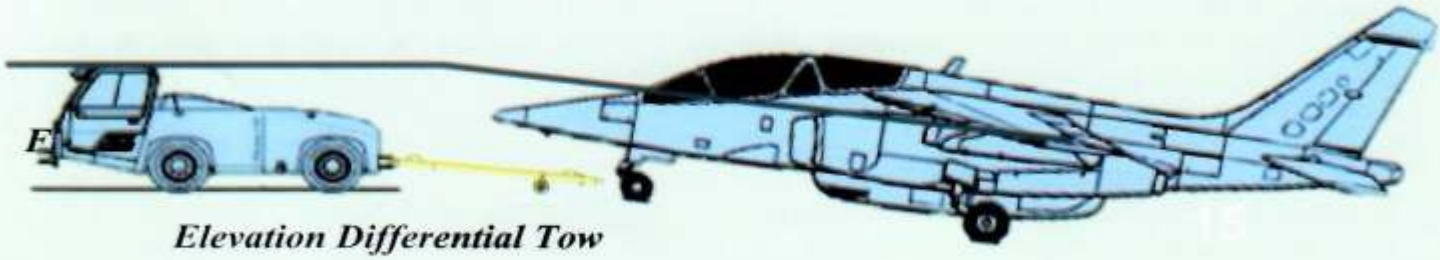


Figure 3 Angled Tow





Elevation Differential Tow

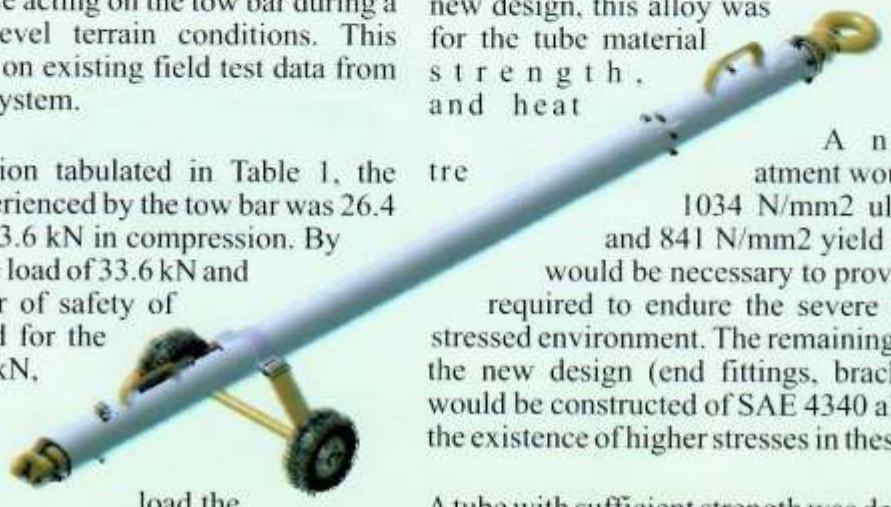
original tow bar. A sequence of quasi-static load analyses were performed for various manoeuvres and are summarized in Table 1. In this table, a straight tow refers to the towing vehicle pulling the aircraft straight forward or pushing straight backwards (see Figure 2) while the angled tow refers to the manoeuvring through turns of both vehicles (see Figure 3). Furthermore, elevation differential refers to towing the aircraft up or down inclined surfaces (see Figure 4).

Table 1 Summary of Quasi-Static Load Analysis

Manoeuvre	*Maximum Tow Bar Load (Tension/Compression)*
Level Terrain, Straight Tow	*10 / 18.4 kN*
Level Terrain, Angled Tow	*18.8 / 29.2 kN*
Sloped Terrain, Straight Tow	*12 / 20.4 kN*
Sloped Terrain, Angled Tow	*22.4 / 33.6 kN*
Stationary Turn	*10 / 16 kN*
Elevation Differential, Straight Tow	*14 / 19.2 kN*
Elevation Differential, Angled Tow	*26.4 / 31.2 kN*

All loads shown in Table 1 are axial loads (quasi-static). There were no torsion and only a small magnitude of bending loads applied to the tow bar because all aircraft-to-tow bar connections act as universal joints allowing for rotation (see Figure 4). The bending load applied was due to friction between the lunette and pintle during towing (see Figure 5). In view of these finding, it was decided that only the tow bar tube would be modelled and idealised for the stress analysis. Further work would entail conducting analyses on individual components of the tow bar. In addition to the quasi-static analysis, the dynamic analysis showed a 22.4 kN steady-state force acting on the tow bar during a 10km/h tow on level terrain conditions. This estimate was based on existing field test data from the current tow bar system.

From the information tabulated in Table 1, the maximum load experienced by the tow bar was 26.4 kN in tension and 33.6 kN in compression. By using the worst-case load of 33.6 kN and introducing a factor of safety of 2.5, the design load for the tow bar was 84 kN, axial tension or compression. This represented the maximum load the tow bar was to sustain before material began to yield.

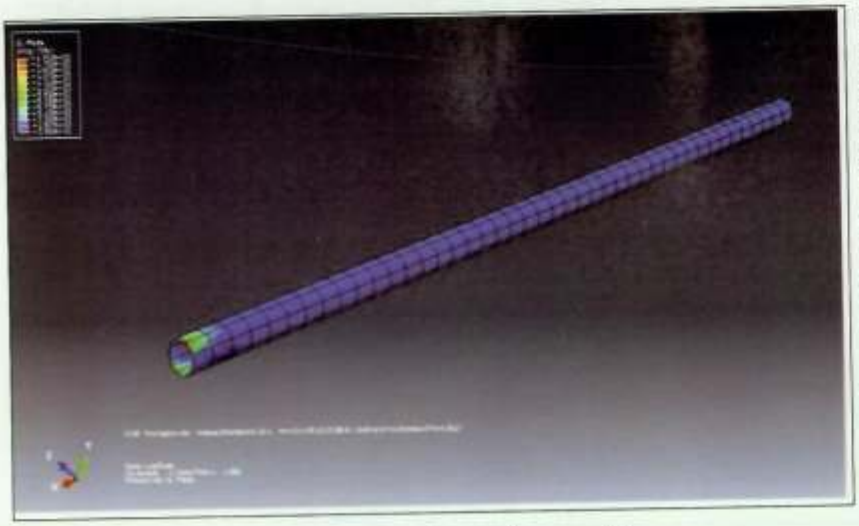


Towing Bar Design

Following the SAE Aerospace Recommended Practice ARP1915E and ISO 9667 which specify dimensional and physical requirements of tow bar connections to tractor and aircraft, this information was then used in the selection of materials used for the components, critical dimensions, design standards used and its limitation. A conceptual design was created using 7 various design considerations to meet the working requirements and to overcome the limitation of the earlier design. Figure 5 shows the model of the towing bar designed using CATIA V5. The structure was designed to withstand an Alpha Jet aircraft weight of 7,600 kg (critical weight) at the angle from 0-60° at the horizontal plane (Manson, 2011). A boundary condition was identified as a fixed end with all the degrees of freedom being constrained at the flat end of the structure (Jafari et al., 2006).

All components of the currently fielded towing bar, including the angled wheel support legs, are constructed of SAE 4130 alloy steel. In the new design, this alloy was used only for the tube material due to its strength, toughness, and heat treatability. A nominal heat treatment would generate the 1034 N/mm2 ultimate strength and 841 N/mm2 yield strength, which would be necessary to provide the strength required to endure the severe tow bar highly stressed environment. The remaining components of the new design (end fittings, brackets, and pins) would be constructed of SAE 4340 alloy steel due to the existence of higher stresses in these components.

A tube with sufficient strength was designed utilizing



the load and material criteria from above. The calculated dimensions of this tube were exact and would be costly to fabricate on a prototype basis. Therefore, for this reason, the dimensions calculated were regarded as minimum values and tubing of the nearest larger standard size was used in the fabrication of all prototypes. To be able to sustain the tensile and compressive loads of 84 kN, the minimum required cross sectional area of the tube was calculated to be 176 mm2. This area must be distributed in such a manner to resist both column and shell buckling resulting from compression loading. Because the critical buckling load, modulus of elasticity (30x10 6 psi), and length of the column (same as the current tow bar, 2.95 m) were known, the only unknown was the moment of inertia. Euler's Equation was then manipulated to determine the ideal inner and outer radii of the tube.

The stress induced in the tube was calculated to be 421.7 N/mm2. This stress is less than the yield strength of the material, therefore, the geometric and material properties of this tube enable it to support the required axial loads. The next step was to determine the critical buckling load for the tube. This was calculated to be approximately 114 kN. This load is greater than the required 84 kN, therefore, this tube surpasses this column buckling load requirement. The final check was to calculate the critical shell buckling stress due to compressive loading. Shell buckling is a localized collapse of a thin-walled tube (shell) subjected to compression loading. The critical shell buckling stress was calculated as 2,657.3 N/mm2. The maximum axial stress of 421.7 N/mm2 was well below this value. Therefore, the shell buckling requirement was easily satisfied.

Finite Element Analysis

The model of the structure was then imported into ABAQUS for its structural analysis. The mesh was created using the software and the boundary conditions were determined to simulate the real-life situation that the structure experiences during its operation (Figures 3 to 5). There were four turning cases that were found to be practical for this analysis; the load at angles of 0, 30, 45 and 60°. For each case, the load was increased from 1 kN up to a point where the maximum stress experienced by the structure

Table 2 Maximum force and maximum deflection at different angle before the structure yielded.

Degree (°)	*Maximum Stress (N/mm²)*	*Maximum Deflection (mm)*
0	*450*	*1.02*
30	*413*	*2.4*
45	*374*	*3.55*
60	*323*	*4.6*

reached the maximum yield strength. The yield function of material deformation is the distortion-energy theory and is called the Von-Mises theory. Therefore, it is the most suitable theory to be used for ductile materials (Shigley & Mischke, 1989).

Results And Discussion

The parameters recorded for each case were the load when the structure yielded and the maximum deflection of the structure. Figure 6 shows the region where the maximum stress. Since the critical weight of the Alpha Jet aircraft during operation is roughly 7,600kg (74 kN), the maximum force would have to be greater for the structure not to fail. In a situation where the load applied to the towing bar is greater than the maximum force for a certain angle, the structure would deform permanently or even break (Xu et al., 2007). Table 2 shows the maximum forces that the structure can withstand at the studied angles of load and the maximum deflection before it fails at maximum stress (maximum yield strength of 841 N/mm2).

Based on the results obtained from the analysis, maximum stress significantly reduces when the load is applied at increasing angles. On the other hand, the maximum deflection of the structure increases, indicating that the greater the angle of the applied load, the easier it is for the structure to deform or fail (Suripa & Chaikittiratana, 2008). This follows that stress increment always associates with a given strain increment (Mingzhou et al., 2002). From the different towing conditions analysed, it has been determined that the maximum stress on the tow bar and for safety reasons should not exceed 841 N/mm2. However, the results show that at the maximum operating angles of 0 - 60° the maximum load that can be applied is 450 N/mm2, which is 1.9 times less than the allowable stress. This simulation result further validates the calculated stress of 421 N/mm2. It also indicates that it is almost impossible for the towing bar to fail during its operation, taken into consideration that its use follows the standard procedures provided.

Conclusion

In this study, FEA simulations of an Alpha Jet towing bar under static loading was carried out. The maximum forces that can be applied to the towing bar reduced drastically when the load is applied at increasing angles, while the maximum deflection of the structure increases. The computer simulated maximum stress is 450 N/mm2, which is 1.9 times less than the value specified in the aircraft's towing procedure. This analysis provides users with acceptable data for the operation of the towing bar at different angles. The simulation results for the deflections also give qualitative (visual) and quantitative (maximum deflection) data on how the towing bar's structure behaves in the case of failure.

The FEA simulations conducted in this study only identified the maximum force as well as the locations of maximum stress and deflection when the load is applied to the towing bar. It is suggested that further experimental analysis be conducted on individual component parts of the towing bar in order to reaffirm the findings of this study.

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Nigerian Navy Research Perspective -Heralding Local Content as Panacea for a Self Reliant Armed Forces

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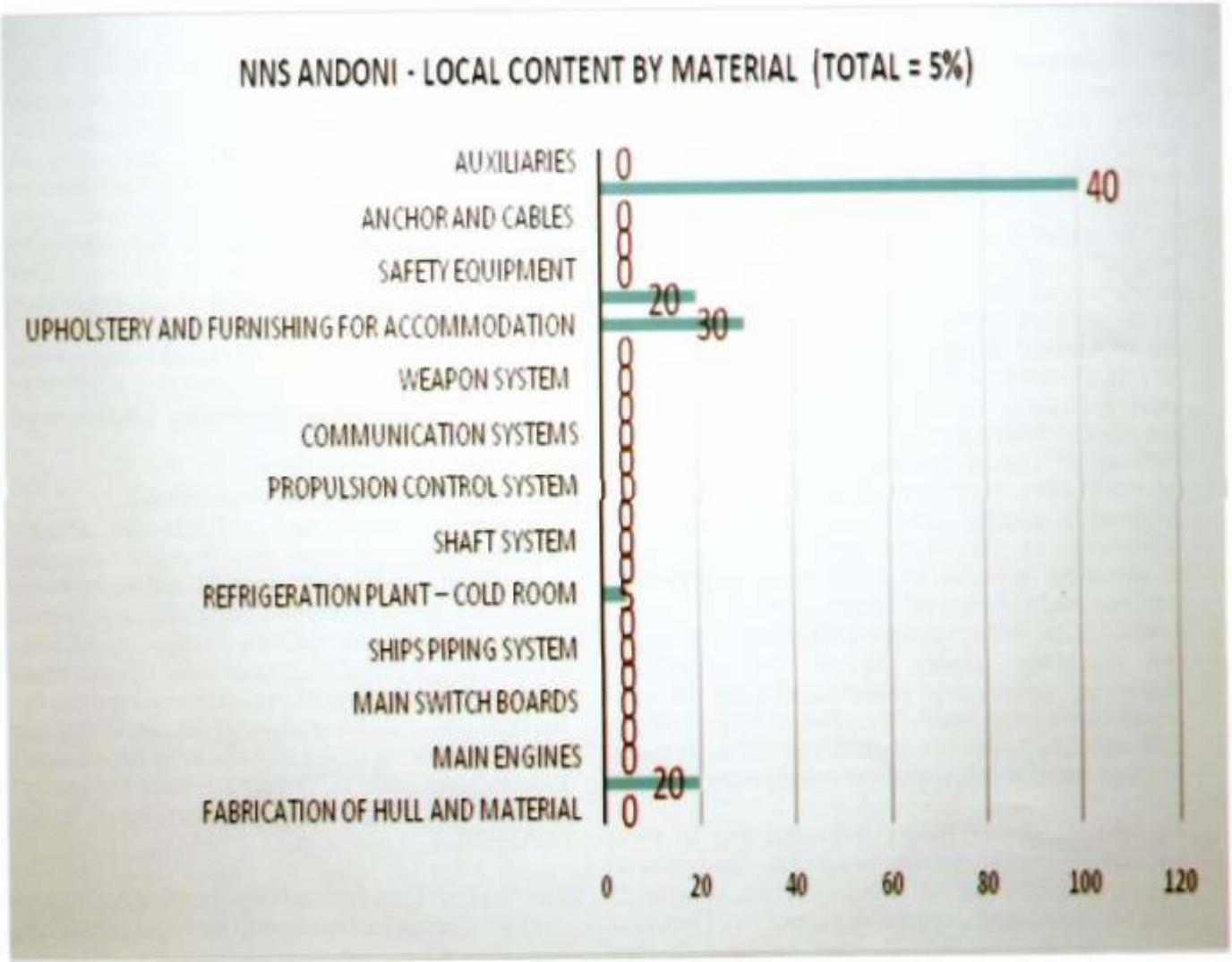
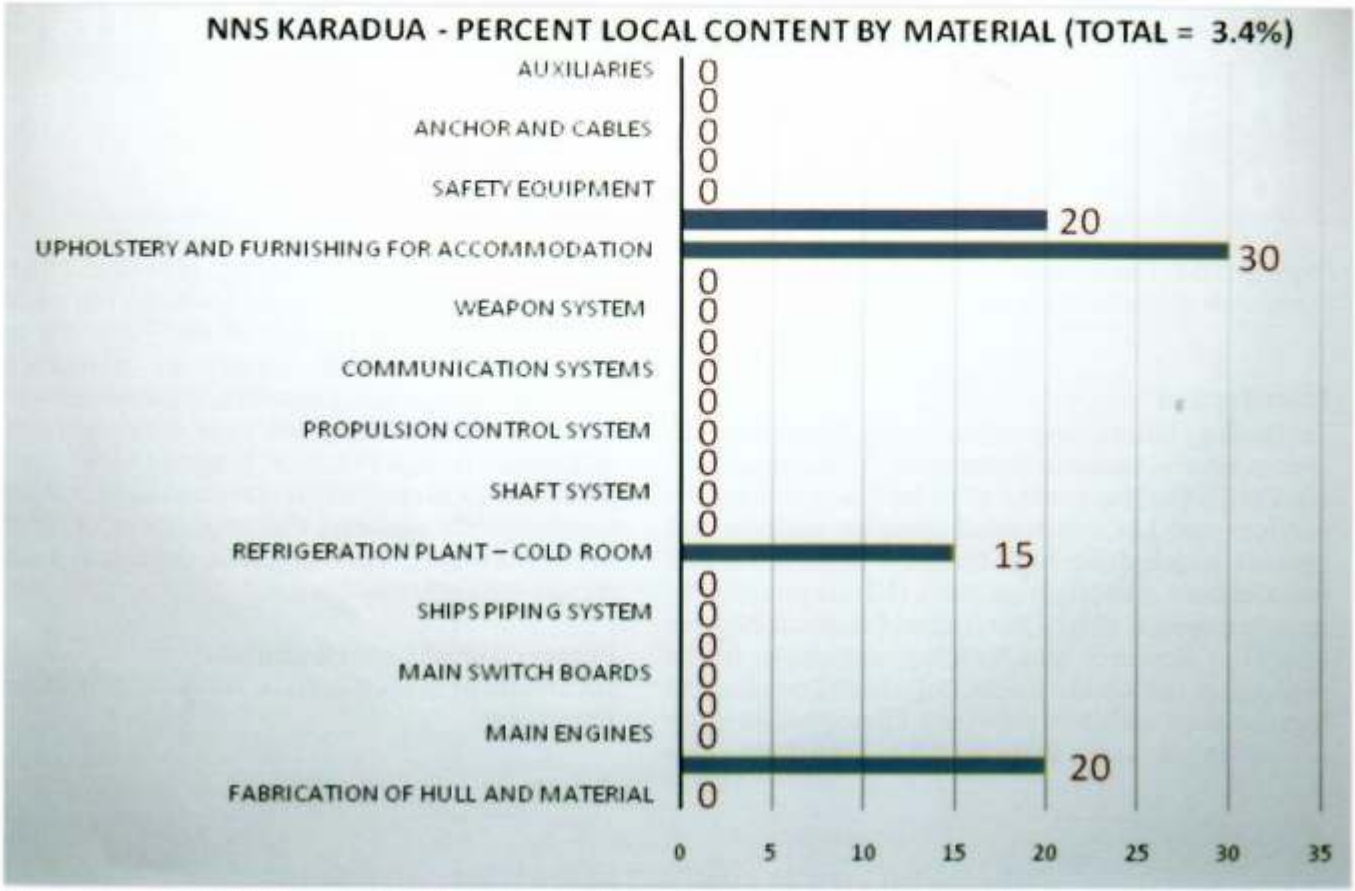
Introduction

Technology is fast changing and new systems which are unconceivable continue to emerge with alarming costs. Generally, the Navy is the most technical among the services and has interrelated complex systems and sensors which drive high costs for acquisition and maintenance. The Nigerian Navy (NN) is proudly the most successful arm of the Armed Forces of Nigeria (AFN) in Research and Development drive. In the recent past, the NN has successfully built 2 combat and logistic ships within its dockyard. These platforms are active in service and in NN inventory. The achievements, notwithstanding, provided range of challenges which the NN is surmounting. Foremost, is the dearth of involvement of the Nigeria's local industries that could supply or manufacture hardware/equipment. Therefore, in perspective of the Commander-in-Chief (C in C) vision for a sustainable self-reliant Armed Forces of Nigeria (AFN), the NN pursued a local content involvement and established requisite collaborations. This paper therefore intends to discuss ways of heralding local content as panacea for self-reliant Armed Forces.

