

BUILDING INDIGENOUS ENGINEERING CAPACITY
FOR GHANA'S ACCELERATED GROWTH
- Ing. Sir Frederick K. Akwaboah

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**BUILDING INDIGENOUS ENGINEERING CAPACITY
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President 2008/2009

Abstract

Poverty is the greatest obstacle to achieving a higher standard of living for the citizens of any country; therefore the ultimate goal of national development is to improve and enhance the quality of life of people of all nations. Countries which have succeeded in lifting themselves out of poverty in recent times have acknowledged that infrastructure is fundamental to human development. It has also been accepted by these countries that efficient infrastructure delivery is highly dependent on the quality of engineering practitioners available in a country. Ghana and the rest of the developing countries are therefore urged to place great emphasis on building a large stock of skilled engineering capacity to accelerate the growth of their countries if they are to catch up with the developed countries.

1.0 Introduction

It is a matter of concern for humanity that, while a few countries in the world are enjoying unimaginable prosperity, the majority of countries in the world today are facing poverty, hunger, disease, illiteracy and civil strife. While it is widely acknowledged by the developed countries that it is science and engineering that has contributed to their high quality of life, the role of engineering in improving the quality of life is often not well understood by the poor countries, including Ghana. The following statistics reveal the state of poverty in the world to set the tone for the urgent necessity for Ghana and other developing countries to lift themselves out of poverty by adopting scientific and engineering approaches to accelerated development.

The World population as at the mid-2008, according to 2006 UN report, stood at about 6.8 billion that may be divided into the following broad categories:

- (i) More developed Regions: 1.3 billion,
- (ii) Less developed Regions: 5.5 billion,

It has been estimated that by the year 2050 the world population will increase to 9.6 billion. Almost all of this increase will be in the developing countries, principally in the urban centres, since the developed world's population is declining. This trend will certainly pose immense global sustainability challenges.

Based on the World Bank Development Indicators published in July 2006, the 10 richest countries in the world had a per capita GDP (Purchasing Power Parity corrected) ranging from US\$31,530.00 (Belgium) to US\$ 61,610.00 (Luxembourg). The corresponding figures for the 10 poorest countries (nine in Africa) ranged from US\$ 550.00 (Sierra Leone) to US\$

810.00 (Yemen). The world's richest nations enjoy GDP per capita up to 115 times greater than those of the world's poorest countries.

The richest 1% of adults in the world owned 40% of the planet's wealth in the year 2000, and 10% of the world's richest accounted for 85% of the world total. In contrast, the bottom half of world adult population owned barely 1% of global wealth. Just five percent of the world's population consumed 23% of its energy!

Nearly one in four people, 1.3 billion live in abject poverty, subsisting on a daily income of less than US\$1 per day (now US\$1.25); 3 billion - about half of the world's population – have a daily income of less than US\$2 per day; 800 million people in the world suffer from hunger and malnutrition; about 40 million people are HIV positive of which 60% is in Sub-Saharan Africa; 1.6 billion have no access to safe drinking water and 2 billion people have no access to commercial energy.

The above statistics reveal that the countries of the developing world, including Ghana, face enormous challenges to improve the quality of life for their citizens. The importance of the role engineering capacity in achieving this will be examined in this presentation.

2.0 Global Efforts at Poverty Alleviation

The ultimate goal of national development is to improve and enhance the quality of life of people of all nations. Every human being requires some basic needs for survival. Article 25 of the Universal Declaration of Human Rights states that *“everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control”*. The quality and quantity of such facilities and services available in a country is a good measure of the progress of the country and the standard of living of her people.

At the World Summit for Social Development held in Copenhagen in 1995 it was observed that in today's world *“we are witnessing in countries throughout the world the expansion of prosperity for some, unfortunately accompanied by an expansion of unspeakable poverty for others.”*¹⁰ Abject poverty was considered a severe injustice and abuse of human rights. The leaders of the Summit concluded that *“sustainable development is the key to poverty eradication that will ensure a higher standard of life for all people.”*

Concerned about the worrying and unacceptable level of poverty and suffering in the world, in September 2000, the world's leaders comprising 189 countries signed and adopted the Millennium Declaration, committing their nations to stronger global efforts to alleviate poverty, improve health and promote peace, human rights and environmental sustainability. The Millennium Development Goals (MDGs) that emerged from the Declaration are specific, measurable poverty alleviation targets with a timeline of 2015.

3.0 The Topic and Overview of Terminology

To fully understand the topic under consideration it is necessary to understand some terminology which will be encountered during the course of the discussions.

Development

Development generally means finding practical solutions to society's challenges in order to improve people's lifestyles. National development entails the provision of the necessary social and physical facilities or infrastructure towards the realisation of the abilities and talents of each individual for his or her own satisfaction and the enhancement of the good of the community and the nation. Sustainable development is defined as *"development that meets the needs of the present generation without compromising the ability of future generations to meet their own"* (Sharhan 2000:44).

In today's world, physical infrastructure means facilities necessary to enable the nation and all citizens to engage in income generating activities for local consumption and for export. It includes the development of the built environment to provide decent housing, transportation, industries, health facilities, drinking water, energy, communication, educational facilities etc;

Economic Growth, GDP and Development

The Advanced Learners' Dictionary defines an economy as *"the system according to which the money, industry and trade of a country or region are organised"*. It gives a second definition as *"a country's economy is the wealth that it gets from business and industry"*. The Pocket Oxford Dictionary defines economy as *"community's system of wealth creation"*. Wikipedia – the free encyclopaedia defines an economy as *"the realised social system of production, exchange, distribution and consumption of goods and services of a country or other area"*. Whatever the definition, the most important aspect a country's economy is the ability to generate wealth to finance social and physical development of the country. In today's world, the most reliable method of generating wealth is through industrial production of goods and services. The level of production of such goods and services is a good indication of the size of the economy of a country.

