THE ROLE OF PHYSICS IN NATIONAL

DEVELOPMENT

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TABLE OF CONTENT

DEDICATION

This work is dedicated to my friends Rasine Obo, Stella Ikang, Bassey Archibong and Emmanuel Okotie - whose smiles have kept me in high spirits. This has been the secret of success. I owe them a lot.

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To God be all the glory!

Victor Ekpo

CHAPTER 1 INTRODUCTION

1.0 About the Topic

Throughout history, the difference between a victor and a victim nation, a technologically advanced and deficient nation, a socially respected and maligned nation, and an economic buoyant and crippled, has been the existence of a group of people called Physicists, who through their work in Physics helped bring development to their nations.

Physics has been the bane of developing countries, who struggle endlessly with economic and industrial reforms without paying attention to scientific research. On the other hand, Physics has been the catalyst for development of industrialized nations of the world. It alone has the power to change a hitherto poor nation to one of the best of industrialized nations. Nations like America and China have been put on a strong footing by their physicists.

George Sarton puts it rightly: “the best way to explain American achievement is to focus upon a few of the leading scientists”. This is corroborated by Anthony Serafini in his book, Legend in Their Own Time: “American scientific giants of the 20th century have transformed the world in terms of scientific understanding, military preparedness and the quality and comfort of our daily lives.”

This gives us a firm description of the role Physics plays in national development. Physics has not just been all about research. It has played a significant role in development. For what is research, if it does not bring development and how can development come without any change to better ways of living, which can only be discovered through research. A great scientist and philosopher, Francis Bacon thought of this and warned that “the true end of knowledge is not the pleasure of the mind but a line and race of inventions that may in some degree subdue and overcome the necessities and miseries of humanity.”

This is the purpose of Physics and the role it ought to play in the society. To fully understand this role, it is important to note that all technological advancements in science have in one way or another been as a result of the accumulation of knowledge in the field of Physics.
This ranges from the discovery of cathode ray tubes which eventually led to the invention of the television; the work on nuclear physics, radioactivity and atomic physics that led to the manufacture of the atomic bomb; the discovery of x-rays by Wilhelm Roentgen which finds applications today in medicine and chemistry, works of Fritz Haber on easier production of ammonia that is used in agriculture today as ingredient for fertilizer; the works on magnetism and electromagnetism with wide range of application from electric bell and speakers to computers; works on optics, used in microscopes, telescopes, periscopes and many other optical instruments ; works on gravitation that have led to space revolution. From electricity and transport to

Computers and the internet, physics has laid the foundation for numerous transforming technologies over the past 200 years and beyond.

As we celebrate the World Year of Physics (2005) which coincides with 100 years after Albert Einstein's relativity law, this paper will look at what roles physics has played in national development, and also look at the future to ascertain what role physics has to play.

1.1 Physics as a Discipline

Physics is the science of the natural world, dealing with the fundamental constituents of the universe, the forces they exert on one another, and the results produced by these forces *(Wikipedia Internet Encyclopedia: www.wikipedia.org).*

Its etymological origin is traced to the Greek word for nature. Physics thus deals with a variety of physical phenomena and finds applications in almost all the other sciences, which deal with studies of specific aspects of matter.

Physics can thus be referred to as the core of the sciences. Its branches include: astronomy, atomic physics, biophysics, cosmology, dynamics, electricity, electrodynamics, field theory, fluid theory, fluid mechanics, particle physics (high energy physics), hydrostatics/hydrodynamics, magnetism, mechanics, nuclear physics, optics, plasma physics, quantum electrodynamics, quantum mechanics, solid state physics, statics, suface physics, thermodynamics and a host of others.

Physicists usually study more than one of these branches for effective application. For example, cosmology & astronomy can be studied together, electricity & magnetism (giving electromagnetism), and fluid theory & fluid mechanics.

1.2 Indices of National Development

There are certain parameters used to measure how developed a country is. These are the indices of national development. They are: poverty rate, life expectancy, Gross Domestic Product (GDP), literacy rate, unemployment rate, healthcare delivery, food security, access to clean water, mineral reserves, GNI per capita, transport facilities, etc.

