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MICROELECTRONICS AND EMBEDDED SYSTEMS DESIGN AND DEVELOPMENT: TOOLS FOR ACHIEVING NIGERIA'S VISION:20:2020

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ABSTRACT
This paper presents development and diffusion of microelectronics and embedded systems technologies in Nigeria as key tools for achieving Nigeria's Vision20:2020. The Vision20:2020 objectives and necessary developmental steps (Investments in technology driven Agriculture and Hi-tech manufacturing industries to boost the Nation's GDP and GNI) identified as vital to its achievement are discussed. Researchers have observed that appropriate diffusion of microelectronics and embedded systems technologies enhance economic activities and transitions developing economies from consuming to creating. They drive all key sectors of the 21century, hence the paper argues that they will provide Nigeria with the necessary growth engine needed to produce an accelerated economic growth. A road map to facilitate development and diffusion of these technologies in Nigeria was clearly articulated. With appropriate Government policies, support from all stake holders and the will to stick to the implementation plans, in place, sustenance of achieved development and economic growth will be guaranteed.

KEYWORDS: Embedded Systems, Microelectronics, Nigeria, Road map, Technology, Vision20:2020

INTRODUCTION

Nigeria often referred to as the Giant of Africa has not been able to show dominance in many of the metrics (GDP, GNI, Standard of living of her citizens, etc) used in comparing nations. (NairaBrain 2009, USAID 2010, NigeriaWorld 2010, Segun 2010, Nigeria-Planet , 2011). Nigeria has continued to lag behind among the committee of nations despite her abundant natural and human resources due to the inability of her government and people to identify and summon the will to invest massively in key areas that will make the most impact on her economy. The prevalence of corruption coupled with the lack of adequate commitment and dedication as well as unwillingness of Nigerians to make sacrifices has made things worse.

Several governments in Nigeria have come up with different policies and plans aimed at achieving certain set goals which were clearly defined (NPC 2011, NigerianWiki, 2008, Ogugua 1994, NigeriaWorld 2010). These policies and plans have not yielded the expected results due to weak implementation and lack of political will to see the development strategy through to the end (NPC 2011). This is evident considering the development and efficiency level of public infrastructures and systems in Nigeria. These have resulted in poverty, hunger, fallen standards in education and living, etc. These issues must be tackled from selected front lines where the most efficient result will be obtained.

At the end of the 2008 Nigeria Economic Summit, a vision termed NIGERIA VISION 20:2020 was identified to put the nation among the top 20 economies in the world by the year 2020 (SciCon 2011, NPC 2011). Progressive achievement of this vision is the focus of all development programmes embarked upon by the nation's governments and people, since then. Key areas identified as front-liners in achieving the vision must be vigorously pursued so as to avoid a repetition of history where the goals and objectives of the vision will not be realized by the end of the projected period.

It has been generally agreed by many stakeholders that investing in developing the Nation's technological education is a major key to achieving economic growth and development (Jorgenson and Motohashi 2005, Rukmani 2008, Mokyr 1992, Allafrica 2009, Onyenekenwa 2011, Accessmylibrary 2008). Countries that must lead other countries in economy, GDP, GNI, developed infrastructures, etc, must first lead in the development and the sustenance of their technology. This paper aims to clearly articulate the path Nigeria needs to take in developing and diffusing microelectronics and embedded systems technologies and how to use them as tools to accelerate the economy so as to position Nigeira among the top twenty nations of the world in no distant time.

MATERIAL AND METHOD

This is a literature based conceptual paper. The authors reviewed literature on Nigeria's Vision 2020 and how microelectronics and embeded systems can be developed and diffused in Nigeria with a focus on releasing their potential to provide the needed growth engine to drive Nigeria's economy to achieve vision 2020. A plan or road map was developed to facilitate development and diffusion of these technologies in Nigeria stating clearly the

numerous advantages that should serve as a stimulant to policy makers to both adopt and implement the plan.

OBJECTIVES OF THE NIGERIA'S VISION 20:2020

The two broad objectives are to make efficient use of human and natural resources to achieve rapid economic growth as well as to translate the economic growth into equitable social development for all citizens. The development aspirations cut across four dimensions: Social (building a peaceful, equitable, harmonious and just society), Economic (developing a globally competitive economy), Institutional (having a stable and functional democracy) and Environmental (achieving a sustainable management of the nation's natural resources).

