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MANUFACTURING AND COMPUTER AIDED ENGINEERING: A PANACEA FOR WEALTH CREATION

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MANUFACTURING AND COMPUTER AIDED \ ENGINEERING: A PANACEA FOR WEALTH CREATION

The Vice Chancellor and Chairman of this Inaugural Lecture,
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Teaching and Non Teaching Colleagues,
My Lords Spiritual and Temporal,
Invited Guests and Friends of the University,
Gentlemen of the Press,
Distinguished Ladies and Gentlemen,
Great UNAABITES.

INTRODUCTION

Glory and Honour be to God forever and ever, He who has the ability to take people from grass to grace. Who is the only one that has the capability and attribute of lifting

be my tower and my strength in time of struggling, right from the time I was born, progressing from Primary School to Modern School to become a Messenger, through Trade Centre to become a Craftsman cum Technician; to Polytechnic to become a Technologist; advancing to the University to become an Engineer, a holder of Master and Doctorate Degrees culminating in my eventual appointment as a Professor of Mechanical Engineering. This is a herculean task, with so many obstacles, hindrances, mountains to climb, many hurdles to cross, barriers to overcome, with many bus stops on the road and more importantly, with many people who are only interested in subtracting value from your life. The foregoing happens to be my life- experience. I therefore give thanks, honour and adoration to God Almighty who has made it possible for me to be where I am today.

In view of this, looking at my past life, I feel highly honoured, privileged and delighted to deliver the 27th Inaugural Lecture of the University of Agriculture, Abeokuta, Ogun State of Nigeria; the first in the series from the College of Engineering and the first from the Mechanical Engineering Department.
This lecture is titled: Manufacturing and Computer Aided Engineering: A Panacea for Wealth Creation.

1.1 Wealth Creation

Mr. Vice - Chancellor Sir, Nigeria is endowed with rich and diverse natural resources which can be tapped for the use of its citizens. However, many of the resources remain untapped fully to the benefit and well being of its present citizens and future generations. (NEEDS, 2005 and Adejuyigbe, 2008a,&b). The manufacturing sector, including micro, small and medium size enterprises, which have the potentials for wealth creation, as witnessed in the developed countries, is still in the infant stage in Nigeria. Worse still, Nigerian manufacturing industries witnessed stagnation and reverse in its contribution to Gross Domestic Products (GDP) while the employment opportunity provided by this sector remains small. This sector is dominated by import-dependent processes and factors. Although, reliable data are very difficult to get, however we shall use the available ones to draw reasonable conclusions.

Ibhadode (2006) noted that wealth may be categorized into two viz;

Natural Wealth: This is derived from crude materials, that is, materials occurring in the natural state such as mineral deposits in the earth's crust, and agricultural products. Mineral wealth is delectable and the wealth obtained from agricultural products without man-made inputs is

unsustainable in modern times.

Man-made Wealth: This is derived from refined or manufactured products over which man exercises enormous control. This type of wealth is usually sustainable.
Economic growth is often measured as the percentage increase in GDP, adjusted for inflation, from one year over a series of years. Trend growth rate for an economy sector or industry is calculated over series of years.

Wealth Creation Principle through Manufacturing
Wealth creation is the missing link in Nigeria's development. Where there is no Manufacturing, there is no wealth creation. Manufacturing does not just include physical manufacturing – it encompasses many activities where input are transformed to outputs. Manufacturing Engineering is superficially well known. For example, a car manufacturer combines rubber, glass, steel, aluminum, and plastic to make a car. The combination of items into marketable items using design and processes make the items valuable and unique. Manufacturing adds labour, intelligence and capital to transform raw materials into output of much higher value. The process of modern manufacturing is based upon the use of leverage to increase quality and to decrease costs. At the same time, the purchase of a manufactured good depends upon the value of intelligence that

goes into it. This is shown in the design, quality, packaging, and branding of the manufactured item.

Gross Domestic Products (GDP) growth is an important economic indicator. It measures progress or the rate of expansion of the economy's capacity to produce output (goods and services). It is examined as a measure of the short-term stability or instability of the economy. GDP is also a reflection of the future consumption possibilities for a nation and it is the main source of improvements to our standard of living over time.

The principle of wealth creation through manufacturing is the basis of many large fortunes. The very *word, Industrialist,* originally referred to someone who had successfully created wealth through manufacturing. No wonder, Ibhadode (2006) in his argument, said that manufacturing is an assured means for creating wealth. The prosperity of the Group of Seven Industrialized Countries (G7) is predicated on manufacturing which contributed about 19% to their GDP. That of Nigeria in that same year is about 4% which is considered to be very poor.

Wealth creation and accumulation is the antidote to the prevalent mass poverty in Nigeria today. This is combined with a progressive social policy of a more equitable distri -

bution of the nation's income.

Morris and Undy (1997) revealed that the processes associated with designing, producing and distributing products, which we refer to as the operations or manufacturing function, are undergoing profound change. Many firms that were dominant in their markets for generations had run out of business. Competition has suddenly become global. New products, based on developments in the basic and applied sciences, appear at rapid rate. These new products compete at the bases of their quality and performance, as well as cost. As a result, the survivors in the year 2000 and beyond must modify the practices and policies used in the manufacturing and distribution of their products.

Information processing has become cheap, fast and ubiquitous. This has led to computerization of many of the basic manufacturing tasks (design, process analysis, scheduling, material control, process control,etc.). Intelligence (whereby systems can learn and make decisions) has been introduced in process control and management system. Similarly, electronic displays and data processors have been incorporated in the design of many products (e.g. fuel injection, voice recognition).

Therefore, the creation of wealth through manufacturing and the development of Computer Aided Engineering used as

a tool for wealth creation is what I have investigated in my research for the past twenty seven (27) years as a Lecturer in the University and the Polytechnic and as a person who started his engineering career thirty six (36) years ago from the grassroot as a Fitter Machinist.

1.2 Manufacturing Engineering

According to Adejuyigbe (2003b, 2006e,f, 2007d, 2008a), manufacturing, which comes from the Latin words *manus* (hand) and *facere* (to make), include the following definitions;

- large scale production of goods using machinery;
- an industry that makes automobiles, books, clothing, furniture, paper, pencils and thousands of other products;
- the conversion of raw materials into industrial standard stock which is further processed into finished products.
- the transformation of materials and information into goods for the satisfaction of human needs.

Manufacturing is as old as man. Early man, fully aware of the limitations of his physiological make-up and conscious of the need to survive, realized that he could not survive the harsh environment in which he found himself without

the manufacture of tools. Hence, man decided to develop different types of tools and methods to make life comfortable for the human race. Manufacturing can be considered as a system in which products design is the initial stage and the delivery of finished products to market is the final output. Manufacturing integrates many disciplines in engineering and management. Manufacturing is critical to a country's economic welfare and standard of living because primarily, the goods and services that are available to its people determine the standard of living in any society. Thus, manufacturing comprises the organised activity that converts the material energy and purchase items into marketable goods.

Mr. Vice - Chancellor Sir, manufacturing technology can be looked at in three broad headings as shown in Table 1 below:

Table 1: Stages of Manufacturing Technology

Stages	Characteristics
Craftsmanship (Pre-1870)	High degree of manufacturing flexibility, product variety, and potential for qualities were some of the main advantages. Limitations included low volume and high cost.
Mass Manufacturing (1870-1945) A. Scale Strategy B. Variety Strategy	Parts standardization and mechanization of parts fabrication allowed for significant increases in volume. Production costs decreased, but manufacturing flexibility and product variety suffered. Product variety and manufacturing flexibility improved while the advantages of cost and scale were maintained.
Automation Technology (1945-Present)	Automation of individual technologies allows lowering of cost and improvement of quality. The degree of flexibility and product variety is maintained and in some cases improved. The main limiting factor is the difficulty of achieving coordination between individual automation technologies.

Source: Morris and Undy (1997)

At each stage in Table 1 above, the appropriate manufacturing technology was adopted.

As noted by Stalk and Hauk (1990), the following sequence of manufacturing strategies was adopted in Japan:

1. 1945-1960: Low Labour Cost Strategy: Labour intensive industries.

3. 1965-1970: Focused Factories: Product lines were narrowed with high -volume market
4. 1970-present: Flexible Factories: A strategy based on low volume and high variety of world competitive prices.

The question here is that which one has Nigeria adopted? The pace of technological development in manufacturing has accelerated throughout the world. With the development of computers and communication technology over the last decades, the use of automation technology in all phases of product life cycle has flourished.

Before the arrival of white men in Nigeria, all sorts of tools were locally manufactured by artisans. Iron was mined and smelted around Ajaokuta (Kogi State of Nigeria) and Ojirami in Edo State of Nigeria. These were forged by blacksmiths into basic agricultural tools (cutlasses and hoes) and military tools (guns and arrows). Copper (Cu) and Zinc (Zn) were mined and alloyed from which bronze products were manufactured (Adejuyigbe, 1995, 1998d). However, the white man coming to Nigeria in the early 19th century led to the decline of local participation in Industry. But by early 1970's when Nigeria became a major exporter of crude oil, new ideas in manufacturing complemented new requirements for living and

survival, this culminated into jobs for millions of Nigeria. The contribution of the manufacturing sector to the economy of this country has not improved and its contribution to GDP is very low compared to the industrialised nations, hence, the clarion call in this Inaugural lecture to showcase the wealth in manufacturing and the use of Computer in our manufacturing industries, so that wealth can be created in a developing economy like Nigeria.

1.3 Computer Aided Engineering (CAD, CADD, CAM, CAPP, CIM, Knowledge Based Expert System (KBES), Artificial Intelligence (AI) Automation and Robotics)

Byron (2006) explained in his study that many traditional manufacturing firms, including automobile manufacturers, computer manufacturers, and other consumer product manufacturers, no longer manufacture but merely assemble components provided by the deep network of suppliers. Some don't even assemble, but invest in their expertise in product development and look outside the company of manufacturing capability. In the manufacturing sector, in advanced countries, manufacturing has now swung to connect to the consumer outsourcing of their needs and at the same time becoming more directly linked to the customer through services. It is however noted that these

changes were made possible by advancements in technology, that is, the introduction of computer facilities that enabled firms to maintain accurate and almost instantaneous decisions and good communication between them and customers for the supply of the products.

Computers quickly process information, whereby, the process of manufacturing must not only accomplish their objectives quickly but also be designed for almost split-second response to change. Suppliers must provide instantaneous replenishment and production processes must be totally flexible. Services must meet customer needs immediately.

Adejuyigbe (2003b, 2006e,f 2007d, 2008a) added that the trend in manufacturing calls for the development of the following modern day manufacturing systems namely:

- global competition in the manufacturing market;
- demand for high-quality goods, with low production cost and timely delivery of manufacturing products; and
- Increase in the variety of products, thereby choosing the product life cycles to be shorter.

Therefore, the modern day technology that manufacturing systems make use of are different types of Computer Aided Engineering (CAD, CADD, CAM, CIM, CAPP, Knowledge- Based Expert System, Artificial

Intelligence, Robotics and Automation). Manufacturing system entails a large number of interdependent activities consisting of distinct entities such as materials, tools, machines, power, and human beings. It is a complex system because it comprises many diverse, physical and human elements. The choices are many, so the manufacturing engineers should be able to select correctly which one will profit the whole manufacturing system.
Adejuyigbe, (2003b, 2006e,f, & 2007d), Rao (2004), Zeid (2005), Microsoft Encarta Encyclopedia 2005 have all defined and reported on the various Computer Aided Engineering components as enumerated below:

(a) **Computer Aided Design (CAD) -** This is a design activity that involves the effective use of the computer to create, modify, or document an engineering design. The need to program at each stage of manufacture is avoided by the use of standard form of data already stored in the computer by CAD.
(b) **Computer Aided Manufacturing (CAM)** - This is the use of computer system to plan, manage and control the operation of manufacturing plants through either direct or indirect computer interface with the plant's production resources. It includes the use of digital computer to enhance the shop floor manufacturing process; includ-

ing monitoring and controlling of manufacturing equipment shop floor information system with automatic data gathering as part of a CAM system. CAM, is a form of automation and control system that employs feedback, i.e. they use part output to control their input.

(c) Computer Aided Design and Drafting (CADD) - The engineering drawing has been an integral part of industry for many years. It is the link between engineering design and manufacturing.

(d) **An Integrated CAD/CAM -** Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) refer to the integration of computers into the design and production process to improve productivity. CAD/CAM is the technology concerned with the use of digital computers to perform certain functions in design and production. This technology is moving in the direction of greater integration of design and manufacturing, two activities, which have traditionally been treated as distinct and separate function in the production form. Ultimately, CAD/CAM will provide the technology base for the computer-integrated factory of the future.

(e) Computer Integrated Manufacturing (CIM) - Computer Integrated Manufacturing (CIM) system is primarily concerned with the integration and management of

the total manufacturing process. It is a system that recognises and supplies computer services to each phase of the manufacturing cycle independently, while at the same time maintaining a database that serves a single source of data for all company activities and applications.

Many specific approaches have been developed for limited manufacturing domains. For example, a solid model may be directly converted into Numerical Control (NC) code for a computerized milling machine. But when we try to extend the planning to cover a number of domains, there are no satisfactory techniques. This still leaves many unresolved problems when converting a product from design features to manufacturing features.

(f) Computer Aided Process Planning (CAPP) - Computer Aided Process Planning (CAPP) can be defined as

- the method that helps to simplify and improve the activity of process planning, provide the user with optimum process plans in a quick, consistent fashion and achieves a more effective use of manufacturing resources and
- a means to automatically develop the process plan from the geometric image of component.

Traditionally, process planning is performed manually by highly experienced planners who possess, in depth,

knowledge of the manufacturing process and the capabilities of the shop floor facilities. Because of the experienced factor that is involved in planning for the physical reality of the product and in the absence of standardization of the process, conventional process planning has largely been subjective.