To calculate these parameters, it is important to know the population of the country in question. In Nigeria, the last population census was held in 1991 and cannot be said to be applicable today, since Nigeria has a population growth rate of 2.3%. There are therefore conflicting figures of the total population of Nigeria, which is very much expected. While the United States CIA (Central Intelligence Agency) puts the figure at 128.77 million people, the United Nations puts the figure at 130.2 million people, and yet others calculate it to be approximately 150 million people. It is however accepted that the population of Nigeria is about

130 million people. Whatever the figure, Nigeria remains the most populous nation in Africa. The Federal Government of Nigeria will however hold a population census on March 21 25, 2006 and put to rest the begging population question.

Nigeria has a poverty rate of 60%, life expectancy of 43 years, GDP of $125.7 billion with oil revenues taking 20% of GDP, 95% of foreign exchange earnings and 65% of budgetary revenues. Its literacy rate is at 68% and HIV/AIDS prevalence rate is 5.4%, not forgetting that Cross River State has the highest prevalence rate. Estimate deaths resulting from HIV/AIDS yearly are 310,000 (2003). Access to clean potable water is below 50%. People in the rural areas usually have to trek long distances to get to streams whose water cannot be said to be potable. Nigeria has a GNI per income is $390. Our roads are barely motorable, railways are non-functional. Though Apapa seaport is the second largest seaport in Africa, water transport is very much undeveloped. Air is the best means of transportation, but can only be afforded by the elite. Still yet, security cannot still be guaranteed in the air. This was evident in the ill-fated Bellview air crash of 22nd October, 2005 that took with the lives of all 117 crew members and passengers on-board.

With all these information, Nigeria is far from being a developed nation. Efforts must therefore be geared towards taking the “giant of Africa” from the pit of under-development.

CHAPTER 2 ROLE OF PHYSICS IN HEALTHCARE

2.0 Introduction

The health of a population is a fundamental element contributing to progressive sustainable national development. Throughout the course of medical history, physics has been one of the fundamental medical sciences. It was first applied to understand the function of the human body *(World Conference on Physics and Sustainable Development 2005: www.wcpsd.org)* There is a long and rich history of applying physical principles and the development of many types of technology for both the diagnosis of disease and injury and for a variety of therapeutic purposes.

Revolution in health was experienced following the discovery of "a new kind of radiation" by a physicist, Prof. Wilhelm Conrad Roentgen in 1895 (Roentgen is the first Nobel Laureate in Physics). For a century, physicists have developed and supported the clinical application of radiation.

Medical Physics' main areas of interest are in the treatment of cancer by ionizing radiation (radiation oncology), in diagnosing imaging with x-rays, ultrasound and nuclear magnetic resonance (diagnostic radiology), in diagnostic imaging with radionuclides (nuclear medicine) and in the study of radiation hazards and radiation protection (health physics).

Other applications are bioelectric investigation of the brain and the heart (electroencephalography and electrocardiography), biomagnetic investigations of the brain (magnetic source scanning), medical uses of infrared radiation (thermography), heat for cancer treatment (hyperthermia) and lasers of surgery (laser surgery).

Medical Physicists are generally involved in four areas of activities: clinical service and consultation, research development, teaching, and administration. Usually, a medical physicist is involved in all four areas.

2.1 Role of Physics in Detection and Diagnosis

Medical Physics has made it possible to study the brain while it is in action. This is through a new type of Magnetic Resonance Imaging (MRI). With this, it is possible to check the activities of the brain. Its application lies in the study of the psychological effects of an occurrence. Recently, ***The Times*** reported how this technique was used to examine the effect of prayer on a Buddhist monk. The result was positive, i.e. prayer does have an effect positively on the happiness of individuals.

Magnetic Resonance Imaging also helps in the diagnosis of brain damage its effect and portions.

The physics of sound and vibration is used to detect osteoporosis more cheaply and safely than with x-rays. Without this new development, an estimate half of all women in the United Stets would break a bone because of osteoporosis *(American Institute of Physics)*. Osteoporosis is the lack of calcium in the bone.

Superconducting sensors can pinpoint the active centers of epileptic seizures, helping researchers develop new treatments.

Skin cancer is a disease in which cancer (malignant) cells are found in the outer layers of the skin. Melanoma is a type of skin cancer in which cancer cells are found in the cells that colour the skin (melanocytes). It can be caused by sunburns and ultraviolet light which damage the skin. In 1996, 38,000 melanoma cases were reported in the US. Today, over 51,000 cases are reported to the American Cancer Society each year, and it is likely that a great many more occur and are not reported *(Skin Cancer Foundation: www.skincancer.org)*. This dreaded disease can easily and efficiently be detected by the CD-ROM technology. CD-ROMs can efficiently and inexpensively store baseline images of skin. If detected early, it can help cure the disease before it escalates.