Necessary Actions to be Taken to Achieve the Vision

Nigeria needs to urgently address the most serious constraints to her growth and competitiveness, aggressively pursue a structural transformation of the economy from a mono-product to a diversified and industrialized economy and invest in human capital to transform Nigerians into active agents for growth and national development.

Picture of the Desired Economy by 2020

Manufacturing and services are expected to dominate the structure of national output, while gross national investment is expected to increase, and the infrastructure base of production is expected to improve considerably. Income per capita should have risen to $US4,000 from the estimate of US$1,230 in the year 2008 (NPC 2011).The growth strategy requires divestment from dependence on oil as an engine of growth, transformation of the structure of exports from primary to processed/manufactured goods and the attainment of high levels of efficiency in production. Thus, NV20:2020 will effectively link industrial activities with the primary sector, domestic with foreign trade, and the services sub-sector to all other productive activities.

How Possible is Achieving the Vision?

Nigeria must grow at least 9.5% annually within the next eleven years, 2011 included. It was ranked 44th ($174b, 2009) and chasing Belgium which was 20th ($471b, 2009), according to International Monetary Fund (IMF) (Admin 2011). Making that jump will require a compounded interest of 298% by 2020 which will translate to 171% percentage growth in the GDP. This analysis assumes that the GDP of the 20th economy will remain constant in 2020. For a nation that has averaged about 5.5% in growth, in the last seven years, it does mean that it needs a new growth engine.

We believe that developing our microelectronics and embedded systems technologies will provide us with this new growth engine because they will provide indigenous technological solutions to our indigenous problems. They enable you to design, develop and manufacture innovative components, products and services at reduced cost while maximizing functionality which will enhance Nigeria's capacity towards becoming a creating economy.

What are Microelectronics and Embedded Systems?

Microelectronics describes a group of technologies that integrate multiple devices into a small physical area. Several components are available in microelectronic scale such as transistors, capacitors, resistors, diodes, insulators and conductors. Microelectronics can be divided to its subfields namely: micro electromechanical systems (MEMS), nanoelectronics, optoelectronics and single electron devices (SED). Integrated circuits and microchips are typical microelectronic devices, which can be found in computers, mobile phones, medical devices, process control equipments, technology based agricultural and manufacturing tools and equipments, automobiles, etc.

Embedded systems are small, fast, and very powerful tools, gadgets and equipments which have become part of our everyday life. An embedded system is a micro-processor based system that is built to control a function or range of functions (Heath 2003). They form a part of a larger system or product, part of anything: mobile phones, medical devices, agricultural farming tools and equipment, manufacturing equipment, etc. They are a combination of hardware and software, and perhaps additional mechanical or other parts, designed to perform a dedicated function (Netrino 2011). Although the user can make choices concerning the functionality, he cannot change the functionality of the system by adding or replacing software as is possible with the PC. An embedded system is designed to perform one or a few dedicated and/or specific functions but with choices and different options (Heath 2003, Michael 2007).

Why We Need to Develop Microelectronics and Embedded Systems Technologies

Microelectronics and Embedded Systems technologies play major roles in our modern day history because they continue to shape global commerce and industry. They drive medicine, energy, agriculture, entertainment and all key industrial areas of the 21century. Researchers have observed that appropriate diffusion of nanotechnology, microelectronics and embedded systems technologies enhances economic activities and helps to transition developing economies from consuming to creating (Ekekwe 2010, Brishti 2000, Norman 1980, Electronics Weekly 2009).

Today, more microprocessors around the globe are being manufactured using microelectronics technologies. A large percentage of these microprocessors are used in embedded systems rather than in PCs. Those already large numbers are increasing at a phenomenal rate as the devices that surround us become smarter and smaller. This is a consequence of our insatiable drive towards having control over devices and access to data anywhere, anytime.

General-purpose computers, like PCs, would be far too costly for the majority of products that incorporate some form of embedded system technology (Christoffer 2006). Also, general-purpose solutions might also fail to meet a number of functional or performance requirements such as constraints in power-consumption, size-limitations, reliability or real-time performance, etc. Microelectronics are presently at the forefront in developing human health solutions as they are presently being used in systems being developed to mimic some vital functions of the human body (Wang et al. 2009).