Perspective of Local Content

Involvement In The Nigerian Navy Ship Building Expedition





Over the years, the NN designed and built 2 combat war ships namely; NNS ANDONI and NNS KARADUWA. These ships are in operation as part of the NN fleet on patrols within and beyond Nigeria's Economic Exclusive Zone (EEZ). The NN success in the design and construction of these ships is a result of long term planning in its manpower capacity development in higher degrees and various specializations related to maritime technology. From the conceptual design stage to completion of the project, about 60% of the manpower was derived from local industries whilst, the remaining 40% was provided by the NN personnel. However, it is amazing that over 95% of the hardware material ranging from the steel plates, machinery, electrical and electronic equipment among others were imported. The taxonomy of the local and foreign content involvement in the NN ship design and construction scheme is shown below at Figures 1 and 2. In the case of ANDONI, the 40% indicated that the Anchor was cast and machined locally. In all, the propulsion machinery, power sets, pumps and even the steel materials were imported. The NN and local industries fabricated the hull which includes welding, forming, shaping, installation, alignment among others.

The results shown below indicated gap in local industrial participation and are considered inappropriate by the NN administration, despite its *effort in providing the requisite manpower. The Chief* of the Naval Staff (CNS), Vice Admiral IE Ibas described the situation as 'unsecure and unjustifiable'. Though, the cost implication was significantly lower than what it would have cost if the ships were constructed abroad, the CNS directed the Directorate of R&D to fashion out how Nigeria's industries could be mobilized to provide shipbuilding material and equipment to remedy the 'unsecured and unjustifiable' foreign domination of the local shipbuilding ventures. Therefore, the CNS reiterated the need for collaboration between the AFN and local industries with a view to attaining sustainability in self-reliance and industrial growth for the country. This leads to the NN research expedition.

Nigerian Navy research expedition

The NN Directorate of R&D embarked on exploration for local capacity with a view to mitigating over reliance on foreign materials and equipment for the Nigeria's nascent ship building industry. A number of industries were identified with capacity. Although, statistically, some of these local industries were in the brink of collapse, they indicated interest to partner with the NN to develop local capacity for the AFN at large. Most astonishing in the NN research expedition for local industry, is the discovery of National Agency for Science and Engineering Infrastructures Institute (NASENI).

The NASENI is a Federal Government Agency with over *9* Research Institutes with various specialization

across the country. NASENI is charged with responsibility to drive R&D support to/from local industries. The Directorate of NN R&D visited the following NASENI Institutes and firmed up collaboration with the institute for joint R&D study and training:

a. Scientific Equipment Development Institutes (SEDI) in Enugu SEDI mandate is to develop and produce scientific equipment.

b. National Engineering Design Development Institute (NEDDI), Nnewi. NEDDI mandate is to develop engineering design capacity in the country and dissemination of same to industry with a view to ensuring that Nigerian made products attain standards specifications and make then globally acceptable.

c. Electronic Development Institute (ELDI) Awka . ELDI mandate is to develop and produce electronic devices and assemblies, computer technologies and their production systems.

d. Scientific Equipment Development Institutes (SEDI) Minna. Its mandate is akin to SEDI in Enugu.

e. Hydraulic Equipment Development Institute (HEDI) Kano. HEDI's mandate is to develop and produce hydraulic and pneumatic machinery, materials, fittings and their production systems.

f. Advanced Manufacturing Technology Project (AMT-P) Jalingo AMT-P's mandate is to develop components, machineries, their production systems and the transfer of these to private sector satellite industries.

g. Power Equipment and Electrical Machines Development (PEEMADI) Okene with a mandate of developing and manufacture of machines to manufacture power equipment and electrical machines.

h. Engineering Martials Development Institute (EMDI) Akure. EMDI mandate is to develop and produce engineering materials and their production systems.

i. Prototype Engineering Development Institute (PEDI) Ilesha. PEDI's mandate is to develop engineering prototypes and their production systems.

In retrospect, the NN R&D identified certain grand consideration which could be negotiated for the empowerments of the local industries and advance its projects. These considerations which are discussed hereunder, if implemented would provide level ground for synergy with industries as panacea for self-reliant.

Panacea and way Forward For Self Reliant Armed Forces

The aforementioned encounter with NASENI is insightful and provided panacea on how the AFN could reach out and utilize Nigeria's local industrial capacity for self-reliance. Therefore, the way forward is enumerated as follows:

a. The AFN could provide its manpower expertise to guide the industries with relevant designs to support reverse engineering.

b. The AFN could continuously patronize the industry. In this case, an MoU could be signed to firm up agreement(s).

c. The AFN could collaborate with the industry in joint R&D studies and training.

d. The AFN could develop its military standards (drawing from developed nations) custom to Nigerian operational needs to guide the local content scheme.

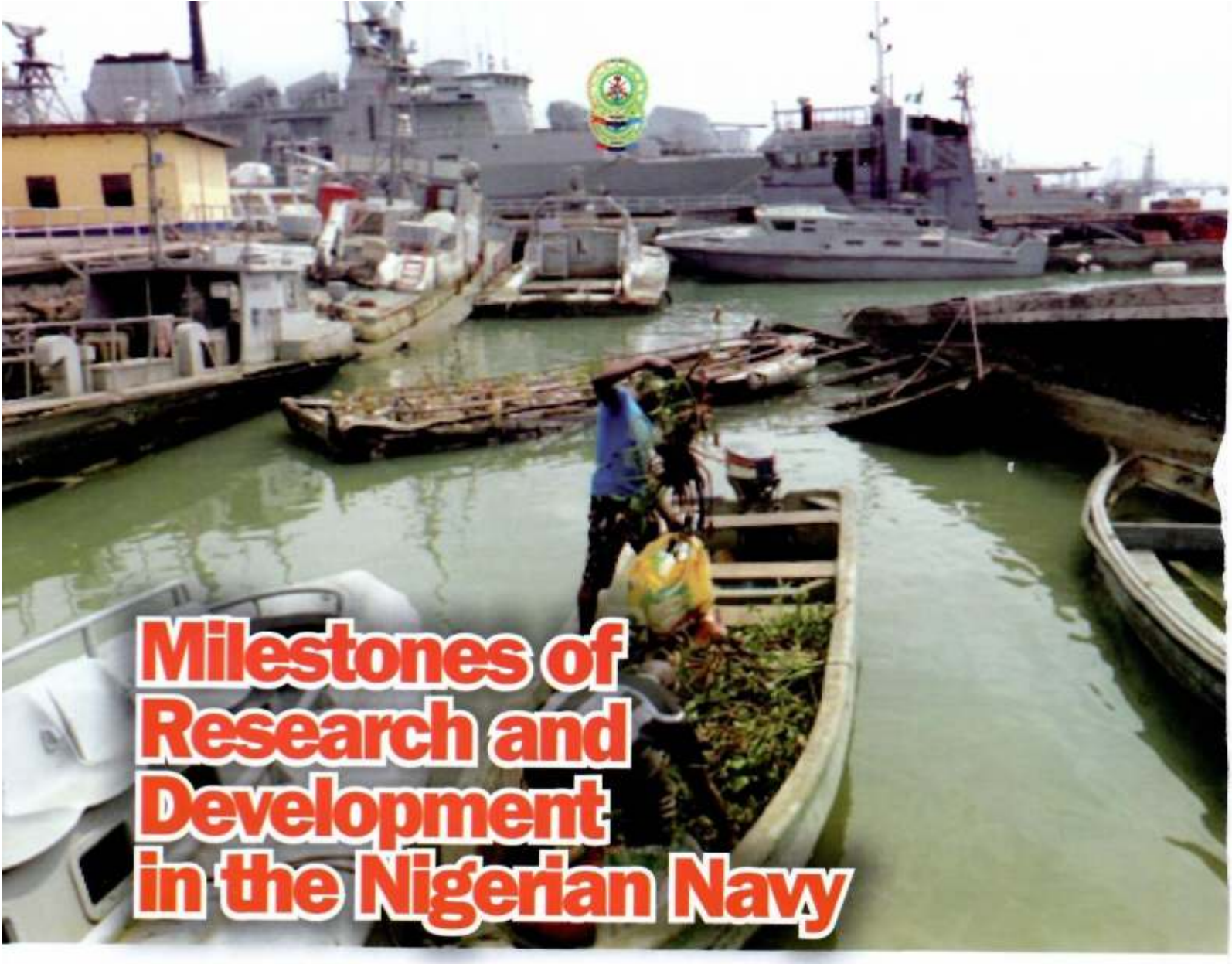
e. The AFN could promulgate a policy to allocate 5% of its budget for R&D studies.

f. Any member of the AFN proceeding for foreign training must be tasked to provide written recommendation for R&D consideration.

g. The R&D Units of the Services could be tasked to develop mechanism to monitor progress of projects with the local industries and ensure timelines are kept within reasonable limits.

Conclusion

The imperativeness for the AFN to develop capacity and identify local industries for self-reliance have been highlighted in this paper. In the NN the CNS' assessment of current situation as 'unsecure and unjustifiable' to the local industries is overriding. Worthy for consideration is synergy with NASENI as well as AFN's commitment to patronize local industries. Additionally, the Directorates of R&D could be empowered with annual allocation of 5% of the AFN budget. The suggested way forward such as use of the AFN expertise for reverse engineering and MoU with local industries for equipment production among others, could provide the panacea for self-reliant AFN. Drawing from the foregoing hypothesis, it is recommended that the AFN should engage the NASENI Institutes and adopt other aforementioned way forward in this regard.



Milestones of Research and Development in the Nigerian Navy

Introduction

Research and Development (R&D) services in natural sciences and engineering according to the glossary of statistical terms refers to any creative systematic activity in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of such knowledge to devise new applications. This brief will be focused on Nigerian Navy (NN) in the realm of knowledge movement. The NN is operating in a third world country where, like other countries in this bracket is faced with myriads of challenges of under development, low industrial base support and dearth of infrastructure requiring urgent attention.

NN is a technologically driven organisation and has over the years, proactively situated itself in the nature of its operating environment. In the quest to overcome its challenges, NN has adopted technologies from different nations at varying levels of technologies. The NN operates as a knowledge driven organisation and attempts made at R&D to unlock areas of challenges. The present drive of the CNS is to reinvigorate R&D as the pivot of attaining a technological self-reliance organisation with clearly identified sources of support. In this regard, the NN Directorate of the R&D (DR&D) was revived in 2015 and a number of NN R&D focus areas were identified for research studies. The R&D Policy was also promulgated in 2017, and the implementation committee constituted for its actualisation.

The NN R&D focus areas are drawn from the field experiences ranging from operational failures, system breakdowns, essential equipment retrofit and improvement. Consequently, the DR&D compiled a compendium for amenable areas and created cells at various locations. Since then, a number of research projects have been undertaken which includes; affordable housing initiative using Compressed Earth Block (CEB); this project has been fully realized, message encryption also achieved, crystallization of obsolete munitions and research studies in fuel/oil purification system among others. The purpose of this paper is to provide the milestones of NN R&D efforts. This paper will cover the NN R&D focus, R&D focus areas, and ongoing R&D projects.

Nigerian Navy Research & Development focus

The peculiarity of NN operating environment makes

the use of sophisticated equipment necessary to enhance her effectiveness. The NN depends highly on the employment of technology to achieve superior capability which can determine success in operations. To facilitate gradual technological development towards self-reliance, the NN needs to emplace a vibrant R&D organization.

The processes of R&D have been straighten in the NN through co-operation with local and international which include the following:

a. Raw Material Research Development Agency – sponsorship to develop R&D products.
b. Lake Chad Research Institute Maiduguri – Development ofdryration.
c. NNPC Directorate of R&D – R&D in POL products to detect adulteration and locally cookedproducts.
d. National Technology Incubation Centre – Federal Governmentsupportandfurtherdevelopmentof R&D products.
e. National Technology Acquisition and Promotion (NOTAP) –Federal Government support and further developmentofR&DintheNN.
f. Petroleum Technology Development Fund (PTDF) Abuja–SponsorshipofresourcepersonsintheNN.
g. BAE Systems (British Aircraft, Defence Electronics and Warship Manufacturers) – Technology transfer in AvionicsandAeronauticalEngineering.
h. National Research Institute for Chemical Technology (NARICT) – Ordnance study and crystallization of obsoletemunitions.
I. Centre for Energy Research and Training (CERT) is currently making arrangement for training of 6 NN personnel on Design and Production of Explosives at ZariawhichhasbeenapprovedbytheCNS.
j. Petroleum Training Institute (PTI) Warri has been chosen for 50/60 Hertz frequency differentials experimentation and control, fuel oil analysis and training.

Furthermore, NN R&D is anchored on the commitment to continuously develop, nurture and utilize available resources to enhance NN capability to ensure Nigeria's maritime defence and security. Efforts are ongoing to identify and collaborate with several organisations engaged in R&D that would be beneficial to the NN and the nation in general.

ResearchandDevelopment Focus areas

Key functions of the NN R&D include research into operational problems associated with safe operations, administration, training among others including general matters with a view to finding possible solutions to them. However, the impact of scarce resources and lack of requisite manpower capacity is exacerbated by the often disparate nature of the platform obsolescence and reliability. The NN R&D studies/activities focuses on delivering following services:

Solving NN operational problems.

Improvement or retrofit of equipment.

Reverse engineering.

Innovation.

The foremost objective was to address the immediate problems associated with NN operational, logistics and administrative matters, including technology acquisition and local capacity development, in order to attain a high level of self-reliance. In this wise, the areas of interest include, propulsion system, sensor and security system, software design and development, medical sciences, building design, personnel management systems, material design and so on. For a start, the following are some of the focus areas identified for immediate R&D intervention:

a. Engineoverheat.
b. EngineandTelegraphControl.
c. Fuelcontaminationandpurification.
d. ElectronicCryptographicMessagingSystem.
e. Corrosioncontrolandprevention.
f. MedicalSciences.
g. Personnelmanagementsystems.
h. Affordablehousing.
i. Shipdesignandconstruction.

The critical areas that could improve operational readiness of the NN have been given higher priority. Consequently, the following focus areas were considered:

a. Seaweedcontrol.

b. Re-crystallization of stock pile of obsolete munitions.
c. Resilient design for engine overheat.
d. Experimentation studies on 50/60 Hz frequency systems in conjunction with PTI, Effurun and NAF research Centre.
e. Design for compact landing vessel for landing SBS.
f. Design and Construction of Hydrodynamic Tank for ship model experimentation.
g. Fuel/Oil purification system.
h. Corrosion control.
I. Design and Construction of Sound Proof Shooting Range using CEB scheme.
j. Reverse Osmosis System for onboard fresh water production.
k. Maintenance research on weapons for ship borne arms.
l. Affordable housing using Compressed Earth Block (CEB).
m. Collaboration and affiliation with Private and Government R&D agencies/technology providers.
n. Affiliation of NNEC with foreign University for R&D and Training.

