

INCLUSION OF ROBOTIC WELDING CONTENTS INTO METAL-WORK TECHNOLOGY PROGRAMME IN THE NIGERIA CERTIFICATE IN EDUCATION CURRICULUM**BY****Alexander Gbenga OGUNDELE: Department of Metalwork Technology, Kwara State College of Education (Technical), Lafiagi, Nigeria; E-mail: alexnig2003@yahoo.com****Prof. Emmanuel J OHIZE: Department of Industrial and Technology Education, Federal University of Technology, Minna, Niger State; E-mail: eohize@futminna.edu.ng****Dr. Ibrahim Yakubu UMAR: Department of Industrial and Technology Education, Federal University of Technology, Minna, Niger State; E-mail: umaryakubu@futminna.edu.ng****Abstract**

It is evidently clear that, economically developed countries in the world such as the United States of America, Germany, France, United Kingdom, Russia, China, and Japan, among others have robotic welding operations in the curriculum of their schools and colleges creating a huge gap between the developed and developing nations. This is needed in Nigerian schools and colleges in order to bridge the gap with the developed world. The minimum standards for Nigeria Certificate in Education as structured by the Federal Republic of Nigeria's National Commission for Colleges of Education, shows clearly that Robotic welding is missing in the curriculum for Metalwork Technology Programme. This study focuses on the need to include robotic welding into Metal-work Technology Programme in the Nigeria Certificate in Education Technical Curriculum, overview of robotic welding, rate of usage of robots and robotic welding across the globe, benefits of robotic welding and robots market forecast for 2019 – 2021. In conclusion, the paper recommends among others that, all agencies and stakeholders responsible in curriculum development should always consider the current needs of the society and do away with stereotype curriculum that will not benefit the oncoming generations.

Keywords: Robot, Robotic welding, Curriculum, Metalwork-Technology

Introduction

Gone are these days when human beings were used to legs, animals, and cart to move from one place to another as a means of transportation. In today's world, man does not only invent and use airplane but also using technology for transplanting pregnancy (The BBC, 2020). Technological innovation and its impact in the society are becoming inseparable making waves in shaping the future of man and the society from engineering, transportation, healthcare, manufacturing, business, to law and communication. With the trend of technology evolving around human lives, technology has become part of human lives since the invention of hand tools, electricity and machines for the basic needs of the society. In today's world, the advent of technology has given birth to a robot which utilizes, 'artificial human intelligence' and as a matter of fact, manufacturing industries are making waves too in the use and need of skills on the usage, repair and invention of robotic welding as the world is tailoring towards this technological path. It is no longer news that Nigerian youths are making waves in terms of robot competition across the globe from the secondary school levels (Africa Technology Hub, 2018). Despite the interest in working and designing robots among school pupils/students across Nigeria, there is no robot/robotic welding programme offered at the Nigeria Certificate in Education (NCE) level neither is it included in the NCE curriculum, where the training of manpower in the area of technology among others is required.

One of the objectives of Technical Teacher Education is to provide trained manpower in applied sciences, technology and business particularly at craft, advance craft and technical levels and also, provide qualified Technical Teachers motivated to start the so much desired revolution of technological development (National Commission for Colleges of Education, 2012; National Policy on Education, 2013). As the situation is, students at the NCE level where Metalwork Technology course is been offered

need to be exposed to robotic welding and operations. The need for the inclusion of robotic welding into the curriculum will have more youths acquainted with skills in robot design, robot operation, and maintenance.

Overview of Robotic Welding

A robot is a computerized controlled system which allows the use of computer and computer software that supervises the operation of a control system. These operations can be easily and cheaply changed by making software modifications, without making any complicated modifications to circuitry or apparatus. Robots have the capacity to use a set of programme that control the automatic actions of machines which involves sensor motor, emotional, social and cognitive intelligence. The process of using machines to perform a faster task than human beings as a result of latest trend in technology warranted the invention and usage of robots. Aririguzo and Agbaraji (2016) reported that robot has the potential to improve the productivity of manufacturing industries as it performs tasks traditionally conducted by humans especially in the area of welding and fabrication from improved flexibility.

Welding is widely used in industry as a joining technique both for fabrication in production and for repairs. It has almost completely replaced riveting and assembling the structural steel members of bridges and buildings in joints where permanent solutions are required. Kah, Hiltunen, and Martikainen (2015) reported that robotic arc welding was first used in production in the mid-1970s and subsequently in the leagues of welding processes because as a reprogrammable and multifunctional manipulator, it is designed for the performance of a variety of tasks for moving tools, parts, materials, or specialized devices, to programmed motions. In this current technological era, robotic welding has become modern welding technology.