We cannot conduct our normal modern daily lives, today, without this technology. We all own at least one piece of equipment, which contains a microprocessor, whether it is a phone, a television, an automatic washing machine or an MP3 player. All sectors of the economy

have been influenced by the digital revolution and the industry has experienced tremendous developments in all aspects of engineering disciplines (Bruce 2011).

As Nations drive to become global leaders in technology creation, massive diffusion of microelectronics and embedded systems technologies must necessarily be the anchor for that development. Several initiatives (MOSIS (USA), CMC Microsystems (Canada), Europractice (Europe) and TSMC (Taiwan) have been used by some developed and developing economies, all programs supported by their respective governments towards practical oriented training and learning on microelectronics (The MOSIS Service 2010, CMC Microsystems 2012, Europractice 2012, TSMC 2012, Quintão, et al. 2012). Over the years, these initiatives and several others (Savage 1997, Reynolds 2007) have enabled the different nations to train and develop more relevant practically oriented professionals for the Industries.

ICT is rapidly moving Nigeria towards knowledge-based economic structures and information societies. This remarkable success of ICT in Nigeria and indeed globally since the dawn of the 20th century has been enabled by the phenomenal growth of the microelectronics and embedded systems technologies all over the world. Microelectronics is the engine that drives the information age and without its constant evolution, ICT cannot advance (Courtney 2011). Unfortunately, the microelectronics industry does not have presence in Nigeria despite a hugely expanding ICT sector.

Over the years, many Nigerian Institutions have developed and taught courses on microelectronics. However, lack of institutional capabilities, like excellent facilities, teaching and learning environments have stalled its capacity to offer practical and relevant skills needed by its students and industry to facilitate the diffusion of microelectronics technology from bottom-up approach in the nation. At present, to the best of the author's knowledge, no Sub-Sahara African University or Institution has a world-class microelectronics and embedded systems teaching and training environment. There is the challenge of the lack of adequate funding which has partly affected the abilities to have the right mix of people, processes and tools. This has affected Africa's capacity to develop world-class programs on microelectronics and embedded systems. This is a challenge we must tackle and overcome if we must advance in this age where technology drives development.

The European, American and Asian Governments and Industries take investment in research, innovation and development as vital tools to achieving national development (Kostas 2006, BMBF 2009, Bisht 2001, Microsoft 1999, Peter 2006, David 2009, Mosk 2004, TCS 2007, Quintão, et al. 2012). We cannot ignore the importance of investing in developing and diffusing key technologies like microelectronics and embedded systems which create a platform for others to thrive and hope to enjoy the impact they have on national development.

Road Map to Position Nigeria to Lead in Microelectronics and Embedded Systems Technologies in Africa.

Due to our unflinching belief that developing and diffusing microelectronics and embedded systems technologies in Nigeria will provide us with the new growth engine needed to accelerate and drive development in Nigeria towards achieving Vision20:2020, we have developed a road map to position Nigeria to lead in microelectronics and embedded systems technologies here presented in three phases: Acquisition of necessary personnel, equipment and infrastructure, Human capacity building and lastly, Innovative products and services development through collaboration between established Research Institutes and Centres on microelectronics and embedded systems technologies and the industry. Figure 1 shows the proposed Microelectronics and Embedded Systems Centre and the Collaborations.

Acquisition of Necessary Personnel, Equipment and Infrastructure.

The necessary equipment and Infrastructure has to be acquired first to provide a suitable environment for human capacity building. We propose the setting up of microelectronics and embedded systems research and training Centres in each State of the federation through collaboration between the Federal and State Government as well as relevant Industries. They will be equipped with necessary personnel, facilities, equipment and software for research and training in microelectronics and embedded systems technologies. They will serve as research and training Centres for both Industries and Educational Institutions (Primary, Secondary and Tertiary Institutions) in the area where they are located.

Primary Educational Institutions are included to introduce the pupils early to relevant superficial but fundamental knowledge of these technologies. This will help to get the interest of the pupils in these technologies early. The Centres will also have International collaborations with other microelectronics and embedded systems training Centres in developed countries of the world.