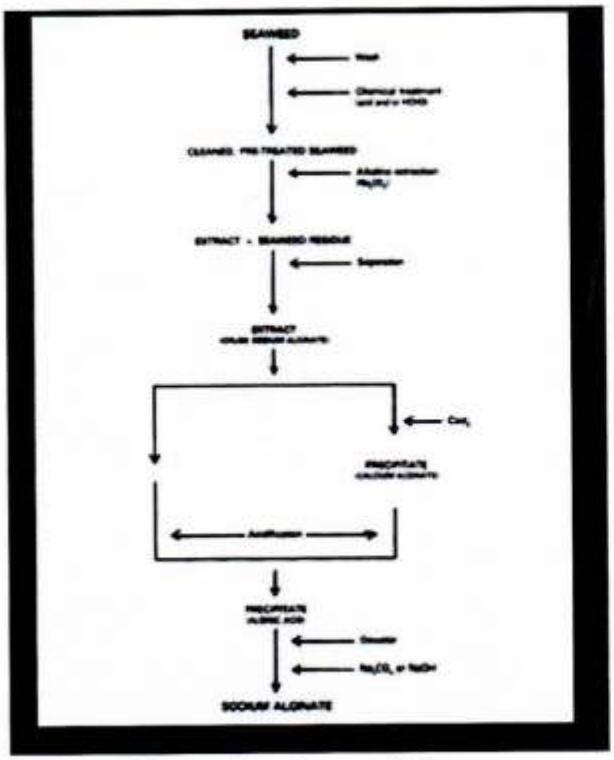
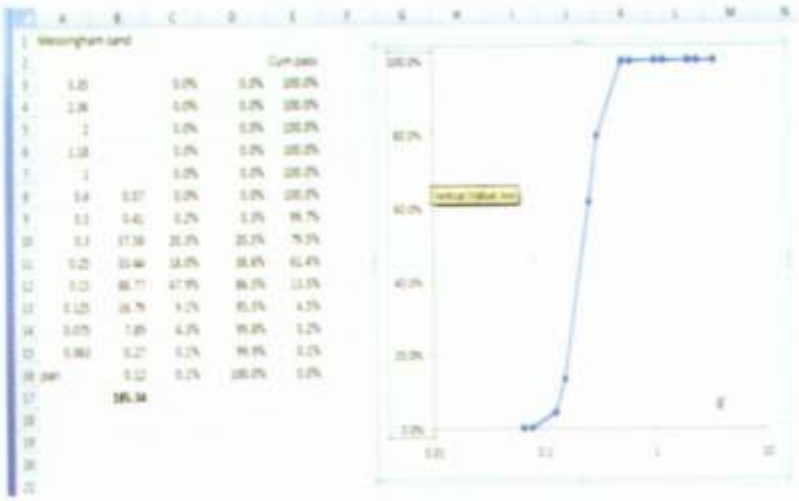


Figure Harnessing Seaweed for extract Alginate and Clearing Waterways



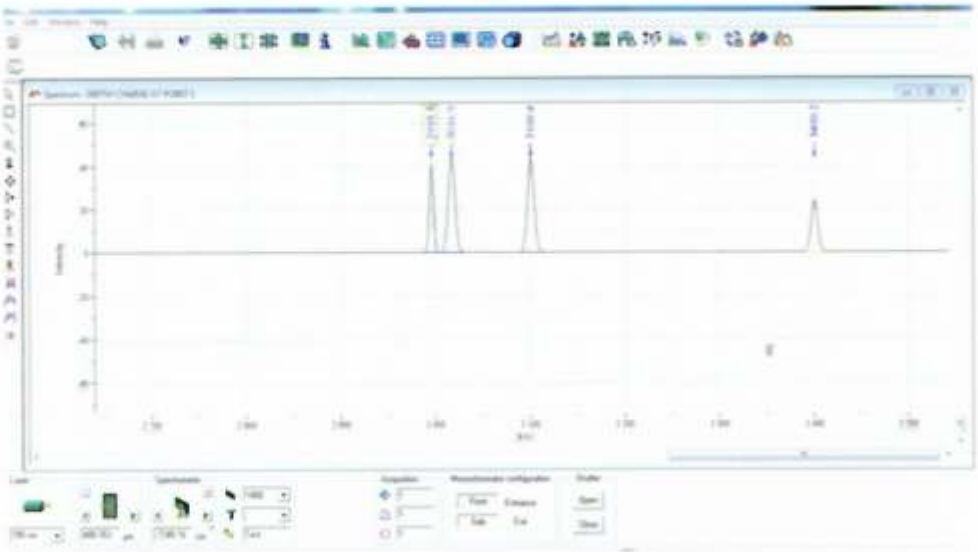
Ongoing research and development projects

The DR&D of NN is currently undertaking projects in seaweed control, finding usefulness of obsolete NN munitions, engine overheat control, safe usage of 50Hz frequency supplies, fuel/oil purification system and the steel pan yard development. Most of these projects have reached advanced stage and would be made available to the NN systems and the general public in the nearest future:

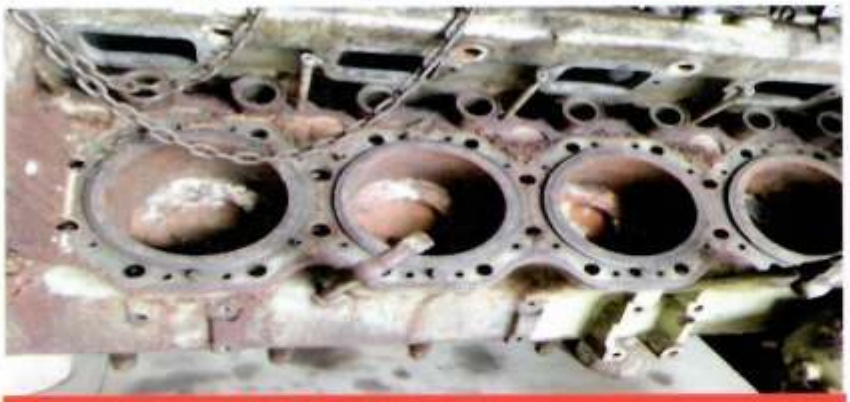
a. Harvesting of Alginate From Seaweed For Pharmaceutical Application And Further Development on CEB Housing. Over the years, the Nigerian water ways has been occupied by seaweed resulting in hindrances to safe navigation. The weeds settles around anchorages, sea basins, bases and jetties where NN ships are secured. Consequently, some of these weeds are sucked-in by the outlets which leads to overheating of engine and breakdown. In some cases, the weed carry along dangerous reptiles and sea animals that later climb the ships and pose danger to personnel. It could also provide cover for saboteurs and frog men. Clearing of these seaweeds needed to be carried out to solve these problems. The research effort was geared at solving the menace of sea weed in the channels. The set out objective was to find a commercial value for the weed in order to arouse the interest of harvesters. The project is undertaken is as shown in figure 1 and tested as shown in figure 2 and 3.

b. Re-Crystallization of Obsolete Munitions Stockpile. The purpose of the research into recrystallization of obsolete munitions was to ascertain the potency of the content of 500 Pounds Depth charges and other obsolete ordnances with a view to re-crystalling them into smaller units of 30, 20 or 10 Ibs as may be feasible thus, allowing for re-usability. The NN R&D embarked on the study for design, retrofit and production of explosives

following discovery of local expertise and research institutions. In that wise, NN expert in Nuclear Physics is on research expedition in collaboration with Nigerian Centre for Energy Research and Training (CERT) and NARICT on the possibility of fission and fusion of stockpile of 500 pounds depth charges explosives into usable Topex Bombs. The major breakthrough in the research study on munitions is the potency test. The work progress is as shown in figures 4 and 5.



Resilient Design for Engine Overheat. In reaction to frequent engine breakdowns of NN ships; main engines and generators, this research work sets out to determine the course(s) of these breakdowns; could it be material failure, poor usage and environmental factors etc. The outcome of the study will help to sustain unbroken period of engine operations and

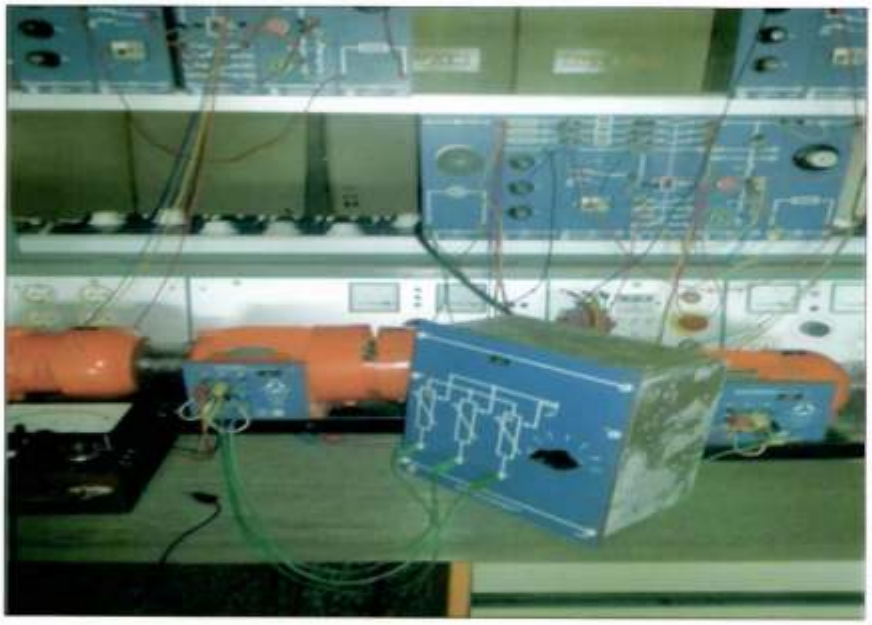


Cylinder head of a Ship Engine under repair

improve NN operations in general. Engine overheat is critical to equipment availability and a common cause of engine failure. This common cause of failure has no immediate remedy which leads to total unavailable of equipment until faults are rectified. Overheating in a marine diesel engine can be caused by a wide number of factors, but as with the diagnosis of all faults, it is important to check obvious and easily rectified causes before investigating more deeply. Research study is in progress at NNEC using 2 MTU and 2 CAT marine engines at NNEC. The major impediment to the research task was non availability of functional engine for experimentations. Consequently, the NN R&D found 3 disused engines for the research purpose. Figures 6 and 7 demonstrates the R&D direction in this project.

d. Experimental Studies on 50/60 Hz Frequency Systems. The research work set out to ascertain the effect of 50Hz frequency on 60Hz designed motors of various ratings fitted onboard ships, the former being shore power supply frequency rating and the latter is that of onboard rating of motors. It would end-up providing guidelines on use of shore supplies by NN ships and could help other mariners with similar challenges with expected positive impact on safety of personnel and onboard equipment. The ships' electric motors are designed with 60 Hertz frequency unfortunately, these ships are connected to shore power supply that is rated 50 Hz whenever ships are fastened to the jetty (shore). Over the years there has been controversies whether or not this practice is safe for the motors? This study will investigate the fallacy and come up with optimum solution. The experimentation is carried out as shown in Figure 8 and displayed for analysis in line with Table 1.

e. Design for Compact Landing Vessel for SBS Operations. The R&D in collaboration with University of Strathclyde Glasgow (USG) has commence the design of a Compact Landing Vessel capable of deploying Special Forces and launching of surveillance drone. Concept design has been perfected and the details perfected. The compact landing vessel could be constructed at jetty in Nigeria or abroad. Figure 9 is pictorial sketch of the compact landing vessel that could be used by the NN Special Boat Service (SBS).



f. Fuel/oil Purification System

The purpose of the research work on fuel/oil purification system was to find solution to incessant failures of engines due to contamination of the working fluids; POL. The resultant conditions being blocked injectors, failed fuel pumps and poor running of engines. The research studies in fuel/oil separation was informed by incessant failures of engine due to contamination of the working fluids namely; Petroleum Oil and Lubricants (POL). Similarly, field experience revealed how low quality POL products caused serious damages to engines. Fuel analysis is beneficial in helping to find out why machines failed or not running at optimum condition. Blocked injectors, failed fuel pumps and poor running are all symptoms of a fuel that does not meet the required quality specification. Figures 10 and 11 shows the parts and the main frame of the developed fuel/oil separator being utilized by NN DR&D for the project.

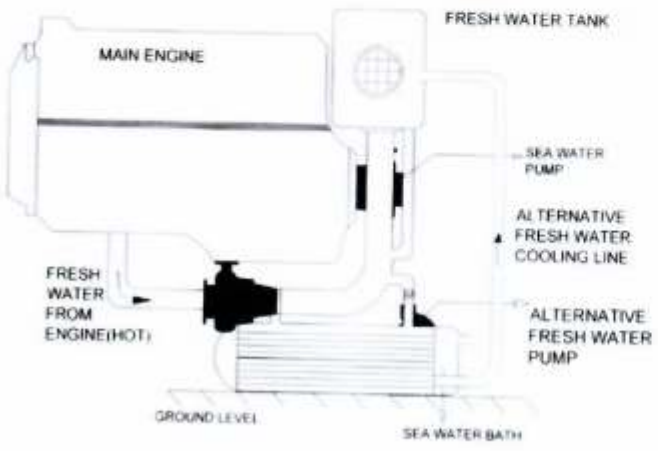
g. Research study on Steel Pan Musical Artefact

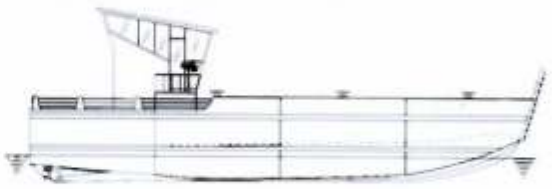
The purpose of this research work was to create a steel pan yard owned by the NN. The CNS approved a research study to determine possibilities to establish a Steel Pan Yard (SPY) at the NN School for Music (NNSM) Otta. Consequently, preliminary study was carried out by the Directorate of R&D along with officers from the NNSM that were trained in in steel pan production at Trinidad and Tobago. The study determined the appropriate site to which the SPY could be located, costs for construction for the yard, equipment, tool and pan yard requirement among others. Tentative costs and the resource person's capability were explored. It was therefore, concluded that the NN has the technical expertise to design and construct steel pan musical instruments using local expertise and material.

60 Hertz Voltage		50 Hertz Rating (+or- 5%)	Optional Voltage		Remarks
(a)			(b)		(c)
230		190	200	208	
460		380	400	415	
575		475	500	520	
Derate	ODP	.85	.80	.75	
Factor	TEFC	.80	.75	.70	

Conclusion

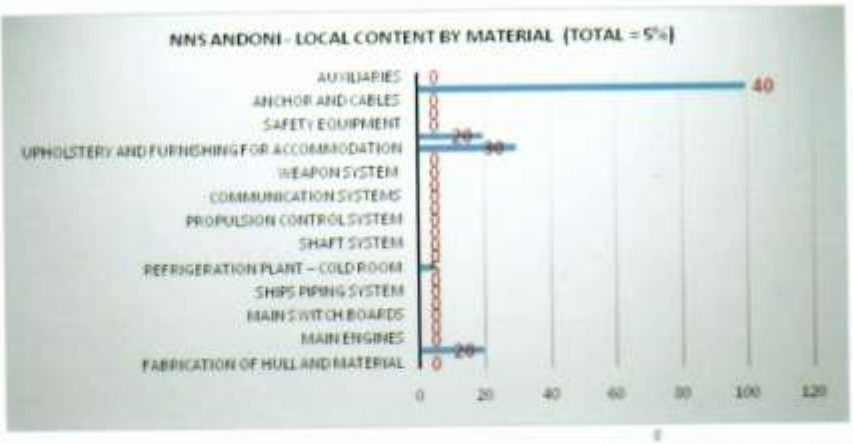
The NN has gone a long way in R&D and has established key focused areas to contribute to its development and that of the general public. The

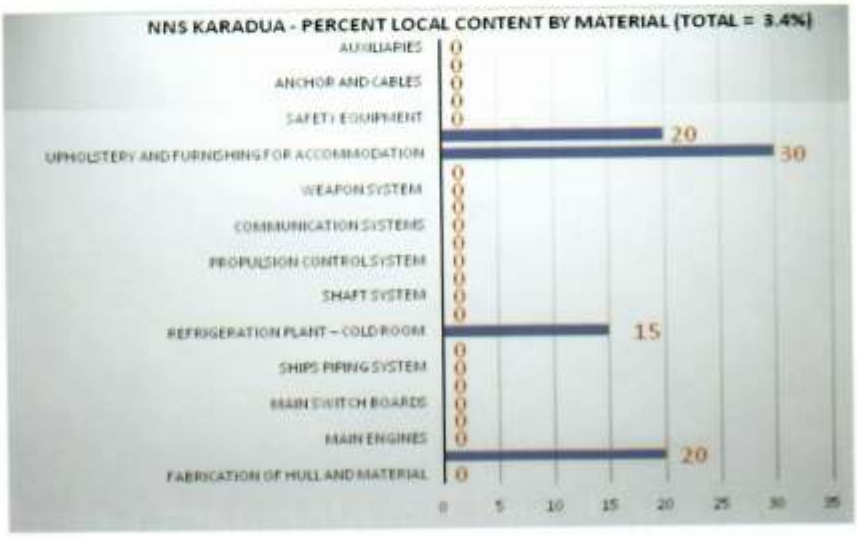


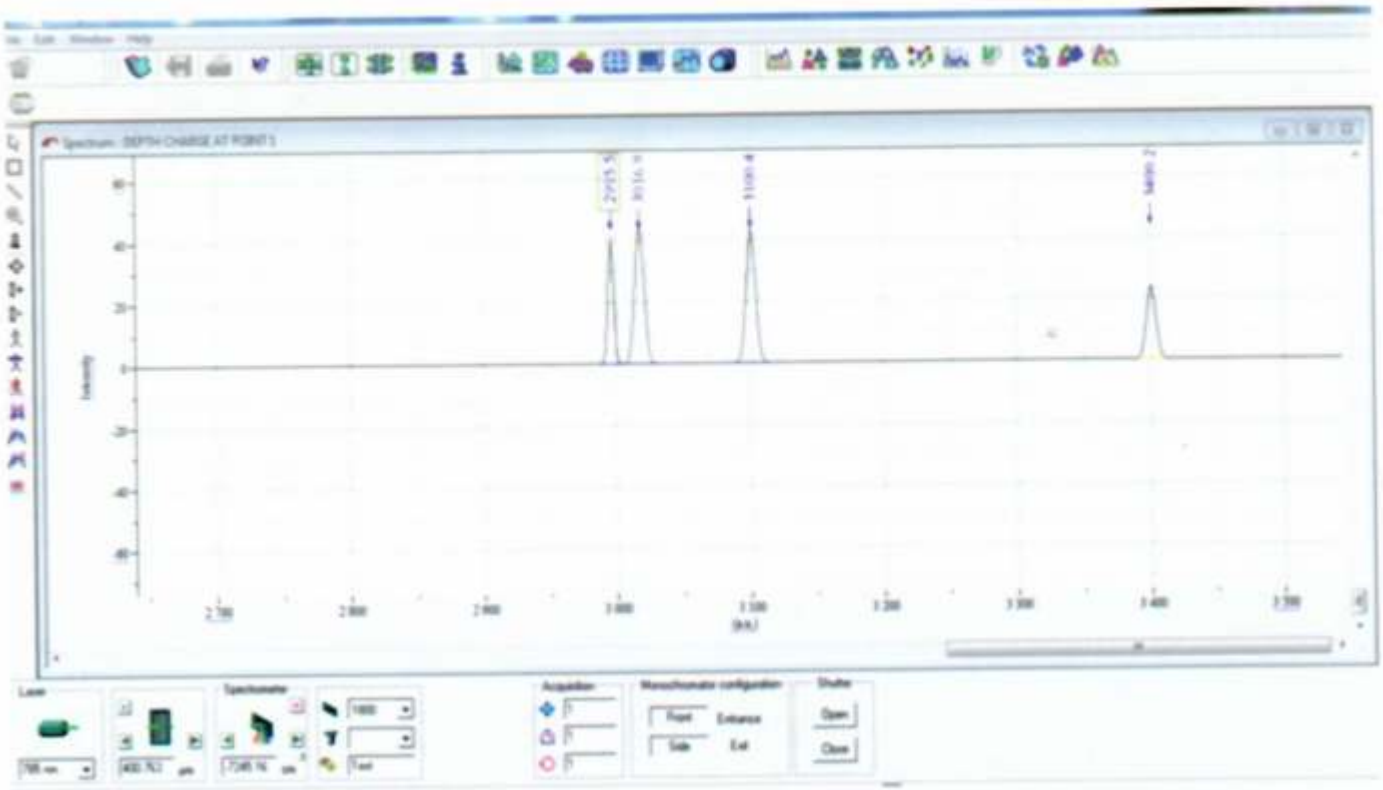


peculiarity of its operation, the operating environment and instrument of operation makes it mandatory for NN to take R&D serious. Being a highly technical arm of the Armed Forces of Nigeria charged with the responsibility of the maritime security of the nation, in particular the beautiful bride that lays the golden egg; oil and gas production areas. The DR&D of the NN focus area includes; operational problems, administration and training among others within the ambits of the available resources. It also adopts a think-through process and thinking outside the box to overcome its challenges.