Wikipedia defines economic growth as *"the increase in value of goods and services produced by an economy"*. A country's economy needs to grow over a period in order to generate more wealth to sustain development and reduce poverty. According to the World Bank, the rapid reduction in global poverty is in large part due to economic growth. It is also reported that the decline in poverty has been slowest where growth performance has been the worst (i.e. in Africa).

The most widely accepted indicator of the size of the economy of a country is Gross Domestic Product (GDP), which represents the total value of all finished goods and services produced in a country. The GDP per capita is the most frequently used indicator of the standard of living of the citizens of a country. Economic growth is conventionally measured as the percentage increase in GDP during one year. Studies have shown that economic growth, indicated by GDP, is a clear marker of development, and countries that grow usually reduce poverty. (See Fig1).

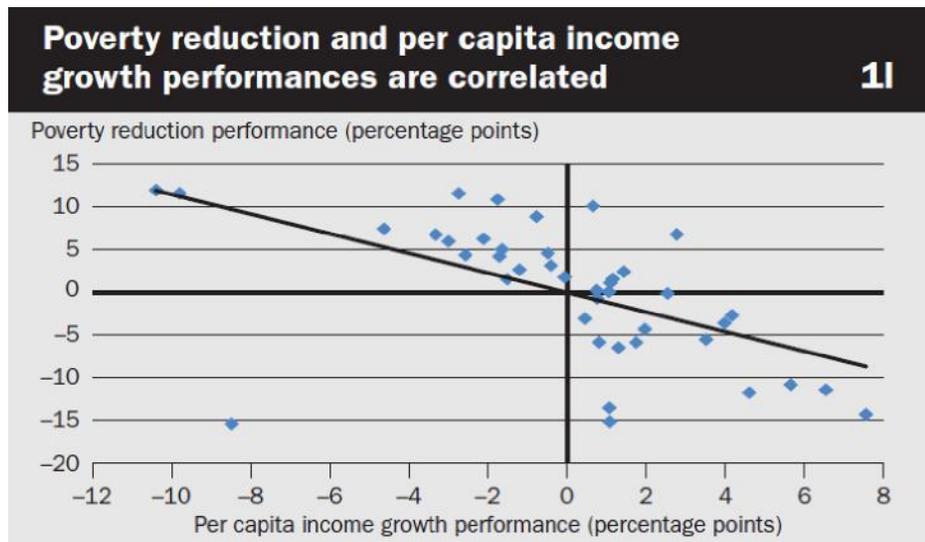


Fig 1: Poverty reduction and per capita income growth performances

Engineering Capacity

Engineering may be defined as the turning of the resources of nature into products and services for the benefit of man using the principles of science, and which is largely based on intellectual understanding that gives the ability to explain facts and experiences, predict new possibilities and solve new problems and on the ability to apply codified knowledge that is often learned by tuition and practice, to solve defined problems and implement known solutions. Engineers are persons in the practice of engineering. They are accordingly responsible for finding practical solutions to society's challenges in order to improve people's lifestyles. In other words, engineers play a pivotal role in promoting the development of any country. Engineers must be both creative and analytical and must exercise leadership to achieve goals. They must have a strong sense of ethics and understanding of society and the environment in which they live.

The UN Development Programme (UNDP) has defined "capacity" as "the ability of individuals, institutions and societies to perform functions, solve problems, and set and achieve objectives in a sustainable manner". The terms "capacity building" or "capacity development" describe the task of developing levels of human and institutional capacity.

Capacity building aims at developing secure, stable, and sustainable structures, systems and organizations, with a particular emphasis on using motivation and inspiration for people to improve their lives.

4.0 The Importance of Accelerated Growth

Countries of the World today are classified according to their level of development, vis:

- Developed or advanced country;
- Newly industrialised country;
- Emerging economy;
- Developing Country.

The term developed country, or advanced country, is used to categorize countries with developed and industrialised economies and with usually a high per capita income of US\$11,456 or more. Developing countries are, in general, countries that haven't reached Western-style standards of democratic government, free market economy, industrialization, social programs, and human rights guarantees for their citizens. Countries with more advanced economies than other developing nations, but which have not yet fully demonstrated the signs of a developed country, are grouped under the term newly industrialised countries. Other developing countries which have maintained sustained economic growth over the years and exhibit good economic potential are termed as emerging economy.

It is the aim of all developing countries to catch up with advanced economies and sustain this growth over time. Countries that adopted this strategy have over the years exhibited accelerated growth and improved standards of living for their citizens by reducing poverty. (See Fig. 1).

For example, it is reported that between 1965 and 1995, Asia was the only major region to achieve significance convergence toward the developed countries' level of GDP per capita. Per capita income in the newly industrialized economies of Asia- Hong Kong (China), the Republic of Korea, Singapore, and Taiwan (China) - increased from 18 percent of the developed countries' average in 1965 to 66 percent in 1995. At the same time Africa, for instance, became even poorer in relative terms. The average per capita income in African countries equalled 14 percent of the developed countries' level in 1965 and just 7 percent in 1995. The average GNP per capita in developed countries was \$24,930 in 1995.