(g) Knowledge-Based Expert System - Knowledge-based expert system is a category of artificial intelligence programme that makes use of information gathered from previous projects. Professionals, who are well-skilled and are experts in a particular field of specialization like Production, Medicine, Law, Accounting, Agriculture, other Engineering fields, are generally very scarce and are well paid for acquiring such knowledge. If one has the ability to capture the knowledge of human expert and make it accessible to everyone through a computer programme, definitely the price will be very high. The experts have the ability to create their own computer programme using their knowledge. This is what is known as expert systems or knowledge-based. Expert system can, therefore, be defined as computer programmes that provide advice to decision makers who would otherwise rely on human experts. The programme differs from the normal programmes in the sense that;

-conventional programmes are used to perform rou-

tine tasks on data, while the
-expert system programmes are used to provide advice on very specialized tasks that typically require a human expert.

Many expert systems use so- called fuzzy logic which allows users to respond to questions in a human-like way or used to allow users human like input.

Expert systems are created using a programming language or a shell, which is a special kind of software that allows a person to custom-build a particular kind of expert system.

(h) Artificial Intelligence (AI) - Artificial Intelligence is the field of research which stimulates human thought processes and actions. The goal of artificial intelligence is not to replace human intelligence which is actually not replaceable, but it helps people to be more productive than before.

It attempts to develop computer system that can mimic or simulate human thoughts processes and actions. The human thoughts and actions include:

- Reasoning
- Learning from the past action and
- Human senses such as vision and touch

It is, however, noted that although there are efforts to do exactly what human beings can do, and that various tools

have been developed that have practical applications in law, manufacturing, business, law, medicine and many other fields, they cannot perform exactly like human beings.

Robotics and Automation - Robotics is the field of study that is concerned with development and use of robots. Robots are computer-controlled machines that mimic or imitate the motor activities of humans.

Automation can be defined as a system of manufacture designed to extend the capacity of machines to perform certain tasks formerly done by humans and to control sequences of operations without human intervention. An inquiry into the nature and causes of the Wealth of Nations (1776) indicated that in manufacturing, the division of labour results in increased production and a reduction in the level of skills required of workers.

2.0 INCOME GENERATION THROUGH MANUFACTURING

Some other researchers have worked in the areas of industrialization and manufacturing in Nigeria. Some are (Adejuyigbe, 2002, 2005a, 2006d, Adejuyigbe and Dahunsi 2005, 2008, Aderoba, 1995, Blah, 2003, Milner, 2005, Marsh, 2005).Their research works include the following:

- Trends in the economy of Nigeria;
- The Appraisal of Communication and Automation in Nigeria;
- Forecasting the performance of the Manufacturing industries in Nigeria;
- Tools of Engineering Management;
- The role of technology in the Technological Development of Nigeria;
- Productivity growth in Nigeria Manufacturing and its correlation to trace policy regimes/ indexes. 1962-1985.
- Forecasting the product demand for a Bottling Company.

The results of these obtained in the advanced countries like USA and Britain as well as that of a developing country like India was used to compare the growth of manufacturing in Nigeria. The result of the findings is presented;

(i) Income Generation through Manufacturing in USA, Britain and India

In USA - To put things into perspective, manufacturing sub-sector of the economy provided employment for a third of the United States' employees fifty years ago. The manufacturing sector's output grew strongly over the

decades to 2000, in tandem with the strong economic growth that took place over much of this period. The economic downturn and recession of 2001 hit the manufacturing sector hardest and the sector has not fully recovered from that setback. The recent depreciation of the US dollar will no doubt help manufacturing exports, and will hopefully increase capacity utilization rates (IBIS, World News Letter, 2004)

In Britain - The income generation in Britain, according to UMIST, Britain, 2005 is analysed below:

- Since manufacturing accounts for about 76% (1994 figures) of British exports - as it does broadly for the other three major economies in Europe - there is a strong correlation between manufacturing output per employed person in the economy and overall growth of the economy.
- Taking the conventional measure of labour productivity as added value per employee, Britain's manufacturing labour productivity at £32,000 pa (1994) is about 60% greater than the productivity in the private services sector (£20,000 pa) and about 68% greater than that in the public service sector (£19,000 pa).
- Foreign earnings per employee in manufacture are around ten times those of employees in the private services sectors.

- Besides the visible earning from manufacturing, other three invisible sources of cash flow are Private services, Overseas investment and Government transfer.

Marsh (2005) and Milner (2005) in their analysis said that 'Manufacturing in Britain still has a decent future'

In India - Income generation by statistics in India has improved over the years. India has improved in its manufacturing and industrial outfit than most of the developing nations. The Small Scale Industry Impressive Achievements of India is as a result of the policies followed since independence. (IBIS World Newsletter, 2004).

UMIST (2005) recorded that Switzerland has the highest GDP and the highest manufacturing output per person of any industrial economy in the world. Germany, Japan, France and the USA sit in between Britain and Switzerland on both measures.

From the foregoing analysis therefore, it was discovered that manufacturing in the countries enumerated above were moving forward and that income generation through it is still enormous and their economy still depends on manufacturing for survival.

(ii) Income Generation through Manufacturing in Nigeria.

According to Ojo (1998), World Bank (1991), Union

Digest, (1997),NEEDS-2 2008 – 2011 (2007), Nigeria has a dual economy with a modern segment which is dependent on oil earnings overlaid by a tradition agricultural and trading economy. At independence in 1960, agriculture accounted for well over half of GDP, and was the main source of export earnings and public revenue. The econo-economic growth since 1970s has been erratic, driven primarily by the fluctuations of global market. During the 1980s and 1990s Nigeria faced growing economic decline and falling living standards.

The industrial sector (manufacturing), contributed 4.8% to the GDP in 1998 and employed 8% of the workforce. Emphasis has shifted towards more low-cost, integrated, high value-added industries which rely on local, rather than imported raw materials and capital goods, and on shifting away from Lagos where all inputs of production are more expensive. Manufacturing is dominated by light consumer goods and is oriented towards import substitution. The manufacturing sector, despite its huge potential to create wealth and employment in Nigeria has remained stagnant contributing 3.6% on average to GDP between 2001 and 2004, In 2004 the sector grew marginally, contributing 3.68% to GDP and in 2005 and 2006 the sector remained

stagnant contributing 3.79 to GDP, and in 2007 grew marginally contributing 4.01 to the GDP (Tables 2&3). The performance of manufacturing with other selected activity sectors shows that there is decline in the Manufacturing GDP at 1984 constant factor value. This is a serious threat to the existence of manufacturing in Nigeria. Instead of increase in manufacturing, there is a decrease in the GDP. Nigeria has one of the lowest manufacturing values added output in black Africa. According to UNIDO, in 1997, and NEEDS-2 (Table 4) the black Africa average manufacturing value added per capital was US $40, whilst that of Nigeria was US $ 17, less than half.

This type of problem should not be allowed to continue in Nigeria. The wealth of manufacturing should also be witnessed in Nigeria.

Table 2: Macroeconomic Indicators and Sectorial Contributions in Nige-

Macroeconomic Indicators	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
GDP Growth	1.19	4.89	4.72	4.63	9.57	6.5	6.23
Oil Sector(%)	-7.5	11.13	5.23	-5.17	23.9	3.3	0.5
Non-Oil Sector (%)	4.37	2.87	4.54	8.27	5.17	7.76	8.21
Inflation Rate	0.2	14.5	16.5	12.2	23.8	10	11.6
Maximum Lending Rate	27.1	26.8	23.9	29.7	22.5	20.6	25.76
Industrial Capacity							
Utilisation	32	33	34	36	49	54	55
Sectorial Contributions							
Agriculture	43.45	42.65	42.3	42.14	41.01	40.98	41.21
Petroleum	24.45	25.91	26.04	23.46	26.53	25.72	24.33
Solid Minerals	0.25	0.25	0.25	0.26	0.25	0.26	0.27
Telecommunication	0.45	0.46	0.55	0.78	0.99	1.2	1.45
Manufacturing	3.49	3.44	3.52	3.7	3.57	3.68	3.79
Financial Institutions	4.05	4.03	4.02	4.97	4.12	3.96	3.82
Wholesale &Retail Trade	13.46	13.04	12.76	12.99	12.54	12.9	13.64
Others	18.25	10.1	10.42	11.54	10.87	11.18	11.36

Source: NEEDS -2 (2007)

Table 3: Sectoral Contribution to GDP

Sector	2004	2005	2006	2007
Agriculture	40.98	21.19	41.77	41.63
Petroleum (Crude Petroleum and Natural Gas)	25.72	24.26	21.93	20.82
Solid Mineral	0.26	0.27	0.28	0.28
Telecommunication and Post	1.20	1.45	1.82	2.23
Manufacturing	3.68	3.79	3.79	4.01

Source: NEEDS -2 (2007)

Table 4: Manufacturing Value-Added: A Comparative Analysis (%)

	1980	1990	2000	2005
Nigeria	8.4	5.5	4.5	4.6
Mexico	22.3	20.8	20.3	17.7
Indonesia	13.0	20.7	27.7	-
Brazil	33.5	-	17.1	-
Ghana	7.8	9.8	9.0	8.6
South Africa	21.6	23.6	19.0	19.1

Source: NEEDS – 2 (2007)

There is a serious danger in manufacturing sub-sector of Nigeria's economy. Adeosun (2009) reported that

Ambassador Segun Apata, Chairman, Nigeria Bottling Company Plc. attributed the failure of the manufacturing sector to inadequacy of power supply, which the major factor is militating against the growth of the manufacturing industry in Nigeria. He calls for urgent solution to the problem of power supply in Nigeria. He said that Nigeria Bottling Company (NBC), a beverage company, was operating on a 24-hour basis and that because of the instability of power supply, it was powering its operations through generators. The cost of generating this electricity was too much to bear, a situation which has forced many companies to fold up. He finally asserted that there is no way Manufacturing Engineering can grow in Nigeria without commensurate investment in the energy sector. It is pertinent to note that some of our manufacturing industries like the Nigeria Machine Tools(NMT), textile industries, those operating on Jobbing Shops were closing down in Nigeria without replacement (Adejuyigbe, 1999b,c, Adejuyigbe and Aderoba, 2000).

Worse still, the Manufacturing Association of Nigeria also raised alarm that the only surviving automobile industry, Peugeot Assembly of Nigeria (PAN) that was booming in the 70s is now nudging towards extinction (The Punch Editorial, April, 15, 2009). The Nation has failed to pro-

vide the enabling environment for car manufacturers. Argentina, Brazil, India, Malaysia and others which started the automobile business with Nigeria have become big names in the industry. The economy is import- dependent and completely hostile to local production. It was the stiffening business climate that throttled the operations of ANAMCO, VoN, Steyr, PAN and other automobile companies. The nation's demand for Peugeot, Volkswagen and other local products was also considerably encouraging in the past, bolstering employment and wealth creation. PAN alone employed over 1,000 expatriates in the 70s.

Olaoye-Osinkolu (2009) in her analysis on manufacturing quoted Mr. Femi Mokikan, Human Resource Director of 7^{up} Bottling Company that many companies have relocated to neighbouring countries due to "the Government's business policies and environment in Nigeria have forced many companies to relocate to where they could make profit". One of such is PZ Cussions which has scaled down its operations in Nigeria and moved part of its subsidiaries to Ghana. This situations has claimed thousands of jobs, which is listed in the causes of job losses in Tables 5,6,&7 below and suggested how to fight them. He also offered solutions on job creation

Table 5: Manufacturing Employment by Sector (December 2002 – Decembe 2007)

S/N	Sub-Sector	2002	2003	2004	2005	2006	2007
1	Food, Beverages and Tobacco	372,209	322,630	254,549	245,678	273,728	274,690
2	Textile Append and Footwear	80,392	88,088	574,340	40,430	37,171	39,968
3	Wood and Wood Products	165,814	166,892	136,053	89,793	35,207	62,543
4	Pulp, Paper and Publishing	152,863	126,172	200,845	40,337	48,950	46,429
5	Chemical and Pharmaceutical	142,896	122,408	65,581	56,360	67,563	72,253
6	Non- Metallic Mineral Products	94,038	101,181	104,611	160,660	130,695	147,517
7	Domestic/Industrial, Plastic, Rubber and Foam	148,302	158,066	106,785	150,750	156,005	163,419
8	Electrical and Electronics	76,000	69,318	87,325	90,340	76,955	88,841
9	Basic Metal, Iron and Steel	87,149	82,181	80,897	110,890	116,206	99,408
10	Motor Vehicles and Miscellaneous Assembly	75,750	71,561	78,330	55,468	63,380	32,631
11	Average Employment Sector	2,841,083	2,716,244	1,172,410	1,043,982	1,005,861	1,027,799

Source: From various issues of MANEconomic Review

Employment dropped from 2,841,083 in 2002 to 1,027,799 in 2007.

Table 6: Textile Companies that Have Closed Down within the last 10 Years

S/N	LAGOS STATE	16	Nigeria Synthetic Fabrics Ltd.		KANO STATE
1	Afprint Nig. Plc.	17	Reliance Textile Ltd.	1	Bagauda Textile Mills Kano
2	Western Textile Mills Ltd	18	First Spinner Plc.	2	Kano Textile Printers Ltd
3	President Industries Nig. Ltd	19	Specomill Textile Ltd.	3	Dangote Textiles
4	Pacific Weaving Coy. Ltd				
5	Vinkay Industries Nig. Ltd		KADUNA STATE		OTHER SATES
6	Nibeltex Industries Ltd.	1	United Nigerian Textile Ltd	1	Asaba Textiles Mills Asaba
7	Abel Abu Industries Ltd.	2	SRC Industries Ltd	2	Stretch Fibres Industries Ltd
8	Jay Bee Industries Nig. Ltd.	3	Arewa Textiles	3	Horison Fibres Industries Ltd
9	Aswani Industries Nig. Ltd.	4	Matex Nig. Ltd	4	Aba Textile Mills Ltd, Aba
10	Kay Industries Nig. Ltd.	5	Supertex Limited	5	Dorji Textile Mills Ltd, Benin
11	Diamond Spinner Nig. Ltd.	6	Blanket Manufacturing Co. Ltd	6	Edo Textile Mills Ltd, Edo
13	Texlon Nig. Ltd.	7	Finetex Ltd	7	Odu'a Textile Industries Ltd, Ado Ekiti
14	Bhojray Industries Plc.	8	Kaduna Textile Ltd		
15	Textile Specialities Nig. Ltd.	9	Unitex Ltd		

Source: Nigeria Textile Manufacturers Association, February, 2009

Table 7: Nigeria Poverty Level

Year	1980	1985	1992	1998	1999	2004	2006	2008
Poverty Level (%)	28.17	46.0	46	65.6	70.9	70.0	70.9	N/A

Source: UNDP Report on Nigeria 2007

Poverty level moved from 28.17% in 1980 to 70.99% in 2006. The figure for 2009 is being contested (probably because it is higher than the 2006 figure).