The foremost objective is to address immediate problems associated with the focus areas. In this regard, research work has been conducted into the propulsion system, sensors, soft and hardware design and development. In doing this, chosen MDAs and civil organisations have been identified and utilized for research and innovation works, some of these institutions include: PTI Effurun, NARICT, University of Strathclyde Glasgow UK and NASENI Institutes among others. The NN intends to utilize the outcome of some of these research works to enhance its operations.







Research and Development Effort on the Fabrication of Mobile Solar Power Generator by the Defence Industries Corporation of Nigeria

Introduction

The Defence Industries Corporation of Nigeria (DICON), a parastatal under the Federal Ministry of Defence is mandated by a 1964 Act of Parliament to produce materiel for the Nigerian Armed Forces and other security agencies. The Act further empowers the Corporation to use its excess capacity to produce a wide range of civilian products. Such excess capacity has been used to provide engineering and power solutions to mitigate challenges in critical national sectors. The challenge of power supply poses a critical problem to any nation. Several measures are been taken to mitigate the challenges posed by lack of power supply globally. DICON embarked on a research effort to tackle the problem of power especially for use in operations by evolving the Mobile Solar Power Generator (MSPG).

The need to maintain secrecy in operations cannot be overemphasised. Most alternative sources of power are prone to giving away the position of friendly forces by the virtue of the noise they produce. The research effort therefore sought to balance the need to generate power with the requirement for the elimination of noise using solar medium. This was equally considered in line with the mobile nature of operations which demands a mobile means of power supply without loss of momentum in dynamic operations.

Mobile Solar Power Generator

In fulfilling these objectives, DICON designed and produced a renewable energy contraption MSPG. It is to solve the perennial energy crises for troops on FTXs, CPXs, MOOTW and other outdoor training exercises. This contraption can further be used for civil purposes. The main advantage is the elimination

Solar Power Generating Set constructed by DICON)

of noise which can give away own position to the enemy. The other advantages are easy mobility, zero maintenance cost and the ability of the device to self-charge itself for extended period of time.

The first prototype was exhibited at the Nigerian Army Day Celebration (NADCEL) 2016, Gusau where it became the cynosure of all eyes and caught the interest of the distinguished guests. It was further exhibited at the maiden seminar of the Nigeria-South African Defence Exhibition, Abuja. Based on the penchant of the CDS to meet the welfare needs of his men as well as the tactical advantage of the device, an order was placed to produced 1 x 10.5KVA for the Defence Headquarters. Consequently, a proposal is hereby forwarded for the CDS's perusal and further directives.

Technical Details

The technical details of the MSPG-16/2 is as follows:

a. Application: The MSPG–16/2 finds application in the provision of lighting, power and charging of communication devices during FTXs, CPX, MOOTW, military check points, IDP Camps, training camps, NYSC Orientation Camps, remote primary health care centers, farms, etc. The generator can comfortably power three (3) single phase water pumping machines.

b. Main Characteristics: The MSPG-16/2 is designed and built to withstand tough environmental conditions. It can be towed cross country over long distances and it is adaptable for most terrains in Nigeria. It has double-eye lift spring for better suspension and easily deployed.

c. Performance Specification. The power generating capacity of the device is 8400W (10.5 KVA) at 240 volt alternating current per day. It has 9 x 250W mono crystalline solar panels as well as 14 x 200 amperes hour (ampH) deep cycle, long life, maintenance free batteries. The Gross weight is 4000kg with dimensions of 3590m x 1790m x 1740m (in motion) and 3590m x 5090m x 1740m (in motion) and 3590m x 5090m x 1740m (fully deployed).

d. List of Accessories: The MSPG has the following accessories:
   (1) Spare tyre
   (2) Toolbox
   (3) 4 x supporting rods.
   (4) Bolts and nuts.
   (5) Fire extinguisher.

Conclusion

DICON has designed and produced a renewable power solution that is of immense tactical advantage to the Armed Forces of Nigeria. With this innovation, it is equally possible to address the challenges of power supply in remote places. Going by its noiseless characteristic, the MSPG is not only apt for military operations, it is highly suitable for hospitals, offices and areas that requires the reduction of noise to the barest minimum. The MSPG has been mass produced and is equally available for public use.

DRDB Deploying Innovations, Partnerships for Self-reliance in Defence needs of the AFN – *AVM Osahor*

The Director General of the Defence Research and Development Bureau, Air Vice Marshal Onyemaechi Jomo Osahor has disclosed that the organisation is committed to being an internationally recognised research and development centre capable of meeting Nigeria's defence and security needs. He said this will be achieved through leveraging on the expertise of indigenous and international partners.

The Director General who was speaking during an interview with members of the Defence Researcher editorial team said the mission is "to provide strategic direction for self-reliance in defence and security needs through research and development". He also disclosed that while being innovative, the organisation will collaborate with others in order to drive the process.

The vision of the Bureau is "to be an internationally recognised research and development centre capable of meeting Nigeria's defence and security needs while leveraging on the expertise of indigenous and international partners" while the mission is "to provide strategic direction for self-reliance in defence and security needs through research and development"

This is an excerpt of the interview:

Sir, as the Director General can you please educate us on the mandates of the Bureau?

Thank you very much. Firstly, let me commend the editorial team for the good work being done on the Bureau's Journal. The mandate of the Bureau is to provide strategic direction for self-reliance in defence and security needs through research and development. Accordingly, my tasks as the DG include the following:

a To advice the CDS on R&D matters.

b Formulating R&D policies for the Armed Forces of Nigeria (AFN).

c Selecting research projects, after consultation with management teams and partners in line with national strategic and operational defence needs.

d Directing the implementation of emerging scientific breakthroughs on national defence strategy.

e Coordinating and harmonizing R&D efforts of the Services and other collaborating research institutes.

f Overseeing the execution of all research, development, test and evaluation programmes of Defence Research and Development Bureau to ensure that they conform to best practices and acceptable standards.

g Organizing annual R&D seminars and defence exhibitions with stakeholders in the industries and the academia to build capacity as well as provide update on R&D development.

h Giving final approval to trials and evaluation results.

i Carrying out any other functions as may be assigned by the CDS.

As the Director General, based on your given mandate, you would be guided by a vision and possibly a mission. Tell us your Vision and Mission statement.

The vision of the Bureau is *"to be an internationally recognised research and development centre capable of meeting Nigeria's defence and security needs while leveraging on the expertise of indigenous and international partners"* while the mission is *"to provide strategic direction for self-reliance in defence and security needs through research and development"*.

Human capacity building plays a major role in Research and Development. How do you intend to build capacity in the Bureau?

Human capacity building is really a very important aspect of the Bureau. It is not a one day thing; so basically, it would be achieved through training and participation in workshops as well as seminars.

There is no doubt the fact that collaborative activities play a significant role in Research and Development. Are you in collaboration with any organisation(s) and if so are they indigenous or foreign?

Our motto is Innovation, Partnership and Self-reliance. It means that while being innovative, you need to collaborate to drive the process. Therefore, in line with our motto, we are in realistic and productive partnership with both indigenous and foreign institution and organisations based on their capabilities in our specific areas of need. Some of the products of these partnerships are already in use in the AFN while others will soon be rolled out.

AVM Osahor (middle), Brig Gen Ekwesi (right)and Editor Defence Rearcher, Nats Odaudu during the intrerview.

DG, DRDB AVM Osahor and CEO Innoson Motors, Chief Innocent Chukwuma (both in the middle) Flanked by DRDB team during a visit to innoson workshop.

Defence Headquarters Partners Innoson Vehicle Manufacturing Limited and Maintenance Company

The Chief of Defence Staff, General Abayomi Gabriel Olonisakin has expressed his commitment to encouraging indigenous efforts in research and innovation. This drive was expressed recently when he commissioned a four man team to court the partnership of Innoson Vehicle Manufacturing (IVM) Company Nigeria Limited.

The partnership which is to encourage the improvement in the quality of their products was sequel to the discovery of some technical challenges in the IVM products earlier procured by the Defence Headquarters. This development necessitated the need for DRDB to interface with the company with the aim of resolving the identified challenges for further patronage of their products.

In addition, the team was to discuss the possibility of the company setting up a maintenance workshop at the Mogadishu Cantonment solely for the maintenance of the IVM vehicles currently being used by the Armed Forces of Nigeria (AFN).

The team which was led by the Director General of the Defence Research and Development Bureau (DRDB), Air Vice Marshal Onyemaechi Jomo Osahor visited the company's factory at Nnewi, Anambra State. The team was warmly received by the management of IVM led by its Chairman, Chief Innocent **Chukwuma**

The Chairman led the team on a guided tour of the factory which lasted for about an hour and half. During the tour the team visited all sections of the factory where component parts for different brands of IVM vehicles were produced. At the assembly section, the team inspected already assembled

DG in a test drive of IVM G12 Series

vehicles including IVM 17 seat buses, ambulances and saloon cars amongst others. A new variant of the IVM vehicle called IVM G12 which can be used to transport troops was introduced to the team.

During the interactive session, the DHQ team made it clear to the company that the observations being raised by the AFN were to help improve the company's products for better service delivery. It was mentioned that industrialized countries achieved technological breakthrough through a feedback mechanism from end users and organizations that patronized their products. The team enumerated the observations of AFN on the vehicles so far procured and deployed in the field. The visit afforded the DRDB an opportunity to open a channel of communication with the company.

Responding, Chief Maduka thanked the team for the observations and agreed that without such observations from customers the company will not forge ahead. The company informed the team that most of the observations were already raised by other customers and they were already being addressed by the company. The company promised that all the observations raised have been corrected in the 2018 productions. The company also agreed to open a maintenance workshop at Mogadishu Cantonment as well as the training of AFN personnel on basic maintenance of IVM vehicles. With respect to spares, the Chairman informed the Team that the Company has a spare parts shop in Abuja. He requested the Team to assist the company to disseminate this information to the Services.

Other members of the team were Brig Gen EC Ekwesi, Col BY Sakaba and Sqn Ldr AH Hussaini.

DRDB Endorses SUNUP Logistic Capability in Military Technology

The Defence and Research Development Bureau (DRDB) has come to the conclusion that partnership with Sunup Logistics Limited will boost the nation's drive for a robust military industrial complex.

A DRDB team led by the Director General, Air Vice Marshal Onyemaechi Jomo Osahor which made this observation after a tour of the company's facilities in Port Harcourt, Rivers State also agreed that the Company is capable of filling most of the existing deficiency gaps in Nigeria's military engineering efforts. The team's visit was to ascertain the possibility of collaboration with the company in the production of vessels, gunboats, spares and other relevant areas of interest to the military.

Sunup Logistics is a subsidiary of MG Vowgas Nigerian Limited which was incorporated in 2006 with solely 100% Nigerian ownership. The Company has 4 ultra-modern workshops, a full time strength of 130 dedicated/experienced staff and contract staff strength of 500. Its strategy is anchored on use of latest innovative technologies and systems for the production of boats suitable for operations. The Company is versatile in general fabrication, production, maintenance of marine vessels and is active in the oil and gas industry.

The estimated time for the Company to produce 10 tug boats is 3 months, one house boat 35-45 days and 15 badges in 3 months.

PHOTO NEWS

DRDB team visit to SUNUP

Centre for Energy Research and Training (CERT), ABU Zaria, visit DG, DRDB

PHOTO NEWS

DG DRDB visit to Erisco Foods Company

DG visit to Defence Identificatioin Centre (DIC)

DHQ Team Visits Department of Polymer and Textile Engineering, ABU Zaria

PHOTO NEWS

DRDB team visits Centre for Energy Research and Development, OAU Ile-Ife

DRDB team visits to SUNUP facilities

DRDB Team Visits Centre For Energy Research and Training, ABU, Zaria

PHOTO NEWS

Professors from FUT Minna visit CDS with DG DRDB in attendance

CDS (middle) during an inspection tour of DRDB new office complex, with him are DRDB DG and other senior officers from DHQ.

PHOTO NEWS

Professors of FUT Minna visit to DRDB

DRDB Technical team visits Op DELTA SAFE

DRDB Technical team visits Op LAFIYA DOLE

PHOTO NEWS

DPR officials visits DRDB

Unmanned Aerial Vehicle (GULMA)

DRDB visits PROFORCE

DRDB participates In Science and Tech Innovation Expo 2017

Adapting Science Technology and Innovation as Prerequisite for Success in the 21st Century Combat Environment: The Nigerian Army Perspective

INTRODUCTION

The persistence of war and other deadly threats to national security particularly, contributed to Adam Smith's (1776) insistence that the provision of defence financed by the tax payers' money is the "first duty of the sovereign". Similarly, Sun Tzu (in Cleary 2005), rationalized having a corps of professional army to secure the fatherland and execute the rebellious where necessary. War is one of the most enduring human experiences whose nature is immutable. It aims at creating the condition for one nation to impose its will on another. War will always involve violence, chaos, suffering, social and economic dislocation as well as destruction of life and property. In contrast to the immutable nature of war, warfare, which is the conduct of war, has changed over time. Warfare essentially involves the application of planning, military skills, organization, communication, weapons, logistics and leadership.

The conduct of warfare has over the ages been transformed by science, technology and innovation which have also by extension impacted societies that engage in war.

The evolution of warfare strategies throughout history has largely depended on the level of technology available to warrior and leaders. Although the basic human instincts remain much the same, technology has, over time, multiplied the human capacity to cause damage and destruction. Nations compete in the international community either by attaining higher levels of techno-economic performance or by denying others the capacity to advance technologically and economically. As the famous Henry Kissinger (quoted in Nwolise, 2013:117) once asserted: "In matters of State, he who has the power often has the right, and he who is weak can only with difficulty, keep from being wrong in the

opinion of the majority of the world". In all these dynamics, whether at national or international level, it is the quality of strategy combined with Science Technology and Innovation (STI) that provides the vital edge in winning a war. STI remains the prime instrument for enhancing national defence, security and development.

The 21st Century has witnessed an unprecedented change in technological, social, economic and political developments which have affected national defence and security brought about by globalization. Many developed nations including the United States of America (USA), Britain, France, Russia and China are thus reforming their military to take advantage of the Revolution in Military Affairs (RMA) that is currently evolving because of globalization and associated diplomatic interventions (Fierce, 2005; Kaldor and Luckham, 2001). These transformations led to the rapid advancement in information technology which has extended the sphere of military operations to the 5th dimension of information warfare in addition to land, sea, air and space domains. In this regard, emphasis is being placed on command, control, communication, computer, intelligence, surveillance and reconnaissance (C4ISR).

The pursuit of technology is natural to man and nations: whether small or big, more developed or less developed; whether it be for survival, defence, development, or at times for more devious designs. Nigeria, and indeed the NA have recognized this fact and cannot be mere spectators or, worse still, leave our fate completely in the hands of others, no matter their benevolent stance. The difficulties experienced by our nation in the procurement of military hardware towards the prosecution of counter insurgency operations in the North East is a constant and bitter reminder that our defence and security sector must embrace STI as an imperative for national survival.

The purpose of this article is to give an overview on the activities of the NA towards embracing STI to improve the effectiveness of the NA in confronting current security challenges. It will also enable policy makers and implementors in the different sectors of our national affairs to appreciate the perspective of the NA regarding how STI impacts Nigeria's defence and security. The paper covers framework for STI in the NA and some STI activities of the NA while touching briefly on some challenges.

Aim

The aim of this paper is to highlight the activities of the NA towards imbibing STI to professionalize the Army in confronting contemporary security challenges.

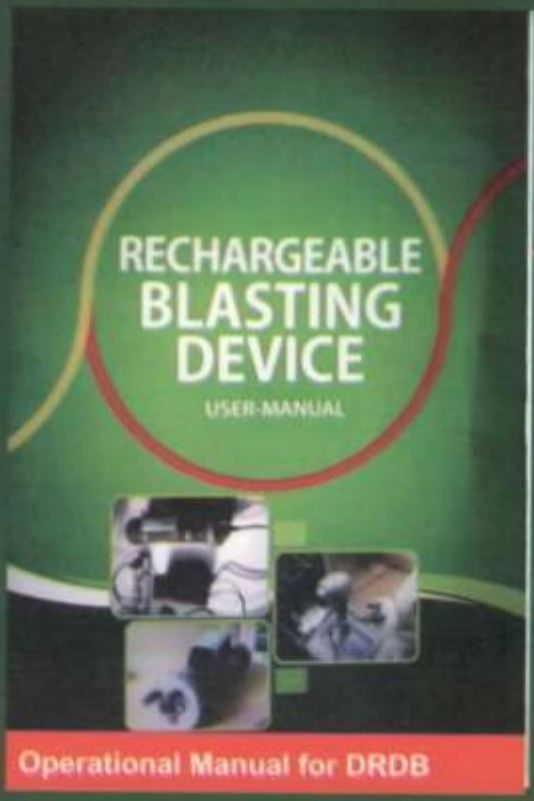
Framework for Science Technology and Innovation in The Nigerian Army

The NA STI framework is predicated on the need to drive the transformation programme from bottom up by providing practical solutions to field problems. To this end, the Army Transformation and Innovation Centre (ATIC) was upgraded in 2016 to a full fledge AHQ Department now known as AHQ Department of Army Transformation and Innovation (DATI). The Department therefore coordinates all research and development efforts of the Nigerian Army as it relates to STI.