5.0 Strategies for enhancing economic development and growth

Several decades ago, it was considered to use foreign aid, investment in machines, fostering education at primary and secondary levels, controlling population growth and, giving loans and debt relief as conditions necessary to stimulate economic growth of poor countries. Studies have now shown that efforts at stimulating economic growth of developing countries by this method have not succeeded. Instead, in a book entitled "The Elusive Quest for Growth", William Easterly ⁰ concluded that two areas that can likely lead to the desired economic growth in developing countries, and can lead them toward economic self sufficiency are:

- *Utilisation of advanced technologies, and*
- *Education that leads to high skills in technological areas*

Today, it is acknowledged by most countries that the two most important factors necessary for achieving economic growth are:

- Engineering capacity, and
- Physical Infrastructure

Economic Growth and engineering capacity

Studies have shown that the phenomenal economic growth achieved by the Asian countries in recent times is attributed mostly to their concerted efforts to enhance the education of their indigenous engineers and technology graduates. For example, it is reported () that in 1970 South Korea had about 6,000 engineering graduates. In 1980 these were increased to 14,000. By 1990, the figure had jumped to about 80,000, equivalent to about 1,850 per one million of their population at that time. When plotted against South Korea's per capita GNP growth, the number of engineering graduates almost directly parallels the growth of the South Korean economy, offset by a few years. This data appears to show a direct cause and effect – investment in building a well qualified and sufficiently large pool of engineers leads to sustainable economic development.

In the case of India there has been a long-term effort to increase the numbers of engineering graduates and the quality of their education. Whereas in the past, many of these graduates sought employment outside the country, now many are returning and newer graduates are staying to work in India in the software and design industries, often to high-tech cities where well-paying careers and extensive numbers of colleagues await them. The growing number of technically proficient and well-educated specialists also has enabled India to become a prime location for the outsourcing of technical support by the world's leading technology firms.

In China, already a major economic power, the proportion of first science and engineering degrees to all bachelors-equivalent degrees was 59%, as compared to about 33% in the US in 2001 (Source: *Science and Engineering Indicators 2004*, National Science Foundation, National Science Board). The report opens with the statement:

“Excellence in (science and engineering) higher education helps a country to be technologically innovative and economically competitive.”

Economic Growth and Infrastructure

It is incomprehensible to imagine how any country in the world today, especially the developing countries, can achieve and sustain economic growth and therefore provide acceptable living standards for her citizens without effective infrastructure.

Poor infrastructure and inadequate infrastructure services are among the major factors that hinder Africa's development.⁰ Without adequate infrastructure, African countries will not be able to harness the power of science, technology and innovation to meet development objectives and be competitive in international markets. Infrastructure promotes agricultural trade and integration into world markets. It is fundamental to human development, including the delivery of health and education services.

Quality transport infrastructure is critical to supporting internal trade growth and improvement in export performance of a country through international market access. Irrigation is most important for accelerated agricultural growth. All significant scientific and technical efforts require reliable electric power and efficient logistical networks. In the

manufacturing and retail sectors, efficient transportation and logistical networks allow firms to adopt process and organizational innovations, such as the just-in-time approach to supply chain management.

Telecommunications infrastructure has so led to such a revolution in information and communication technology (ICT) in the world today that it will be a disaster to attempt to develop without them. Electronic information systems account for a substantial proportion of production and distribution activities in the secondary and tertiary sectors of the economy of developed countries. Unfortunately, the poor state of Africa's telecommunications infrastructure has hindered the capacity of the region to make use of advances in fields such as geographical information sciences in sustainable development.⁰

Capabilities in engineering determine the ability to provide clean water, good health care, adequate infrastructure, and safe food. Information and communications technologies (ICTs) can help expand primary, secondary, and tertiary education by facilitating distance learning, offering remote access to educational resources, and enabling other solutions.

6.0 Ghana's Development Vision

As reported in the Ghana Country Review Report of July 2007⁰, at the time of independence in 1957 Ghana had good prospects for economic growth and development. However, the economy suffered a decline of more than 30% during the seventies and early eighties. With the implementation of an economic recovery programme, followed by a structural adjustment programme in the eighties the economy began to experience relative stability. From a negative growth rate of about -3.3% during 1979-1983 the GDP growth rates experienced upward trends averaging about 4.5% between 1984 and 2000. However, by the year 2000, as a result of a big drop in world cocoa and gold prices and excessive government spending in the face of pending elections, the country faced serious social and economic challenges characterised by large fiscal deficits, a heavy debt burden, falling currency and high inflation, a combination of which placed severe limitations on the nation's capacity to address the high incidence of poverty. As stated in the report, 49.5% of the total population and 63.9% of the rural population of Ghana remained below the poverty line of US\$ 1.00/day in 2000. Indeed, after forty years of independence, Ghana had been left behind the progress of countries that were about the same level at the time of independence. For example, South Korea, Taiwan, Malaysia, Botswana, Kenya, Mauritius, Seychelles, Jamaica, Tunisia, Morocco, even the desertbound Namibia -- all of which had comparable, sometimes lower, levels of per capita production than Ghana at the beginning 50 years ago -- now have considerably higher levels of per capita income. The brightest stars of contemporary economic development, India and China, were prey to recurrent mass famine at the time when Ghana was reasonably well-fed and liberally provided with social services⁰.

Consequently, in 2001, in order to reduce the debt burden and have access to more resources for accelerated poverty reduction, Ghana adopted the Heavily Indebted Poor Countries (HIPC) initiative. As a requirement for accessing the HIPC initiative, the Ghana Poverty Reduction Strategy (GPRS I) was formulated and implemented over the period

2003-2005. This was followed by the Growth and Poverty Reduction Strategy (GPRS II): (2006-2009) policy. The central goal of GPRS II is to accelerate the growth of the economy so that Ghana can achieve middle-income status by the year 2015 with a per capita income of at least US\$ 1,000.