Highlighting the potentials of the sector for job and wealth creation, Mokikan stated that apart from the government, no other sector has more potential for employment creation than manufacturing, all other things being equal (Olaoye-Osinkolu, 2009). It is instructive to note, however, that the much publicized goals of the Seven Point Agenda of the Government of Nigeria as well as the Vision 20: 2020 may be difficult to achieve if the country's manufacturing sector remain at its current state. It is impossible to grow the economy and generate employment with a prostrate manufacturing sector. The cost of privately generating power constitutes between 30 and 35% cost of production while in most parts of the world, it

stands at between 5 and 10%. When the cost of generating sets is added to other cost arising from infrastructural deficiencies, the cost of manufacturing in Nigeria becomes globally uncompetitive. The cost of manufacturing in Nigeria therefore, is nine times than that of China, four times than that of Europe, four times above figure in South Africa and double the figure in Ghana (The Punch Editorial, May 11, 2009).

New manufacturing venture and the expansion of existing ones naturally will provide opportunities for people of different professional backgrounds and experiences, such as, accountants, agriculturist, production engineers, maintenance managers, inventory managers, and other categories of workers.

3.0 CONTRIBUTION TO KNOWLEDGE

Mr. Vice Chancellor Sir, distinguished ladies and gentlemen, permit me at this juncture to personally use this unique and rare opportunity to mention some of my modest contributions to the field of Technological Education Development; Computer Aided Engineering (CAD, CAM, CADD, CIM, CAPP, KBES, AI, ROBOTICS); Manufacturing Engineering and Management. For the purpose of this discussion, this section will be divided into three broad headings which are the areas my researches focus

on.

- Technological Education Development in Nigeria and Ghana;
- Manufacturing Engineering and Management; and
- Computer Aided Engineering (CAD /CADD / CAM /CAPP /CIM), Knowledge Based Expert System, Artificial Intelligence, Automation and Robotics.

3.1 Technological Educational Development in Nigeria and Ghana

Looking at my background, having passed through all the facets of Technological Education both in Nigeria and Britain, I did research on how people with technical certificates will excel competitively in their chosen profession in Nigeria and other West African Countries.

Mr. Vice Chancellor, Sir, since I joined UNAAB, the urge to do more research and to lend my voice more on the aspect of continuity of technological education for its possessor has increasingly dawned on me. I discovered that in the academic community, we have not departed from the past, where people with technical certificates are looked down upon as nonentities. The belief that they cannot progress academically, thereby turning their certificates to

terminal ones, and the limitations which cannot be used to further their education to higher level is examined in this research. Some Universities in Nigeria have overcome this barrier while some are still lagging behind. Even the colonial Masters who handed over this legacy have changed drastically to give this set of people opportunity to progress academically. No wonder nearly all the Polytechnics in Britain have now changed totally to Universities. Since the mandate of the Polytechnics is not well understood by developing nations like Nigeria and Ghana, I concentrate my work on them.

Mr. Vice Chancellor Sir, I first researched into Production Engineering Education and Training in Nigeria. Therefore the inability to distinguish between Mechanical Engineering and Production Engineering and the rest of engineering field was dealt with. The Universities and The Polytechnics offering the courses in Nigeria were also researched into. Engineering and Technological Education training and Development was also looked into and the causes of low turnout of students in this sector was also researched into (Table 8 and Fig.1). I discovered that the non continuity of the courses beyond craft level is the major problem facing this set of people in our society. Ways to alleviate this problem were suggested. Critical Path Method (CPM) was used to develop a model for the

continuity of Technological Education using Nigeria and Ghana as a case study. This model completely eliminates the terminal certificates awarded in some Nigerian and Ghanaian Technological Institutions

Other educational lines like: Education, Art and Sciences were compared with that of Technological line and solutions were proffered to the identified problems. See Table 8 and Fig. 1 (Adejuyigbe, 1994b,1996, 1999a, 2006 d, 2007 a,b)

Table 8: CPM Calculations for the Proposed 6-3-3-5 System of Education for Nigeria and Ghana using Education, Science, and Technological Lines.

Activity Code No.	Duration	Earliest start	Earliest finish	Late start	Late finish	Slack	Critical Yes or No
1 – 2 A	6	0	6	0	6	0	Yes
2 – 3 B	3	6	9	6	9	0	Yes
2 – 4 C	3	6	9	6	9	0	Yes
3 – 5 D	3	9	12	9	12	0	Yes
4 – 5 E	3	9	12	9	12	0	Yes
4 – 6 F	3	9	12	9	12	0	Yes
4 – 7 G	3	9	12	9	12	0	Yes
5 – 8 H	5	12	17	12	17	0	Yes
6 – 8 I	5	12	17	12	17	0	Yes
6 – 9 J	5	12	17	12	17	0	Yes
6 – 10 K	5	12	17	12	17	0	Yes
7 – 10 L	5	12	17	12	17	0	Yes
8 – 11 M	1	17	18	17	18	0	Yes
9 – 12 N	1	17	18	17	18	0	Yes
10 – 13 O	1	17	18	17	18	0	Yes

Note: Activities A-L = Undergraduate; M-O = Masters

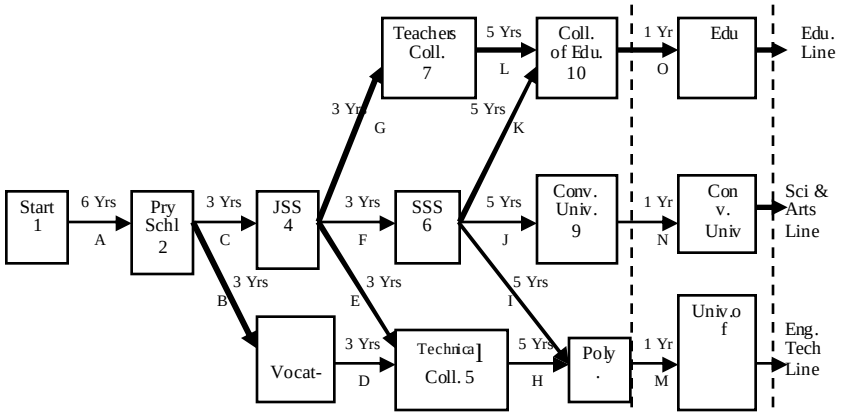


Fig. 1: Educational, Science and Art, Engineering and Technological Lines for the New Suggested 6-3-3-5 System of Education in Nigeria and Ghana.

3.2 Manufacturing Engineering and Management

It is interesting to note that this aspect of my research started as a Fitter Machinist in 1974 after my Trade Centre School at Osogbo, Osun State of Nigeria. What I was able to achieve in this area was borne out of my experience and background as a Fitter Machinists. Some of my modest contributions in these areas can be divided into the following sub sections:

- Machining Operations
- Machines Fabricated and Developed

- Human Factor Engineering/ Ergonomics
- Production /Operations Management

(i) Machining Operations

Oketola (2009) reported that the Nigeria lubricants market has largely been fraught with importation of substandard lubricants since February 1995 when the lube of the Kaduna refinery which was the only Nigeria-based oil producing refinery was gutted with fire. The importance of quality lubricants is "just as blood is to the proper functioning of the entire body organ, so also is lubricants to the proper functioning of machines. It is the artificial blood that keeps the wheel of industrial progress moving".

(ii) Developments of Textbooks and Coolant for Machining - Research into machining operations were carried out. Apart from developing special tools, and even textbooks for both Secondary Schools (Adejuyigbe and Akinlosose 1987a,b,c; Adesokan, Adejuyigbe, Fagbemi, and Adewale 1988a,b,c), Polytechnics and Universities (Adejuyigbe, 1997b, 2000, 2002b, 2002c, 2007d), the use of soybean, groundnut oil, palm oil as an alternative to soluble oil in machining mild steel materials was also carried out (Adejuyigbe, Morka, Ologunleko, 1999;

Adejuyigbe and Owoyemi, 1997; Owoyemi and Adejuyigbe,1997; Adejuyigbe 2000, Adejuyigbe and Ayodeji, 2000a,b; Ologunleko, Adekola and Adejuyigbe,2002; and Adejuyigbe, 2004). The work done in this area entails a detailed comparison of soluble oil with the performance of soybean oil, groundnut oil, and palm oil as coolant. The performance of that of palm oil was not suitable for use. It has a low correlation. The performance of soybean oil was found to be moderate, the coefficient of correlation (r) that was computed was found to be average. Groundnut has the highest correlation 0.772 and 0.842 in its natural state without additives. Further improvement was done to make it excellent lubricating oil for machining mild steel. The mixture of groundnut oil and different proportion of carboxlyic acid and Sodium Nitrate were used to determine the suitability of this oil as lubricant. The result revealed that the groundnut oil are good fit having 0.91446, 0.9883 and 0.9427 correlation with soluble oil, so it can be used in place of soluble oil. The performance of the coolant- lubricant was evaluated from its effect on mild steel. This can further be commercialized and it will bring an adaptation of our own indigenous technology and eliminate the imported soluble oil which are imported to Nigeria and thus increase our foreign reserve.

(iii) Development of Tool Wear Detector - A further research in machining was carried out in looking into the area of Computer Aided Model for automatic tool wear detection in Machining Operations by Adejuyigbe, Adeoye, Mogaji and Awopetu (2007) (Figures 2a –f and 3a-h). A computer image processing system was used to analyze the image of tools wear. The images of tools were used as a case study. The cutting tools with the different shapes (High Speed Steel cutting tool and Parting-off tool) were taken with the use of a digital camera. The pre-processing operations on the images (taken on photographic cards) included scanning in order to transfer onto a computer and convert them to digital images. Thresholding and segmentation were done in order to convert the altered background of the scanned images to a pure white background; the images were enhanced by flood filling. For the purpose of detecting the edges of the images after segmentation, the images were read and then saved as Portable Pixel Map (PPM). The edges of the images were then detected using an algorithm developed in FORTRAN based on the principle of edge detection algorithm. The functions relationship above was written in a programme, and the particular image whose edge was to be detected after being saved as Portable Pixel Map (PPM) was read and processed through the programme, Edge detection oracle j model was developed

using JAVA language default package.

Development of Single Point Tool for Machining Plastic Materials - Also a research into the design of Nigeria-made Single Point Cutting Tool to be used on the lathe machine for machining plastic materials was developed by Abadariki, Adejuyigbe, and Olarewaju (2009) - (Plates 1-8). The two major types of cutting tool materials being used for machining plastic materials are sintered carbides and high speed cutting tools which are imported into the developing countries. This research looked inwards to develop cutting tools locally to replace the imported ones. The research carried out showed that medium carbon steel rod can be shaped into blanks and heat-treated to get the required hardness of the cutting tool blanks.
All these were done to promote the wealth of manufacturing in the area of machining to a developing country Nigeria.

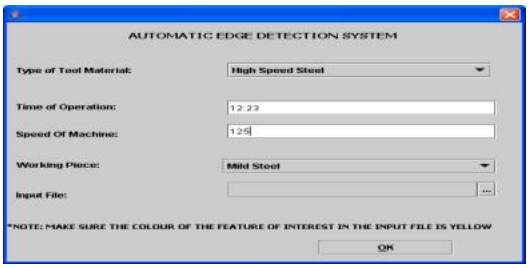


Fig. 2a: Showing the Interface

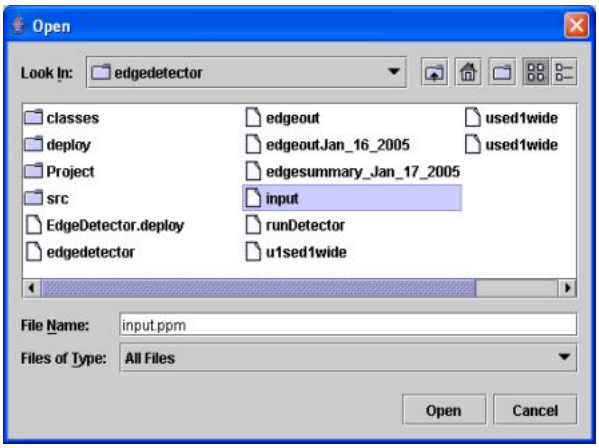


Fig 2b. : Showing Edge detector Interface

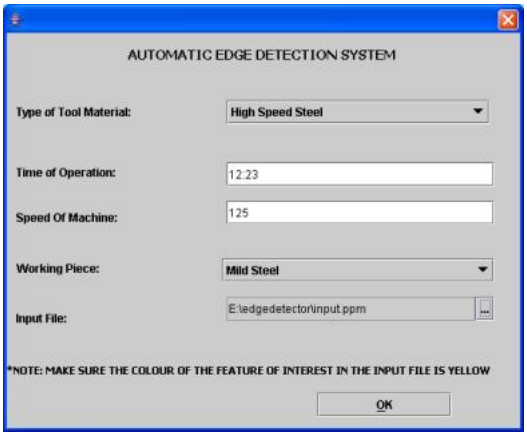


Fig.2c : Showing Edge detector Input Interface

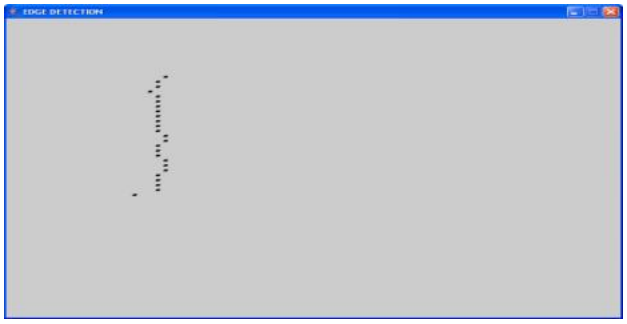


Fig. 2d: Showing Wear Detection

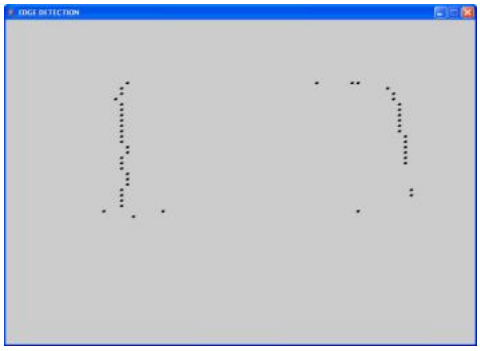


Fig. 2f: Showing Wear Detection

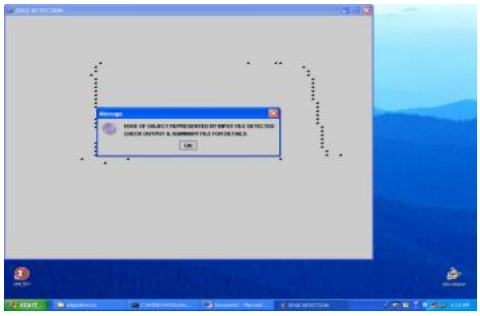


Fig. 2e : Showing Wear Detection Output

The following results were obtained from the image analysis and processing of the four images.