The NA philosophy for leveraging STI for

enhanced efficiency is based on building capacity for maintenance while developing competence for local production through research and innovation in collaboration with the civil sector. It is this philosophy that enabled the NA to resuscitate more than 101 Armoured Fighting Vehicles (AFVs) amongst other vehicles using NAEME leading to the successful recapture of all lost territories in the North East. Similarly, the NA is undertaking several other innovative projects with direct positive impact on the operational efficiency of the Army. The driver of the new focus is the general ideological shift from military led STI to military adaptation of civilian technologies.

This ideological shift has led the NA to achieve collaboration with local manufacturing industries and workshops as part of the ongoing process to adapt STI. It is in pursuance of its innovative programme to enable the NA achieve self sustainment through domestic manufacturing and fabrication of new equipment as well as spare for its usage. Reverse engineering has been identified as a viable approach using the NA Central Workshop as the pivot for this option.



These collaborative efforts have resulted in projects like adaptation of the unarmed aerial vehicles for tactical surveillance as well as the development of virtual reality training systems and Improvised Explosive Device (IED) detectors. It is the conviction of the NA that military research and innovation would not only provide enablers for better operational efficiency, but also act as a means of stimulating economic growth through job creation, improved productivity and enhanced national security.

Major NA Activities Involving STI

The NA recognizes the impact of STI in the application of military power for national defence and security. The Army has since its inception encouraged the application of technology to solving military problems especially in the areas of field and mechanical engineering. The results of these efforts are highlighted as follows:

Fabrication of Rechargeable Blasting Device. A Rechargeable Blasting Device known as Ode Rechargeable Blasting Device (ORBD) was developed and fabricated by Maj Gen (then Brig Gen) EG Ode and 2 others under the facilitation of AHQ DATI. The device is capable of blasting both hard and soft surfaces. Before now the main equipment used by the Nigerian Army Engineers (NAE) for demolition was the Dynamo Condenser Exploder (DCE). This equipment currently in the NA inventory are obsotete globally. The situation prompted the NAE to embark on a research to locally produce a device that would serve the purpose. The effort resulted in the fabrication of the ORBD. The device has been successfully tested several times and currently deployed in the NE. Discussion on the ORBD revealed that it could improve Combat Engineers Support even in the offensive role and for troops' protection when used in an integrated obstacle plan.

Infantry Patrol Vehicle (IPV). The IPV is a wholly indigenous combat patrol vehicle locally manufactured in Nigeria by the NA in collaboration with Go-Future Technologies Nigeria Limited. The IPV is designed as a light highly mobile cross country combat patrol platform with air cooled engine. It has a long endurance of up to 3000km and a speed of 140km/hr. The vehicle would provide the much-needed force multiplier for enhanced flexibility and manoeuvrability in the conduct of asymmetric operations. These laudable innovations have been achieved through a well thought out plan which aims to integrate Science, Technology and Innovation in the transformation of the Nigerian Army "to a professionally responsive army in the discharge of its constitutional roles". The prototypes of the IPV are currently being test run in the NE. However, modification of the vehicle to suit the peculiarities of different operational areas is ongoing. Its mass production to meet operations need especially in the NE theatre has been authorized by ASA.

Development of Nigerian Army Low Altitude

Platform Station (NALAPS). The NA developed the Nigerian Army Low Altitude Platform Station (NALAPS). The device is configured to enhance operational effectiveness in Communication, Command and Control System (C3S). It is also a source of information on the activities of insurgents and terrorists. NALAPS gives the NA "eyes in the sky" capabilities at tactical and operational level. It has wide range of applications which includes and not limited to:

a. Detailed ground surveillance.
b. Video and thermal imaging.
c. Command and control of ground troops.
d. Monitoring/protection of critical infrastructures.
e. Combat reconnaissance.
f. Security and border control.
g. Route clearance.
h. VIP escort.
i. Environment sensing.
j. Automated long range hostile signal target acquisition and direction finding to detect, locate and archive data.


ODE Rechargeable blasting Device (ORBD)

This technology was tested during the NADCEL 2013. The upgrade of the platform is in progress to increase the range, night visibility, target location data, mobility, remote control and wireless operation, use of solar system to power the payload equipment. However, inadequate funding to compare and mass produce the system is a major challenge to its further development. Adequate budgetary provision could ameliorate the challenges.

Lighthouse Collection System. The NA has been collaborating with the Naval Postgraduate School Monterey California to establish a Lighthouse Collection System which utilizes smart phones/computer tablets using social network to track and destroy dark (terrorists and illicit) networks. This facility is currently being experimented in North East Operational Area to fight terrorist. Work is already at the advanced stage but lack of funds is hampering the follow up process.

Nigerian Army Information Processing Centre. AHQ DATI developed the use of WIKI system as a shared repository for intelligence. Towards this end, the NA established the Nigerian Army Information Processing Centre (NAIPC). This system which is domiciled in HQ NAIC, incorporates our intelligence gathering apparatus to the open source of information as observed, which are rarely factored into the intelligence analysis as clearly shown in Dodson Paper of Man-hunting, Nexus Topography, Dark Networks and small worlds. NAIPC has contributed immensely to our operation in the North-East Flank and general security in the Country. This Centre is operational and the contact numbers have been made available to the general public for timely passage of information. As the globe transits into the Information Age, the vision of transforming the NA into a modern force is apt and timely. DATI is working on the combination of NALAPS, Lighthouse and use of Wiki System as a shared repository for the NAIC to launch the NA into use of Network-centric warfare for all its operations. The lack of capacity building programmes for the operators and the inability of NAWANI to link up with the WIKI system are major challenges to the operational use of the system. It will be desirable if more budgetary allocation is made for the upgrade and sustenance of the system. Liaison with state government and Federal Capital Territory Administration to give publicity to the work of NAIPC is very necessary. Furthermore, there is the need to have a 4-digit emergency phone numbers to facilitate easy access to the Centre by members of the public.

Platoon Ration Vehicle. The Platoon Ration Vehicle is an innovation by Lt Col UB Garba of the NAAC and supported by AHQ DATI. The aim is to develop a trailer with a rack capable of carrying and distributing ration to troops in defensive locations. Demonstration and presentation of the vehicle has been made to AHQ DATI. However, concerns have been raised on the aspects of protection of the crew, vehicle noise, performance and angle of slope. These have been passed to inventor to effect necessary correction and modification of the

vehicle. More budgetary allocations need to be made to enable the completion of the work.

Prototype House using 100 per cent locally sourced materials

Real Time Pipeline Monitoring System

The NA in collaboration with Messrs Geological Drilling Energy and Gas is developing a Real Time Pipeline Monitoring System. The franchise is based on real time data acquired from field study on NNPC-PPMC oil pipelines from Atlas cove to Mosimi in Lagos and Ogun State respectively. The system is capable of detecting any vandalism on pipelines and providing real time data acquired from collections sensors and transceivers. The system could be useful to our troops deployed for OP DELTA SAFE in the Niger Delta and could assist to reduce pipeline vandalism.

Eaglebot Survey/IED Robot Project

The Eaglebot is a remote controlled robotic equipment that could be used for CASEVAC, IED detection and also an armed Observation Post. On the directive of AHQ, Maj AS Imam of the NA, then a PHD student at Newcastle University UK devised the Eagle Bot Survey /IED Robot. The EagleBot could also be applied in surveillance and monitoring, stores/arms and ammo delivery, combat sp as well as EOD and IED disposals. Based on the desirability of Eaglebot robot, the officer has made presentation and demonstration of the Robot to AHQ. The officer has also produced a compendium on the automation of most equipment from either analogue or manually operated system. Funding is a major challenge to the mass production of the robot.

TILT – Rotor Unmanned Aerial Vehicle

The Tilt-Rotor Aircraft is a Technology Demonstrator (TD) Unmanned Aerial Vehicle (UAV) designed and built as a R&D Innovation under the Mechatronics/Robotics Research Group at the Department of Mechanical Engineering, Nigerian Defence Academy. It is one of the research Innovation of Maj AS Imam and funded by the NA. The vehicle combines the vertical lift capability of a helicopter with the speed and range of a conventional fixed-wing aircraft. It is equipped with 4-rotor system, which allows it to take off and land vertically as well as hover like a helicopter.

For vertical flight, the rotors are angled so the plane of rotation is horizontal, lifting the way a helicopter rotor does. Additionally, it flies forward with the speed and efficiency of a fixed-wing aircraft. As the aircraft gains speed, the rotors are progressively tilted forward, with the plane of rotation eventually becoming vertical. In this mode the wing provides the lift, and the rotor provides thrust. The vehicle initial concept envisaged to accomplish 3 technology goals namely:

a. An all-electronic propulsion UAV that ensures a precise rotor speed and orientation control.
b. High payload carrying ability (up to 40 kg).
c. Aerial bomb drop capability.

The vehicle is presently about 60 percentage completed as a TD platform.

"Homes Fit for Our Heroes" Prototype House

The homes fit for our heroes is an initiative of AHQ DATI under the guidance of the COAS to evolve a welfare scheme that provides affordable houses for both serving and retired personnel. The "Homes Fit for Our Heroes" housing scheme is regarded as a giant leap towards the actualization of houses for personnel both in retirement and in death (for the families of deceased personnel). The unique feature of the low cost houses was the use of innovative designs and local materials to achieve affordable houses. The first wave of beneficiaries of the "Homes Fit for Our Heroes" initiative would be our fallen heroes who paid the supreme price in operation LAFIYA DOLE

and those wounded in action. A prototype House of the "Homes Fit for Our Heroes" scheme was commissioned on Fri 21 Jul 17 by the COAS. The first 50 units of the "Home Fit for Our Heroes" houses are to be constructed in Keffi.

Challenges

It is an imperative for the NA to pursue the adaptation of STI as a solution for relevance in the 21st Century combat environment. Certain factors identified as impediments must be overcome to actualize our dreams. Some of these factors include poor military R&D base, inadequate funding, weak technological and industrial base amongst others.

Poor Military R & D Base

One of the challenges identified in our efforts to enhance the impact of STI on combat efficiency of the NA is the dearth of research and development capacity for military research. It is in consideration of this constraint that in February 2017, the NA organized the First Research and Innovation Summit towards enhancing the collaboration between the Army and the academia on one hand and the public sector on the other towards developing capacity for military research and innovation. The outcome of the summit is the improved collaboration between the NA and the Manufacturers Association of Nigeria (MAN) as well as many universities and research institutions. It is in line with this collaboration that the NA is driving the establishment of the local content group in the defence sector of our economy. The increased participation of local industries in defence production is bound to enhance operational readiness and self sufficiency and sustenance. Additionally, as a way of bridging the gap in human resource development in military research and innovation, the NA has concluded arrangements for the establishment of the Nigerian Army University of Military Technology in Biu, Borno State. The university serves as a centre of excellence in military research and innovation, focusing principally on providing solutions to everyday problems and requirements of Nigeria's defence and security needs.

Inadequate Funding

A major constraint in our efforts towards application of STI to enhance the NA's defence capability is that of inadequate funding. Though the National Policy on Science Technology and Innovation (NPSTI) provides for military research, there are no statutory funds allocated for the purpose. The NA has therefore undertaken the funding of its research efforts within its limited resources. The NPSTI provides some incentives to encourage private sector funding for research and development. These incentives include provision of tax relief as well as grants and endowments to individuals and institutions to actively engage in R&D activities. The policy encourages commercial and merchant banks to set a fixed percentage of their loanable fund at low interest rate for financing capital-good industries. It also envisages strengthening of venture capital investment schemes to provide risk capital to small and medium technology-oriented businesses, especially in high capital risk projects such as in defence production. Despite these provisions, the level of private sector participation in defence research and production in Nigeria has been abysmally low. Consequently, the NA has adopted an alternative funding mechanism by encouraging joint venture participation with the private sector, especially with start-up companies to develop prototypes that meet the Army's requirements. In this arrangement, the Army provides initial funding for concept development as well as prototype design and production, while the start-ups avail their expertise as equity contribution. The Intellectual Property Rights for such projects are registered jointly by the NA and the private company. This model has worked so far in the production of the IPVs and the Virtual Reality Training and Simulation Systems development. It is however important to note that it may be difficult to extend such models to more capital intensive projects due to the expenditure limits of the Services as well as other competing needs, thus the imperative for a dedicated fund for military research and development.

Weak Technological and Industrial Base

Defence production requires a strong technological and industrial base driven by functional infrastructure, knowledge, resource and material science. Although Nigeria can boast of

knowledgeable citizens in different fields of material science, there appears to be a failure in policy implementation especially in establishing the base industries needed to produce the right materials for the defence industry. For example, the non-completion of the Ajaokuta Steel Industry remains a big setback in Nigeria's quest for industrialization and self-sufficiency in defence production. Despite these challenges, the NA has continued to strive to integrate new technologies into its innovation efforts by adapting civil and commercial technologies to solving military problems. The NA plan is to invest in emerging technologies in the areas of space technology, DEW as well as material science research and development. The objective is to leapfrog technology thereby maximizing value and efforts in support of national defence and security while enhancing national development. It is however imperative to note here that Nigeria would need to fully integrate all elements of national power especially the diplomatic and economic aspects in support of these objectives.

Combat Fighting Motorcycle Platoon

Conclusion

The impact of technology on security has continued to increase over the past 6 decades with impressive advances in modern technologies. The NA therefore established AHQ DATI to drive the process of adapting STI to improve the efficiency of the NA in both combat and peace time roles. The strategic framework of adapting STI has since been guided by extensive collaboration with local stake holders in the manufacturing sector. This collaboration resulted in products like the IPV amongst others. Modern technology will inevitably spread to all parts of the world, rich and poor alike, albeit at different levels thereby narrowing the gap between conventional forces and none-state actors and increasing threat to national and international security.

It is equally important to encourage private sector participation in the defence industry by establishing a local content group in the sector as well as increasing joint venture participation in military research and development. Ultimately, Nigeria would need to fully integrate all elements of national power especially the diplomatic and economic elements in support of her efforts to maximize the impact of STI on national defence and security. It is however important to note that technology, or the military hardware produced by it, is in itself, only a means, not an end. Well-trained, motivated and committed personnel, security planning and military strategies as well as the organizational infrastructure to implement the strategies are the key to having a professionally responsive NA in the discharge of it constitutional roles.

Strategic Considerations on Enhancing Regional Security Cooperation within West African Maritime Domain

Cdr PEC Onwuzulike

Introduction

The dynamic nature of domestic and global events has continued to provoke fresh thoughts about challenges to states' national interest and objectives. The priorities of the states' aspiration are embedded in their core values and interests. Core values and interests of a State are generally regarded as those kinds of values for which the State is willing to make ultimate sacrifices. The core values amongst others include the defence of the State's sovereignty, territorial integrity and her interests in the living and non-living resources within her territory including the maritime environment for States bordered by the sea.

The sea is the lifeblood of any country and indeed of any continent. Apart from being the provider of trade routes, the sea provides food, commodities, income from tourism and even moderates the climate. The importance of the sea was aptly captured on the cover page of the United States Maritime Strategy, 'A Cooperative Strategy for 21st Century Sea Power' where it posited that "Ninety percent of the world's commerce travel by sea; the vast majority of the world's population live within a few hundred miles of the oceans; nearly three quarters of the planet is covered by water". Alfred Mahan, an American strategic thinker in 1890 equally recognized the relevance of the sea when he declared that "the destiny of the world will be decided in the waters". However, in the last 2 decades, the global maritime environment otherwise known as the global commons has been inundated with unpredictable threats especially by non-state actors. These threats which include illegal trafficking in goods, humans, drugs, poaching of fishery resources, crude oil theft and illegal bunkering among others have resulted in huge financial losses to littoral states. Thus, maritime insecurity within the littorals has become of significant concern to States and regions that efforts to mitigate them are therefore a national security objective of such states. The maritime domain of the States within the West African region has not been spared of this insecurity as current global statistics on maritime crimes reveals rising incidences of piracy, sea robbery, smuggling and other illegal activities within th region.

In line with the provisions of the African Maritime Strategy (AMS), the African Maritime Domain refers to "all areas and resources of, on, under, relating to, adjacent to, or bordering on an African sea, ocean, or African lakes, intra-coastal and inland navigable waterways, including all African maritime-related activities, infrastructure, cargo, vessels and other means of conveyance. The West Africa Maritime Domain (WAMD) as implied from these provisions would be those within the Atlantic Ocean that extend from Cape Verde in the North to Nigeria in the South West. The WAMD offers all West African nations, vast growth opportunities and a network of sea-lanes of enormous importance for their security and prosperity. It is of huge importance in terms of natural resources and energy, trade and industry, scientific research and leisure. The Gulf of Guinea (GoG); which is within the WAMD, is home to huge hydrocarbon deposits, making it a future resource to meet global energy needs. Besides its hydrocarbon riches, the GoG is also a reservoir of rich fish stocks. In addition, the numerous vessels, ports, shipyards, and support industries in the WAMD provide thousands of jobs for West

Africans.

Clearly, disruptions in West Africa's maritime system with its supply chains and industries despite existing security initiatives can thus have costly impact on a large number of participants in the economies of many West Africans. Since most maritime crimes are transnational and the area to be policed to ensure maritime security is vast, coupled with the relatively weak economies of the states within the region, hence, the need for littoral states within the WAMD to coordinate and cooperate to emplace adequate maritime security initiatives in order to secure the domain that significantly support their growth and development. Added to this is the existence of several regional and extra-regional maritime security initiatives that are beset with numerous challenges ranging from inadequate political will to tackle maritime security disruptions to infrastructure deficits that ultimately impair security cooperation. Consequently, redressing these shortcomings would require evolving strategies for enhanced security cooperation between and among States within the region as well as constructing the array of intra-governmental and extra regional partnerships in order to exploit the synergies offered to be effective in combating maritime security threats within the region. It is for this reason that the WAMD regional security architecture requires evaluation to expose its inadequacies.

The purpose of this paper therefore is to appraise the existing regional security cooperation within the WAMD with a view to proffering robust strategic considerations to enhance regional security cooperation within the Region. The paper will cover Emerging Maritime Security Threats and Vulnerabilities within the WAMD, Assessment of Existing Regional Maritime Security Cooperation Mechanisms within the WAMD and Strategic Planning on Enhancing Regional Security Cooperation within WAMD.