Both GPRS I and II had the objectives of wealth creation and poverty reduction. In formulating both policies, account was taken of the objectives of the UN Millennium Development Goals (MDGs). Following the declaration of the Millennium Declaration in 2000, Ghana has also adopted the Millennium Development Goals (MDGs), as its long term minimum objectives for socioeconomic development.

Ghana has made substantial progress towards accelerated growth and poverty reduction in recent years as a result of the implementation of GPRS I and II as evidenced by the following key facts:

- Average per capita income: US\$683 (Annual Progress Report of Ghana Poverty Reduction Strategy II, 2007). UK: US\$69,560 (£37,600) (World Bank development data, 2005).
- GDP growth rate increased from 3.7% in 2000 to 6.2% in 2006. (Annual Progress Report of Ghana Poverty Reduction Strategy II, 2007).
- Poverty level fell from 39% in 1998/99 to 26.5% in 2006. (Annual Progress Report of Ghana Poverty Reduction Strategy II, 2007).

Due to the recognition of the success in its economic and democratic governance performance, in 2006, Ghana signed a five-year \$547 million anti-poverty compact with the United States' Millennium Challenge Corporation. The compact focuses on accelerating growth and poverty reduction through agricultural and rural development.

7.0 The role of Engineers in Poverty Reduction in Ghana

Ghana's stated goals are to accelerate economic growth, improve the quality of life for all Ghanaians, and reduce poverty through broad-based social and rural development among other poverty-alleviation efforts.

A major contributory indicator of the progress so far achieved under GPRS I & II, according to the Ghana Country Review Report of July 2007, has been infrastructure development. For example, the growth rate of the construction sub-sector rose from 4.8% in 2001 to 10% in 2005, and levelled off at 8.2% in 2006. The provision of ICT infrastructure also experienced substantial progress. The number of schools which have been equipped with computer terminals and PCs increased from virtually nothing in 2002 to a total of 913 at the end of 2005 and exceeded the overall target by 399. The number of fixed telephone lines installed increased significantly from the 2002 level of 200,000 to 331,000 in 2005, while the number of cellular phones and pay-phones stood at 2,655,000, and 11,037 respectively (about 72% and 11% increases respectively, over their 2004 levels).

However, the Ghana Country Review Report of July 2007 acknowledges that major challenges still remain to be overcome to move Ghana forward on the path to accelerated growth. The key challenges include:

- Energy issues;
- Low level of accumulation of technological capabilities;
- Bridging the infrastructure gap.

Achieving accelerated growth in these and many more other areas cannot be done without effective indigenous engineering capacity.

8.0 Infrastructure Challenges in Ghana

Infrastructure, as mentioned earlier, typically refers to the technical structures that support a society, such as buildings, roads, water supply, waste water disposal, power grids, flood management systems, communications (internet, phone lines, broadcasting).

Almost half of Ghana's population has little or no access to clean water, electricity or adequate health care, transport and communication.

Transportation Challenges

According to the National Road Condition Survey (2006 - 2007) Report, Ghana had a total of 62,954.0 km of road network in the country as at 2007. This is made up of 11,180 km trunk roads (18%), 42,010 km feeder roads (67%) and 9,764 km urban roads (15%). 10,096km of all entire road networks (16%) is paved while the remainder 52,854km (84%) is unpaved. The conditions of the roads were classified as 24,450 km (32%) good, 18,559 km (29%) fair and 19,945km (32%) as poor. Poor rural transport has been blamed for problems in agriculture and social service delivery.

Road transport development in Ghana has many challenges which require the joint effort of both Government and the engineering profession to address.

The country's rail network is 953km in length; all tracks are 1.067m (narrow) gauge and all but 32km are single track. There is not much to feel proud about the country's railway system.

Water Supply Challenges

Before 1957, there were 35 pipe-borne water supply systems in the country. In a bid to promote rapid national development after Ghana's Independence, the Government launched a crash programme for urban water expansion and accelerated rural development. As a result, by 1979 there were 194 pipe-borne and 2,500 hand pumped borehole systems in the country. By 1984, additional 3,000 boreholes had been drilled and fitted with hand pumps. However, by the late 1980's and early 1990, 33% of the water supply systems had deteriorated greatly or completely broken down due to inadequate funding to carry out maintenance and rehabilitation.

The current production/performance trend shows that GWCL is very far from meeting customers' satisfaction and expectation. While population is growing about 2.6% per

annum together with improved living standards among the urban majority and the attendant use of more water, sector expansion has on the average been hovering around 1% per annum. Presently GWCL operates 84 urban water supply systems throughout the country. The installed capacity of all the systems is about 740,640m³/day. Present potable water demand in the urban areas is estimated at about 1,101,032 m³/day whilst average daily production is about 646,495m³/day. Effective urban supply coverage is about 59%; a coverage considered quite low compared with the UN Millennium Goals and the country's own GPRS targets. Households in urban areas without access to clean water are forced to use less reliable and hygienic sources. The lack of clean drinking water and sanitation system is a severe public health concern in Ghana, contributing to 70% of the disease in the country.

Certainly in the area of water supply and sanitation there are numerous challenges which engineers can exploit to help accelerate Ghana's economic development.

Environmental Sanitation

Almost all our major cities are saddled with waste disposal problems. This is particularly so with solid waste because the public encounters the problem directly each day. Polythene bags litter and mounting heaps of garbage are seen. Liquid waste disposal, especially industrial waste, is also a major problem. This problem is acute in the mining areas where in recent times people in some communities suffered from Buruli Ulcer. For how long can we rely on septic tanks for sewage disposal in our cities. Attempts were made to introduce central sewage facilities in Accra and Kumasi but little progress has been achieved in this field.