Fig. 3a

Fig. 3b

Fig. 3a & b represented the actual image analysis of the scanned image of the new parting-off tool.

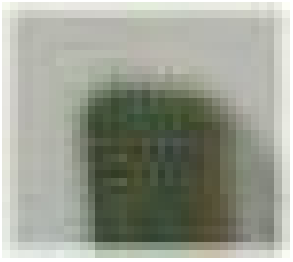


Fig. 3 c

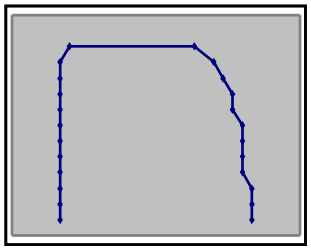


Fig. 3 d

Fig. 3c & d represented the expanded image analysis of the scanned image of the new parting-off tool.

Fig. 3 e

Fig. 3f

Fig. 3e & f represented the actual images analysis of the scanned images of the used parting-off tool.

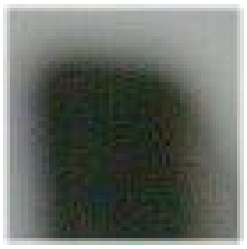


Fig. 3g

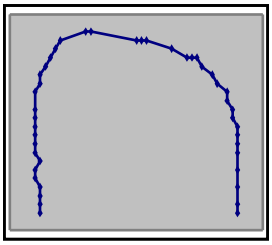


Fig. 3h

Fig. 3g & h represented the expanded image analysis of the scanned image of the new parting-off tool.

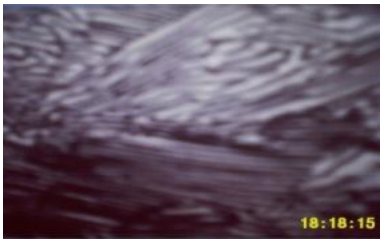


Plate 1: HSS 10 standard

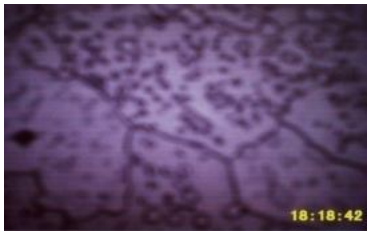


Plate 2: Blank (untreated)

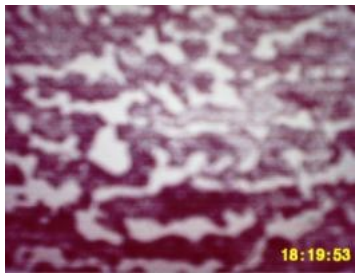


Plate 3: Blank (brine before tempering)

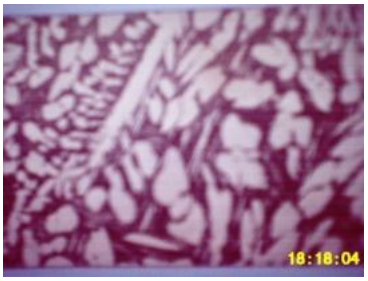


Plate 4: Blank (brine after tempering)

Plate 5: Blank (ammonia before Tempering)

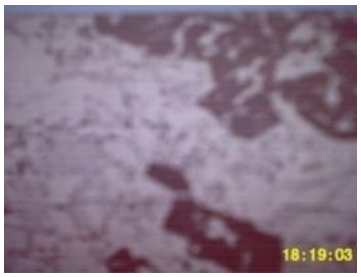


Plate 6: Blank (ammonia after Tempering

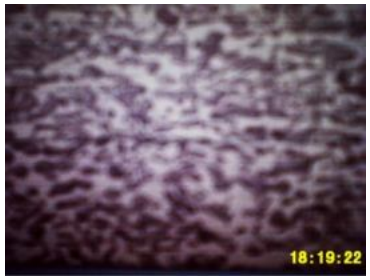


Plate 7: Blank (Oil before Tempering)

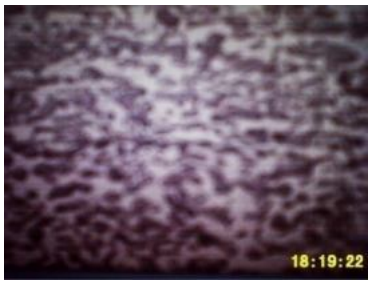


Plate 8: Blank (Oil after Tempering)

(iv) Machines Fabricated and Developed
A research into machine fabrication and development was carried out. Extensive work has been done in this area of research that will add wealth to our economy if properly harnessed. Some of the machines fabricated and constructed are presented.

(v) Looking at the Industrial sector of our economy we research into how some of the problems in this sector can be eliminated. Some of the work done in the areas are further enumerated; Adejuyigbe and Oke, (2000) took up the challenge to design, fabricate and carry out the performance evaluation of a domestic water treatment plant for the Nigerian market, using Ibadan as a case study. It was discovered that the plant developed performed excellently well than the imported ones when it was put into use (Fig. 4). Looking at the various types of keys used in Nigeria Adejuyigbe and Oyedele (2004) developed a suitable die casting mould, designed and constructed, suitable for the production of various sizes of key blanks. It makes use of grouping various types of keys that are most commonly used. If properly harnessed, it will eliminate importation of these key blanks into Nigeria (Fig.5). Oyelami and

Adejuyigbe (2006) worked on the design of a radiation- recuperative heat exchanger for a 200kg capacity rotary furnace. The heat losses to the surroundings through the waste gases were returned substantially back to the furnace through the recuperator called heat exchanger designed (Fig. 8)

Also the design, moulding and performance evaluation of cylindrical fibre- cement silo for storing two-tonnes of maize were carried out. The coconut fibre (coir) was used. The performances of the fibre – cement silo are much better than those of the existing ones. This is because, the quality of grain stored in the existing silos is lower to that of fibre – cement silo (Adejuyigbe and Akinnuli, 2006). Adejuyigbe and Bolaji (2005) carried out a design, fabrication and performance evaluation of bean dehuller having the average capacity of 3.6 kg/h and efficiency of 75.7 % for the use of our local and mini industrial farmers (Fig.6). The development of Pump Housing and Impeller by casting using local raw materials which could compare favourably in terms of performances with the imported ones was carried out by Adejuyigbe and Ayodeji (2007). Replica of the two components were carefully produced in wooden patterns to make the sand mould easy, while the casting was made using grey cast iron because of the need to machine it to its final dimensions with ease. The results obtained from the various

test carried out shows no significant difference from the standard result of the imported ones (Fig. 9). Adejuyigbe and Osasona (2007) designed and fabricated the prototype incubator for birds. Temperature range between 35 ^{o}C and 39 ^{o}C with favourable Relative Humidity needed for viable development of eggs during incubation periods were achieved. The egg trays were designed to tilt at a regular interval so as to prevent the egg embryo from getting stuck to the egg shell during incubation period. The results of the test conducted show that the best temperature for most effective hatch inability of the eggs ranges from 36.5 ^{o}C to 37 ^{o}C. However, the problem of unhealed navel as well as that of wet down feather of the chicks which were prevalent in most industrial incubators were curtailed by this newly developed prototype incubator (Fig.10). The human comfort at home was also researched into by Adejuyigbe (2007c), the design and fabrication of a pineapple fruit juice extractor that operates using pressure which is provided by screw press for the purpose of squeezing juice out of pineapple fruits was done. The device can either be operated manually with an average capacity of 14.2litres/hr or with electric motor with an average capacity of 31.3litres/hr (Fig. 11). Also the design, construction and performance evaluation of a

locally developed cassava chipping machine was carried out by Bolaji, Adejuyigbe and Ayodeji (2008). The machine has a maximum capacity of 245 kgh^{-1} at 500 rpm and maximum chipping efficiency of 92.6% at a speed of 300 rpm. The overall best performance of the machine is obtained at a speed of 400 rpm with chipping efficiency of 86.5% and chipping capacity of 240 kgh^{-1} (Fig. 12)

The automobile industry encounters a lot of problems when working on the automobile engine. In eliminating some of these problems Adejuyigbe, Bello and Agboola (2005) developed an Internal Combustion Engine Valve Installation Machine. It was designed in such a way that it can remove and install the engine valve more neatly, faster and accident free from workers (Fig. 7). Adejuyigbe, Ayodeji and Dafe (2008) also looked at the local mechanic problems and developed auxiliary equipment for improved reliability of tyre removing machine. This machine is an improvement on the type of tools/implements used by local/roadside vulcanizers. This device laid emphasis on solving some of the problems facing the local/roadside vulcanizer and the various factors causing damages on tyres**.** The results of the test show that using the constructed device for vulcanization , no

wound is inflicted on the tyre bead either when a tyre is being removed from or fixed into a car rim. It also shows that it takes an average of 3mins to break the bead of a tyre, 2mins and 3mins to remove from and fix a tyre bead into a car rim respectively. The method of operating the machine is simple. The machine ensures a safe working condition with little maintenance while the cost of production is not as much as that of an imported tyre removing/fixing machine (Fig. 13).