During World War II in the 1950s, sonar devices, that are used to image the heart, were invented - another breakthrough in treatment of heart diseases.

In the 1960s, diagnostic ultrasound was first used. Diagnostic ultrasound has also made diagnosis of disease cheaper and less traumatic for patients. Three-dimensional ultrasound allows for faster and more accurate identification of tumors and heart diseases. Medical ultrasound is also in use in obstetrics, to know the gestational age and sex of an unborn baby.

Particle Physics has also contributed its quota to medical science. PET, an acronym for Positron Emission Tomography images internal body structures in action.

X-rays are a common medical apparatus. A physicist invented it. Its application to image the internal organs of the body has helped in the diagnosis of bone fractures and deformations. This has saved the lives of many involved in accidents.

The physics of blood flow through veins and arteries can be modeled using computers. Computer models assist in diagnosing disease, planning surgery and prescribing appropriate amounts of exercise and medication. Research has shown that the hardening of the arteries leads to heart attacks and strokes, which are the leading causes of death in the western world.

Fiber optics, the telecommunication tool, has enabled the use of novel probes in non-invasive surgery and cancer detection techniques.

Physicists at the University of California (UCLA) have created a first of its kind nanoscale sensor that uses a single molecule less than 20 nanometers long more than 1,000 times smaller than the thickness of a human hair as its primary detector *(http://today.ucla.edu)*.

This miniscale machine could be used to detect the earliest signs of genetic diseases or identify a growing number of cancers, for which genetic markers are known. Giovanni Zocchi, an associate professor of Physics and leader of the research team says that it is possible to "detect genetic diseases at an earlier stage", and that the work will "ultimately lay the groundwork for creating artificial systems with more and more of the characteristics that have been unique to living things".

On 8th September, 2004, the Institute of Physics revealed a new way of taking pictures of the retina. This, she said, will give "medics a powerful tool in diagnosing and monitoring the most prevalent diseases of the eye glaucoma, diabetic retinopathy and age-related degeneration". Dr. Andrew Harvey, one of the supervisors of the project says "this new technique is safe, quick and simple, and totally non-invasive". Before now, screening techniques, such as Fluorescein Angiogram, were painful and in some cases dangerous, especially with patients dying during treatment. It is estimated that by the year 2020, there will be 200 million visually impaired people worldwide but 80% of these cases are preventable or treatable. *(Institute of Physics: http://www.iop.org/news/818).* With this method, the major eye diseases are dealt with.

Dealing with cancer, heart diseases, epilepsies, bone deformations, obstetrics and the eye, physics has donated its fair share disease diagnosis and detection, and though will still do more, stands vindicated.

2.2 Role of Physics in Treatment of Diseases

It would be an incomplete work if after detection and diagnosis, treatment is "quackly" done. Physicists have therefore continued to strive for cheaper, faster, more efficient and safer techniques in the treatment of diseases.

One of the techniques being used in cancer treatment involves radiation. Regarding radiation in treatment of diseases, cells seem most vulnerable to damage when they are dividing. That is why cancer uncontrollable cell growth is vulnerable to radiation damage. The objective is to kill the tumor without killing the patient. Brachytherapy, the placement of radioactive materials near or in diseased tissues, has been used for over a hundred years as a method of treating cancer. Over 18 anatomic sites in the body can be treated with brachytherapy and about 5% of patients with cancer are candidates for brachytherapy *(Richard Barrans, http://www.newton.dep.anl.gov)*.

Particle Physics also has a cure for cancerous tumors. Here, particle accelerators invented by high energy physicists are used. In 1930, cyclotrons were first used to treat cancer, using neutrons. Particles include neutrons, protons, positrons, etc. Protons can also be used to treat this

disease. This was invented by the Harvard Cyclotron Laboratory in the 1940s. Particle (neutron) therapy takes one-third the time of traditional radiation therapy.

A certain Physics theory, the chaos theory, can be applied to control epilepsy and heartbeat irregularities, and implement more effective vaccination strategies to reduce the spread of infectious diseases.

