

# COMPUTER ENGINEERING AND ITS SPECIALTIES: HELPING TO DRIVE TECHNOLOGICAL DEVELOPMENT IN NIGERIA

**Author:** Lawal Oluwaseun Bernald

## ABSTRACT

Computer engineering is the outcome of the merger between two very distinct field of study—electrical/electronic engineering and computer science—and not all about fixing of computer or laptop issues—as some assume. The major aim of computer engineering is solving of specific problems through the knowledge and training derived from its two foundational backgrounds. Though it might not be as old as other engineering disciplines but its impact in technological advancement in this modern age has been tremendous. Over the years, quite a number of specialties has emerged from computer engineering which has had, and still having, great impact on technological advancement around the world. Professionals in some of these specialties has been the brain behind many of the technology hubs and startups we have in Nigeria that are training young people on how to develop solutions to problems using technological approach. Students offering this course in higher institutions across the nation also get trained in one or two of the specialties which help them develop technological approach to solving problems. So, this paper aims to look at how computer engineering and its specialties are helping to drive technological development in a developing country like Nigeria.

## Keywords:

Computer Engineering, Computer Engineering Specialties, Computer Hardware Engineer, Computer Software Engineer, Technological Development, Tech Hubs, Tech Startups

## INTRODUCTION

Subjectively, the computer has been man's greatest invention till date because its application cuts across almost—if not—all the field of endeavor one can think of. The invention of the computer has helped man in no small ways to do things he doesn't have the capability to ordinarily do. For instance, the computer can perform tons of calculations and execute myriads of tasks and instructions at an amazingly fast rate than any human could ever do, also the computer can retain voluminous data for as long as one needs it. In this modern era, the computer has become indispensable and its various applications has been pivotal to the many great advancements we have had in science and technology, telecommunication, industrialization, medicine and surgery, space exploration etc. Because of the immense contribution of computer applications to the advancement of many areas of human endeavor, quite a number of fields of interests has emerged over time to further study and fashion out innovative ways in which computer-oriented technology and applications can better our lives. Some of these fields of interests are Computer Science, Computer Engineering, Information Technology, and Information Communication Technology amongst others.

One particular field of interest I will mainly focus on in this paper is Computer Engineering (and its specialties) and how it has been helping to drive technological development in Nigeria. On hearing computer engineering for the first time, what comes to the mind of the average person out there is that anyone who is studying, has studied or is a professional in computer engineering only fixes computer hardware or software problems i.e., he or she is a computer technician. But no, this is not what computer engineering entails; in fact, this field encompasses a whole lot beyond computer or laptop repairs. So, then what is computer engineering?

Computer engineering blends together electrical/electronic engineering and computer science to further advancements in digital technology, computer networking, computer systems, and to design and develop technological devices that solve specific problems. Basically, computer engineering was birthed through the integration of two distinct and very relevant fields—Electrical/Electronic Engineering and Computer Science. Computer engineering, as a field in



seamlessly and developing ways to make computers and computer-enabled devices faster, smaller, and more capable.

- Computer engineers are improving the ability of computers to “see” and “think”. The “see” and “think” in this context will be explained a bit under the specialties of computer engineering.
- Computer engineers are the brains behind the computerization of engineering processes in industries.
- Computer engineers write software and firmware for embedded microcontrollers.
- Also, computer engineers write programs that run computers and computerized devices and equipment using languages such as C, Assembly, C#, Java, or C++.

Talking about the aspects, computer engineering has two major aspects: hardware and software. This means there are computer hardware engineers and also computer software engineers. The software aspect is further divided into two—application software and system software. Some of the most prominent pioneers in computer hardware include: Blaise Pascal (inventor of the mechanical calculator), Charles Babbage (inventor of the Analytical Engine), J. Presper Eckert & John Mauchly (builders of ENIAC, then later UNIVAC—the first computer to be sold commercially), Seymour Cray (the “Father of Supercomputing”), Steve Wozniak (designer of Apple I & II personal computers and co-founder, along with Steve Jobs, of Apple Computer), Adam Osborne (builder of the first portable computer, the *Osborne 1*) etc. Some of the pioneer innovators in computer software include: Alan Turing (who made huge contributions to computer science, and this includes inventing the Enigma code-breaking machine that broke the German ciphers during World War II and doing much pioneering work in artificial intelligence and neural networks), George Boole (who formalized binary (“Boolean”) algebra), John Backus (leader of the team that invented FORTRAN (FORmula TRANslation), the first high-level programming language), Dennis Ritchie & Ken Thompson (developers of the UNIX operating system and also C programming language), Bill Gates (founder of Microsoft Corporation), Vint Cerf & Bob Kahn (regarded as “Fathers of the Internet”, they are the inventors of Transfer Control Protocol and Internet Protocol (TCP/IP) etc. Now from these two main aspects—that is, hardware and software—there are quite a number of specialties or specializations computer engineers can choose to major on.