Regarding Environmental Sanitation, it would be useful if engineers could play a major role in advancing technology to first reduce waste production and secondly to manage the waste. Waste Management could even result in recycling. Waste Management methods vary widely between areas for many reasons including type of waste materials, nearby land uses and the area available.

Disposal of waste in a landfill involves burying the waste to dispose of it. Landfills are often established in abandoned or/and used quarries, mining voids, or borrow pits. A properly designed and well managed landfill can be hygienic and relatively inexpensive method of disposing of waste. Poorly designed or poorly managed landfills can create a number of environmental effects such as wind blow litter, attraction of vermin and generation of liquid leachates and offensive odour.

Other methods of waste disposal include incineration and recycling. Yet another is the "energy recovery method", whereby the energy content of waste products can be harnessed directly by using them as direct combustion fuel or indirectly by processing them into another fuel. Recycling through thermal treatment covers the use of waste as a fuel source for cooking or heating and also fuel for boilers to generate steam and electricity in a turbine.

Technological development in Ghana therefore has a lot to contribute to advance the growth of the country.

Energy Issues

Ghana in the recent past was faced with a serious energy crises that resulted in power rationing. This was largely due to the low level of the Volta Lake. To avoid over reliance on power generation from the Volta Dam, thermal generators have been installed. Unfortunately these rely on imported crude oil for operation. Recent rising crude oil prices, however, adversely affected thermal generation. This resulted in an upward tariff review and the government was forced to absorb some of the cost by way of subsidy to ameliorate its effect on the citizenry.

In the area of petroleum products, the recent increases in the crude oil prices have taken a serious toll on transportation. Industry has been grossly affected and some industries have even indicated that future upward tariff review for electricity may render them uncompetitive.

Thankfully, the West African Gas Pipeline project (WAGP), which is an ECOWAS project is nearing completion. However, the commencement of the flow of gas is uncertain. Again the country has been lucky to discover oil. Both the WAGP and the oil discovery in the Western Region have opened opportunities for Ghanaian engineers to get involved and learn on the job. The oil industry is a new field for this country and it behoves upon our training institutions and engineering professional bodies to organize and develop programs in this area to train engineering personnel. Engineers should also consider post graduate studies abroad in petroleum engineering that have the requisite training programs.

Ghana should learn from the experiences of other countries, such as neighbouring Nigeria and take note of the challenges associated with the blessings of the oil discovery. Engineers need to play a major role in the environmental issues of oil drilling to save the environment from degradation. Training should aim at developing local competency to complement foreign personnel and take advantage of the provisions for local content.

Agriculture, communication, health, education and unemployment are other major areas where the role of the Engineer is immense.

9.0 Engineering Capacity and Ghana's Accelerated Development

In the Issue No. 5, 2004 of West Africa Review, Benjamin Asare and Alan Wong wrote as follows⁰: "Ghana and Malaysia had much in common four decades ago. They are both former colonies of the British Empire and they attained independence from Britain in the same year, 1957. Both independent countries began with a rich mix of resources, significant gold and foreign-currency reserves, strong British legal and political institutions, and similar educational systems. Malaysia had a GNP per capita of about US\$200 and Ghana had a GNP per capita of US\$170 in 1958. Today, these two member-countries of the Commonwealth have very little in common".

Table 4 gives a comparison of Ghana with Malaysia according to UNDP 2006 report. According to the report, Malaysia had a GNP per capita of \$5,490, about 11 times that of Ghana's GNP per capita of \$520. In recent years, Malaysia has an average adult illiteracy rate of 11 percent while Ghana, with about 42 percent adult illiteracy rate, has more than three times Malaysia's [UNDP, Human Development Report 2007/2008]. Ghana (in 2005) had an infant mortality rate 68 per 1,000 live births, while Malaysia's rate was 10 per 1,000 live births. Ghana has remained largely an agricultural country, with the agricultural sector contributing about 37 percent to its gross domestic output. Malaysia has become highly industrialized, with the agricultural sector contributing only 9 percent to its gross domestic output. The development of one product, palm oil, also tells part of the story of the contrast between Ghana and Malaysia. Ghana grows and processes the rich red oil to make soap and cooking oil. Malaysia, which imported its first palm oil trees from West Africa in the 1950s, has not only become the largest palm oil producer in the world, but has also developed a high-tech industry which makes sophisticated chemicals and food additives from the raw berries.

After fifty years of independence, Ghana is still among the poorest nations while Malaysia is a fast developing country, joining the rank of middle-income group of nations. Comparison between Ghana and other emerging countries such as Singapore, Brazil, India and China, will produce similar results as Malaysia. The question one asks is why has Ghana's development experience been so different from that of Malaysia since their independence and what lessons can Ghana learn from them?

TABLE 4: Comparison Statistics (Ghana and Malaysia)

Description	Malaysia	Ghana
Population (millions) –2007	26.6	23.5
Percent of population below the national poverty line (1990 – 2004: US\$1.00 per day)	15.5	39.5
Paved road as % of total (2006)	79	32
Per 1,000 people: Telephone Main Lines (2005)	172	15
Per 1,000 people: Cellular Phones (2005)	771	129
Per 1,000 people: Internet Users (2005)	435	18
Foreign Direct Investment % of GDP (2005)	3.0	1.0
Exports of Goods & Services as % of GDP (2005)	123	36
Adult Literacy Rate (1995 – 2005)	88.7	57.9
GDP (Current US\$ billions) (2005)	130.5	10.7
GDP per capita (US\$) (2006)	5,490	520
Population without electricity (millions) (2004)	0.6	11.3
Population using improved water resource (%) (2004)	99	75
Tertiary students in science, engineering, manufacturing and construction (% of tertiary students) (1999 – 2005)	40	26
Public Expenditure on Education (% of GDP) (2002 – 2005)	6.2	5.4

10.0 Building Indigenous Engineering Capacity in Ghana: The Challenges

The main lesson to be drawn from the phenomenal development of Malaysia and other newly emerging countries is that they invested considerably in the development of human resources, especially in the science, technology and engineering sectors. Another critical aspect of Malaysia's development has been a large indigenous entrepreneurial class mainly made up of dynamic ethnic Chinese business people. The majority ethnic Malays dominate politics and the civil service, while the ethnic Chinese tend to drive the economy.