Aim

The aim of this paper is to evaluate the existing regional security cooperation within the WAMD with a view to making recommendations.

Emerging Maritime Security Threats and Vulnerabilities within the WAMD

In order to fully understand the security imperatives of the WAMD, the geo-strategic importance of the WAMD, emerging threats to maritime security within WAMD and vulnerabilities with the maritime system that perpetuates these threats will be reviewed.

Geo-strategic importance of the WAMD

West Africa as a region is composed of 16 States as follows: Benin, Burkina Faso, Cape Verde, Ivory Coast and the Gambia. Others are Ghana, Guinea, Guinea Bissau, Liberia, Mauritania, Mali, Niger, Nigeria, Senegal, Sierra Leone and Togo. Apart from Mali, Burkina Faso and Niger that are landlocked, the other States are littoral states. The WAMD is bounded by Mauritania in the North and Nigeria to the South and includes the Bight of Bonny and a substantial part of the GoG. All West African States are signatories to UNCLOS III, hence, their territorial waters, contiguous zones, continental shelves and Exclusive Economic Zones (EEZ) are delimited accordingly as indicated in Figure 1 below. The entire WAMD covers an area approximately 2 million square kilometers over which States within the region have sovereign rights to both living and non-living resources therein.

The WAMD is one of the most prolific hydrocarbon provinces in the world as well as

being endowed with other resources like fish, prawns, cobalt, nickel, diamond, gold and manganese. Nearly 70 percent of Africa's oil production is concentrated in the West African coast of GoG. By 2020, oil production in the GoG is expected to surpass the total production of the Persian Gulf Nations: 25 percent of the global production as compared to 22 percent from the Persian Gulf. The world's largest reserves of offshore deep water oil are found in the waters around Nigeria. Nigeria's current oil reserve is estimated to be 37 billion barrels . The gas reserve on the other hand is estimated to be 600 trillion cubic feet. In the same vein, Ivory Coast's reserve is about 250 million barrels, Ghana accounts for 660 million barrels and Benin is estimated to have 8.00 million barrels. This Region equally has natural gas proven reserves in Nigeria, Ivory Coast, Ghana, Mauritania and Benin. Global energy security concerns and competition for resources have attracted the attention of countries like United States, China, India and some European Union members to the region to source for oil and gas to meet their rapid economic and industrial growth. It is no wonder, therefore, that suddenly the maritime area of the West African Region has become of strategic importance and a major variable in the foreign policy calculus of the US, China and other huge consumers of energy precisely because of their need for energy security.

The WAMD is equally endowed with fishery resources that contribute significantly to the food security index of the region. Species of fish found in the region include coastal demersal species on the continental shelf like shrimp, cephalopods, wide range of fish species such as croakers, groupers, sea breams, etc. Small pelagic species migrating between countries like sardinellas, anchovies, mackerels, bonga shad as well as large pelagic species like tuna stocks migrating through deeper waters. Over 1.6 million tons of fish are caught annually in the region with an estimated wholesale value of $3 billion. Seaborne trade also flourishes within the WAMD as the region has over 200 ports, most of which serve local, regional and international maritime traffic. The four main ports are Lagos (Nigeria), Abidjan (Cote d'Ivoire), Dakar (Senegal), and Cotonou (Benin). The yearly total container traffic of West African ports is just under 3 million TEUs (Twenty-foot Equivalent Units). The proceeds from port dues and other related shipping levies contribute significantly to the economies of the States within the Region in addition to the employment opportunities associated with the shipping industry. The WAMD equally gives shipping access from USA and Western Europe to some Central and South African States. It's over 6,000 kilometer coastal arc which stretches from Mauritania in West Africa, through Nigeria in South Western Africa, embodies its value as an area of global geo-maritime importance. The growing investments in the Region, especially in offshore oil infrastructure, mean that coastal trading and maritime traffic are bound to increase.

Threats to maritime security within West African Maritime domain

Maritime security in the territorial waters of West Africa is precarious. Threats to maritime security within the WAMD emanate mainly from non-traditional security threats resulting from the dynamics of economics, socio-political, environmental, technological and security factors. These threats include piracy, poaching, smuggling (drugs, arms and human trafficking), environmental degradation and maritime terrorism.

Piracy/Sea Robbery. According to the International Maritime Organization, maritime piracy in West Africa increased from 54 in 2015 to 95 in 2016. Additionally, the International

Maritime Bureau (IMB) ranks the Gulf of Guinea as one of the most troubled global waterways. During the first three quarters of 2017, of the 37 incidents of piracy worldwide, 63 per cent were in the GoG. Seven ofS the incidents took place in the waters off Nigeria. Apart from Nigeria, other countries with high number of incidents include Guinea, Ghana, Ivory Coast and Benin. Nigerian Naval Headquarters attribute the upsurge in piracy off the coast of Benin to Nigerian pirates who are now extending their attacks further out at sea. Piracy in the 21st Century is a serious and growing problem. The interdependent and interconnected global society supported by a global economy cannot function if the world's oceans are not safe and secure for maritime commerce. The WAMD being part of the global common cannot be an exception.

Poaching. Poaching, otherwise referred to as Illegal, Unregulated and Unreported (IUU) fisheries, as a global phenomenon, generally refers to the act of fishing in a nation's waters without permission or license. The Food and Agricultural Organization (FAO) reveals that one-quarter of all fish stocks worldwide are being increasingly overexploited largely due to poaching. The West Africa Waters are endowed with one of the world's largest concentration of highly cherished fish, crustaceans and molluscs, which are exploited by various categories of fishing groups in the fishing industry. Illegal fishing by foreigners within the WAMD has been on the increase due largely to the limited policing capacities of the West African States. IUU fish loss per boat per year is estimated to be up to $3,000,000 in the West African sub-region. Poaching is therefore depriving the nations within the West African Region the necessary income to pursue their respective national developmental goals as well as depriving millions of individuals' adequate protein from fish as well as the opportunity to earn income.

Smuggling. Smuggling as defined by the UNCLOS is the act of taking or bringing people or goods secretly and illegally into or out of a country. Weapons, drugs, goods and smuggling of persons (human trafficking) are major problems off the West African Coast. Drug trafficking constitutes the most serious immediate security threat within the WAMD. The GoG's proximity and easy access to the American continent coupled with the non-existent maritime security infrastructure have transformed the Gulf into the favorite transshipment zone for the Colombian and other Latin American narcotics cartels. For some time now it has become evident that the vulnerability of certain West African States is being exploited, as manifested in the increasing volume of cocaine passing through West Africa to markets in Europe. The largest single seizure occurred in Senegal, where the authorities uncovered a Latin American operation with 1.2 metric tons of cocaine destined for Europe. SALW smuggled within the WAMD has equally gone a long way in sustaining intra-state conflicts within the Region. The socio-economic infractions to the Region courtesy of smuggling therefore cannot be overemphasized.
Maritime Terrorism.

The ascendancy of terrorism as a form of waging wars by non-state actors has generated concerns all over the world. The maritime environment has not been spared from this scourge in the form of maritime terrorism. Although considered as primarily a land-based challenge, terrorist groups have demonstrated a capacity to use the seas as a means of conveying and positioning their agents and logistics to wreck havoc including explosive-laden suicide boats to target vessels, port facilities or off-shore platforms. Incidentally, there have only been a few global occurrence of maritime terrorism. The most significant attack in terms of casualties occurred in February 2004 when the Abu Sayyaf Group attacked a passenger ferry in the Philippines resulting in almost 100 deaths. Unfortunately, the largely unpoliced WAMD provides great opportunities for exploitation by terrorists. The several attacks by Niger Delta militants, particularly the Movement for the Emancipation of Niger Delta (MEND), on off-shore oil installations in Nigeria's oil fields are credible manifestations of this challenge. Maritime terrorism has the potential of restricting foreign investments in the deepwater reserves within the WAMD in addition to crippling shipping activities and commerce within the region.

Environmental Degradation. The main concern of West African States in terms of maritime related environmental degradation stems from the degradation of their coastal habitats and biodiversity through pollution, saline intrusion and erosion, as well as the over-exploitation of their fisheries resources. The Niger Delta, with its 606 oilfields is widely recognized as the world capital of oil pollution. The majority of the spills are the result of leakage and illegal tampering with pipelines. Also, gas flaring is a serious environmental hazard and poses a significant health risk to local populations. Moreover, it has the potential to impair soil fertility in surrounding

farmlands diminishing agricultural yields. Additionally, medical studies have shown that gas burning in the Niger Delta region contributes to the low average life expectancy of its inhabitants in addition to degrading the ecosystem (depleted fish stocks) through acid rains.

Vulnerabilities within the maritime system of the West African region

Certain vulnerabilities exist within the maritime system of the West African Region that contributes to the maritime insecurity prevailing in the region. These vulnerabilities manifest in inadequate capacities for maritime governance, poor maritime domain awareness and inadequate enforcement/ policing capacities amongst others.

Inadequate Maritime Governance. Most of the littoral states of West Africa have established legal codes for enacting statutes to define criminal acts affecting the maritime domain, as well as institutions responsible for investigating and prosecuting crimes. However, even when appropriate laws exist, the ability to effectively prosecute depends on the strength and independence of the judiciary. In most cases, a combination of corruption, inefficiency and capacity constraints compromise the effectiveness of the judicial system. Maritime security governance issues also manifests in the region's lack of robust legislative and judicial arrangements for maritime arbitration. While countries in the region are signatories to most relevant international maritime conventions, very few have taken concrete measures to ratify and institutionalize these protocols domestically. This vulnerability equally erodes the potential for cooperative regional security as issues relating to maritime jurisdiction, hot pursuit and sovereignty are still contentious.

Poor Maritime Domain Awareness

Maritime Domain Awareness (MDA) refers to the effective understanding of anything associated with the global maritime domain that could impact security, safety, economy or the environment. MDA is a key enabler of maritime security as it is the product of 3 capabilities: the ability to sustain a relevant and accurate picture of presence and activities in a nation's maritime domain, the ability to communicate this information in a clear and timely fashion to those responsible for acting on the data, and the ability to interpret, understand, and act on the information. Unfortunately, Nigeria is the only country within the region with physical MDA infrastructure on the ground, though with limited capacity. The poor maritime domain awareness within the WAMD undermines security by making it possible for criminals to operate with impunity thereby jeopardizing safety and regional security.

Inadequate Policing/Enforcement Capacities.

Policing or enforcement functions within the maritime domain are normally within the purview of the Navy, Airforce and the Coast Guard. Effective region-wide response and policing capacity does not exist in West Africa. This is because the capacity and capability to carry out enforcement duties within the maritime areas claimed by states in the WAMD are weak. Apart from the Nigerian Navy and Ghana Navy, the navies of the other states barely show presence at sea. The maritime policing and enforcement efforts of West African States are equally inundated with challenges like obsolete equipment, wrong mix of vessels, dearth of capacity building infrastructure, inadequate funding, lack of coordination between maritime security stakeholders and manpower deficits. The inability to police the WAMD inhibits the ability to deter illicit activity, respond to emergencies, and enforce the rule of law and good order at sea.

Assessment of existing regional maritime security cooperation mechanisms within the WAMD

The existing regional maritime security cooperation initiatives within the WAMD and the attendant challenges to regional security cooperation within the domain that have allowed the prevalence of insecurity will be examined.

Existing regional maritime security cooperation mechanism

The existing regional maritime security cooperation mechanisms within the WAMD are bilateral; OPERATION PROSPERITY and multilateral in structure; Gulf of Guinea Commission (GGC) and the Maritime Organization of West and Central Africa (MOWCA). Added to this is an extra-regional collective maritime security mechanism; United States sponsored African Partnership Station.

Operation Prosperity

The Governments of Nigeria and Benin Republic in October 2011 set up a combined maritime patrol off their waters code-named OPERATION PROSPERITY. This bilateral initiative was a timely response to the escalating incidences of piracy and sea robbery within Nigeria and Benin maritime domain. Sequel to the bilateral agreement, a combined maritime patrol task group was set up drawing assets from the Nigerian Navy

(NN), NIMASA and the Beninese Navy. Following the inauguration of OPERATION PROSPERITY, the incidents of piracy, sea robbery and other maritime related crimes off Nigeria and Benin have significantly reduced. Notwithstanding its successes, the combined operation faces major constraints, including the high operating costs, lack of enhanced surveillance systems, paucity of patrol boats and better maintenance capabilities and information sharing. These challenges underscore the urgent need to explore appropriate and better ways to enhance maritime security within the region.

Gulf of Guinea Commission

The GGC was founded in 2001 and comprises 8 resource-rich countries of the GoG; Angola, Cameroon, Congo Brazzaville, Congo DRC, Equatorial Guinea, Gabon, Nigeria, Sao Tome and Principe. Amongst others, it aims to strengthen ties of cooperation and solidarity among member states and harmonize policies of member states regarding matters of common interest. Despite the forays made by the GGC in maritime security, it is inundated with several downsides. Of significance is the feeling amongst member states that Nigeria as the prime mover for the establishment of GGC, intends to use the medium to foster her hegemonic aspirations within the region. This has brewed mistrust and suspicion which stalls most of the plans conceived to move the Commission forward. It is generally believed within the maritime industry also that this mistrust is largely responsible for member states of the GGC not being able to operationalize the Gulf of Guinea Guard Force (GGGF) meant to secure the GoG maritime domain despite its endorsement by all member states.

Maritime Organization of West and Central Africa (MOWCA)

MOWCA was established under the Charter of Abidjan in 1975 and it consists of 25 African states, including five landlocked countries and was created with the aim of providing an inter-governmental institution for maritime safety and security, transport to and from landlocked countries and the implementation of international conventions amongst others. Challenges to the organization in terms of regional security cooperation have been in translation of plans and policies to implementation. For instance despite the adoption of an integrated approach to regional security cooperation, concerns still persist in areas of State sovereignty especially as it concerns 'Hot Pursuit'. Additionally, most member states are yet to domesticate international agreements and conventions subscribed to by MOWCA. This challenge manifests most times in the trial of suspected pirates where States interpret piracy contrary to the provisions of the IMO.

African Partnership Station

Africa Partnership Station (APS) is an international initiative developed by United States Naval Forces Europe-Africa, which works cooperatively with US and international partners to improve maritime safety and security in Africa as part of 'USAFRICOMs Security Cooperation Program. The professionalism of African militaries are enhanced through ship visits, aircraft visits and training. One of such trainings is conducted through exercises like Obangame Express. Obangame Express focuses on maritime interdiction operation, as well as visit, board, search, and seizure techniques (VBSS). Since 2011, Obangame Express has been held annually however, it continues to contend with challenges that include interoperability of equipment, inadequate vessels and limited MDA infrastructure on the side of participating countries within the WAMD. Added to these challenges is lack of funding for the logistics required to participate in the exercises as some countries rather prefer to participate as observers. The awareness and commitment to maritime safety and security as well as regional security cooperation by the participating countries would obviously be impaired if these challenges are not adequately addressed.

Challenges to regional security cooperation within the WAMD

There are several challenges to regional security cooperation within the WAMD which continues to undermine the various initiatives that have been put in place within the region. Notable are lack of political will to enforce security reforms, weak maritime legislation and policies and funding.

Lack of Political Will

Maritime security has been considered secondary in the threat perception of most West African States as a result of 'sea blindness' and considerations for traditional land-centric security operations. Historically, West African security authorities and institutions have focused mainly on land based threats. Consequently, land based operations had received prominent attention in terms of funding, resources and policy attention while navies and other maritime security enforcement outfits remain subordinate to armies. Despite the current realization of the importance of maritime security, most of the governments within

the region still lack the political will to fund maritime security operations, fight corruption and build effective governmental institutions. For instance, Nigeria loses about $25.3 billion annually due to criminal activities in the maritime environment. Despite the enormity of these losses and its adverse effects on the economy and national security, the government still pays lip service to funding maritime security operations adequately.

Weak Maritime Legislation and Policies

The issue of weak maritime legislation and policies is a direct offshoot from the poor maritime culture and lack of awareness exhibited by the political leadership in West Africa. Different states within the region have different priorities for maritime security depending on their unique national circumstances and domestic policy priorities. Consequently, the region's governments have different legislation and policies on maritime insecurity because they do not all suffer from its impact in the same way. The consequence of weak maritime policies is the lack of coordination amongst national maritime security stakeholders. West Africa's national, bi-lateral and regional maritime regulations need to be more coherent and robust. The penalties for piracy, for example, must be the same wherever the offence is committed within the WAMD in order to enhance regional security cooperation.

Funding

The discourse on allocation of resources to sustain maritime security which will in turn engender regional cooperation and eventually lead to economic prosperity has always been a contentious issue among governments of West African States. It is accepted that most African states are constrained by a lack of funds, or by a lack of priority for maritime matters. The GDP of sub-Saharan Africa in 2007 was some $691 billion – approximately the same as the Netherlands; only 7 countries, excluding South Africa and Nigeria, had a GDP in excess of $10 billion. Apart from the protection of the domain, governments have several obligations to its citizens – education, health, food security, infrastructure and so on. All these compete for the limited funds available to governments. It is therefore on this premise that the funding of maritime security evokes considerable debate within the region.

Strategic planning on enhancing regional security cooperation within WAMD

In planning for enhanced regional security cooperation, it would be imperative to examine the strategic ways and means of enhancing regional maritime security cooperation, the prospects of the enhanced regional security cooperation as well as the anticipated challenges of the strategy to enhance regional security cooperation. This is with a view to proffering ways of resolving these anticipated challenges.

Strategic ways and means of enhancing regional security cooperation within WA

A strategic approach for enhanced regional security cooperation within WAMD requires an effective strategy which incorporates national, regional and global realities. The ways and means of enhancing regional security cooperation will be considered under political, economic, legal, and military cooperation in addition to cooperation and partnerships.

Demonstrable Political Commitment towards Regional Security Cooperation

The political leadership of West African states needs to demonstrate a strong political commitment towards enhancing regional security cooperation within the WAMD. Strong political commitment that would demonstrate an unwavering will to address maritime security governance issues and implement comprehensive strategies for maritime security is urgently advocated as against the myopic concerns on land-centric security operations to protect political regimes. Given the trans-national character of maritime security threats, political commitment must also be expressed regionally. In this regard, countries in the West African Region must be willing to cede sovereignty concerns to advance regional solutions towards maritime insecurity. Consequently, ECOWAS through its highest policy making organ; the ECOWAS Heads of State and Government, could play a role in strengthening regional security cooperation. Resolutions of the ECOWAS Heads of State and Government as well the ECOWAS Mediation and Security Council could be employed to strengthen the commitment towards funding maritime security.