Though computer engineers are trained to use the techniques and principles of electrical/electronic engineering and computer science to solve problems, but some computer engineers major in one specialty or the other i.e. some focus on the specializations in the hardware aspect and some on the specializations in the software aspect; this doesn't mean that there are not some who strike a balance between the hardware and software aspect. Now, let us take a look at some of the specialties in computer engineering.

### **SOME OF THE SPECIALTIES IN COMPUTER ENGINEERING**

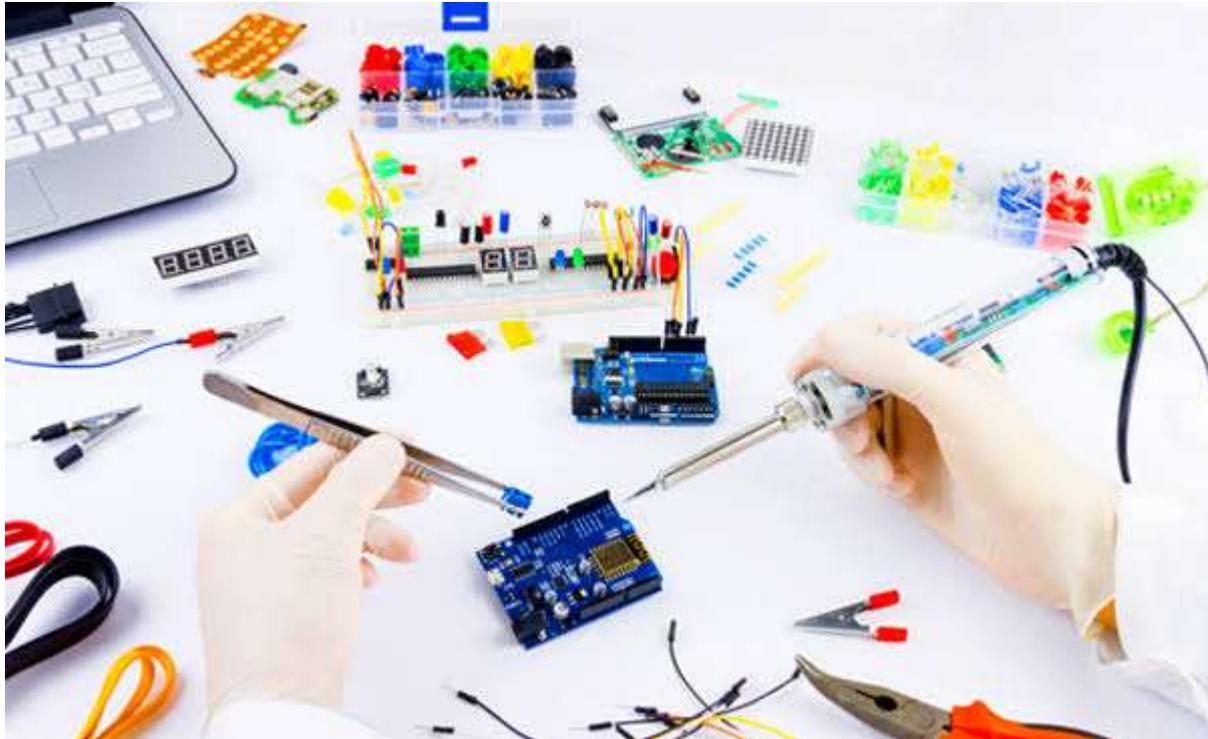
- **Communication and wireless networks:** Computer engineers in this specialty work on the advancement of telecommunication systems and networks (especially wireless networks).
- **Distributed computing, mobile computing and computer networks:** Computer engineers in this specialty design and build integrated environments for computing, communication and information access.
- **Cryptography and Information protection:** Computer engineers in this specialty design and develop new methods for protecting various information from any form of malicious intrusion of privacy by hackers.
- **Compilers and Operating Systems:** Computer engineers in this specialty focus on designing and developing compilers and operating systems (like Windows and Linux for computers and Android and IOS for smartphones). A compiler is a computer program