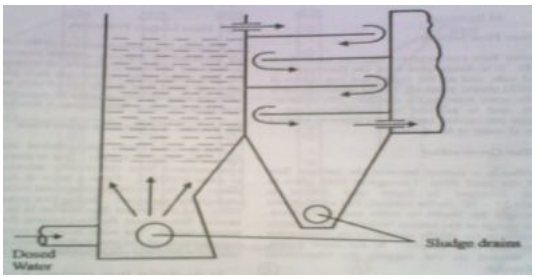


Fig.4(a) Construction of Combination Flocculator

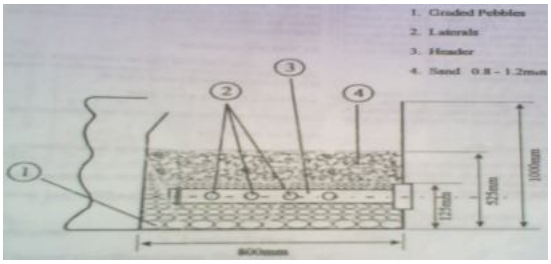


Fig. 4(b) The Filter

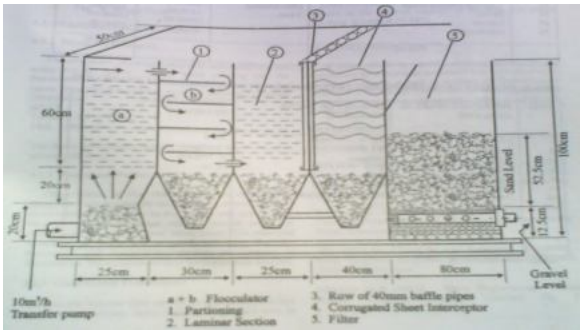


Fig. 4©.Internal View/dimensioning $10m^3/h$ plant

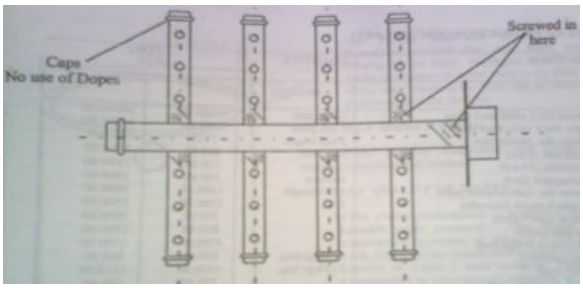


Fig. 4(d) Under side view of Header/Lateral Assembly

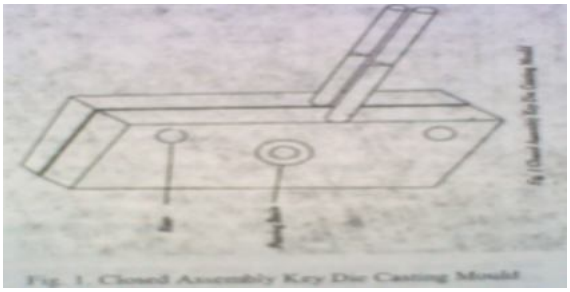


Fig.5(a) Closed Assembly Key Die Casting Mould

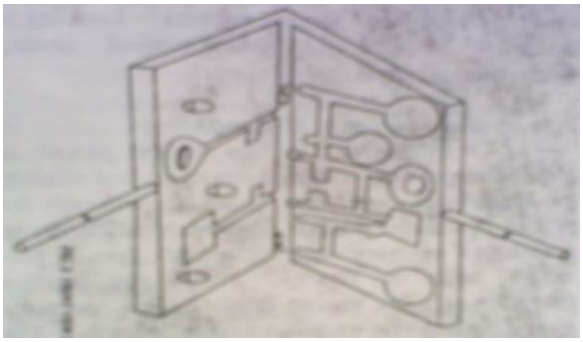


Fig.5(b)Front view of the open Key Blank Mould

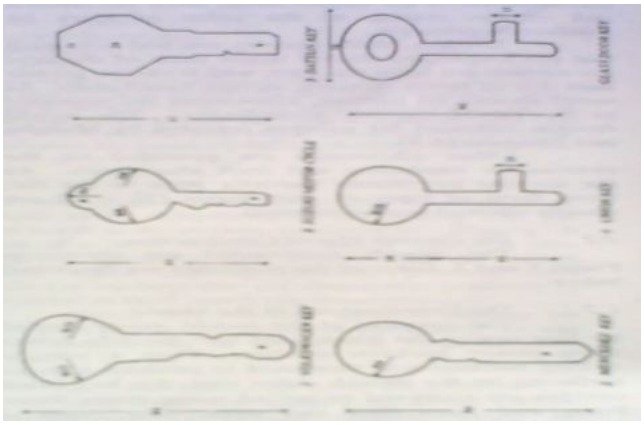


Fig.5(c) Sizes of Key Blanks

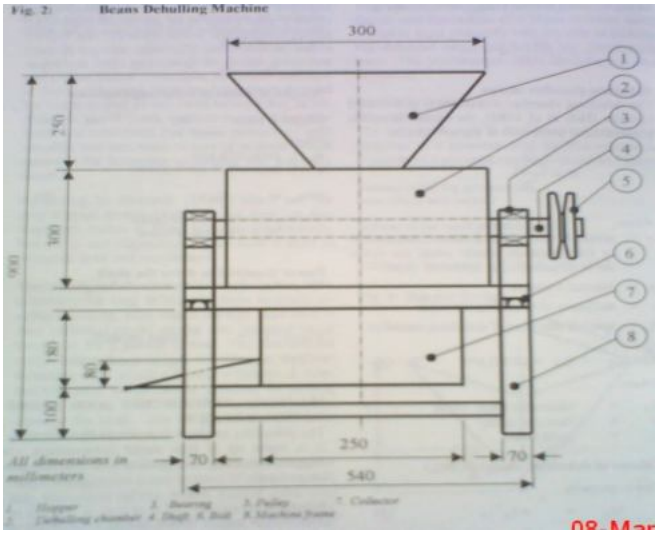


Fig. 6 Beans Dehulling Machine

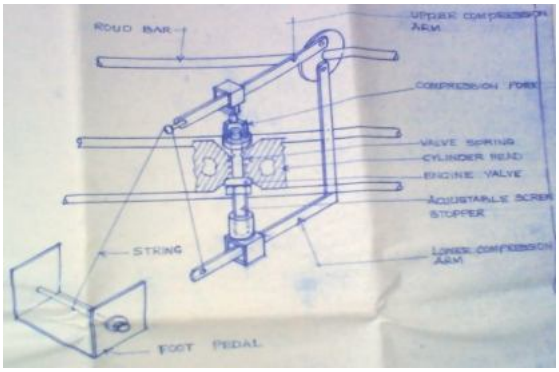


Fig. 7(a) Operational sectional View of Internal Combustion Engine Valve Installation Machine.

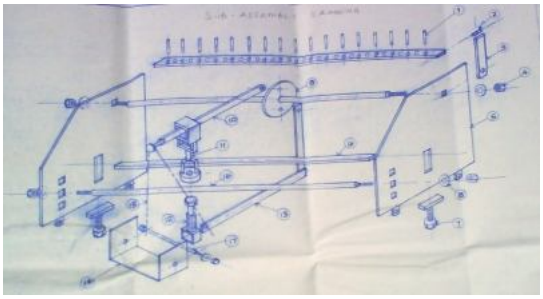


Fig. 7(b) Sub Assembly Drawing of Internal Combustion Engine Valve Installation Machine.

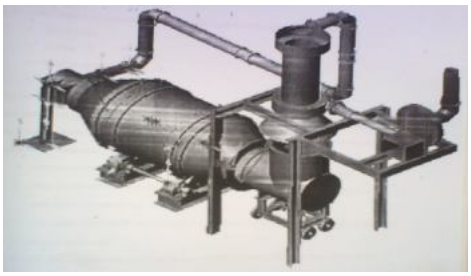


Fig. 8: Construction of Rotary Furnace

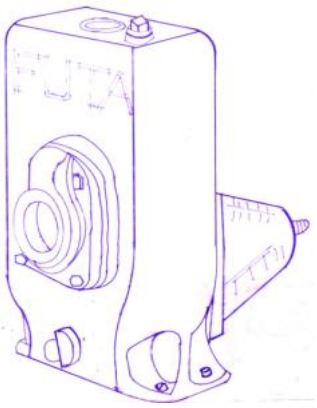


Fig.9a: Pump Housing to be cast

Fig.9d: Finished cast pump housing front view.

Fig.9e: Finished cast pump housing back view

Fig.9f: Finished cast impeller

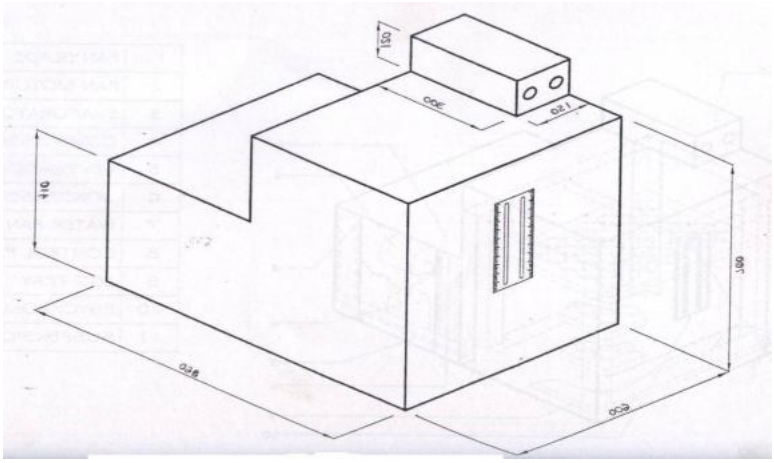


Fig.10a: Isometric view of the prototype incubator

Plate 10c: Photograph of already constructed Egg Chamber and the control panel

Plate10d : Photograph of the inner part of the Egg Chamber

Fig. 11a : Plate of the fabricated juice extractor

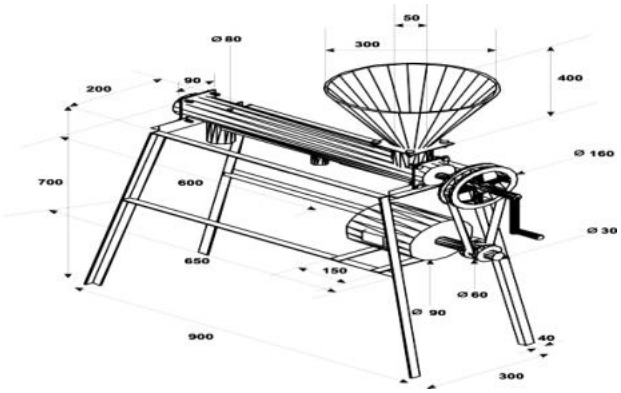


Fig11b: Construction diagram of the fruit juice extractor with measurement

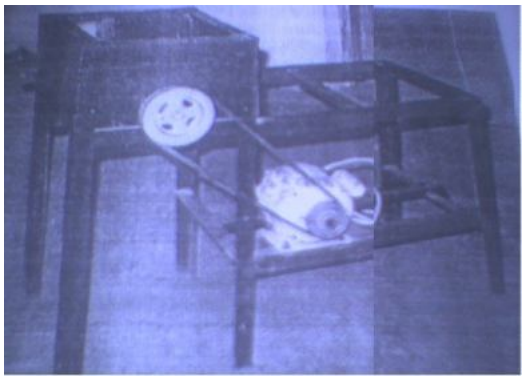


Fig. 1: Cassava chipping machine

Hopper, 2. Feeding chute, 3. Chipping unit, 4.Discharge chute, 5. Machine frame and 6. Electric motor

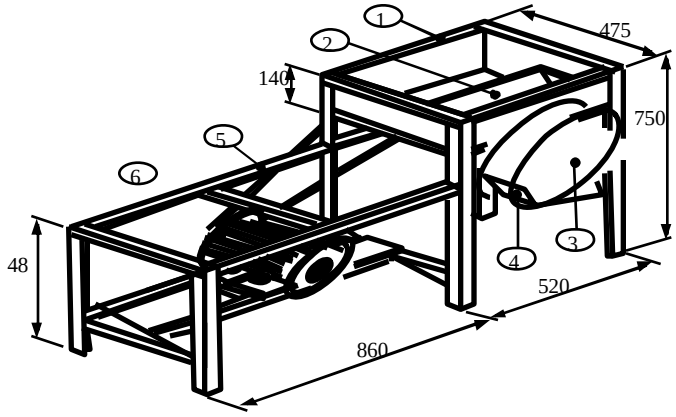


Fig. 12: Isometric drawing of the cassava chipping machine

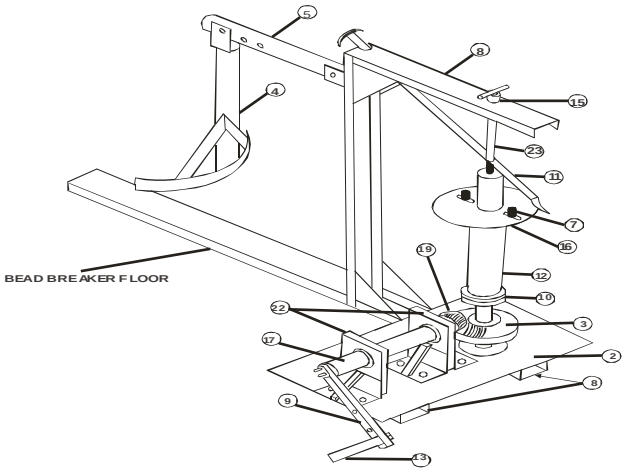


Figure 13a: Front View of the Machine

Fig. 13b: Tyre Removing and Fixing Machine

Human Factor Engineering/ Ergonomics

Human Factor Engineering / Ergonomics were researched into. Some of our model contributions in this field of specialization are enumerated below:

In relation to human comfort Fapetu and Adejuyigbe (1998) looked at alternative energy resources and potential in the next millennium. Adejuyigbe and Adeyemi (2000) carried out a research and looked at the ergonomic assessment of mass transit vehicles in Nigeria using a state owned mass transportation company as a case study. The major factors considered include the comfort of passengers' seats and the conveniences of drivers. The study revealed that the Nigerian built passenger vehicles provide no comfort for both passengers and drivers. Areas of defects in the construction of these vehicles are identified against established international standard. Also Adejuyigbe and Ali (2004) researched into the Ergonomic Evaluation of Furniture in Higher Institutions using FUTA School of Engineering as a case study. This study looked at seat occupant posture and workspace design using furniture in a higher institution as a case study. The study identified the ergonomic problems of various furniture items used by staff and students and prescribed opti-

mum designs forthwith. Adejuyigbe and Ayodeji (2008) researched into an Anthropometric data of Nigerian paraplegics and also developed a tricycle(Plates 9). This data was used to design wheel chair and tricycle for the paraplegics by developing suitable software using Visual Basic, Auto-CAD, Access and CorelDraw programs. The software developed is capable of designing within 2 minutes (Fig.15) an ergonomically viable wheelchair for any category of paraplegic using their anthropometric data.

In researching into industrial engineering ergonomics Adejuyigbe (2001) looked to the incessant burst of crude oil pipeline in Nigeria which has resulted in the death of so many in Nigeria and has been a problem and concern to all. This research investigates the causes of pipeline burst or oil spill incidents from 1990 to 1998, using the crude oil pipeline in one of the foremost petroleum development companies based in Nigeria. The research findings revealed that the major cause of pipeline burst is corrosion. Other factors are a result of sabotage, mechanical failure, production operations and engineering activities. Solutions were proffered to reduce incidence of crude oil burst and explosion. Also Adejuyigbe (2005b) looked at the Cost-to-Worth Value Engineering Analysis of Manufacturing Industries in Nigeria.

The production operations in our industries today have some of their components contributing to the cost. The result of the investigation shows that labour has very good savings, while energy has the highest value, followed by inventory and maintenance. Material purchase and quality are a little bit above normal worth. As the savings in labour gives the company's advantages, it adversely affects the labours that are paid far less than their normal worth. Adejuyigbe (2004d,e), also carried out the machine installation, mounting of shaft alignment and balancing, lubricant, lubrication, gasket and seal, for the machine installation for Oye Local Government, in Ekiti State. The safety requirements and training of the local government engineers with the ergonomics values needed for proper maintenance of the machines were done.

In the area of environmental ergonomics Bolaji and Adejuyigbe (2006) researched into the environmental pollution from vehicle sources which continues to attract worldwide attention. The danger posed to the natural environment and human health is multi-dimensional and bound to grow in significance following the global upsurge in automobile vehicle ownership and use. This research reviews the status of vehicle emissions and their effect on the natural environment. The implications of emissions such as hydrocarbons,

oxides of nitrogen, carbon monoxides, carbon dioxides among others, were discussed. Various methods of effective control of vehicular emission were also presented. Adejuyigbe and Adesona (2007) conducted a technical assessment of mechanic village in Lagos state – layout model. The findings of this research work are that the mechanics are not properly trained, the workshops are ill equipped, safety standards are low and quality of auto maintenance is poor and the location of some of the villages are poor. Therefore, a proposed new layout model for the establishment of mechanic villages that will engender higher productivity and good quality maintenance was developed. Kareem, Adejuyigbe and Ayodeji(2009) conducted a survey of automobile materials using Peugeot as a case study. It was however discovered that the materials used nowadays has changed to what is used to be.