Cooperation and Partnerships for Enhanced Regional Security Cooperation

Maritime security requires a coordinated effort within and among member states including public and private sector organizations and international partners. The establishment of a national inter-agency policy, strategy, and implementation team (IPSIT) on national and regional security led by the Office of the National Security Adviser (ONSA), composed of at least the ministers of foreign affairs, finance, defence, police affairs, interior, transport, economy, labour, agriculture and

petroleum resources as members and convened under the auspices of the National Security Council (NSC) to coordinate inter-agency strategic planning and implementation in the West African region is advocated. The strategic importance of the WAMD; especially when viewed from the energy security concerns of some extra-regional entities like USA, EU and China, equally justifies international partnerships that could assist in addressing insecurity within the domain.

Funding for Maritime Security Cooperation

Funding constraints manifests in all aspects of MSO within West Africa and by extension regional security cooperation. To address this, it is proposed that states within West Africa establish a National Maritime Security Trust Fund (NMSTF) through national legislation. Funding for the Trust Fund could be sourced by placing a levy of 1.5 per cent of cost, insurance and freight (CIF) on all exports and imports by each country within the region. Added to this is also a levy of 1.5 percent of annual operating profits from oil and gas companies of countries within the region. For countries not endowed with oil, any resource that accounts for a significant part of its foreign exchange earnings could suffice. The national IPSITs could invest the funds from the NMSTF in science and technology with the aim of addressing the insecurity within the maritime space.

Maritime Space Legislation and Legal Reforms

Countries within the West African region had accorded maritime legislation and laws little importance due to 'sea blindness' and the land-centric approach to security. Consequently, most countries in the region are yet to adopt and ratify international conventions on maritime security, which could provide a framework for a robust regulatory framework for maritime security adjudication. The weak policies and legislation that result from this flaw have contributed to the uncoordinated approach to maritime security governance within the region. There is therefore the need for countries within the region to adopt and domesticate these conventions while harmonizing policies relating to maritime security in order to make them more robust and cohesive. Also, West African states need to review domestic legislation within the region so as to harmonize regional laws. This could facilitate policy implementation on issues like sovereignty and collaboration on issues like 'hot pursuit'.

Prospects of Enhanced Regional Security Cooperation

Enhanced regional security cooperation within WAMD could come with some prospects in terms of enhanced maritime security governance, improved and sustainable MDA as well as strengthening regional peace and security. These prospects are discussed below.

Maritime Space Governance

Institutionalization of regional maritime security cooperation and the expected contribution of international and extra-regional maritime security initiatives as envisaged and could enhance maritime space governance within West Africa and promote good order at seas. Reforms to improve governance of the economy and security sector, comprehensive and effective maritime public policies and practical regional cooperation with a resolute political commitment beyond declarations of intent could find a place within the WAMD courtesy of the benefits from cooperative maritime security and regional security cooperation and partnerships.

Enhanced Maritime Domain Awareness

An effective understanding of the maritime domain enables focused law enforcement and military action and operational threat response while promoting freedom, civil liberties, and prosperity for all. Unfortunately, Nigeria is the only country with a relatively significant but limited MDA infrastructure. Consequent upon the strategic importance of MDA to MSOs and in line with the synergies to be harnessed by the region in terms of regional security cooperation and partnerships as conceptualized, the WAMD could benefit from improvements in MDA infrastructure as well as technical support and assistance from the advanced MDA infrastructure of international partners.

Regional Peace and Security

The importance of regional peace and security cannot be overstated. It is line with this consideration that the strategic considerations to enhance regional security cooperation within the WAMD through the various mechanisms and strategic principles could guarantee individual, national, regional and international security. Issues such as piracy, proliferation and smuggling in SALW as well as pollution within the maritime environment that negatively impacts the ecosystem with its socio-economic consequences could be adequately addressed by enhanced regional cooperation. In particular, proliferation and smuggling in SALW that continues to aid insurgency and separatist movements within the region could be tackled effectively. Additionally, human and food security as guaranteed by combating human trafficking through the maritime

domain and the strict control of IUU fishing within WAMD could also contribute significantly to economic prosperity of the region in promotion of regional peace and security.

Anticipated Challenges To Enhanced Regional Security Cooperation

The anticipated challenges to enhanced regional security cooperation within WAMD is in the areas of language and the influence of extra-regional entities that could tend to compromise regional security cooperation.

Differences in Language

The West African region is made up of countries with 3 official languages; English, French and Portuguese. These languages were adopted courtesy of the states' colonial orientations. It is envisaged that these differences in language could pose a challenge in regional cooperation especially in communications ranging from civil dialogues to military operational matters. For instance, OBANGAME EXPRESS I and II sponsored by USAFRICOM through APS revealed this shortcoming. Similarly, OPERATION PROSPERITY between Nigeria and Republic of Benin had to contend with bridging the gap between English and French language right from conception to operations. This challenge could however be addressed in the long term through individual state educational policies of incorporating foreign languages in their educational curriculum and making 2 of the region's official languages compulsory in higher echelons especially public service positions.

Influence of Extra-Regional Entities

The limited capacities and capabilities of the States within West Africa in enforcing maritime security in the region underscore the need to embrace cooperative maritime security as a strategy. Cooperative maritime security equally recognizes the role of extra-regional entities like international organizations and extra-regional countries with common interests in a region to cooperate in enhancing regional security. These extra-regional entities could use soft power overtures to sway states within the region to project maritime security policies in support of their interests against competing extra-regional entities. This challenge could be addressed by the maintenance of agreements or protocols that holds overall regional interests well and above state interests within the domain as is exemplified in the African Maritime Strategy that charges African States to "Think Africa Above All" as enshrined in Article 4 of the Constitutive Act of the AU.

Conclusion

The WAMD is one of the most prolific hydrocarbon provinces in the world as well as being endowed with other resources like fish, prawns, cobalt, nickel, diamond, gold and manganese. The domain also accounts for significant shipping activities which have brought huge investments for the prosperity and well being of its people. Threats to maritime security within the WAMD were revealed to include piracy, poaching, smuggling (drugs, arms and human trafficking), environmental degradation and maritime terrorism. Certain vulnerabilities also exist within the maritime system of the West African Region that contributes to the maritime insecurity prevailing in the region. These vulnerabilities manifest in the form of inadequate capacities for maritime governance, lack of political will by West African governments, poor maritime domain awareness, inadequate enforcement/ policing capacities amongst others.

In response to maritime threats and vulnerabilities within the WAMD, West African states conceived some cooperative mechanisms to deal with maritime insecurity. The existing regional maritime security cooperation initiatives within the WAMD are bilateral; OPERATION PROSPERITY and multilateral in structure; GGC and MOWCA. Added to this is an extra-regional collective maritime security mechanism; United States sponsored APS. The study revealed several challenges to existing regional security cooperation mechanisms within the WAMD which has served to undermine the various cooperative initiatives that have been put in place within the region. Amongst these challenges are lack of political will to enforce security reforms and governance within the maritime space, weak maritime legislation and policies, funding to effectively cover the vast WAMD.

The challenges being faced by the existing maritime security cooperation initiatives underscored the need for a more robust strategic plan towards enhancing cooperation within the region. Consequently, the paper highlighted the strategic considerations in planning for such enhanced regional security cooperation beginning with the strategic ways and means of enhancing regional maritime security cooperation. The prospects of the enhanced regional security cooperation were also highlighted.

RECOMMENDATIONS

It is therefore recommended as follows:

a States within the West African region should:
   (1) Accede to and domesticate all necessary international legal instruments on maritime security including SUA, MARPOL, SOLAS, ISPS, SAR, and UNCLOS.
   (2) Embark on judicial reforms aimed at strengthening the independence of the judiciary.
   (3) Establish a national IPSIT on national and regional maritime security.
   (4) Strengthen cooperation and partnerships with extra-regional entities.
   (5) Establish a National Maritime Security Trust Fund (NMSTF) through national legislation.

b ECOWAS should:
   (1) Facilitate multilateral agreements at the Presidential level between member states to enable regional maritime security cooperation.
   (2) Strengthen commitment towards funding maritime security operations, fighting corruption and building effective governmental institutions.

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Military Industrial Complex as a National Security Component for Nigeria: Analysing the BRIC Countries of Brazil, India and South Africa

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Abstract

This article seeks to examine the concept of Military Industrial Complex as a critical factor in the promotion of national security in Nigeria. It examines the experiences of the BRIC Nations of Brazil, India and South Africa to demonstrate the models other countries have adopted in the development of indigenous defence industries which are critical for fostering Military Industrial Complex (MIC). Thus, the existence of a viable MIC and robust manufacturing industries increases the capacity of states in readiness towards curbing threats leveled within or outside its territorial boundary. This paper argues that the weak manufacturing base of Nigeria significantly contributes to its failed efforts at evolving a strong and robust military industrial complex. Therefore, it is pertinent for Nigeria's capacity and readiness to respond to security challenges to be enhanced quickly with the development of a strong military industrial complex.

Keywords: National Security, Military Industrial Complex, BRIC

Introduction

The government of every country has been tasked with the responsibility to protect and ensure the safety of lives and properties of the citizenry within the territory of each state. From the annals of history, it has been discovered that states have been tested for their ability and readiness in responding to security threats emanating from outside its borders. Thus, the ability of a state to guarantee an atmosphere of peace, stability and development within its territory depends largely on the efficient measures set in place to prevent and respond to the sources of threats which can endanger the lives, values and assets of the citizens.

With this in mind, the military and other security agencies play a crucial role in ensuring that the citizens are protected within the state and to this effect, the success in responding to threats and security challenges levelled against the state depends not only on the quality of security officials engaged with the task of providing adequate security but also on the availability of the necessary equipment (weapons, ammunition, etc.) needed to perform the task of maintaining the defence and security of the state. Hence, the governments of each country strive to develop the right industrial base that will contribute to the design, maintenance and supply of military assets needed to make the country safe.

In the attempt of ensuring a safe and secure environment, states have acquired the most advanced military equipment for their armed forces by leveraging on their military industrial complex (MIC)

In the attempt of ensuring a safe and secure environment, states have acquired the most advanced military equipment for their armed forces by leveraging on their military industrial complex (MIC) or by weapons acquisition abroad. While the countries of the West otherwise known as the most industrialized countries rely on their MIC in the task of maintaining national security, the countries of the South (developing and underdeveloped) lack the technical know-how and a strong industrial base to produce appropriate defence equipment. As a result of this, these states rely heavily on the purchase of security products from the international market. When a state relies heavily on foreign acquisition, its economic costs increases, especially when it is faced with security challenges and hence, this situation predicates the importance of a military industrial complex and a strong manufacturing industry as a crucial factor in effectively promoting national security.

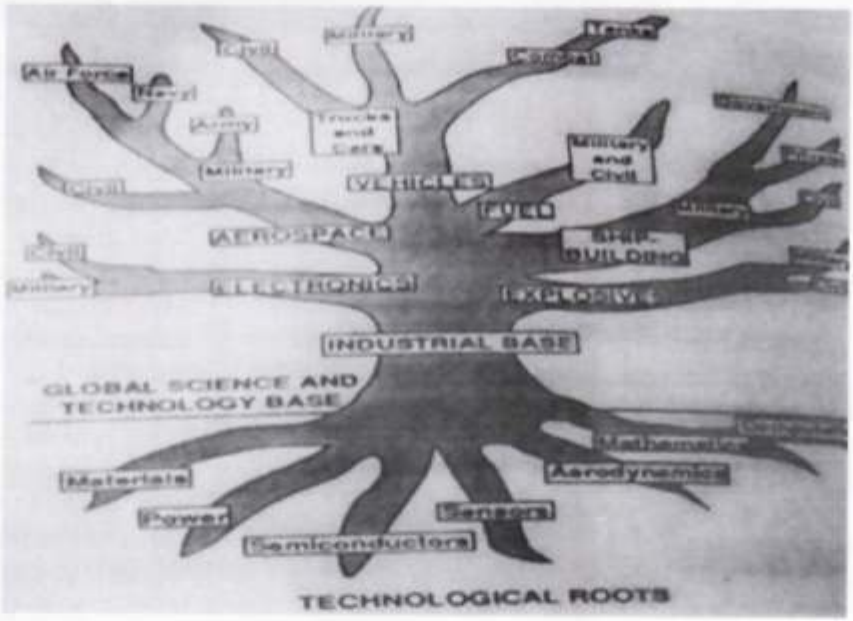
It is therefore against this backdrop that this paper focuses on the Nigerian context to underline the importance of the military industrial complex and strong manufacturing industries as critical indices of national security. Of recent, Nigeria has had to contend with evolving security challenges- the Boko Haram Situation, which have called to question the state of the country's military industrial complex and the level of material support given to the military and other security agencies to respond effectively to these security

challenges. This paper will examine the MIC of the BRIC countries of Brazil, India and China as opposed to the Nigerian context of providing a strong MIC and manufacturing base as a crucial element towards creating a strong national security component for Nigeria.

Epistemic Context- Military Industrial Complex, Manufacturing Industry and National Security

Given the tendency for concepts such as the Military Industrial Complex to elicit varying interpretations, matters of epistemic clarifications are apposite in this context. As such, the MIC, manufacturing industries and national security are the key concepts central to this paper and hence, deserve further clarification. The MIC was first coined by President D. Eisenhower, during his admonition/farewell address to the nation in 1961. He maintained that:

> In the councils of government, one must guard against the acquisition of unwarranted influence by the military industrial complex. The potential for a disastrous rise of unprecedented power will persist, but we, as a nation must not allow the weight of this power endanger out democratic process. We must take nothing for granted and it is only an alert citizenry that can compel the proper meshing of strong military machinery with our methods/goals of peace in order for security and peace to prosper together (Eisenhower 1961:1035)



Since delivering this speech, the term military industrial complex has been used to relate the existence of armaments industry to the economic and manufacturing base of the state. However, with the differing views with regards to MIC, understanding the concept is subject to different interpretations. Looking at the example of MIC in Russia (formerly Soviet Union), it was highlighted that there were high levels of policy influence within the military and the industry rather than hijacking the foreign policy by a collective interest. According to Weber (2001:13), the MIC refers to the cooperative relationship between the military and the industry that produces the military equipment. Koistinen (1980:1) on the other hand, views MIC as an accepted process by which other institutions, most especially the military and other business ventures work together to provide the state with the business capabilities of war.

The differing definitions on the subject matter of military industrial complex shows that there is no universally accepted definition. However, for this study, MIC will be defined as "the broad spectrum of relationship and support between the military and other strategic non-military establishments that are involved in the research and development of services critical to the sustenance and boosting of the state's capacity to meet its security needs" (Aminu 2012:57). In clearer terms, it is the cooperative relationship between the producers and consumers of military goods and services. On manufacturing, it refers to the "process and combination of machines, tools and labour to produce goods for use and for sale. It can also be seen as the range of human activity from handicraft to high-tech, but is mostly commonly applied to industrial production of which raw materials are transformed into finished products for immediate use" (Aminu 2012:57-58).

The vast nature of manufacturing industries is of high importance to the development of the economy of any state and to this end, it is critical to job creation as well as provision of services to other sectors of the economy. In light of this, manufacturing industries provide important material support for national infrastructural development. As shown in the diagram below, a strong MIC boosts the potentials of a state to generate the necessary equipment which will aid in the promotion of national security The idea of national security has several differing definitions. On the security of a nation, Lippman (1945:5) is of the view that "national security is when a nation is secure to the extent that it does not have to sacrifices its legitimate interests to avoid war" (Lippman 1945:6). Omotola (2006:3) in a more recent definition noted that "national security focuses more on the freedom from danger or absence of threats to the multidimensional elements that may

affect the ability of a nation to protect and develop itself and most importantly protect the lives and security of its citizens" (Omotola 2006:3). From an organizational perspective, the International Working Group on National Security of the Center for Security Sector Management (2009) provides a more comprehensive approach to the definition of national security. The organization maintains that:

Prima Facie, the most important obligation of any government is upholding the national security of the State. This not only involves the security of the citizenry but guarding the national interests and values against internal and external threats that have the capacity to undermine the security of the state. Again, it must not only include freedom from the necessary evils of fear against their person but must also preserve the political, economic and social values, rule of law, human rights and the environment which are central to the quality of life with the state (IWG 2009).

This definition provides a more comprehensive outlook to national security as well as a broad view which covers the economic, political and most importantly the military issues of the state, and hence, the context of national security is germane to this paper and it thereby informs on the application of the concept.

Models of Developing the Defence Industry to Foster the Growth of Military Industrial Complex: A Cue from the BRIC countries of Brazil, India and South Africa.

The Military Industrial Complex in context has been acknowledged by countries world over as these countries have followed different methods in order to develop their MIC. I will briefly engage in a comparative study of the BRIC of countries of Brazil, India and South Africa and the development of their defence industries in order to draw lessons for Nigeria

Brazil's Military Industrial Complex

There are several views on the military industrial complex of Brazil. While some opposing analysts argue that Brazil focused solely on commercial considerations before incorporating the defence production in the national arsenals, others claim that the emergence of a defence industry in Brazil resulted from the need to project its national power, national interests and national image on a global scale. The varied opinions of the above analysts have provided an inference on the origins of the defence industry in Brazil which are based on a combination of geopolitical, military and commercial roots.

Between 1960 and 1980, the Brazilian armed forces and private industries combined their efforts in order to enlarge the military industrial base of the country and as a result of this, over 100 joint ventures with the European firms were established and co-production agreements between the US, Italy, France and the UK on the incorporation of components to produce home-made goods were signed. However, Brigagao maintained that the process of transferring technology was inefficient because incorporating the imported components preludes the transfer of technical know-how and manufacturing technology to produce the same components. However, regardless of the inefficiency in the transfer of technology which was as a result of the incorporation of joint foreign ventures, the spin-offs have been more beneficial to Brazil (Clovis 1986:102).

The vast nature of manufacturing industries is of high importance to the development of the economy of any state and to this end

On the upsurge of arms production, Brazil used its civilian components in manufacturing of weapons through a technological-adaptation process. Here, the collaboration between the civilian and defence industry played a major role for the simple designs and low prices of the Brazilian made weapons on the international market (Clovis 1986:103).The Brazilian government, earlier on signed a legislation of tax reduction, access to bank finances and subsidies into law in order to encourage military exports. With this industrial policy, the institutionalization process of integrating the defence industry into the state economy was successful (Katz 1984:79).