which transforms source code (human-readable instructions in a programming language) to object code (an output of the instructions entered).

- **Computer Architecture, Parallel computing and Dependability:** In this specialty, computer engineers work on research projects that allow for reliable, secure and high-performance computer systems and also develop algorithms and some other tools that add functionality to computer systems.
- **Computer vision and Robotics:** In this specialty, computer engineers make computer-enabled, electronic devices to “see”, “think”, and “act”. In other words, computer engineers in this specialty focus on developing *visual sensing technology* to help computer-enabled, electronic devices sense an environment, obtain the representation of an environment, and carry out manipulation of such an environment—which are the fundamentals upon which a robot operate.
- **Artificial Intelligence (AI) and Machine Learning (ML):** Computer engineers in this specialty focus on the design and development of computer systems that are able to perform tasks which normally require human intelligence such as decision-making, speech recognition, visual perception, outcome prediction and translation between languages. Also, they design and develop machines which are able to learn and act intelligently. The concept of AI and ML has been used and is continued been used in cars, smartphones, ATMs, Smart homes etc.
- **Embedded Systems:** An embedded system is nothing but a computer system which is designed to perform many operations such as to access the data, process the data, store the data and also control the data in electronics-based systems. Computer engineers in this specialty focus on the combination of computer hardware and software—either fixed in capability or programmable—to perform a specific function or functions within a larger system. There are a number of types of embedded systems, such as stand-alone systems that don't require a host - an example of this is video game consoles. Real-time embedded systems, which runs specific tasks in specific time frames. Network-embedded systems, which are connected to a network. Then mobile embedded systems, which can be found in portable devices, as the name suggests. Embedded systems can be found in laptops, microwaves, washing machines, TVs, DVD players, routers etc.
- **Internet of Things (IoT):** In simple terms, IoT are devices and things that are connected to the internet. These devices and things include smart watches, smart glasses, health indicators, home automation, autonomous vehicles, connected ‘smart’ cities among

others. Computer engineers are part of the professionals needed to make IoT viable for the present and for the future.

- Designing VLSI chips, analog sensors, and mixed signal circuit boards.



In 1971, the first computer engineering degree program was established at Case Western Reserve University in Cleveland, Ohio. Due to its increasing relevance, computer engineering is now becoming a choice engineering discipline in many universities worldwide. It was not until few years ago that the degree program started been offered in Nigeria. Only nine Federal, eight State and eight Private universities and some Polytechnics in Nigeria offer the degree program. At the Federal University of Technology Akure (FUTA), the degree program came into inception in 2015. Students pursuing a computer engineering degree are exposed to the basic knowledge—as well as some hands-on—about how computer hardware, software, embedded systems, and networking work and how these systems all integrate to solve problems in today’s technology-driven world. The full breadth of knowledge needed to become a professional in computer engineering is beyond the scope of undergraduate degree hence the need for master’s degree program (to choose an area of in-depth study and specialization) and professional training in some specialized institutes. Now the big question... how is computer engineering and its specialties helping to drive technological development in Nigeria?

## HOW COMPUTER ENGINEERING AND ITS SPECIALTIES ARE DRIVING TECHNOLOGICAL DEVELOPMENT IN NIGERIA



One of the major aims of computer engineering is creating a broad way to design and develop more comprehensive solutions to solve problems using computer-oriented technology and innovation. In Nigeria, computer engineers are helping to develop solutions to some of Nigeria's technological challenges in the software and hardware aspect. For the software aspect, majority of the job is tied to developing, implementing, and maintaining software that address specific problems. The engineers developing these software solutions are known as **computer software engineers** and here are some of the areas they major in:

- Computer networking: Building networks, both WAN (Wide Area Network) and LAN (Local Area Network) and may also work in mobile and wireless technology, telephony communications, and integrated services.