In Ghana, by contrast - as in most African countries - the industrial sector is dominated by the subsidiaries of multinational companies and much of the retail trade is run by immigrant Indians or Lebanese.

The relative lack of an indigenous business class means that some of the profits from these economic sectors are siphoned out of the country. The cycle of substantial savings leading to investment, and so increased productivity - which in turn can lead to more savings - has yet to be established in Ghana.

Ghana, like all developing countries, needs a solid base of technologically prepared people in order to effectively improve their economies and quality of life. Such a base of qualified engineers and technologists will facilitate the infusion of foreign capital through attraction of multinational companies to invest in the country, assist in making the most of foreign aid funds, and provide a basis for business development by local entrepreneurs.

Since its establishment forty years ago, the Ghana Institution of Engineers (GhIE) has, in collaboration with various Government Departments and others, been pursuing a number of activities aimed at building indigenous engineering capacity. Its main objective is to advance the science and the engineering profession to the benefit of society and to establish and manage a register of all engineers qualified to practice in Ghana.

The GhIE has played a pioneering role in the organisation of professional development courses for practicing engineers and other professionals. In the early days, such was the demand and uniqueness of the courses that seminars could record as many as 90 participants with courses like contract management, finance and accounting for non-financial managers, lubricants oils and greases, communication skills, safety and health management, etc. The GhIE led the way by providing opportunities for practicing professionals to learn skills that they had not been taught in the universities. The GhIE has a vast pool of human resource in its membership from which it can tap expertise for various courses and assist organisations requiring engineering expertise.

In pursuit of its objective, the GhIE has developed and began implementing a strategic plan aimed at catapulting the institution into the forefront of the engineering and technological revolution in the country. Through the implementation of the strategic plan, GhIE seeks to address the following issues:

- Education and Training
- Professional Practice
- Membership and Welfare
- Corporate Governance

The Ghana Institution of Engineers has been working hard over the years to ensure that at all times engineering practitioners in the country are well trained and constantly updated through continuing professional development. The Institution has accomplished a great deal in this regard but several challenges still remain to be overcome to enable indigenous engineers contribute effectively in the fight to achieve accelerated growth for the country. The challenges still facing the Ghanaian scene include the following:

- Inadequate investment in human capital;
- Inappropriate level of Science, Engineering and Technology (SET) in national decision making;
- Insufficient number of engineers;
- Poor quality of engineering works and services due to lack of regulations and enforcement of standards;
- Lack of self worth.

Challenges of Education and Training

The main challenges include:

- . Insufficient numbers of engineers
 - High ratio of Arts/Science enrolment in the country's universities (66:34) % as at 2003-2004 figures (Source NCTE, 2003).
 - Inadequate infrastructure at the universities in terms of lecture rooms and laboratory spaces;
 - Obsolete teaching, testing and research facilities;
 - Difficulties in finding appropriate training industries for engineering students, an important and mandatory part of engineering education.
- Inadequate investment in human capital

As stated earlier, excellence in science and engineering higher education helps a country to be technologically innovative and competitive. A study conducted in 2007⁰ as part of the input for Ghana ICT4AD process on the number of research scientists and engineers in the Universities and the number of registered practicing engineers in Ghana estimated that the number of these professionals per million persons was close to 300. This is woefully inadequate. Less than 10% of the number was involved in research and development (R&D) works. This was interpreted to mean that Ghana had as little as less than 30 scientists and engineers per million persons involved in research and development. The number of R& D scientist and engineers available in a country is one of the indicators used to assess the level of capacity for development in a country. In the period 1985-95 the comparable figures for Singapore and Malaysia were 2,728 and 500 respectively. Comparable figures for USA, Japan, and UK (1985-1995) were 3,732; 6,309 and 2,417 respectively (See Table 5). *"The recommendation here is that if Ghana is to make any progress in developing high-tech export industry to enable it address the challenges of weak and narrow export based dominated by traditional products, a lot of efforts will need to be directed at developing the nation's R&D base developing particular attention to establishing linkages between industry and the research institutions and universities"*, the report said. There is further urgency to this due to rapid population growth and the recently discovered oil and gas in Ghana which will require even more scientists and engineers.

Table 5: Number of Scientists and Engineers for Selected Countries

Country	R&D Scientists and Engineers (per million population)
	1985-1995
Australia	3,166
Canada	2,656
China	350
India	149
Japan	6,309
Malaysia	500
New Zealand	1,778
Singapore	2,728
United Kingdom	2,417
United States	3,732

Source: The World Competitive Yearbook, 1998, 2000

Challenges of Professional Practice

Professional practice in Ghana is characterized by the following:

- Lack of protection of indigenous firms against domination by foreign firms;
- Lack of self worth;
- Lack of teamwork among indigenous firms;
- Inability to retain engineering practitioners in engineering profession;
- Slow growth of the Construction and Manufacturing Industry
- Inadequate support and protection from Government and other Regulatory Bodies.