One foundry laboratory for the production of integrated circuits should be established by the Federal Government in collaboration with relevant Industries to provide foundry services (fabrication of ICs and PCB) for the research and training Centres established all over the country and other countries in Africa.

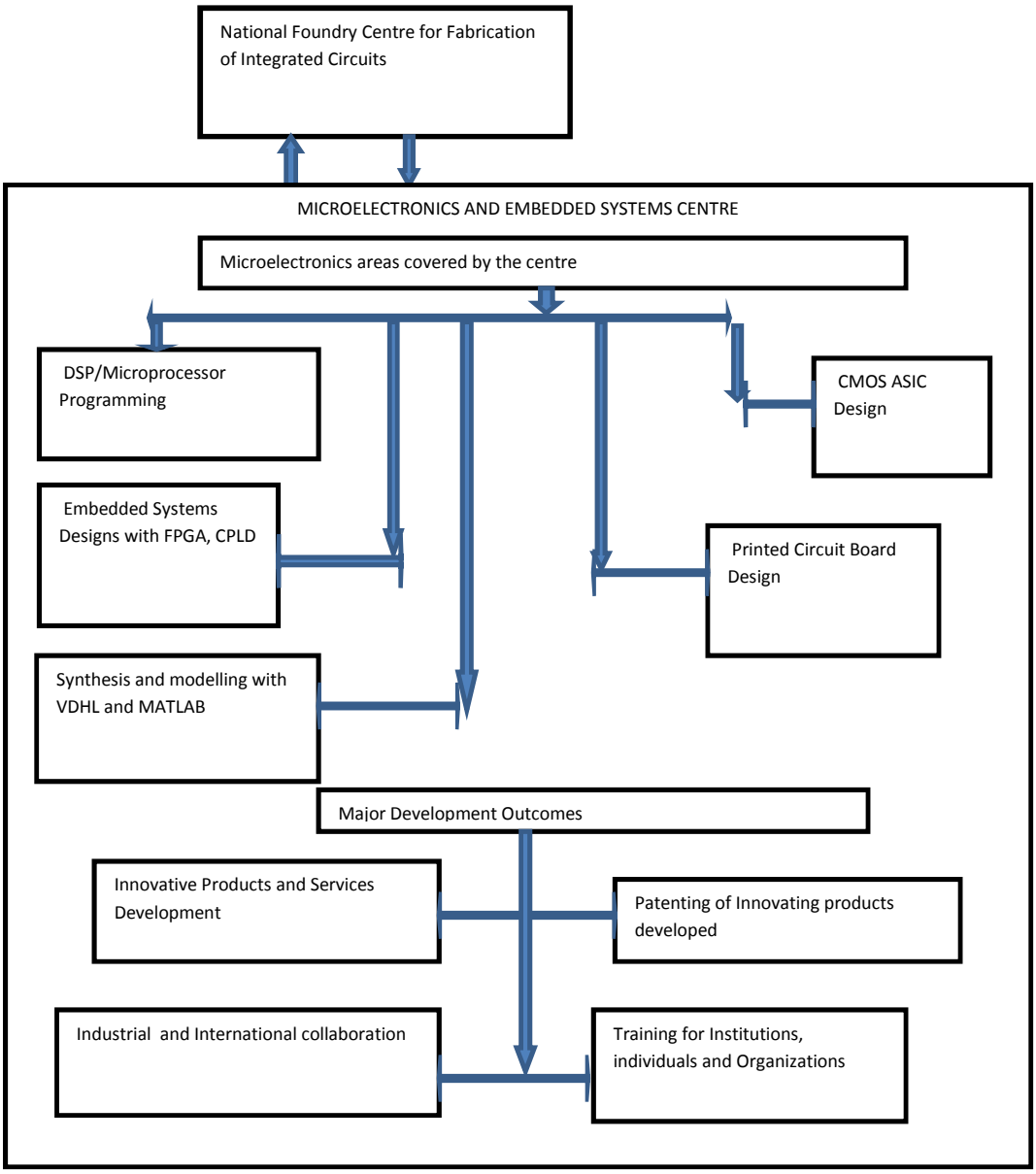

Figure 1. Microelectronics and Embedded Systems Training Centre and the Collaborations

Human Capacity Building

This phase which covers the training section involves all the required training needed to develop a deep core knowledge base in microelectronics and embedded systems technologies in Nigeria. Introductory courses in Microelectronics and Embedded Systems Technologies, FPGA synthesis design, Microprocessor programming, digital signal processing, Advanced Analogue Integrated Circuits, CAD Design of Digital Very Large Scale Integrated (VLSI) systems and Printed Circuit Boards (PCB), etc. will be taught and the necessary practical applications will be carried out.