- Computer software development: Developing, testing, and debugging programs and applications that run on computers, servers, and mobile devices (smartphones). Usually the main programming languages used are C, C++, Java, JavaScript, Swift etc.
- Computer graphics and visualization: Computer graphics technology is used here in creation of synthetic 3D and 2D environments and user interfaces, image processing, visual representations and design, data visualization etc.
- Computer and network security: Providing enhanced security for computing and cyber systems, wired/wireless systems, networks, and applications.
- Machine learning: Though relatively new in Nigeria, machine learning engineers typically focus on giving computers the ability to process information on their own rather than being specifically programmed to do so, and also creating entirely new ways of using data and technology.
- Artificial Intelligence (AI): Also, a relatively new tech field in Nigeria as well, but with great prospects for further development and adoption. Computer engineers in this specialty are making use of AI technology in analyzing and executing complex task that would normally take much time and effort for any person to do.
- Internet of Things (IoT): Yet another new tech field in Nigeria with prospects for further development as well, in here computer software engineers—in working partnership with other IT professionals—focus on the implementation of Internet of Things.
- Interface design or user interface engineering: Design of software interfaces for devices, such as computers, mobile devices, home appliances, and other electronics, in which the user find easy to use or pleurably interact with.



For **computer hardware engineers**, they mainly identify problems in computer hardware and computer-enabled devices, develop/test possible solutions, and also explore the best way to implement these solutions. Some of their duties include:

- Working on/with computer systems and components. These computer hardware engineers focus on fixing hardware issues with computers, computer-enabled technological devices and also their components.
- Designing and building circuit boards, routers, robots, and other embedded devices. Here computer hardware engineers work on designing and building digital circuit boards, routers, robots, and various devices for embedded systems.
- Testing models of computer hardware. These computer hardware engineers majorly work on testing various models of computer hardware and other peripherals to know which ones are best suited to execute particular functions.
- Maintaining and updating existing computer equipment. Computer hardware engineers here have the major task of maintaining and updating existing computer equipment.
- Working with computer software engineers. Just as their duty here specify, computer hardware engineers partner with computer software engineers in designing and developing seamless hardware-software integration for computers and computer-enabled devices.



Computer engineering professionals in these highlighted software and hardware aspects and more have all together been driving technological development in Nigeria by designing, developing, and implementing high-value tech solutions for Nigerian:

- Government agencies & parastatals
- Firms (e.g. telecommunication firms)
- Financial institutions (e.g. banks, insurance companies)
- Industries
- Research institutes
- Non-Governmental Organizations (NGOs)
- Enterprises
- Tertiary institutions etc.

The significant roles of computer hardware and software engineers in these aforementioned places and more is helping to ensure that computer-oriented technological solutions or approaches are been deployed to address various technological challenges that arise due to the need for 21<sup>st</sup> century technological development. For instance, computer engineers (mostly computer software engineers) working with government agencies and parastatals have the major task of building and maintaining computer software applications, web portals, secure web servers, and ensuring that the services of these agencies and parastatals are digitalized. In another instance, computer engineers (also mostly computer software engineers) working with financial institutions (such as banks) are tasked with developing and maintaining highly secure networks and servers, building applications (for both computers and mobile), and overall helping these financial institutions deliver cutting-edge services using computer-oriented technology.

Then in another instance, computer engineers (both hardware and software) working with telecommunication firms are tasked with duties as such maintaining computers and other peripherals used in telecommunication networks, building and updating software that will enhance network service delivery, ensuring that cyber networks and systems are secure etc. In yet another instance, computer engineers working with industries and research institutes across Nigeria through their use of software development, artificial intelligence (AI), embedded systems etc. to meet some specific technological goals of these various industries and research institutes, are helping to drive technological development in Nigeria. With these instances and more, it can be said that professionals in computer engineering and some of its specialties are helping to drive technological development in Nigeria.