The world technology is fast changing towards digitalization and automation in every sector of the economy with the use of robots. The manufacturing industry where welding is used to assemble parts by automated robotic weld is not left behind which is believed to increase productivity and greater output efficiency. According to Farkas (2018), manufacturing industries have widely adopted the used of automation in welding to improve welding process efficiency, increase productivity, enhance welding quality, and reduce scraps and other harmful agents in form of ultra-violet light exposure, welder's flash, and toxic fumes. Because of the advantageous side of robotic welding over the manual welding, many welding industries across the globe have realized the potential increase of using a robot to weld giving a quality weld with little or no hazards compared to the manual weld. With this development, the use of robotic welding is fast driving industrial welding robots market growth as the demand keeps increasing (Farkas, 2018).

Usage of Robotic Welding

The application of robotic welding has gone a long way in assisting the manufacturing and assembly industries where welding of various components with high heat intensity are involved. Because of the involvement of heat intensity, rays from the arc, complex and intricate shapes, the accuracy of welding beads, deposition and penetration level, distortion and residual stress, and physical contact with human operators in manual welding operations, robotic welding is now becoming more and most preferred. Robotic welding is highly consistent with the ability to produce high quality speed, distance of electrode travel, weld beads and welding angle (Erin, 2017; Gnanavelbabu, Arunagiri and Dhanasekar, 2017).

The usage of robots in the world has come to stay and is taking over many jobs that ordinarily can be handled by casual workers. Currently, as shown in Table 1, millions of dollars are being invested on robots every year in the area of professional service robots, public relation robots, household robots, entertainment robots, and handicap assistance robots.

Table 1: Statistical data of the rate of usage robots in the world

Items	Years	Units	Sales Value
Professional service robots	2017	109,543	US\$ 6.6bn.
	2016	59,269	US\$ 3.0bn.
Public relation robots (telepresence, mobile guidance and information).	2017	10,043	US\$ 177m
	2016	6,388	US\$ 118m
Mobile barn cleaners or robotic fencers for automated grazing control.	2017	6,375	US\$ 120m
Field robots.	2017		US\$ 966m
Service robots for personal.	2017	8.5 million	US\$ 2.1bn
	2016	31%	
Household robots.	2017		US\$ 1.6bn
	2016	30%.	
Entertainment robots	2017	2.4 million	US\$ 0.44bn
	2016	12%	
Handicap assistance robots	2017	6,423	US\$ 127m
	2016	5,313	

Source: World Robotics Service Robots (2018).

Looking at the projection of a likely increase in demands for robot services across the world, it was discovered that there will be a sharp increase in the number of units by 2021 and the sales value will be high. Table 2 below shows the projection line from 2018 to 2021. It is expected that by 2021, about 736,000 units of the professional service robots will be demanded for with a sales value of about US \$37billion.

Table 2: Projections 2018 and 2019-2021 professional service robots

Items	Years	Units	Sales Value
Professional service robots	2018	165,000 (32%)	US\$ 8.7bn.
	2019 to 2021	736,600	
Compound Annual Growth Rate expects	2019 and 2021		US\$ 37bn.
Sales of logistic systems	2018	115,000	US\$ 3.9bn.
	2019 to 2021	485,000	
Automated guided vehicles		189,000	

Source: World Robotics Service Robots (2018).

In 2018, the demand for domestic service robots among other robots was projected for 7.5 million units as shown in Table 3 with a sale value of US\$ 2bn. By 2021, the unit value projected is 39.5 million with a compound annual growth rate of US \$11.1billion. This can be a good investment for African countries like Nigeria, Ghana, South Africa, and Kenya to take advantage of utilising the opportunity in incorporating and designing robot courses into college curriculum, as the revenue generation of such country may also be more on the increase.

Table 3: Projections 2018 and 2019-2021 personal/domestic service robots

Items	Years	Units	Sales Value
Robots for domestic	2018	7.5 million	US\$ 2bn
	2019-2021	39.5 million	US\$ 11.1bn.
Professional service robots	2017	109,500	
	2018	165,300	
	2019-2021	736,000	
Service robots for domestic/ Household tasks:	2017	6.1 million	
	2018	7.5 million	
	2019-2021	39.5 million	
Service robots for entertainment:	2017	2.4 million	
	2018	2.8 million	
	2019-2021	10.7 million	

Source: World robotics service robots (2018).

Benefits of Robotic Welding

The benefits of robotic welding outweigh manual welding considering the safety and production benefits. Some of these benefits are that:

- ❖ It produces higher quality parts to be produced and drives down labour costs of manual welders.
- ❖ It reduces operator's exposure to hazardous bio-products of the welding process.
- ❖ The welding process is more efficient as it allows for a continuous welding and reduces time when welding does not occur (automated system).
- ❖ It reduces the amount of gas and electrode consumption and eliminates electric shock.
- ❖ It eliminates operator's manner of inhaling toxic fumes and gases like manganese which is harmful and can damage the brain and nervous system.
- ❖ It reduces welder's flash (corneal burn) caused by ultraviolet light exposure which can permanently damages the eye's cornea.
- ❖ It prevents reaction of solvents containing chlorinated hydrocarbons and ultraviolet light which may result to the formation of phosgene gas, which is deadly even in small quantities.
- ❖ It prevents respiratory problems as breathing in iron oxide irritates nasal passages, throat, and lungs. Source: (Erin, 2019; Gnanavelbabu, *et al.*, 2017, The Drake Group, 2017).