Respiratory Distress Syndrome (RDS) can also be treated, thanks to researches in physics on the viscosity in single-molecule layers of human lung surfactant lipids.

A healthy people make a healthy nation. Yes, we can say that Physics has played a role in the development of quality healthcare delivery, which has in turn, brings about national development.

CHAPTER 3 ROLE OF PHYSICS IN AGRICULTURE

3.0 Introduction

Another major development index of a country is food security. Food security is the availability, accessibility and affordability of food. It is common knowledge that development cannot be expected from hungry citizens. Their production output at best would not be optimal, and thus limit the growth potentials of the country.

Hunger has also been the major cause of riots, crises, protests, civil unrest, criminality and the chief, corruption. Hungry citizens tend to foment their frustrations on every other citizen at the slightest provocation. Food insecurity reduces efficiency, service delivery, and in the course of civil unrests, criminality and corruption, leads to insecurity of lives and property. Thus, all efforts in development go up in flames during such a situation.

Agriculture is the main stay of the economy of most nations of the world. Nigeria heavily depended on agriculture for its economic prowess before independence in 1960s (when oil was discovered). Such crops like groundnut, cocoa, cashew, cotton, maize, pineapple, oil palm, onions, yams, and very recently, cassava, still earn for Nigeria a substantial amount of foreign exchange. Malaysia is an example of an agriculture-successful nation, using oil palm, which it borrowed from Nigeria to create wealth.

In this country (Nigeria) where 80% of the land is cultivable with 13% forest land, and even four vegetation belts (coastal mangrove swamps, rainforest, woodland savanna and northern savanna) are present, it is an irony that there is still food insecurity. Nigeria therefore has to adopt Physics to seriously solve its problem, which could see Nigeria's food yield sky-rocket. What role then can Physics play in agriculture?

3.1 Role of Physics in Crop Science

Physics found its permanent position among the agricultural engineers in the 20th century. In 1907, the American Society of Agricultural Engineers (ASAE), now American Society of Agricultural and Biological Engineers (ASABE), was founded. In the 1930s, two very important agricultural institutions were formed also in the former Soviet Union: Laboratory of Physical and Mechanical Properties of Plants (1934) and Research Agrophysical Institute in Leningrad (1932). It is important to note that the second Soviet institution was founded and directed by known physicist academician A.F. Ioffe. The second part of the 20th century was accompanied by quick increase of the role of Physics in agricultural sciences. There was mainly in the “golden era” of Mohsenin's physical properties of agricultural materials in the 1960s 1980s. Physics assisted in new technologies in agriculture.

The main aim is to generate novelties that allow us to produce more with less land and less effort. The Consultative Group on International Agricultural Research (CGIAR) is best known for starting the Green Revolution of rice and wheat in Asia.

In the thirty years from 1971 to 2000, the improved crop varieties produced by the International Rice Research Institute (IRRI) and the International Maize and Wheat Improvement Centre (CIMMYT) have helped raise average rice and wheat yields by 2.3 and 1.65 times respectively, helping to feed an Asian population that grew by almost 70% in the same period. In 1982, IR36 was planted on 11 million hectares, making it the most widely planted rice variety ever.

In Nigeria, the International Institute of Tropical Agriculture (IITA) is taking a leading role, and is helping Nigeria learn the ropes of new cassava species that would make yields increase by 20%.

In 1989, two books appeared on crop formations. They showed that certain crop formations are predictable. Physicists are able to do this by studying the plasma of such crops (Plasma Physics). Plasma carries electric charge, and it travels with respect to the earth's magnetic (geomagnetic) field. English meteorologist, Terence Meadan, first hypothesized this as the cause of crop formations.

Photobiophysics also explains plant behaviour in relation to light (mainly sunlight). Photobiophysicists try to under the process of photosynthesis, of which sunlight is the main requirement. In understanding this, photosynthesis is utilized for maximum crop yield.

Microscopy is another branch of physics that has boosted agriculture and in studying the diseases of plants. These researches in Physics have thus contributed to crop science by increase of yield and in treatment of plant diseases.

3.2 Role of Physics in Animal Science

The major contributions of physics to animal science have been in biophysics. Biophysicists include a group of physics, biology and chemistry professionals. In animals, physicists have made several discoveries.

