

### DESIGN INNOVATION IN PALM FRUIT BUNCH STRIPPER: A CONTRIBUTION TO SUSTAINABLE DEVELOPMENT

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Article Received on 30/11/2017

Article Revised on 21/12/2017

Article Accepted on 11/01/2018

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#### ABSTRACT

Design is a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange. Design can include a wide range of activities

aimed at planning and designing procedures, technical specifications and other user and functional characteristics for new products and processes. The current financial crisis and economic slowdown have made the need to find complementary innovation drivers and models even more acute. As external funding becomes more difficult to obtain for companies, it is important that innovation does not come to a halt. R&D should be encouraged, as should innovation activities that are close to the market and have low capital requirements. Existing knowledge must be used in new ways to bring about innovation, incremental or radical, and products and services that are better adapted to user. The palm bears its fruit in bunches varying in weight from 10 to 40 kg. The individual fruit, ranging from 6 to 20gm, are made up of an outer skin (the exocarp), a pulp (mesocarp) containing the palm oil in a fibrous matrix; a central nut consisting of a shell (endocarp); and the kernel, which itself contains an oil, quite different to palm oil, resembling coconut oil. The fresh fruit bunch consists of fruit embedded in spikelets growing on a main stem. Manual threshing is achieved by cutting the fruit-laden spikelets from the bunch stem with an axe or machete and then separating the fruit from the spikelets by hand. Children and the elderly in the village earn income as casual labourers performing this activity at the factory site. In a mechanized system a rotating drum or fixed drum equipped with rotary beater bars detach the fruit from

the bunch, leaving the spikelet's on the stem Modern methods of stripping have greatly improved production rates and reduced stripping time. The machine consists of stripping unit, gear system frame, and discharge outlets for stripped fruitlets The Brower and empty bunches. The results of the improvements carried out on the design of this stripping machine shows that maintenance cost and stripping time are reduced, operation of the machine does not require special skill, the machine is easy and safe to operate, it is noise and vibration free, the energy required for loading and unloading have reduced since stripping chamber and discharge outlet are enlarged. Environmentally sustainable design (also referred to as 'green design' or 'eco-design') aims to ensure that products, services and systems are produced and provided in a way that reduces the use of non-renewable resources and minimizes environmental impact The scope of this research are to design, model ,simulate: optimize and sustain the analysis of Palm Fruit Stripper.

**KEYWORDS:** Design, Innovation, Bunch Stripper, Sustainability. Development, Environmental and Analysis.

## INTRODUCTION

Palm oil plays an important role in the agricultural and economic sectors of the countries where it is found. The discovery of oil palm fruit (*Elaeis guineensis*) is as old as man, although the production involved purely manual and traditional tools. It is originated in the tropical rain forest region of West Africa, in which the main belt runs through the southern latitudes of Cameroon, Cote D'ivoire, Ghana, Liberia, Nigeria, Sierra Leone, Togo and into the equatorial region of Angola and the Congo (FAO, 2004). Samuel and Alabi (2012) reported that productivity in Nigeria was poor and such important vegetable oils should be highly produced to meet demands. The total money of \$186.65 million was spent by Nigeria to import vegetable oil from Malaysia in 2001, this showed sad state of affair of the country (Samuel and Alabi, 2012).

It is generally agreed that the Oil Palm (*Elaeis guineensis*) originated in the tropical rain forest region of West Africa. The main belt runs through the southern latitudes of Cameroon, Côte d'Ivoire, Ghana, Liberia, Nigeria, Sierra Leone, Togo and into the equatorial region of Angola and the Congo. Processing oil palm fruits for edible oil has been practiced in Africa for thousands of years, and the oil produced, highly coloured and flavoured, is an essential ingredient in much of the traditional.

West African cuisine. The traditional process is simple, but tedious and inefficient. During the 14th to 17th centuries some palm fruits were taken to the Americas and from there to the Far East. The plant appears to have thrived better in the Far East, thus providing the largest commercial production of an economic crop far removed from its centre of origin.