Robotic welding market forecast for 2019 to 2024

From tables 1 – 3 above, it is evidently clear from all indications and previous data on rate of usage, countries that will patronize the use of robotic welding in the world have the USA, Canada, and Mexico on top while the least is Nigeria and South Africa. This means that Nigeria will have to since how in can key into the design and usage of robots in all disciplines. The list below shows how North America ranked 1st on the list of those that will patronise the robot market by 2024 while Africa ranked 5th and last on the need line.

1st - North America (the USA, Canada & Mexico).

2nd - Europe (Germany, France, UK, Russia & Italy).

3rd - Asia-Pacific (China, Japan, Korea, India & Southeast Asia).

4th - South America (Brazil, Argentina, Columbia etc.).

5th - The Middle East and Africa (Saudi Arabia, UAE, Egypt, Nigeria & South Africa)

Source: Global Welding Robot Market Analysis, 2019.

Nigerian Youths and the use of Robot

Nigerian youths have begun to aspire further in the field of Robot and its innovation in the last four and half decades. This is because of their familiarity and usage of robots in their various schools and colleges. Many of these youths are making waves and winning various categories of awards in robot invention and

its applications. Below is the list of some talented Nigerian youths with what they have done in the field of robotics. These are just a few brilliant Nigerian youths among others and so, there is the need for the country to include Robotic Welding into her educational curriculum in schools and colleges to have more youths acquainted with the 21st century robot skills needed on how to use it, repair and invent other robots. It is affirmed that between 2016 and 2019, seven (9) young Nigerians of an average age of 14.5 years distinguished themselves in and outside the country through their robot designs for laundry-folding, grabber sensor, gaming robot, software among others with prizes won (Reuters, 2019; BBC News Africa, 2019; Africa technology, 2018; GITEX, 2017; World Robot Olympiad, 2017 ; Vanguard, 2018). In the event of this, many computer software aids such as the Solid works, and Robots to programme robotic welding skills which can be introduced to learners of Technical Education programmes.

Robotic welding can be included in the Metal-work technology curriculum for effective acceleration in the use of robotics for technological development. Some of the Metal-work technology courses offered at NCE Technical levels is Sheet Metalwork fabrication & Welding; Foundry and Forging; Machine Shop Practice; and Advance fabrication & Welding (FGN/ NCCE, 2012). With this provision, the curriculum can be redesigned to include robotic welding process that could be applied the following types of welding; Arc, Resistance, Spot, TIG, MAG, Laser, and Plasma at NCE level.

The Nigeria Certificate in Education (NCE) Technical programmes

One of the philosophies of Nigeria Certificate in Education (NCE) Technical is to provide the intellectual and professional bedrock for teaching technical subjects in any changing situation in technological development in the world at large (Federal Republic of Nigeria National Commission for Colleges of Education, 2012). One of the objectives of the programme is, “to provide qualified Technical Teachers motivated to start the so much desired revolution of technological development right from the Nigerian Schools”, collaborating the goal of Technical Education.

The Federal Government of Nigeria National Policy on Education (FGN/NPE, 2013) defines technical education as "that aspect of education, which leads to the acquisition of practical and applied skills as well as basic scientific knowledge". The mindset is to train individual to be self-reliant and be productive. This led to the formulations of the following goals of technical education in Nigeria. According to the FGN/NPE (2013), one of the goals of Technical Education is to provide trained manpower in applied sciences, technology and business particularly at the craft, advance craft and technical levels. Students of this programme are equally trained to be self-employed or pick a job in the industry aside the teacher training service.

Conclusion

The fact remains that the world is changing as a result of new innovations in technology, so the educational system must be tailored towards the new changes that will accommodate necessary skills needed for the technological advancement. Since Technical Teacher Education is to provide trained manpower in applied sciences, technology and business particularly at craft, advance craft and technical levels and also, provide qualified Technical Teachers motivated to start the so much desired revolution of technological development as its utmost goal, the curriculum for Metalwork Technology should include robotic welding operations so that youths and other beneficiaries of the programme can fit into the current needs for the 21st century skills.

Suggestions

Based on the many benefits of robotic welding in this 21st century, the following suggestions were made:

1. The sheet metal fabrication and advanced welding that are already imbedded the present NCCE curriculum of Metalwork Technology programme should be integrated with robotic welding procedures and operations.

2. Government and other relevant agencies should partner with manufacturers of world-class robotic welding technology on the supplies of training tools and equipment for the robotics programme just as it is done in developed countries.
3. Schools and Colleges should always expose their staff and students to robotic training/ workshops to enhance their skills and performances.
4. Lecturers should be provided with the software and other robotic simulation for installation to arouse their interest and boost their psychomotor skills.
5. Robotic game should be integrated with robotic welding so that students will not be bored when practical work is been carried out.

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