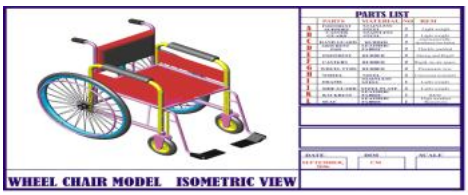


Figure 15a: Isometric View of the Wheel Chair Model

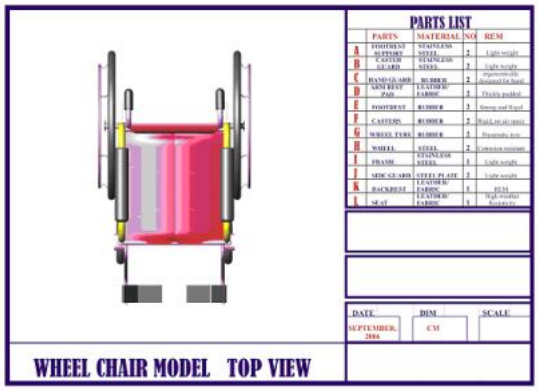


Figure 15b: Plan View of the Wheel Chair Model

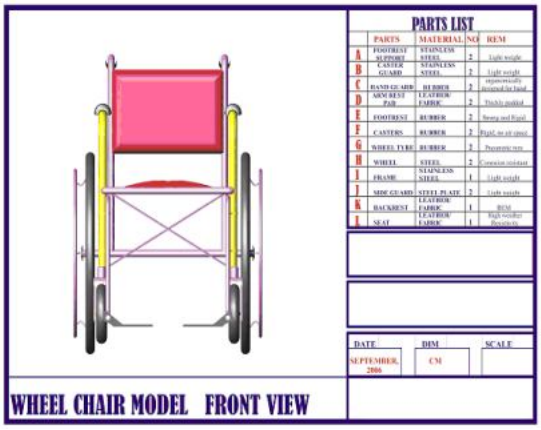


Figure 15c: Front View of the Wheelchair

Plates 9 Showing Developmental Stages of Major Components of the Tricycle

Production /Operations Management

Production and Operations Management were researched into. The summary of the findings are given below:

Operations Management in the industrial set up was researched into by Adejuyigbe (1998c,d,2006e) on Forecasting the Product Demand for a Bottling Company at Kumasi, Ghana**.** Forecasting product demand is crucial to any supplier, manufacturer, or retailer, as the process determines the quantities that should be purchased, produced, and shipped in future. For forecasting the product demand of a bottling company located in Kumasi, seasonality indices were calculated to predict the product demand for the next five years based on data collected from the previous five years. Demands for three products of this company were analysed.

The results showed that one of the products enjoyed the highest volume of demand. The forecast data could be used to plan the production of the products with respect to period of the year in which production will have to be increased above normal. Adejuyigbe, (2008b), also researched into the small scale industrial set up in Akure South Local Government Areas of Ondo State of Nigeria, which is highly unorganised, and most of them are scattered all over around important centres of production. The entrepreneurs are mostly

illiterate and there has been hardly any effort on the part of the industry or the government to impart even the rudimentary industrial skill on them. The study reveals that small-scale industry is faced with the problem of under-utilization of capacity. This is caused by the problems relating to labour, financial constraints, raw materials bottlenecks and demand constraints. The evaluation and determination of the profit analysis was done using break-even analysis. It was, however, discovered that only 30% of the industries under survey got a reasonable break-even points since their year of inception. Adejuyigbe(2006f) evaluated the problems facing manufacturing sector in West African sub-region and use Nigeria and Ghana as a case study. The result obtained showed that there is decline in productivity and that the growth rate of manufacturing sector in the West African sub -region is very low and slow. It also reveals that the income generation to the GDP in this sector is not as high as what obtains in some developing and developed countries like India, USA and Britain. Therefore, attention to salvage the manufacturing sector from total collapse and the ways to move the manufacturing sector forward in developing countries were suggested.

Adejuyigbe(2008a) also researched into the Ownership and Leadership structures of organization in the manufacturing

industry (small, medium and large scale), which has been a problem in a developing economy like Nigeria. The integration of these two in any organization has been a source of conflict which the organization tried to find solution to. This research, therefore, looked at the problems of leadership and ownership in manufacturing industries using ten industries, five of which are of small scale and five which are classified as medium/large scale industrial set up in Lagos State. It was, however, discovered that the liability companies are better managed, more disciplined and workers tend to be more active with best profit and production output than sole ownership companies.

Production engineers play a major role in architectural applications Adejuyigbe, Fadamiro and Oluwatoba, (2008) did a research into the use of some of the engineering materials used for architectural designs. No structure can be erected without making use of one or more materials produced by engineers. In this research, some buildings were examined and we noticed that their window frames, roofs and doors were attacked by termites, corrosion and so on.

It was also discovered that where aluminium materials were used in some of the buildings, the level of durability was high because of their advanced characteristics. Termites

could not attack it, and they can be seen in different forms, (plain or alloy), treated in different way. Adejuyigbe, Ayodeji and Fakiyesi (2008) observed that workers are one of the main causes of low efficiency and poor quality in manufacturing system. The implication of this for practitioners is that the causes of disruption and their system should be carefully assessed before intervening to improve workers' performance. Therefore, this research examined whether or not workers are the main cause of low efficiency and poor quality, as is often assumed by management. The Stochastic Modeling and Human Performance Variation (HPV) models were used in this study. The results show that the system under study has many independent manual operations, many more that are usually dealt with by theoretical studies, hence exhibited very complicated and unpredictable behaviours. Observation of the simulations and the real world system showed that its normal mode of operation is not one of constant material flow, but rather intermittent flow, due to the presence of random breakdowns.

3.3 Computer Aided Engineering (CAD /CADD /CAM / CAPP /CIM), Knowledge-Based Expert System, Artificial Intelligence, Automation and Robotics

This aspect of my research started during my Masters programme when Late Dr. O. Ogunlade introduced the course to me and supervised my Masters Project on Computer Aided Design and Drafting (CADD) of Sand Casting Products (Adejuyigbe, 1997a; Adejuyigbe and Ogunlade, 1998,1999). Prof. Aderoba perfected this area of specialization in me when he supervised my PhD research work in Computer Integrated

Manufacturing (CIM) of Sand Casting Processes (Adejuyigbe, 2002a, Adejuyigbe and Aderoba, 2003, Adejuyigbe, Mogaji and Aderoba, 2003) Since then I had been making frantic effort to research into this modern tool used in eliminating some drudgery in the manufacturing sector and improvement in bringing to our system wealth that is witnessed in developed countries where this tool is in use. Some of my modest contributions in these areas can be divided into the following sub sections;

- Computer Aided Design/ Drafting (CAD/CADD)
- Computer Aided Manufacturing (CAM)
- Computer Integrated Manufacturing (CIM)
- Computer Aided Process Planning (CAPP)
- Knowledge Based Expert System and

- Artificial Intelligence, Automation and Robotics.

Computer Aided Design/ Drafting (CAD/CADD)

A lot of work has been done in this area of research. These are presented in the following analysis:

Computer Aided Design (CAD) Developed: Plant Layout using CAD was researched into by Adejuyigbe and Aderoba (2003), The focus of the study was a re-evaluation of basic plant layout in one of the foundry industries in Nigeria. The computer was used as an aid to design for sand casting foundry shop layout (CAD). The result of the research shows that the alternative layout generated by the computer programme for the case study foundry shop reduces material handling time, cost, maximizes adjacencies between the departments and machines of the foundry shop, improves product quality, boosts employer's morale, reduces product costs and increases overall efficiency and productivity.

Computer Aided Design and Drafting (CADD) Models Developed. The development of a sequential CADD model (process and mould) to be used in sand casting manufacture was carried out by Adejuyigbe (2003a). A suitable CAD software programme was developed using Quick Basic Language tagged CAD PROG I which generate automatically a

drawing of sand casting mould, and all the parameters and data needed to produce a sound casting devoid of defects. The mould designed follows the normal type of cope and drag sand casting which utilizes a 2D schematic solid model of cross sectional area view. The advantage of the model is that numerous data from different materials can be used to automatically give varied output and different shapes and results. Adejuyigbe, Aderoba and Mogaji (2003) developed a computer software to provide a cost estimation of sand casting products. The costing procedure used is a generalized cost-estimation model from Computer-Aided Design and Manufacturing (CAD/CAM) of sand casting products to provide cost estimation for sand casting materials. The cost-estimation model was validated with a practical component produced in a foundry industry using aluminum, cast iron and brass for the casting of bosses and flanges. Adejuyigbe and Adebowale (2008), also developed Computer Aided Drafting of motorcycle assembly. Drafting and Assembly of motorcycle parts may be prepared by other means other than the use of conventional tools. The Computer-Aided Design and Drafting (CADD) is a drafting technique where a computer is used to aid the drafting of a component. This project used CADD drafting technique for a motorcycle assembly. . The methodology used in achieving this research is by understanding the geometry of each component and drafting it

by a CAD package called auto CAD. The result of the CADD obtained revealed that computer is an indispensable tool for drafters and it is a task accelerator that reduces the drudgery of manual drafting. Adejuyigbe and Adekunle (2008) developed a welding operation which is joining two metals together. The need arises on how to minimize or eliminate the error encountered when fatigue sets in due to low efficiency of the local welder. CADD software for welding was developed using Microsoft Visual Basic 6.0 which was used to weld two mild steel plates together automatically. The result of the research clearly shows that robotic welding is faster, error free and uniformly welded all through like that of the CADD welding model developed. It is highly suggested and recommended that further work on robotics can be embark upon to bring Nigeria to the level of an industrialized nation.

Computer Aided Manufacturing (CAM)

Computer Aided Manufacturing in Casting: Adejuyigbe (2002a, 2002c, 2004c, 2006a 2006c),investigates the traditional methods of sand casting processes. It also develops computer software called EASYCAST for manufacturing process of sand casting using computer as an aid. A suitable computer programme was developed to implement the algorithm for the computerization process. A life (two practical)

components or products was used to test the validity of the computer software developed. A further study was done on Computer Aided Design/Computer Aided Manufacturing (CAD/CAM) in Nigeria Casting Industries. Questionnaires were administered in twelve (12) casting industries visited in Lagos, Osun and Kogi States. The result of the research shows that 42% of the industries under study had incorporated CAD/CAM in their casting industries, while about 58% has not incorporated CAD/CAM into their operation. It was however discovered that about 71% of Nigeria casting industries are still depending on foreign raw material (software packages) because of insufficient software developers that are few in our developing society. Adejuyigbe, Mogaji and Aderoba (2003), Mogaji and Adejuyigbe (2007) Developed a suitable Computer – Aided Costing (CAC) software programme using Matrix Laboratory Language (MATLAB) for costing of sand casting product. It makes use of product mix model that was also developed and was used as input for both the computer and manual calculations. Three samples each of boss (round object with hole inside) and flange (two rectangular bosses) from the following materials, Aluminium, Cast iron and Brass were used to achieve the results. The Computer – Aided Costing (CAC) results were compared, analysed and correlated having correlation (R) to be 99.9% with the hand calculated costing

results. Adejuyigbe, Mogaji and Bada (2008), did a research is on computer aided casting of aluminum using die-casting. A piston, which is an automobile part and very important in internal combination engine, was chosen for the research. Pistons are made of aluminum alloy. Models of the products were developed to aid the casting process. The result shows that computer which is faster with accurate result can be used as an aid in the production of aluminum using die-casting process and for accurate planning in the manufacture of the product.

Computer Aided Manufacturing in Cement Industry: Research into the development of software for modeling cement production process in industry using JAVA, a multi-purpose computer programme, was done by Adejuyigbe and Ogbeide (2007).The application of this software to a real life situation using West African Portland cement as a case study shows the effect of machine or material limiting factor on the cement production level for any given period and the associated manufacture cost was done. The computer software was able to offer a better output of cement production within a given period compared to that of the conventional method. The application of this computer software shows a percentage difference in the manufacture cost of between 0.02% - 0.13% when compared to the manual method

Computer Integrated Manufacturing (CIM)

Ogedengbe, Adejuyigbe and Aderoba (2002) investigated the adoption of Computer Integrated Manufacturing (CIM) in Nigeria using manufacturing industries in the southwestern zone of Nigeria as a case study. The result of the analysis revealed that the level of understanding of CIM is generally low; an average rating of 1.94 corresponding to 38.8% of the review instrument. Also, the adoption of CIM is very low with an average rating 0.865. This corresponds to 17.3% of the total point of the review instrument. The study further revealed the various problems facing the adoption of computer integrated manufacturing in Nigeria. Recommendations were made to promote the adoption of computer integrated manufacturing in Nigeria and ensure improved productivity was therefore suggested. Adejuyigbe (2002a) developed an Integrated Computer-Aided Design (CAD) Database System for sand casting operations having modular build up principle. The model incorporates standard shape changes which are required to effect feeding as a result of thermal contraction and solidification. The types of materials, aluminium, cast iron, and brass were used to validate the model developed in a practical Machine Industry having standard foundry shop. The result revealed that the Computer-Aided Design (CAD) database systems achieved a better result than the manually controlled data.

Computer Aided Process Planning (CAPP)

Adejuyigbe (1994a, 2002b 2004a, 2005c), researched into the application of a computer system to plan coil coating processes for an organization known as Enterprise Resource Planning (ERP). A detailed study of the organization's order of production, and finally the finished goods from work in progress and scrap generations were investigated. The programming language used for planning the process is called Oracle. The processes of each step are handled by the department concerned using network system with a central server. Each department has its own report generation from the programme. Findings from the research were that Computer Aided Process Planning used reduced idle time in production and increases the production output twofold. It also reduced the paper work thereby saving a lot of money on stationery for the company.

Also Adejuyigbe and Ayeni (2008) research into the use of Material Requirement Planning (MRP) and the evaluation of raw materials using Computer to aid the planning of a job shop have been undertaken. Raw Material Planning (MRP) models and computer programme (Visual Basic) to automatically generate the result was developed. A typical job shop industry was used to test the validity of the model and computer programme developed. It is found readily useful

in developed and developing countries where the situation prevails. The result shows an improvement upon the vigorous manual method used in the time past, and minimizes the service level of the firm's customer and investment in inventory.