Palm oil is rich in carotenoids, the precursor of vitamin A (pigments found in plants and animals) from which it derives its deep red colour, and the major component of its glycerides is the saturated fatty acid palmitic; hence it is a viscous semisolid, even at tropical ambient temperature, and a solid fat in temperate climates. Stripping or threshing of palm fruit involves separating the sterilized fruits from the bunch stalks. Sterilized fresh fruit bunches are fed into a drum stripper and the drum is rotated, causing the fruits to be detached from the bunch; the bunch stalks are removed as they do not contain any oil (FAO, 2004). Traditionally, the harvested palm fruit bunches are heaped and allowed to ferment to facilitate easy stripping of the fruits. The picked fruits are then collected and digested into a mash, after which it is mixed with water and agitated in a pit to separate the crude oil from the mixture. After adequate mixing, the oil that floats at the top is skimmed off for clarification (Ologunagba *et al.*, 2009). Apart from the drudgery, time wasting and high labour requirement in this method, it gives less quality oil and the period of fermentation increases the free fatty acid content of the oil. Hence, it is important that fresh fruit bunches be processed as soon as possible so as to prevent a rapid rise in free fatty acid which normally affects the quality of the crude palm oil been produced (Ologunagba *et al.*, 2009). In Nigeria today, a lot of work has been done on palm fruit stripping and most of the mechanized systems of stripping oil from palm fruit bunches consist of a rotating drum or fixed drum equipped with rotary beater bars which detaches the fruit from the bunch, leaving the spikelet on the stem. These strippers are available in NIFOR, Benin and Nigeria (FAO, 2004). Ologunagba *et al.* (2009) reported that when manually operated a dual powered palm fruit stripper, the machine had a through put capacity of 0.612 tons/h, stripping efficiency of 68.9% and quality performance efficiency of 47.4% at a sterilization time of 90 minutes. When tested with 3.25KW electric motor at three beater speeds (250, 350 and 450 rpm) and at sterilization time of 30, 60 and 90 minutes, the machine gave best performance at 450 rpm and sterilization 90 minutes.

Generally women in the villages are responsible for the processing and sale of farm produce. Small scale agro processing seems to hold the key to rural poverty reduction and the prolific oil palm tree provides the best raw material for starting rural industries.

Today small scale processors who appreciate the value of using machines, are asking for them to be more sophisticated. Thus current demand for small scale palm oil mills is shifting from simple standalone unit machines to a more integrated system which is easy to operate and maintain. Machinery manufacturers have responded with machines that combine several operations into one machine unit. The complete range of operational machines covering bunch stripping, fruit sterilization, digestion, pressing, clarification, oil drying and storage have been developed for small scale processing applications. The processors can change and/or combine equipment to suit their purchasing power.

The word 'innovation' refers to 'something newly introduced'. Innovation is about applying ideas to create new solutions. This solution may be a new product, a new approach or even a new application of an old product or approach. Business innovation is not just about the generation of new ideas, but also about execution: bringing an idea to market, making a change or doing something in a new way that generates benefits and value for the business.

For many years a number of countries have invested in design to promote their image internationally, raise awareness among local consumers of the value of design and product quality, and to increase interest from local industry in the benefits of design for business performance. The oldest programmes date from the end of the 19th century, when design programmes with roots in the crafts sector were implemented in Scandinavia (Sweden, 1845 and Finland, 1875). The USA followed in 1913. Since then, schemes have spread to practically all developed countries and some developing countries, and have evolved in scope, complexity and ambition. During the period 1940-1960, a number of countries saw the establishment of professional organisations for industrial design: Australia, UK, Canada, France, Germany and Italy. These associations aimed at promoting the use of design in mass production and as an asset for trade and export.<sup>97</sup> The UK Council of Industrial Design was created in 1944, the German Design Council in 1953. The Polish Institute of Industrial Design was also created in the 1950s. In the 1960s and 70s awareness-raising targeted at the general public grew in importance, stressing design as part of national identity, as did educational initiatives. Design organizations were created, such as the Norwegian Design Council in 1963. Others adopted new names with the rise of environmentalism and socially responsible design, distancing themselves from a purely industrial perspective: the British Council of Industrial Design became the UK Design Council. In some industrialized Asian countries, such as South Korea and Japan, awareness about the potential of design was growing.