Also, in Nigeria's tech ecosystem or *techosystem*, there has been quite a number of technology hubs and startups within the country in the last five to ten years that employ the services of computer engineers versed in one specialty or the other. These tech hubs can be anything from incubators, co-working spaces, innovation hubs, makerspaces, and accelerators amongst others. The rise of technology hub centers such as the Co-Creation Hub (CcHub) Yaba, (Lagos)—described as “Africa's Silicon Valley, ByteHub Embedded (Lagos), WenovationHub (Lagos, Oyo), Enspire Hub (Abuja), Innovation Growth Hub (Anambra, Abia), StoneBricks Hub (Abuja), Blub Hub (Kano), LPI Innovation Hub (Oyo), RAIN (Robotics and Artificial Intelligence Nigeria) (Ibadan), Akure Tech Hub (Ondo), Cloud10 Tech Hub (Kaduna), Creative Hub (Rivers), ROAR Nigeria Hub (UNN), Alpha HUB (Kaduna), Vibranium Valley (Lagos) and many others are in no small ways progressively driving technological revolution in Nigeria.

These more than 70 and growing tech hubs are helping to build up teams of tech-savvy youths that can innovatively solve problems and drive technological, economic and social change in Nigeria using the concept of embedded systems, Internet of Things (IoT), artificial intelligence, robotics, machine learning, software development—which are specialties in computer engineering—and other tech concepts. Furthermore, these tech hubs have aided a lot of tech startups within the last seven years in Nigeria. Some innovative solutions in financial tech (*fintech*), education tech (*edutech*), health tech (*healthtech*), agricultural tech (*agritech*), digital security etc. have been the hallmark of these tech startups. Examples of these tech startups are Kobo360, Medsaf, Flutterwave, Prunedge, Thrive Agric, Beat Drone, and Paystack (though now bought by *Stripe*) among others. These tech hubs (that I have talked about) and startups has contributed so much to the technological development of Nigeria and has attracted global tech titans like Microsoft, Google, IBM, and Facebook to further boost the country's *techosystem* by organizing various tech bootcamps and providing seed funds to aid more startups.

In addition, tech companies like Zinox Computers—the first indigenous Nigerian and African computer manufacturer—employs the services of professionals in different specialties of computer engineering for its successful production continuity of PCs. This also goes to show that computer engineering and its specialties has been playing a huge role in advancing technological development in Nigeria.

Higher institutions that offer computer engineering degree program in Nigeria are also not left out in using technological approach in problem-solving. This is in the sense that students offering the course are taken through practical sessions using microcontrollers (such as Arduino board, Raspberry Pi etc.), connected electronic peripherals and suitable programming languages (C, C++) to carry out small to medium scale projects like auto-intensity control of street lights, digital temperature sensor, electronic notice and advert boards, building of simple drones and robots etc. In addition, students learn how to build simple database, web, and computer applications using the concept of object-oriented programming (OOP) languages like C# and C++.

Another area computer engineers—in partnership with computer scientists—will help drive Nigeria's technological development is in the realization of digital economy in Nigeria. Digital economy, for those who have no idea about it, focuses on digital technologies—which is based on digital and computing technologies—and covers economic, business, social, and cultural activities that is backed up by the web and other digital technologies. According to a don, Prof. Francisca N. Ogwueleka of the Department of Computer Science and Cybersecurity, Nigerian Defence Academy (NDA), the backbone of digital economy is hyper connectivity which translate into growing interconnectedness of people, organizations, and also machines that arise from the Internet, mobile technology, and Internet of Things (IoT). She further went on to identify the three major components of digital economy to be the e-business, e-business infrastructure, and e-commerce, then adding that these components are made attainable by the computer engineers and the computer scientists.

## CONCLUSION

Nigeria is a developing country that requires multifaceted technological development, which will in turn contribute to economic growth and development. In a world driven by technology and innovation, computer engineering and some of its specialties are helping to ensure that technological development in Nigeria is not on a decline but gaining momentum. Professionals in specialties such as artificial intelligence (AI), embedded systems, software development, machine learning, Internet of things (IoT), computer graphics and visualization, robotics, computer networking, user interface engineering among others, have in one way or the other been helping to drive technological development in Nigeria through the technological solutions these specialties have to offer. In many sectors of the economy, tech hubs, startups, companies, various higher institutions and research institutes many applications of computer engineering specialties are been used to solve specific problems.

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