Knowledge Based Expert System

Adejuyigbe and Saba (2004) researched into the development of Expert System in Process Planning for Polymer products in a typical polymer processing industry in Nigeria. A suitable Expert System software program model was generated using visual basic language. The program and model are developed to generate automatically manufacturing procedures and parameters needed to plan the polymer production. The results obtained show that the models and the Expert System developed are reliable and can be used in producing a good polymer product without any form of wastage from spillage of raw materials, material mix up during loading and mixing etc. production cost and time are relatively reduced too.

Artificial Intelligence, Automation and Robotics.

Industrial Automation - Adejuyigbe and Ayodeji (2005) researched into technical assessment of welding process automation in Nigeria. The research was designed to assess the degree of use of welding automation in Nigeria manu-

manufacturing industries. Under study, the limitations and problems facing the use of welding automation in the Nigerian manufacturing industries and solutions were proffered where applicable were identified. The study has shown clearly that welding automation is still far from reality in Nigerian manufacturing industries. Adejuyigbe (2006b,g), looked at Industrial Automation in Ghanaian Industries using Kumasi Metropolis as a case study. It was aimed at investigating the various types of industries in the metropolis in terms of operational conditions, evaluating the ones that were Manually Operated, Computer-Aided, Semi-Automated or Fully Automated. It also evaluated the effects of Automation on the companies that are automated and found out ways of improving the manually operated companies. It was, however, realized from the research that Ghana needs a lot of improvement in the area of automation since about 10% of the companies are fully automated. Therefore, it can be concluded that the companies in Ghana are not enjoying the benefits of automation such as reduction in scrap, reduced labour cost as witnessed in advanced countries. Hence the call that manufacturing industries in Ghana should embrace automation so as to enjoy its benefits to its fullest as witnessed in the developed countries of the world. Adejuyigbe (2007a) also conducted a study on industrial automation and communication in Nigeria's industries which

showed that majority of Nigerian industries have embarked on full automation system. Some have the machine already in place, but not in use as a result of one problem or the other. Adejuyigbe (2006g) researched into the convectional engine systems and operations in a Mechatronics World (Fig. 23). In this research conventional engine systems and operations were looked at. It also looked at bits relevance to mechatronics and suggests a way forward to improve the teaching and the introduction of this modern day computer aided electronics market in a developing economy like Nigeria.

Artificial Intelligence and Virtual Reality - Adejuyigbe and Laseinde (2009) researched into the manufacturing of plastic spur gears using Virtual Reality (VR). It aims at developing a functional model and further validating the model for the production of plastic spur gears. Also, it aims at developing Virtual Reality architecture capable of depicting a real life production process of plastic spur gears. The result obtained shows the construction, modeling and rendering of a complete plastic spur gear manufacturing process. This was achieved using AutoCAD, 3Dmax, macromedia flash and Q-basic. In conclusion Virtual Reality can be applied as a useful teaching tool for the improvement of engineering learning processes especially in areas with limited access to required learning infrastructure (Fig. 23)

Software Development for Nigeria Machine Tools, Oshogbo - Adejuyigbe and Olaniyan (2007) developed interactive software known as CADDNMT 2006 using a Visual Basic Program. This software permits proper communication with the user and is interactive in nature. The database is restricted to only engineering and production department of the industry so as to reduce the complexity of the design structure. The visual basic program developed shows the database of the standard facilities that are supposed to be in existence in a standard machine tool industry and the facility available in the case study Nigeria-Machine Tool industry, Osogbo. The software developed shows the database of the difference in the standard and existing facilities. The database of the operation of each section in production and manufacturing department of the industry was also developed using the software. It also links all the sections in the company and network all the departments in the company thereby making it interactive.

Software for Rotary Furnace - Oyelami and Adejuyigbe (2006, 2007) developed software, written in Visual C++ Programming Language, for the design of recuperator-

incorporated rotary furnace. The reliability of the developed software was tested and ascertained by obtaining a set of data from an operating rotary furnace of know capacity; generating a corresponding set of data for the same furnace capacity from the developed program and establishing that there is no significant difference between the two sets of data using t-test. With the knowledge of only the capacity of the rotary furnace, the recuperator is to be used for the developed software has the necessary database to design not only the recuperator but also the rotary furnace itself. This obviates the rigor of designing and redesigning for different furnace capacities.

Software for Jigs and Fixtures - Adejuyigbe, Mogaji and Odufale (2007) designed and developed computer software that would automatically draw the needed jigs and fixtures from the data of the flange (object). A description of the design requirements and constraints was obtained by considering the different configurations of the work piece. A geometric model of the fixture was developed and analysed for kinematics, force and deformation compatibility. A heuristic algorithm was developed and the

program written using JAVA language default package. The program is user-friendly and was written in modules to allow for flexibility and quick responsiveness. The program was validated with real life sample data from a work piece. Figure 16 shows the dialog box displaying the buttons of the database for standard, existing, differences in the standard and existing and the operation carried out in the production and manufacturing department of the industry. By pressing any of the buttons it will take you to another dialog box that displays the different sections of the machine tool industry. By further pressing the buttons of each section, it will display the database of the facilities of the section that shows the facility, the quantity of it and its capacity.

Fig.16a. The dialog box showing the buttons for the database access.

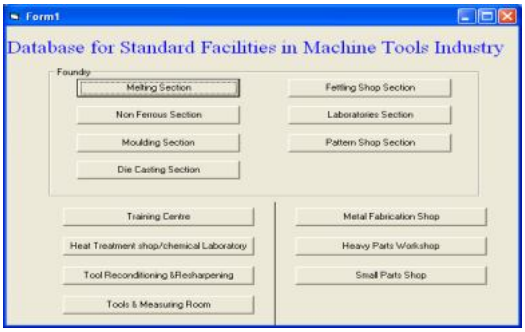


Fig.16b: The dialog box showing the buttons of different sections of the machine tool industry

By pressing any of these buttons it will display the database of the facility of each section. The examples of the databases are as shown in the Figures below:From the database of the difference between the existing and the standard facilities, it was shown that Nigeria Machine Tools only need to upgrade their industry with a few facilities in order to meet the required standard.

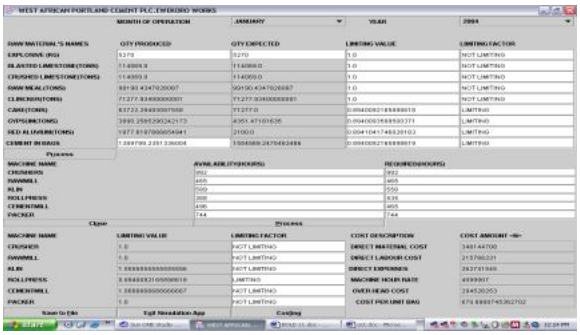


Fig. 17 Developed software

Fig. 17 Developed software showing effect of limitations on production level and manufacturing cost of cement for the month of January.

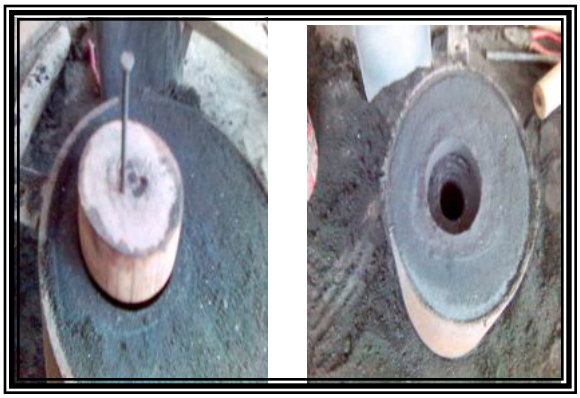
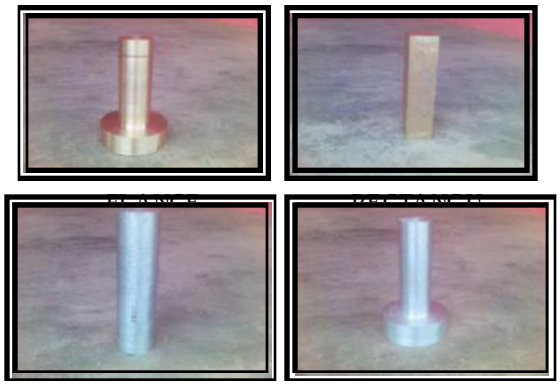


Fig. 18a . Plates for Mould Preparation

Fig. 18b Plates of the Products after Casting before machining



CYLINDRICAL FLANGE

Fig. 18c The Finished Products after Machin-

Fig. 18d The Programme Interface

Fig. 19a Jig Main Menu

Fig. 19b: Data Parameter Interface

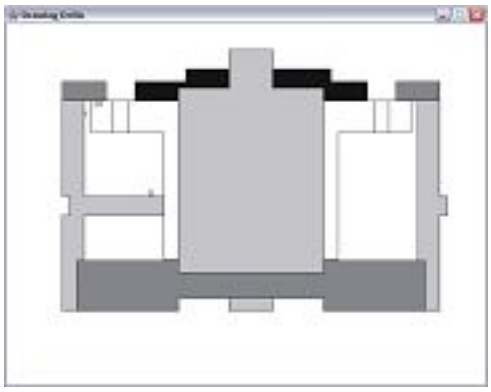


Fig. 19c: Complete Jigs and Fixtures Design for drilling the work

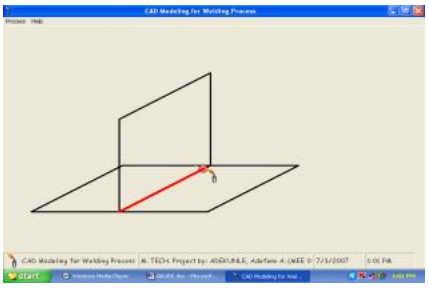


Fig. 20. Automatic gas welding operation

Plate 20 shows the automatic gas welding operation completed. It stopped at the input figure which was 2500mm. The materials' positions can be varied and at the same time, weld's stop position can be altered. Consequently various welding positions were captured.

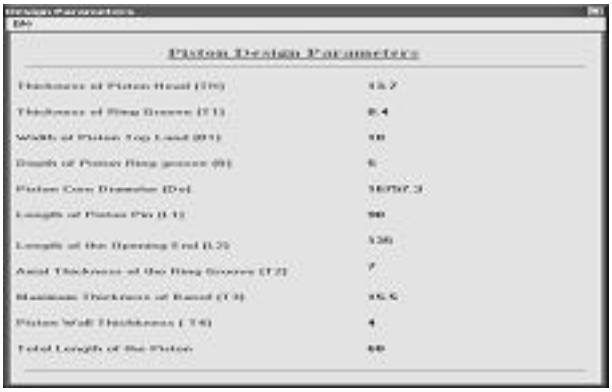


Fig.21a. Piston Design Parameters

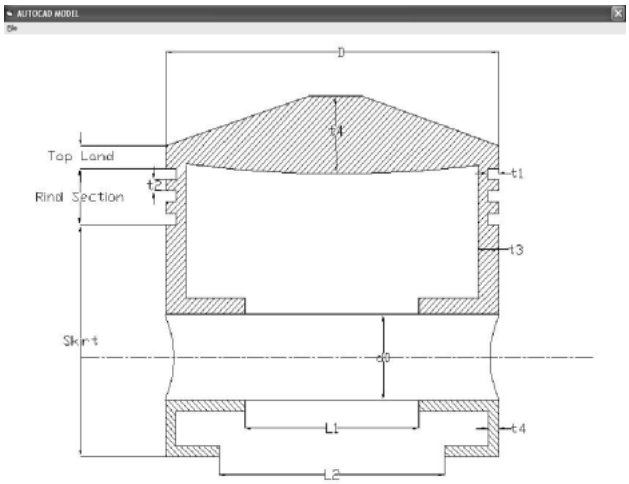


Fig. 21 b: Computer Aided Piston Model Developed

Development of Computer Interface for the Assembly of Motorcycle Parts

The development of computer interface for the assembly of motorcycle parts are done in Figures 22(1 to 32) as shown below thus; The process involves inputting the view you want to start drafting from. Then enter the commands for the creation of the 2D of the view input, then followed by the 3D commands to create the 3D model of the shape. Check if the shape is defined, if yes, then end.

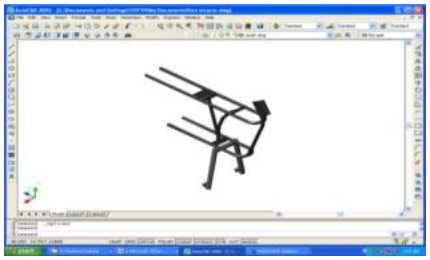


Fig. 22(1): Couple the Main Stand to the Full Frame.

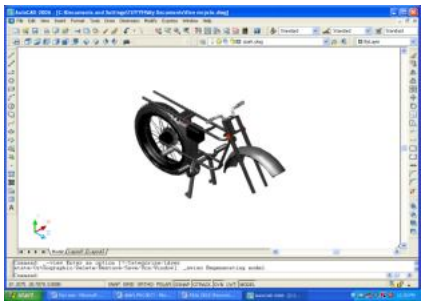


Fig. 22 (13) Couple the Handlebar to the Steering Box.