In ecology, **sustainability** (from sustain and ability) is the property of biological systems to remain diverse and productive indefinitely. Long-lived and healthy wetlands and forests are examples of sustainable biological systems. In more general terms, sustainability is the endurance of systems and processes. The organizing principle for sustainability is sustainable development, which includes the four interconnected domains: ecology, economics, politics and culture. Sustainability science is the study of sustainable development and environmental science. Sustainability can also be defined as a socio-ecological process characterized by the pursuit of a common ideal. An ideal is by definition unattainable in a given time/space but endlessly approachable and it is this endless pursuit that forms a sustainable system in the process (ibid). Healthy ecosystems and environments are necessary to the survival of humans and other organisms. Ways of reducing negative human impact are environmentally-friendly chemical engineering, environmental resources management and environmental protection. Information is gained from green chemistry, earth science, environmental science and conservation biology. Ecological economics studies the fields of academic research that aim to address human economies and natural ecosystems.

Simulation methods of analysis, supported by increasingly powerful and user-friendly software tools, are gaining greater acceptance as an indispensable aid to business managers, engineers, and analysts seeking productivity improvements. Simulation modeling and analysis, along the specialized province of mathematicians and computer science specialists, has entered the mainstream of methods available to help organizations (whether business, governmental, educational, or military) increase their efficiency and effectiveness. The proved abilities of simulation to attack a wide range of problems and investigations rest on its abilities to accommodate stochastic variation, analyze discrete or continuous variables, or both, and provide visualization via animation. Humans have always strived to do things efficiently. Throughout history, tools and implements were developed to perform tasks that were designed to complement human physical strength. The invention of the wheel is probably the most revolutionizing optimization tool developed by humans. In today's complex business and industrial environments, the solution of operational problems cannot be achieved by technological advances alone. The multitude of options available for implementing an operational plan has mandated the development of systematic procedures for selecting the options that best benefit the organization as a whole. The optimization models of operations research are designed to solve such complex problems. An optimization system may be regarded generally as a resource allocation problem in which limited

resources are assigned to activities in a manner that will produce the best value for a selected measure of performance. Such a measure of performance may typically involve minimization of cost or maximization of profit. A simple example of an optimization system involves the determination of the level of production of a number of products that compete for limited raw materials, with the objective of maximizing the total profit for all products. In this situation, each product represents an activity whose optimal production level is determined from the solution of the mode (see fig 3 below).

“A course which does not use professional software is preparing our students for a type of work which does not exist anymore” (Paris, 1991). “Engineering without labs [and design] is a different discipline. If we cut out labs [and design] we might as well rename our degrees Applied Mathematics” (Eastlake, 1986).

Simulation is a powerful approach to modeling manufacturing systems in that many complex and diverse systems can be represented. Can predict system performance measures that are difficult to assess without a model. It is a proven, successful tool and has been in use since the 1950s. The current languages take advantage of the capabilities of today’s microprocessors and provide the user with the needed on-line support for model development, management, and analysis.

CAD (computer-aided design) has its roots in interactive computer graphics. Before the CAD era, engineering drawings were prepared manually on paper using pencils and drafting instruments on a drafting table. The advent of interactive computer graphics replaced the drafting table with a computer monitor and the pencil with an input device such as a light pen or mouse. Instead of using physical drafting instruments, software commands and icons on the computer display are used. The drawing can be created, modified, copied, and transformed using the software tools. At the time, CAD stood for computer-aided drafting. Drafting was confined to 2D because of the paper limitation. With the computer, such limitation is removed. Three-dimensional CAD systems were developed in the 1960s. In 3D CAD, objects are modeled using 3D coordinates ( $x$ ,  $y$ , and  $z$ ) instead of 2D coordinates ( $x$  and  $y$ ). The need for modeling parts and products with complex surfaces motivated the development of free-form surface modelers (illustrate in fig 1 and 4).

## **METHODOLOGY**

### **DESIGN**

Design is a structured creative process. Design is readily associated with industrial product design for manufactured products specifically the ‘look’ of a product. However, the application of design is much broader, for example designing for function; for aesthetic appeal; for ease of manufacture; for sustainability; and designing for reliability or quality and business processes themselves. Service design affects how customers will experience the delivery of a service, such as a bank or a fast food restaurant. Elements of design, particularly graphic design, will form part of product, service and company branding and advertising strategy.

### **INNOVATION**

It is a common misconception that innovation refers only to research and development and technology. Internationally accepted definitions consider the scope of innovation to include the implementation of new or significantly improved products, processes, marketing or organizational methods. This includes improvements to all types of operational processes within a business, such as production lines, financial systems or human resource management, as well as business model innovation (i.e. structural changes, new strategic partnerships or financial models). Innovation may allow existing markets to evolve with better value, allowing firms to compete against and build upon each other’s improvements. This type of innovation is described as sustaining innovation. Sustaining innovation does not disrupt existing markets. Examples include: the early automobile (which was considered a luxury item and did not disrupt the horse drawn vehicle market); and fuel injection. While sustaining innovations are typically innovations in technology, disruptive innovations can have far reaching consequences for existing markets.