Luigi Galvani discovered bioelectricity. Bioelectricity, also referred to as bioelectromagnetism, refers to the static voltage of biological cells and to the electric currents that flow in living tissues, such as nerves and muscles, as a result of action potentials. Biological cells use bioelectricity to store metabolic energy, to do work or trigger internal changes. It is an aspect of all living things (including plants and animals). Some animals have acute bielectric sensors and are highly sensitive to magnetic fields, such as migratory birds and sharks. The electric eel is able

To generate large electric fields outside its body. These properties explain some of the characteristics exhibited by some animals, thereby helping in understanding these animals.

Sound is another aspect of Physics, which has helped in understanding such animals as dolphins and bats. Dolphins use ultrasound and the concept of echolation for location, speed, direction and size of an object, usually a prey. It also explains the pattern of their swimming, which occurs in formations, as they are able to communicate with each other. Some other animals like the bat also use echolation.

In studying the nerves, muscles and properties of animals, Physics has contributed to animal science too.

3.3. Role of Physics in Soil Physics

Soil Physics deals with the physics of soil systems. The area of Soil
Physics span from the physical description of soil particles, soil aggregates, into the storage and transport phenomena of water, gas, heat and solute in soil.

Within this area of research, soil physicists can, measure soil moisture content using electromagnetic and dielectric properties of soil; model the transport of water, air heat and solute in the soil; characterize mechanical properties in soil; manage soil water and irrigation; describe and model soil pore distribution.

Another contribution to improved soil quality is the discovery of Haber Process by physicist Fritz Haber. With this process, the production of ammonia is made quicker and inexpensive. Ammonia is then used to produce fertilizer, which can be applied to the soil to supplement the soil nutrients. This inadvertently leads to higher yield of plants, and was jointly responsible for the Green Revolution of the 20th century.

Soil physics is a major contribution to modern agriculture. With it, the best soil for every plant can be predicted, and food security will be the result. Prominent soil physicists include Edgar Buckingham, Lorenzo Richards and John Philip among others.

Summarily, Physics has contributed tremendously to agriculture.

CHAPTER 4 ROLE OF PHYSICS IN WARFARE

4.0 Introduction

Though wars are not a good cause for celebration, but they also determine who becomes a slave or master. Therefore, in protecting the territorial integrity of our countries, we must be well armed to ward off any intending enemy nation.

Nuclear weapon is the peak of arsenals. It is a weapon of mass destruction. Physicists are mainly responsible for the development of this weapon. It became fully comprehended in the 20^{th} century.

Because of the discovery of the electron and radioactivity, at the start of the twentieth century, the atom was no longer thought to be indivisible. By 1905, Albert Einstein showed in his theory of Special Relativity that a small amount of mass could be converted into a large amount of energy, though the practical significance of this equation was not fully appreciated for many years.

$$Energy = mass \times (speed\ of\ light)^2 ;\ E=mc^2 = 3.0 \times 10^6\ mass$$

Ernest Rutherford in 1911 then indicated that the majority of an atom's mass was in a small nucleus, made up of protons and this was surrounded by a cloud of electrons. In the 1920s, quantum mechanics provided an explanation for processes in the nucleus such as radioactive decay. In 1932, James Chadwick discovered that the nucleus contained another fundamental particle, the neutron, and in the same year John Cockcroft and Ernest Walton first “split the atom”. In 1934, Irène and Frédéric Joliot-Curie discovered that artificial radioactivity could be induced in stable elements by bombarding them with alpha particles, and in the same year, Enrico Fermi reported similar results when bombarding uranium with neutrons.

In December 1938, Germans Otto Hahn and Fritz Strassman published experimental results about the bombardment of uranium with neutrons that their collaborator Lise Meitner (a political refugee in Sweden at the time), with Otto Robert Frisch, correctly interpreted for the first time as the splitting of the uranium nucleus after the absorption of a neutron nuclear fission which released a large amount of energy and additional neutrons. Hungarian physicist Leo Szilard had realized that if a neutron-driven process released more neutrons than required to start, it could result in an expanding nuclear chain reaction after experimentation, he found that the fission of uranium did indeed release two or more neutrons on average. The extra neutrons released start up another reaction, which also release other neutrons starting up other reactions. The reaction goes on violently as energy released increases. This is the history of the creation of the atomic bomb.