Professionals employed at the Centres will be directly in charge of the organized training. Some companies that offer professional training services can also be contracted to participate in the training for a determined time interval. Collaborating Educational Institutions and other Public and Private Research Institutes and Organizations can also train their Faculty and staff at the centre at their costs. The training will be hands on (practical biased) blended with the theoretical training so as to ensure technical transfer of the technologies. A special curriculum will also be developed to train Artisans and Technicians on microelectronics and embedded systems technologies. This will help to bridge the technology gap presently being experienced by indigenous Artisans and Technicians due to continuous advancements in the use of microelectronics and embedded systems in several machines, electronic devices, cars, equipment, etc. A good example of this is the difficulty of our road side mechanics to diagnose and repair new model cars. These cars are fitted with microelectronics and embedded systems which aid diagnosis of fault and repairs in them.Trial and error fault diagnosis in these types of cars will be a huge waste of time, effort and resources.

Innovative Products and Services Development

Participants who show outstanding performances after their training will be retained at the Centre to develop innovative products and services. These products and services will be patented and transformed to finished market goods through collaborations with relevant Industries. Collaboration with the Academia will also be facilitated to ensure that innovative research products developed in these Universities are further developed in the Centre and transformed to finished market products through Industrial collaborations.

Hi-tech parks will be set up where those who have been trained in the Centre can proceed to design and develop innovative products. Through appropriate policies the Government will shield these parks from some negative and stifling bureaucracy that hinders speed of operations and production.The Government shall have a clear and pragmatic policy on the development of innovative products and services from research outputs in the Centre and its numerous collaborations as well as their transformation to finished market products. This will facilitate ease of agreement between the Centre, its collaborations and more importantly relevant Industries.

EXPECTED DEVELOPMENT OUTCOMES

The Centre will facilitate:

- Development of several innovative products and services which will contribute to the Nations GDP and GNI after being transformed to finished market goods through Industrial collaborations.
- Patenting of new products and services developed.
- Human capacity building of those directly or indirectly involved with the project.
- Emergence of technology clusters and hubs in Nigeria.
- Stimulation of Industrial growth in Nigeria through establishment of new firms (SMEs) based on microelectronics and embedded systems technologies and marketing of their products and services.
- Publications on developed innovative products and services.
- A base to attract local and foreign grants for projects in the country.
- Industrial and International collaborations in microelectronics and embedded systems technologies.
- Employment opportunities for Nigerians and others who will participate directly or indirectly in the project.

CONCLUSION

The developed economies of the world know the significance of utilizing scientific and technological knowledge in industrial production, and have explicitly put in place institutions and mechanisms for their exploitation. The successes of these countries show the need to focus on ways to exploit scientific and technological knowledge for national development rather than rely solely on resource endowment. This explains the advancement of some natural resources poor countries like Germany that have transformed imported raw materials into high value products and services through the application of science and technology.

Nigeria has lots of advantages such as abundant human capital, natural resource endowment, good climatic conditions, etc. By summoning the will to have and implement policies to develop our indigenous microelectronics and embedded systems technologies, we will see unprecedented growth in our economy because microelectronics and embedded systems form the bedrock of most technologies found today. Most of the tools and equipment used in industrial and manufacturing processes depend on one form of microelectronics and embedded systems technology or another. Engaging in human capacity building through establishment and funding of research and training centers on microelectronics and embedded systems technologies will provide the platform for indigenous solutions in the form of equipment, machines, tools, products, etc. ranging from very simple to complex systems to be developed. The growing needs of our agricultural, manufacturing and other industrial sectors will be met as other technologies will thrive on this platform. This will provide the new growth engine that will enable us achieve Vision 20:2020.

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