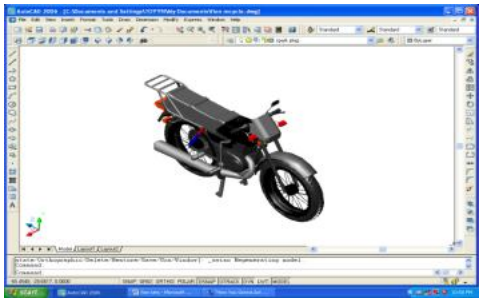


Fig .22(32): Couple the Windshield

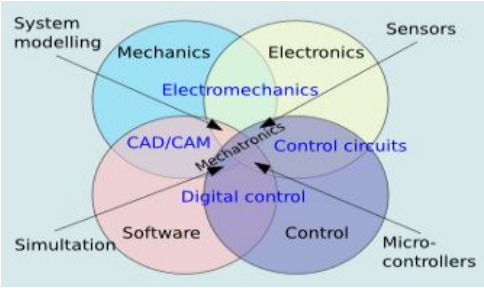


Figure 23: Mechatronics Venn diagram (Source: Wikipedia, 2007)

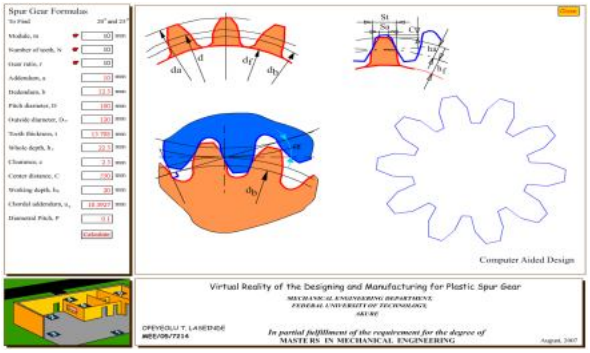


Fig. 24: Spur Gear Calculation User Interface

The parameters were imputed and the results obtained are as shown in Fig.24. Intelligence has been built into the system such that it matches the imputed variables with the standard spur gear formulas already built into the applica-

tion thereby generating accurate results for addendum (a), pitch diameter (D), outside diameter (D_o), tooth thickness (t), whole depth (h_t), clearance (c), centre distance (C), working depth (h_k), diametral pitch (P), chordal addendum (a_c). The results obtained shall be compared with that computed manually in order to find out the level of variation from standard in both cases and an inference/deduction drawn out. Adejuyigbe (1993a, b, 2004a) also examined the adage which says "a hungry man is an angry man". He concluded that no amount of prophetic solution from engineering and technological point of view can eradicate poverty in Nigeria without first solving the inability to produce cheap and abundant food all the year round so that Nigerian masses can feed well. The inability to produce abundant and cheap food all the year round, and the scarcity of food during the dry season in developing countries like Nigeria was attributed to poor planning and the execution of planning that lack adequate tool, control and feed back in the agricultural production structure.

Therefore, this research highlights the role of planning in agricultural production and developed a canonical model used to plan agricultural production with the use of numerical illustrations which dictated how the model can be used to obtain agricultural produce all the year round

(Fig. 25 a,b)

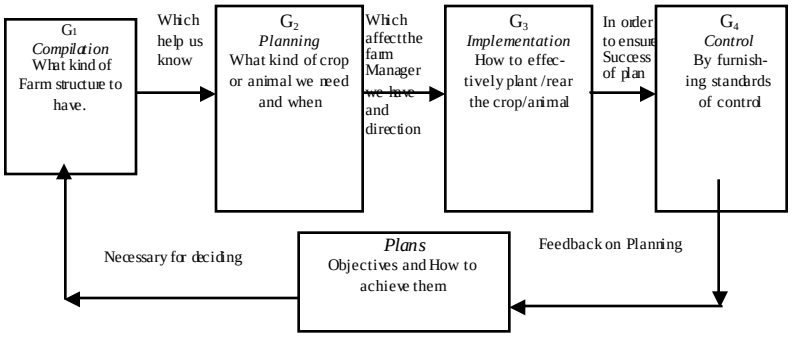


Fig. 25a: The closed Loop of Plan Objective for Agricultural Production.

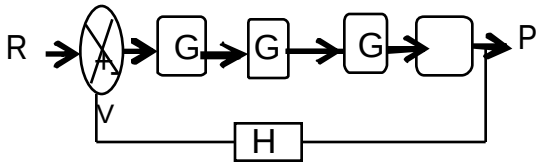


Fig. 25 b: Canonical Closed Loop Diagram.

4.0 IDENTIFIED PROBLEM AREAS AND THE POSSIBLE SOLUTION IN BOTH NIGERIA MANUFACTURING SECTOR, AND THE INTRODUCTION OF COMPUTER TO MANUFACTURING PROCESSES.

The problems identified in the manufacturing sub sector in Nigeria are:

- There is decline in the GDP figures in manufacturing sector which is a bad omen for manufacturing sector in

- West-African sub- sector, especially, Nigeria.
- The non-recognition of the weakness of manufacturing in this region is a problem on its self. The government should, through incentives, encourage manufacturing to teamwork and share facilities.
- Much of the future of manufacturing in this country or West African countries lies in research and development and high-tech innovations which will cut costs and drive manufacturing to its desired position. This is not yet recognized in these developing countries. Much of the research carried out in our Universities and Polytechnics die with them. The will and money to translate it into reality lies with the government and individual entrepreneurship.
- Manufacturing creates a lot of job opportunities in developed countries which is not the case in developing countries. Creation of small, medium and high level manufacturing companies should be established. The already existing ones should not be allowed to die.
- The development of our own indigenous technology is very important and should be encouraged. Enough of wastages in our research efforts in higher institutions. Imported technology which cannot be maintained should give way to our own developed technology, using available local raw materials.

- A lot of manufactured materials are imported into the West Africa sub- region, like lubricants, as discussed in this lecture. The region should endeavour to develop its own technology and put a stop to massive importation. A stop should be put to dumped, second hand, counterfeit and substandard products in the Nigerian market.
- The wages of factory workers in Nigeria is too small when compared with their counterparts, internationally. A value analysis research in manufacturing, as conducted by this researcher in 2003 shows that the power needed to run our industries has replaced what should be paid to workers .This should not be allowed to go on in this sub - region.
- Manufacturing industries should be established in Nigeria to create employment opportunities for thousands of youths seeking employment. Employment prospects have a profound impact on consumer sentiment and cannot be dismissed as a key factor in spending pattern. It cannot also be dismissed that failure to provide employment to the youth has caused unnecessary hardship and armed robbery in our sub - region.
- As a matter of urgency, textile industries in Nigeria should be rescued from total collapse. The Nigerian Textile Manufacturers' Association once predicted a total collapse of the industry, if nothing is done to reverse

the declining state of the industry. Claiming that the textile industry suffered a whopping 64 % decline between 1994 and 2005.

- The contribution of the manufacturing to GDP, which has been declining over the years should be looked into. The manufacturing and other sectors of the economy remain weak in both countries under study (Nigeria and Ghana).
- Drastic currency devaluation, which characterizes the developing country's economy, should be looked into. This makes it exceptionally expensive to purchase inputs and difficult to obtain bank credit which hurt businessmen in the manufacturing sector.
- Local development of our technology should be emphasized.
- Prohibitive interest rates on loans from existing finance institutions should be looked into.
- Unwillingness of foreign partners to form durable partnership with Nigerian Manufacturing developers. The syndrome of '419' should be looked into. The case of Ghana is a little bit different in this because foreign partners are willing to work with them.
- The communal unrest in the areas of gas distribution, through pipelines to the plants that has stagnated manu-

manufacturing, most especially as from 2004, in Nigeria should stop.

- Reduced or no electricity supply and the general poor condition of basic infrastructure, which hamper manufacturing should not be allowed to continue. Power supply should be reliable and dependable. Without this, there cannot be any meaningful manufacturing development in Nigeria.
- The deplorable energy or power situation, which has contributed to low capacity utilisation should not be allowed to continue. I lend my voice to that of Ambassador Segun Apata, Chairman, Nigeria Bottling Company Plc., who attributed the failure of manufacturing to power, which is one of the major factors militating against the growth of manufacturing in Nigeria. He calls for urgent solution to the problem of power in Nigeria
- The new tool of Computer to aid our manufacturing industries and the use of artificial Intelligence, Knowledge based expert system should be explored. This is a new concept that Industrial Nations are using to break even and have sufficient funds to rule the world.

  The computerization of many of the basic manufacturing tasks (design, process analysis, scheduling, material control, process control, etc.) should be pursued. Intell-

igence (whereby systems can learn and make decisions) should be fully introduced in process control and management system of the manufacturing industries in Nigeria. Similarly, electronic displays and data processors (mechatronics) which have been incorporated in design of many products (e.g. fuel injection, voice recognition) in developed or industrialized nations should be embraced in Nigeria, so as to feel the impact of the information technology.

5.0 Conclusion

The analysis of how manufacturing engineering and the use of computer as tools to aid manufacturing for creating wealth in Nigeria has been explored in this lecture. The way to move forward this sector (manufacturing) has also been analysed. When Nigeria decides to take some of the suggested steps, then the sky will be the limit for the growth of manufacturing sector by taking the advantages of what Computer Aided Engineering offer manufacturing. It is however expected that the wealth in manufacturing as witnessed by the developed or industrialised nations known as G7 countries, should also be witnessed in our own country by employing the new engineering methods.

6.0 Acknowledgement

Mr. Vice Chancellor Sir, I am standing before you today to celebrate the goodness of God upon my life by delivering this Inaugural lecture. This is possible through the Grace and Favour which I received from God Almighty, the creator of all things, who nurtured me through the wilderness of life and made me to be fulfilled on earth. That a farm boy of yesteryears is now giving Inaugural Lecture in a Federal University like UNAAB is the Lord's doing. What a privilege to be a University Professor! But God has done it in my life, therefore, for this great and rare opportunity for me to reach this height, I give all the Glory, Thanks, Praise and Honour to HIM for He is Good and His Mercy Endures forever. Chorus: Who is like unto thee……

I want to thank sincerely my parents, Late Michael Obisesan Owolola Adejuyigbe who died on 1st February, 1991. My Mother has no equal (Obinrin bi Okunrin), Deaconess Rachael Dada Adejuyigbe, the Iya Egbe, Christ Apostolic Church, Oke Ayo, Efon Alaye. She was there for me during my struggling days. Seeing me, her last born giving an Inaugural Lecture is a thing of joy. Mama mi e se o. I want to sincerely appreciate my uncle Pastor Dr.

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Mr. Vice Chancellor, Sir, distinguished guests, ladies and gentlemen, I thank you all for listening and God Bless You.

References

Abadariki, S.O. Adejuyigbe S.B. and Olarewaju S.O. (2009). Design of Single Point Lathe Cutting Tool for Turning Plastic Materials. Journal of Applied Science and Technology (JAST) Council for Scientific and Industrial Research (CSIR), Accra Ghana. Accepted.

Adejuyigbe, S.B. and Akinlosose, K.R. (1987a). Ilesanmi Metalwork for Senior Secondary Schools, Book One. Ilesanmi Press (Educational Publishers) Limited. Imo Ilesa. Oyo State, Nigeria. ISBN 97-157-516-8

Adejuyigbe, S.B. and Akinlosose, K.R. (1987b). Ilesanmi Metalwork for Senior Secondary Schools, Book Two. Ilesanmi Press (Educational Publishers) Limited. Imo Ilesa. Oyo State, Nigeria. ISBN 978 – 157 – 538 – 9

Adejuyigbe, S.B. and Akinlosose, K.R. (1987c). Ilesanmi Metalwork for Senior Secondary Schools, Book Three.

Ilesanmi Press (Educational Publishers) Limited. Imo Ilesa. Oyo State, Nigeria. ISBN 978- 157- 518-X

Adejuyigbe, S.B. (1993a). Computer Based Production Planning and Control System in Nigerian Industries. Post Graduate Diploma Thesis in the Department of Mechanical/ Production Engineering of Enugu State University of Science and Technology, Enugu State of Nigeria.

Adejuyigbe, S.B. (1993b). Planned Agricultural Mechanization for Abundant Food Production. Nigerian Society of Engineers Conference, Kaduna. Conference Proceedings, pp 69-81.

Adejuyigbe, S.B. (1994a). Computer Appreciation for Production Planning and Control in some Nigerian Industries. Paper presented in the Nigerian Institution of Production Engineers, First National Conference, Benin City. Conference Proceedings, pp 121-141.

Adejuyigbe, S.B. (1994b). Production Engineering Education and Training in Nigeria: Evaluation of the Problems and Prospects. Paper presented in the Nigerian Institution of Production Engineers, First National Conference, Benin-City. Conference Proceedings, pp 104-120..

Adejuyigbe, S.B. (1995). The Impact of Manufacturing Industries on the Environmental Development of Nigeria. Paper Presented at UNESCO-Nigeria National Committee for Man and Biosphere (MAB). Regional Training Workshop on Impact of Human Activities and Livestock Grazing Lands and Response of Human Savannah to Stresses and Disturbance in West Africa Sub-Region. (A member of the Local Conference Planning Committee). At The Federal University of Technology, Akure on July 23 – 28, 1995. Conference Proceedings, pp 445- 447.

Adejuyigbe, S.B. (1996). The Planning of Continuity of Technological Education in Nigeria: A Critical Path Analysis Approach. A Journal of the Institute of Education, Delta State University, Abraka, Research in Education, Volume 2 No. 2, Sept. 1996, pp 22-36.

Adejuyigbe, S.B. and Owoyemi, J.M. (1997). Metal, the Age-Long Material for Industrial Products. Paper presented at the Maiden Conference on Industrial Design and Technology, FUT, Akure, 8th – 11th April1997. Books of Abstracts – page 3

Adejuyigbe, S.B. (1997a). Computer-Aided Design and Drafting (CADD) in Process Modeling of Sand Casting. M. Eng. Thesis in the Department of Mechanical/Production

Engineering of Federal University of Technology, Akure.

Adejuyigbe, S.B. (1997b). Metal Cutting Machine Tools. Engineering Textbook. Publication for Universities, Polytechnics, Colleges of Education, Technical Colleges and Secondary Schools. Olajuyin Printers and TopFun Publications, Akure – 220 pages. ISBN 978-32744-3-0

Adejuyigbe, S.B. (1998a). Professional Engineering Practice. Engineering Textbook. Publication for Universities, Polytechnics, Colleges of Education, Technical Colleges and Secondary Schools. TopFun Publications, Akure – 69 pages. ISBN 978-028-378-1.

Adejuyigbe, S.B. (1998b). Engineering Law and Management. Engineering Textbook. Publication for Universities, Polytechnics, Colleges of Education, Technical Colleges and Secondary Schools. TopFun Publications, Akure – 70 pages. ISBN 978-028-377-3.

Adejuyigbe, S.B. and Ogunlade, O. (1998). Computer-Aided Design (CAD) in Process Modeling of Sand Casting. Paper Presented in the Nigerian Institute of Engineers (Ibadan Branch) Conference, Ibadan. Conference Proceedings, Vol. 1 - pp 28-40.