4.1 The Second World War Experience

World War II was between the Axis Powers and the Allies. The Axis initially consisted Germany and Italy, later including Japan and much of Eastern Europe. Some of the nations that Germany conquered cooperated, and sent military forces, which fought with Germany. Among them were Vichy France, The Netherlands, Belgium, Spain (though Spain was itself a neutral country and was not conquered by Germany) and also armies of Russians and Ukrainians. The Allies consisted initially of the United Kingdom (UK), including the Commonwealth, France and Poland, but were joined by the United States of America (USA), Canada, USSR and China.

World War II is claimed to be the only real world war because of the enormous number of countries involved. There was the invasion of Poland by Germany, and the wrangling between China and Japan. American physicists wanted to build an atomic bomb first (since the Germans had already started the process). So, they informed their government of their intentions and got the government's blessings and funding, for what was called the Manhattan Project. In doing this, they also had to stop the process of the German project. So, they shut down an industry in northern Norway, which was the major source of hard water, an important ingredient for the German project. So Germany never got enough hard water to build enough of its own arsenals.

The two aspects of creating the atomic bomb were creating it and controlling the reaction process. On July 16, 1945, the Americans had finished building the atomic bomb and did the experiment around 5:30am on Alamagordo Air Base, 120 miles north of Albuquerque, New Mexico. First, there was a brilliant burst of light, soon followed by tremendous blast of the explosion, followed again by a powerful heat wave. Then, the now-familiar mushroom cloud soared nearly eight miles into the sky. Just twenty seconds after detonation, the mushroom cloud was clearly visible far above the town of San Antonio and all over the desert. It was a grand success in scientific and military terms. A line, from the sacred Hindu text, crossed physicist Oppenheimer's mind: “I am Death, the Shatterer of the Worlds”. This was the dawn of atomic age.

Hiroshima was the first victim on August 6, 1945 at 7.30hrs. One hour twenty minutes later, Hiroshima was in ruins, shrouded in a dust cloud that climbed six miles into the stratosphere. The bomb was called “Little Boy”. If what happened was devastating, then Japan was in for a real fight when “Fat Man” destroyed Nagasaki three days later. Japan officially surrendered the next day, and it signaled the beginning of the end of the Second World War.

Physics thus helped bring end to a war that had lasted from 1939 to 1945, claiming the lives of 50 million people, of which 30 million were civilians.

CHAPTER 5 SUMMARY

5.0 Other Roles of Physics in National Development

Physics has played a gender friendly role in societies where women were relegated to the background and given only menial jobs. Thus opening new career windows for women. There is the story of an astronomer, Edward Charles Pickering whose assistant made a careless mistake. So, he burst out angrily: “Damn it, my cook can do a better job than that”. He eventually did hire his female cook, Wilhelmina Flemming, who surprisingly did a “better job”, even though she had no degree. Since then, astronomy has remained one of the female **gender preferences** for science occupation.

Physics has contributed in the **energy** sector, in discovery of cleaner, safer and more efficient sources of energy. Today, solar energy is common, thanks to research work in Physics. Solar energy is just one of the energy types generated. There are a million and one others ranging from heat to wind, hydroelectric to nuclear energy, which can all be used to generate power.

As energy is being generated, Physics also keeps track of the processes of waste disposal to ensure that they are clean and safe. Ozone depletion and green house effects have major sources of worry for physicists. **Environment** protection has led to technologies in waste recycling, whose products can be re-used in industries for production of a wide variety of goods.

In improving access to clean potable **water**, chemical and hydrological measurements can be obtained to tell which water is clean, and also locate where water can be found under the earth surface.

Physicists have contributed individually and collectively to the **politics** of their nations. Arthur Compton was directly involved in politics in the United States of America, drawing courage from his popularity as Chancellor of Washington University and support from the American Federation of Scientists. “It is a fact well established in history that ideas always had a great influence on the course of history and also on politicians”, *(Wolfang Pauli: Letter to Bohr)*

Physics has also contributed to **other fields of science**. In Chemistry, the study of the structure of crystals is possible, thanks to Wilhelm Roentgen's discovery of x-rays. Mathematics, Biology, Geology, Computer Science have all been contributed to, as well as contributed to Physics.

Banking angle, the angle an object can bend, finds application in trains and airplanes. Very early on in history, maps were drawn and compasses were built for sailors. More efficient fuels for cars, ships, trains and planes are being discovered daily. **Transport** has therefore been a benefactor of the power of Physics.