The state ownership of the defence industries in Brazil is almost negligible with 51% going to the air force and 49% to private shareholders. This shows that the Brazilian defence industry was not developed separately from the rest of the economy as Brazil ensured that its industrial policy led to the creation of military research institutes linked with the private institutes which became instrumental to the process of transferring technology. Between 1967 and 1978, resources were provided to research and development in the weapons industry which led to the emergence of several local firms and the development of complex weapons systems. The Brazilian government subsidized indigenously produced equipment in order to make the market competitive and favorable towards

Brazil which transformed the state into an international commercial partner.

Perry and Weiss indicated that the defence industry of Brazil could not have reached its current heights without relying on the supplies of the domestic defence market. The export subsidies accelerated the acquisition of technology which provided the Brazilian weapons market as an alternative market in the supply of weapons, of which countries within the Middle East and Africa were major buyers of these weapons. Of the total production, about two-third comes from indigenous designs, one-third comes from licensed firms outside Brazil and in total, over 500 manufacturers of defence related equipment are resident in Brazil.

The model of developing the military industrial complex in Brazil involved several foreign collaborations combined by license systems of technology transfer; hence, the model employed illustrates the importance of mobilizing industrial resources by purchasing licenses, adapting civilian technology, the need for a government led industrial policy and cooperation between research institutes. This model therefore demonstrates the political will of a government to develop the military industrial complex of the state.

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India's Military Industrial Complex

India's military industrial complex, which has been used as the benchmark for other countries, came about after the country adopted three strategies which it used to strengthen its military capacity and these strategies in turn helped to meet the needs of the national interest by importing conventional weapons and establishing nuclear and space programs which all culminated in the development of a strong Military Industrial Research complex (MIRC). The development of the MIRC was in three phases:

· The Organization Phase (1949-1962);
The Consolidation Phase (1963-1971); and
· The Diversification and Re-evaluation Phase (1972-date).

During the organization phase, India focused on the development of its research institutes, public sector institutions and military ordinance factories. The consolidation period saw the increase in the defence budgets by multiple folds as the production sector and the financial investment began to yield positive results from the phase to the diversification and re-examination periods.

In the last two decades, India has established thirty-three ordinance factories, nine public sector undertakings and thirty-four major research and development organizations, all run and financed by the government. Also, India has built helicopters, aircrafts, armored personnel carriers (APCs) and produced advanced electronic equipment and this has increased the number of jobs by adding 59% of employed workers to the work force which have in turn produced 44% of the goods. The workforce receives half of the capital provided by the government in the development of the MIRC. The government owned defence public sectors produce 50% of the output, employ 33% of the workers and they in turn receive some amount of the capital of the complex.

As of 2006-2007, India had about 40 major defence research and development organizations which are exclusively devoted to the military research. This research and development organizations employ 25,000 people, 6,000 scientists and has been deemed as the largest civilian research organization. Since the government supports over 85% of all research centers in India, it can be concluded that about ¼ of all the research in India is devoted to defence purposes.

The Indian government employed the resource mobilization model and covert system of technology transfer without any foreign collaboration in the development of her defence industry. This model shows the importance of having a sufficient infrastructure and skilled manpower on the ground and like Brazil; it demonstrates the political will of the government to develop a strong military industrial complex.

South Africa's Military Industrial Complex

During South Africa's colonial era, the colonial government established the Armaments Development and Production Corporation (ARMSCOR) as the main industry responsible for its weapons production. ARMSCOR had several research departments that conducted regular military research alongside the National Council for Scientific and Industrial Research and this has placed an indigenous need for the manufacturing of weapons in South Africa on a limited scale for decades.

A restriction was placed by the United Nations on ARMSCOR's activities which led to an embargo on its arms production, thereby leading South Africa to resort to local means of weapons production and a recruitment program to attract research technologists. ARMSCOR exercised control as the manufacturing arm of half of the weapons produced through its subsidiary companies. They had over fifty contractors and 400 subcontractors involved in the manufacturing of weapons.

The South African model involved much foreign collaboration from France and the United Kingdom by using a combination of investment and license systems of technology transfer. This illustrates the importance of mobilizing industrial resources by purchasing licenses and establishing local facilities, recruitment exercises and specialized manpower. Also, it illustrates the need for the establishment of a Defence Production Mobilization Commission. This model demonstrates the political will power of the government to develop a strong MIC in order to increase the state's capacity to promote national security.

In the last two decades, India has established thirty-three ordinance factories, nine public sector undertakings and thirty-four major research and development organizations, all run and financed by the government

The above analysis of the BRIC countries appears to be a representative sample of the types of defence that should be available in other developing countries. These models suggest that the establishment of an indigenous defence industry requires the integration of all the industrial and technological capabilities of a nation. The difference in the industries derives from the difference in size, industry structure, degree of government participation and the capabilities of respective national industrial and technological infrastructures.

While Brazil's industry has been dominated by the private sector, the South African industry is divided between the public and the private sector while India is government controlled. In all cases, it is evident that the political will of the government in developing a viable MIC is strong. While the equipment procured from outside were modified and improved upon, policies were enacted in order to encourage domestic innovations and industries were driven by a high sense of political will, patriotism and commitment. Also, research and development institutes were adequately funded and staffed with experienced specialists.

Across the three case studies, it is evident that the existence of vibrant manufacturing industries was crucial to the evolution of indigenous technologies in order to foster the growth of defense industries which would not have survived if the manufacturing industries had collapsed, hence, every thriving economy requires a vibrant manufacturing sector that would be crucial to the survival of defense industries and MICs.

Nigeria's Quest for Developing a Strong Military Industrial Complex

Since the attainment of independence in 1960, the Nigerian armed forces have been actively engaged in peacekeeping missions alongside the United Nations, a civil war that lasted for 30 months and the recent internal operations of flushing the Boko Haram insurgents out of Nigeria. Notwithstanding these engagements, Nigeria has been sanctioned a couple of times because they deemed some of these engagements as abuses to human rights and during this period, Nigeria focused more on her traditional suppliers in Europe and America for her defence needs at a great cost.

Nigeria had long recognized the importance of a strong MIC as a critical factor in sustaining a buoyant economy and in her efforts to attain self-sufficiency, she collaborated with external suppliers and foreign firms in order to enhance the industrial potential of the Country with positive spillover effects in her desire to build a strong MIC in response to the challenges of national security.

The Nigerian government established several military establishments and manufacturing industries like the Nigerian Machine Tool Industry (NMTI), the Ajaokuta Steel Complex (ASC), the Delta Steel Company (DSC), Project Development Agency (PRODA), the Nigerian Air Force Training Group (NAFTG) and the Nigerian Naval Engineering Collage (NNEC).

With these industries in place, although some of the aforementioned industries are out of order, the Nigerian government moved quickly in the early years to establish various industrial establishments to server her armament requirements, one of which was

the Defence Industries Corporation (DICON), established in collaboration with the Messrs Fritz German Company which focused on the operation, maintenance and control of factories in Nigeria for the manufacture, storage and disposal of ancillary weapons such as the German Beretta Rifles, submachine guns 7.62 and 9mm ammunition etc. However, the government failed to continue funding these operations as a result of the corrupt practices and hence contracted the Messers Fabrique Nationale (MFN) of Belgium which was again stalled as a result of lack of funding.

DICON which was set up at the same time as its Brazilian counterpart was yet to develop into a vibrant military conglomerate, while Brazil had gone light years ahead by producing high grade equipment in the ranks of ships and aircrafts. Beyond DICON, Nigeria collaborated with foreign firms like the Peugeot Automobile and the Leyland Nigeria limited to produce cars and trucks respectively. In the maritime sector, the government contracted a UK firm to construct two naval dockyards and one shipyard which are in Lagos and Port Harcourt respectively and were tasked with the responsibility of repairing ships and refitting naval and merchant vessels, but again, due to lack of funds, these dockyards focus mainly on the repair of ships.

Notwithstanding this drawback from DICON, local production of some components were achieved to a feat and hence, it is evident that Nigeria recognized the importance of building a strong MIC as a harbinger for the attainment of an improved national security.

The South African model involved much foreign collaboration from France and the United Kingdom by using a combination of investment and license systems of technology transfer

Current State of Manufacturing in Nigeria in comparison to the BRIC Countries

The state of Nigeria's manufacturing industries can easily be glanced from available facts that capture the nature of the overall manufacturing sector which has deteriorated in the past three decades although these industries still play a crucial role in the Nigerian economy as they contribute to the Gross Domestic Product. As of 2009-2012, the Manufacturers Association of Nigeria had closed down 820 manufacturing companies as a result of poor performance which has affected its contribution to the GDP. This can be seen in comparison with the BRIC Countries in the table below:

Nigeria's technological base is weak as a result of the lack of investment in research and development. The manufactures highly depend on the import of equipment which is not sustainable due to foreign exchange limitations. Also lacking is adequate manpower necessary to guarantee competitiveness in the current global economy. This therefore implies that there are not growth-propelling resources at the disposal of manufacturing firms in Nigeria and over the years has deteriorated in its growth mechanism. This weakness has led to the closure of these industries and has hampered on the growth of the defence industry which in turn engenders the gradual evolution of a strong MIC in Nigeria. Therefore, it is pertinent for Nigeria to ensure concentrated efforts in multi-sectoral interventions in the manufacturing sector to revive it. The incoming administration of General Buhari, come May 29th should go through the five subsectors of the vision 20:2020 of the past administration which it failed to cover. These consist of:

- Chemical and pharmaceuticals;
- Products, basic metal, iron and steel and fabricated metal;
- Food, beverages and tobacco;
- Textiles, wearing apparel and leather footwear; and
- Non-metallic mineral products.

The above are a clear representation of the manufacturing sector where Nigeria needs to develop comparative advantage. These core areas have proven to have the highest potential to provide raw materials for other key industries in the long run, including the defence industries. To achieve a strong military industrial complex that can contribute to the promotion of national security, the government needs to evolve and implement measures that will aid in the resuscitation of the ailing industries and the establishment of new ones in order to build a robust and vibrant economy.

Readiness of Military Industrial Complex in the Promotion of National Security

The thought that military industrial complex can be a springboard for the maintenance of national security has been strong among nations. For the conceptualization of national security by this paper, having a MIC is not only an indicator, but a crucial factor in enhancing the readiness of the state in preserving its national security. This, the existence of MIC and a strong manufacturing base enhances the capability to deliver national security in terms of human-centric and state centric conceptualization. From the examples of Brazil, India and South Africa, we have seen that they used their military industries to

foster general economic development and attract foreign direct investment. If Nigeria follows suit, she can develop a robust defence industry. Furthermore, a strong and robust MIC increases the quality of arsenal in the inventory of the Army that is produced locally. This will position Nigeria to reduce her dependence on foreign importation of arms and will also increase her capacity and readiness in confronting the security challenges emanating either within or outside its territory.

With the current battle with Boko Haram, the military has been engaged with the responsibility of maintaining national security and has continued to depend on the massive importation of weapons which do not meet their operational environment, with a recent issue, that led to the issuing of death warrants to about 50 officers because they refused to fight without adequate weapons. Apart from detracting the Army from freedom of action, this situation has had adverse effects on its operational effectiveness in its maintenance of national security.

Therefore, as a matter of high importance, it is important to have a functional MIC critical to attaining operational readiness and effectiveness. This can be seen from two perspectives. First, it will reduce the dependence on external importation which will then lead to an increase in the space for the country to achieve its defence goals when faced with a cut in the supply of arms or an embargo of some sort. Secondly, it will enable the country to develop and modify the weapons to suit its environment and terrain.

Years	Brazil	India	South Africa	Nigeria
2009	23%	16%	18%	3.68%
2010	23%	16%	18%	3.79%
2011	23%	16%	18%	3.91%
2012	23%	16%	18%	4.03%

In light of this, the MIC can be said to be an indispensable factor in the national defence and security in Nigeria, especially with the daily challenges of the internal security situation in the country. Thus, the MIC enhances the readiness of the country to provide security and protection to its citizens, reduce dependence on foreign states and enhance domestic defence production. These in turn will improve on the capabilities of the national security and defence of Nigeria

Recommendations and Conclusion

In heading towards the conclusion of this paper, five recommendations towards attaining a strong MIC have been suggested for the incoming administration to focus on, and this will improve on the current state of affairs regarding the promotion of national security for Nigeria. First, there is the need to establish adequate infrastructure, especially 24-hours electricity which will boost and sustain the self-reliance in the manufacturing of equipment and goods and this will greatly improve on the quality and quantity of defence production required for the maintenance of national security.

Secondly, the Nigerian government needs to fast-track efforts at revamping her moribund strategic industries wasting across the country. This will improve the industrial base for the development and sustenance of MIC.

Thirdly, it is of high necessity that MIC requires skilled and innovative personnel in the design, innovation and development of high quality military weapons system. To this effect, the study of military technology should be included in Nigerian institutions, particularly in institutes of technology and the Nigerian Military academy.

Fourth, there is need for greater attention to be paid to research and development in higher institutions and military establishments. A sustainable research and development program will enhance the military industrial complex in order to boost her readiness to respond to defence and national security challenges.

Finally, there is need for the Nigerian government to increase the defence budget in order to make funds available to DICON to promote domestic production of defence hardware. This can lead to an increase from the current 0.6% to 1.2%on the GDP which is within the UN recommended figure of the next five years to fast-track MIC in Nigeria. Also, within the next five years, it is expected that DICON should be able to stand on its own without government funding as it will help in dealing with the problem of inadequate funding, thereby impacting on national security. More so, it is important for the elite class in Nigeria to muster the political will to pursue the policies and

recommendations made in the past that have the potential to transform the defence industrial base of Nigeria. The inconsistency of policies has been the bottleneck towards realizing the strategic projects conceived by the Nigerian government and to this end, adherence to policy consistency is crucial because it ensures that policies and projects are executed to a logical conclusion. It is therefore imperative for the Nigerian government to muster greater political will towards developing a strong MIC that will improve on her readiness to respond to the national security exigencies.

In conclusion, this article has been able to demonstrate that the protection of lives and property is a major function of the government in any state. States are continually confronted with security threats that they need to act swiftly and decisively to contain. In order to do this, states would need to establish a defence industrial base that is not only integrated to the wider manufacturing base of its economy, but also adequate and functional enough to meet its defence and security exigencies. Therefore, national security and defence could be enhanced if a resilient MIC capable of providing the input necessary to create a well led national security and defence component to defend a nation from security threats exists.

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DRDB Pioneering Indigenous Production of 'Meal Ready to Eat' for Troops

The complexities and uncertainties of military operations warrant contingency planning which include logistic supplies. History is replete with military campaigns in which line of supply is cut off thereby leaving troops to endure hunger and thirst. Troops also often embark on long clearance and sting operations that linger over a period of time more than envisaged. In such situations, the need for troops' sustenance becomes critical. Furthermore, in some Low Intensity Conflicts (LIC), training exercises and disaster situations where there is no immediate organised cooking, the need for dry ration known as Meal-Ready to-Eat (MRE) becomes paramount. In applicable cases, the aim is to provide the troops with food for the first 24 to 72 hours as part of their personal effects on the move.

Presently, the Armed Forces of Nigeria (AFN) is engaged in a number of operations within and outside the country. The development has occasioned the deployment of large number of troops on counter-insurgency, counter-terrorism and Peace-Keeping Operations. The logistic demands often put troops in dire strait requiring immediate meals for sustenance pending re-supply thus bringing to fore the need for MRE in AFN. The MRE otherwise referred to as Compo Ration is a self-contained, individual soldiers field ration in lightweight packs prepared for troop in combat or other field exercises where bulk organized cooking could not be organised in the immediate time before pending operations. The MRE may not necessary be for only troops in combat, but could also be provided for civilians during periods of natural disasters in order to alleviate their suffering for short period, before being properly re-settled at a conducive environment. Previous attempts by the AFN to develop indigenous MRE had failed due to lack of continuity, proper planning and commitment. It is with this in mind that the DRDB initiated a process of meeting troops dry ration requirements as part of its mission to provide strategic direction for self-reliance in defence and security needs of the AFN. The

initiative led to series of visit by DRDB teams to some identified indigenous companies engaged in the production of beverages and confectionaries whereby Erisco Foods Limited was considered the most viable. In realisation of this, the DG DRDB and Management of Erisco Foods Limited exchanged visits in order to concretize the production of MRE for the AFN. During his visit to the Company, the DG DRDB stated that "it is more advantageous to collaborate with indigenous companies in the production of MRE for our troops especially as timely delivery safety and security cannot be compromised." He insisted that the required MRE must be of high energy content with a shelf life of not less than 9 months.

After a guided tour of the research, production, quality control, storage, assembly, packaging and other departments of Erisco Foods, the DG DRDB observed that the Company has the human, equipment, materials and laboratories capacity to produce MRE for the AFN. The CEO of Erisco Foods, Chief Eric Umeofia who welcomed the DG DRDN and his Team stated that Erisco Foods Limited was a wholly owned Nigerian Company with its staff being 100 per cent Nigerian and its raw materials completely sourced locally. He also assured the DG of the company's total adherence to safety, security, hygiene and best quality standards which have been guaranteed by Standards Organization of Nigeria as well as NAFDAC. He assured the DG of the company's readiness to supply any quantity of MRE required by the AFN at very short notice. He provided samples of packaged Erisco MRE to the DRDB Team. He also disclosed that the Company would supply DRDB request for MRE with the appropriate packaging within 3 weeks including the period required for mandatory quality control laboratory test. The various menus of MRE displayed by the Company were Ready to Eat spaghetti with Beef, Ready to Eat jollof and white rice, Ready to Eat rice and beans, Ready to Eat potatoes, Ready to Eat 3 in one garri, milk and sugar, Ready to Eat Beans and corn with fish, Ready to Eat Rice and corn with Beef and Individual flameless Ration Heater for heating up the food. Other added desserts included high energy cocoa drinks, milk cubes, chocolate cubes and garri cubes.

The pioneering effort by DRDB in the development and production of an indigenous MRE in partnership with Erisco Foods represents a remarkable achievement and milestone for the Bureau against the background of decades of dependence on foreign campo ration by the AFN. The achievement is an indication that given the right atmosphere, direction and commitment towards research, homegrown solutions towards equipping the AFN for combat by the research and development is in the horizon.

DRDB DG (4th left) CEO ERISCO (4th right) flanked by officers of DRDB during ERISCO's visit to the DG

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