Lack of protection of indigenous firms against domination by foreign firms

Due to the absence of national legislation mandating foreign Consulting Firms to team up with local ones, some foreign firms who are required to undertake engineering works in the country, often as a result of Donor Agencies' conditionalities, operate without any form of association with local counterpart. At best some form of association is established with a local firm, but the apportionment of work responsibility is at the mercy of the Foreign Firm. Most of the time the local Partner is allocated nothing more than data collection services at a fee ridiculously low amounting to 15-20% of what is paid to the foreign counterpart, often dictated by the foreign counterpart. It is not uncommon for the foreign consultant to quote man-month rates of between €18,000 and €21,000 but the Ghanaian, with equivalent qualification and experience being offered between US\$2,500 and US\$3,250 for the same

quality of work within the same time. Compare this to the situation in Malaysia and Singapore, for example and even then local clients, including Government, complain that local consultants are very expensive. In the early 1980s, the Government of Ghana appointed consultants to come out with suitable man-month rates for foreign and local consultants. The recommended rates were US\$8,000 for foreign consultants and US\$3,300 maximum for local consultants. While the rates for foreign consultants have more than doubled, that for local consultants have reduced or at the very best remained the same. The local consultants, with the connivance of his or her own Government and Clients, whether knowingly or unknowingly, have been reduced to the status of hewers of wood and drawers of water.

In Malaysia, foreign engineers may be licensed by the Board of Engineers only for specific projects, and must be sponsored by the Malaysian company carrying out the project. The license is only valid for the duration of a specific project. In general, a foreign engineer must be registered as a professional engineer in his or her home country, have a minimum of 10 years experience, and have a physical presence in Malaysia of at least 180 days in one calendar year. To obtain temporary licensing for a foreign engineer, the Malaysian company often must demonstrate to the Board that they cannot find a Malaysian engineer for the job. Foreign engineers are not allowed to operate independently of Malaysian partners, or serve as directors or shareholders of a consulting engineering company. A foreign engineering firm may establish a non-temporary commercial presence if all directors and shareholders are Malaysian. Foreign engineering companies may collaborate with a Malaysian firm, but the Malaysian company is expected to design and is required to submit the plans. At least 51% of consultancy services must be ceded to the local counterpart for technology transfer reasons. Where no appropriate local partner is readily available, the law still requires Foreign Firms to team up with and train local counterparts. The intended transfer of technology is written into the agreement and is monitored expeditiously by the appropriate Government executing agency. At the end of the contract an assessment of the transfer of technology is carried out to determine whether the objective of the transfer was achieved or not. A similar arrangement is required in Ghana.

In Singapore, while engineering firms can be 100% foreign-owned, the chairman and two-thirds of the firm's board of directors must comprise engineers registered with local professional bodies.

Lack of self worth

There appears to be too much rush to invite foreign firms to undertake engineering works in Ghana. Indigenous engineering firms often feel frustrated about the inability of the nation to challenge them enough. It is sad that fifty years after independence foreign firms are invited to design and construct facilities which can be undertaken by indigenous engineering practitioners. The inability to challenge local firms often creates erroneous impressions in the minds of the public about the competency of indigenous engineering practitioners. How do we build local expertise if we do not challenge indigenous

professionals enough? Failure to build local expertise means that forever we shall have to depend on foreign expertise.

Lack of teamwork among Local Firms

If local firms are to make any impact in competing with foreign firms to secure large projects in the Country, teamwork is imperative. This has worked well in other countries such as Holland. In Holland, most consultants operate through NEDECO, their local Association of Consultants with an understanding to pool resources. Whenever there is an invitation to any firm to submit proposals for a project the particular firm draws on contacts with other constituent firms for the requisite manpower to fulfil the needed staff requirement. There is usually no problem with payment as there is almost universal agreement on man-month rates for professionals of similar qualification and experience. Thus there is no question of wide divergences in man-month rate charges as it is being practised in Ghana.

Inability to retain engineering practitioners in engineering profession

It is becoming increasingly difficult to retain engineers, especially the young ones, in the engineering profession. This is mainly due to the perceived low remuneration and conditions of service in the engineering profession in the country. The drift to other sectors of the economy, such as the banking sector, where higher remunerations and better conditions of service appear better, is becoming alarming to the growth of the indigenous engineering capacity in Ghana. This is often due to the charging of unrealistic rates by local firms that makes it difficult to offer better remuneration to their employees.

Slow growth of the Construction Industry

Construction is one of the oldest of all industries, retaining its role as a core economic activity from the early days of human civilization to this day. It not only provides the infrastructure for all other industries, but also constitutes one of the largest single sectors in the economy on its own. With its close link to public works and hence the implementation of fiscal policy, it has always been considered as a strategically important industry for creating employment and sustaining growth. For the developing economies, the construction sector carries particular importance because of its link to the development of basic infrastructure, training of local personnel, transfer of technologies, and improved access to information channels.

Social and economic development in the world will depend very significantly on the availability of skilled manpower in engineering construction and allied industries. Much more will need to be done in building institutional and human resource capacities, with respect to enhancing indigenous supply and manufacture of construction materials, indigenous contracting industry and construction standard and certification.

The growth of indigenous construction industry has been very slow. The industry is dominated by foreigners. Indigenous engineers are feel too hesitant to enter the construction industry, partly due to some problems in the industry in the country. Firstly, the capital required for securing constructional equipment is often difficult to come by.