The list is endless. Physics, the bedrock of the sciences, has contributed to the emergence of the best of newest technologies.

5.1 Challenges and Problems of Physics in the Process of National Development

The huge technological development of the last century has, of course, come with a price tag. In particular, our use of the earth's finite resources triggered by the insatiable demands of the world's increasing population has escalated. Managing these resources without depleting them a concept called sustainable development is one of the most urgent challenges we face today.

In the past, and even now, astronomers have to sit up for long hours, sometimes for days and nights to observe the cosmos. This greatly affects their **health**. Some physicists are also exposed to radiation, which can cause cancerous tumors that may kill in days. They are also exposed to the risk of losing their lives or permanent disability in performance of some dangerous experiments. Many have lived to tell the story (receiving only electric shocks) while some can only leave their glory for the person who would continue their research. Galileo Galilei lost his eyes in such circumstances, and still did not relent in his efforts in Physics.

Religion has also played a limiting role to Physics. As early as the 16th century, Polish astronomer, Nicolas Copernicus found out from data he collected that the earth is spherical, opposed to the flat earth. He also said the sun was the centre of the universe and not the earth. The powerful *Vatican* refused his ideas because of "biblical teachings". Copernicus was never given a right to fair hearing but was executed. Another astronomer, Tycho Brahe also found the same result but for fear of *The Church*, he devised a system called the Tychonian System, which was acceptable. Later, Galileo Galilei still found the same results to be true, but was asked to rescind his claim, which he did to save his life. Many scientists died in this way, and religion has set scientific progress decades behind time. Today, the sun is accepted as the centre of the universe, which has a spherical earth, and Pope John Paul II of blessed memory did apologize to Copernicus over three centuries after the same Vatican rejected his clams.

Religion also affects the convictions of Physicists not to undergo certain experiments. Compton was suspended from church, and Millikan could not do a research because "the universe is God's handwork and scientists were merely to do God's work" and not go against God.

Funding has been a major source of concern for scientists. Non-scientists usually expect quick results and high profits for their investments in research. In a country like ours (Nigeria) where physics-based industries are absent, and where people are shackled by poverty, physicists face enormous challenges to access resources they need, and to convince government, businesses

and the public that investment in Physics is beneficial and will lead to economic development and an enhanced quality of life.

Misinformation about a particular product may cause it to be useless or may even cause harm. During the Green Revolution in Asia, there were pest attacks, which were caused by the misuse of the rice species. Misinformation may also cause rejection of products, leading to loss on the part of the physicist.

5.2 Recommendations

Let's take some lessons from our African brothers. The level of Physics ranges from near world class in South Africa to almost non-existent in Somalia. This reflects clearly in the economy of these countries. Only two African countries have produced Nobel Laureates in Science South Africa and Egypt. And these two countries stand taller than others in Physics research, ranking 37th and 51st respectively in world rankings. They are also the two most developed African countries.

So if we are to be serious about encouraging sustainable development, we will have to boost our scientific capacity throughout the country. The focus should not be on technology transfer.

While several Asian and Latin American countries have begun to rectify their investments in science, Nigeria must invest in talented young physicists to ensure that they achieve their potentials. China today is reaping economic boom as the rewards of a massive effort in the 1980s and 1990s to educate young Chinese students at overseas universities.

Nigeria must therefore create research institutions that reward excellence, so that young scientists can see a future in their own nation. It is also particularly important to create few world-class centres of excellence in different parts of Nigeria. Scientific talent and know-how can then be maximized by forming a network of such centres. This will foster cooperation between physicists and scientists in general.

While doing this, it is true that resources are limited, especially as population and energy needs increase. Nigeria can also engage some of the most industrialized nations for technical assistance. With this, the sky is the limit for national development of Nigeria.

CONCLUSION

From antiquity to date, improved quality of life has been the desires of man. Physics has been in the forefront of this campaign. In doing research, Physics has discovered many blaze-trailing law discoveries that have led to inventions that improved the quality of life. For Nigeria to benefit from this science, called Physics, it must invest financially and encourage young physicists to showcase their talent and achieve full potential. If this can be done, Nigeria will meet the United Nations Millennium Goals and will be reckoned with as a world authority. Physics, then, would be said to have played its role in national development of Nigeria. Better late than never!

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