Secondly, there are too many cumbersome problems associated with payment for work done. Processes required to obtain payment for work done, especially on Government projects are sometimes frustrating. The situation where over forty people must vet payment invoices or certificates often results in long delays to receive payment for work done. Cash flow to ensure speedy completion of projects becomes a problem and inhibits growth of the construction industry. Thirdly, the terms of contractual agreements are often not respected and indigenous contractors are too scared to resort to legal action for redress for fear of being blacklisted on future projects. Apart from delays in payments, the usual requirement by the Ministry of Finance to obtain a “Certificate to Commence” at the beginning of each year is often at variance with the conditions of contract and causes completion delays. These bottlenecks must be removed if the indigenous contracting industry is to grow and support the growth of the national economy.

Inadequate support from Government

Indigenous engineering practitioners sometime feel frustrated by the lack of engineering inputs into policy decisions involving engineering projects in the country. Consider the following examples:

- The long delay in passing the Engineering Council Bill is creating problems with the effective regulation of engineering practice in the country, especially in the following areas:
 - =. Registration of engineering practitioners, both indigenous and foreign; =.
 - Discipline of engineering practitioners for negligent professional work; =.
 - Enforcing standards in the construction industry;
 - =. Ensuring mandatory association of foreign firms who operate in the country with local counterparts for technology transfer.
- Government negotiation delegations on engineering projects in the country must always include representatives of the indigenous engineering bodies as happens in other developed countries. For example, the representatives of the American and Canadian engineering societies are always invited to join negotiation delegations on engineering projects. A typical example is the negotiations involving the establishment of the North American Free Trade Authority (NAFTA). The Canadian Team consisted of a strong delegation of engineers to advise the delegation on all aspects of the agreement concerning infrastructure. In America the saying is trade follows engineering and this is something the Government of Ghana should pursue religiously.

11.0 The Way Forward

The developed countries as well as countries which have succeeded in lifting themselves out of poverty in recent times have acknowledged that infrastructure is fundamental to human development. It has also been accepted by these countries that efficient

infrastructure delivery is highly dependent on the quality of engineering practitioners available in a country. Ghana and the rest of the developing countries are therefore urged to place great emphasis on building a large stock of skilled engineering capacity to accelerate the growth of their countries. We need professional engineers for policy formulation, training, design, construction and maintenance, management and industry. But we also need quality technologists, technician engineers as well as artisans such as masons, carpenters, steel fixers, welders, electricians, etc, to work with and often under the supervision of professional engineers to ensure effective infrastructure delivery.

The success of the Public Procurement Act 663 (2003) depends on the operations and competent roles played by indigenous engineers. The Government and its agencies, the GhIE as well as the general public have the responsibility to pursue the following strategic actions to facilitate the building of indigenous engineering capacity in Ghana:

Action by Government

- The Engineering Bill which is now before Parliament should be passed without further delay. This will enable the establishment of Engineering Council that will properly regulate and control engineering practice in the country.
- Government must come out with technological developmental targets.
- Government should challenge the engineering profession to meet agreed technological targets or find solutions to specific development problems.
- Government must encourage the growth of small and medium scale enterprises (SMEs) that are engaged in engineering and technological innovations. The success of SMEs, being mostly indigenous, can guarantee the spread of wealth more equitably than high-tech mega ventures.
- In the award of contracts for engineering projects, the criteria should not always be based on lowest cost but due cognisance must be taken of the quality of goods and services as well.
- Indigenous engineering practitioners should be attached to Metropolitan, Municipal and District Assemblies throughout the country to assist in their development activities.
- Lastly, Government must give recognition to indigenous engineering practitioners who sacrifice so much to keep the national infrastructure going. At least some of them may be considered in the award of national honours.

Action by GhIE and Engineering Profession

- GhIE must intensify its efforts to sensitise members on upholding quality and timeliness of projects.
- GhIE must at all times identify and sanction where possible poor performing individuals and firms.

- GhIE must introduce training programmes to prepare the engineering profession to take advantage of the provisions for local content in the oil and gas industry.
- GhIE must direct more attention to the development of small and medium scale enterprises (SMEs) that are engaged in engineering and technological innovations.
- Indigenous engineering practitioners must aim at proper quality control in the preparation and execution of projects.
- Engineering firms, especially Consultants and Contractors, must forge collaborative ties with other firms whenever possible in bidding for projects. This will enable indigenous firms to bid for large projects in the sub-region to enhance the growth of the firms and generate foreign exchange for the country.
- Professional firms must invest in modern technology if they are to make progress.
- Lastly, indigenous engineering practitioners must always pay attention to the requirements of ethical practice in our attempt to utilise public money judiciously.

Action by General Public

- There must be a concerted effort to sensitise the general public about the importance of infrastructure and not to abuse or wilfully damage existing infrastructure such street and traffic lights, removal of rail guards and drain covers for use as scrap metals.
- The general public must be conscious of and take steps to sustain and improve the general state of infrastructure, especially outside their immediate homes.

12.0 Conclusion

In conclusion, let us remember that Ghana and other developing countries need their own indigenous engineering and technology capacity if they are to compete effectively in the global economy. We cannot afford to buy such capacity always from developed countries, and even when technical expertise from developed countries is provided by external funding it is often ineffective in appropriately responding to local needs and constraints. Capacity building of engineering and technical expertise in Ghana and other developing countries is thus the key to enhancing our ability to become economically self-sufficient and improve the quality of life for our peoples.

In less than three weeks Ghana goes to the polls to elect a new government. It is reassuring to note that all the Presidential aspirants are telling the whole nation that they will create jobs, improve living conditions, and remove Ghana from producer of raw materials to a manufacturing industrial based one. In most of these endeavours, engineering capacity plays a significant role. It is my ardent hope, and that of my fellow engineers, that the jobs that will be created will not be undertaken by foreign engineers at the expense of the indigenous ones.