### **SUSTAINABILITY**

Simulation technology has been a significant tool for improving manufacturing operations in the past; but its focus has been on lowering costs, improving productivity and quality, and reducing time to market for new products. Sustainable manufacturing includes the integration of processes, decision-making and the environmental concerns of an active industrial system to achieve economic growth, without destroying precious resources or the environment. Sustainability applies to the entire life cycle of a product shown in fig:2, also detailed component environment impact and Environmental Impact Comparison.

It involves selection of materials, extraction of those materials, of parts, assembly methods, retailing, product use, recycling, recovery, and disposal will need to occur if simulation is to be applied successfully to sustainability. Manufacturers will need to focus on issues that they have not been concerned with before.

### **SUSTAINABLE DEVELOPMENT**

According to the data that member countries represented to the United Nations, Cuba was the only nation in the world in 2006 that met the World Wide Fund for Nature's definition of sustainable development, with an ecological footprint of less than 1.8 hectares per capita, 1.5, and a Human Development Index of over 0.

### **ENVIRONMENTALLY SUSTAINABLE DESIGN**

Designers make decisions on the use of resources, modes of consumption and the lifecycles of products and services. Environmentally sustainable design (also referred to as 'green design' or 'eco-design') aims to ensure that products, services and systems are produced and provided in a way that reduces the use of non-renewable resources and minimises environmental impact. It is increasingly important within the fields of architecture, urban design and planning, engineering and design in general. Some common principles of environmentally sustainable design are as follows:

- Low-impact materials: designing for use of non-toxic, sustainably-produced or recycled materials which require little or no natural resources (such as energy and water) to transport and process, and whose use does not threaten bio-diversity;
- Resource efficiency: designing manufacturing processes, services and products which consume as little natural resources as possible;
- Quality and durability: creating longer-lasting and better-functioning products that last longer, or age in a manner that does not reduce the value of the product, reducing the impact of producing replacements;
- Reuse, recycling and renewability: designing products that can be reused, recycled or composted after initial use.

### **INNOVATION AND DESIGN POLICY**

Whereas design associations, consultancies and academics have long made the link between design and innovation, this is not always the case for policy makers. Although innovation is increasingly mentioned in the context of design, the opposite is less common. In other words, few countries mention design in their innovation strategies. The European countries that



make the most explicit connection between design and innovation policy include the UK, Denmark and Norway: The latest UK White Paper on innovation policy, Innovation Nation, dated March 2008, considers design as a key driver of user-led innovation, frequently refers to design projects as innovation projects, and mentions the Design Council as a key player in the innovation field. The latest Danish innovation plan, 'Innovation Denmark 2007-2010', clearly stresses user driven innovation as complementary to research-driven and other forms of innovation, and mentions design repeatedly. A major programme for user-driven innovation (2007-2010) includes design partners (such as designers, design schools, centres, and agencies) in more than 25% of its projects so far.

The Norwegian White Paper on innovation policy of December 2008, 'An innovative and sustainable Norway', puts great emphasis on design and introduces a new 'Design-driven Innovation Programme', aiming at stimulating the use of design from the idea phase to market introduction. In Finland and Spain, the connection between design and innovation is made at the level of implementation. Finnish Designium, the New Centre for Innovation in Design, provides consultation services in matters relating to the identification, analysis and management of innovations. Both design and innovation are included in the mission of DDI, the Spanish Agency for the Development of Design and Innovation. In the USA, where no explicit design strategy exists at federal level, design and innovation are very often — and increasingly — seen as two sides of the same coin. This is illustrated by the importance given to design management, strategic design and design thinking in design schools. Not only is there awareness that design excellence requires business thinking, but design is also promoted as a discipline that managers in general and executives in particular need a better understanding.

Design management as a discipline aims to raise business professionals' awareness of how to integrate and manage design, and to integrate business issues, methods and understanding in design thinking. The American Design Management Institute (DMI) is an important promoter of design management, also promoting design among non-design executives. In Europe, design management has been encouraged by the Design Management Europe (DME) Award.

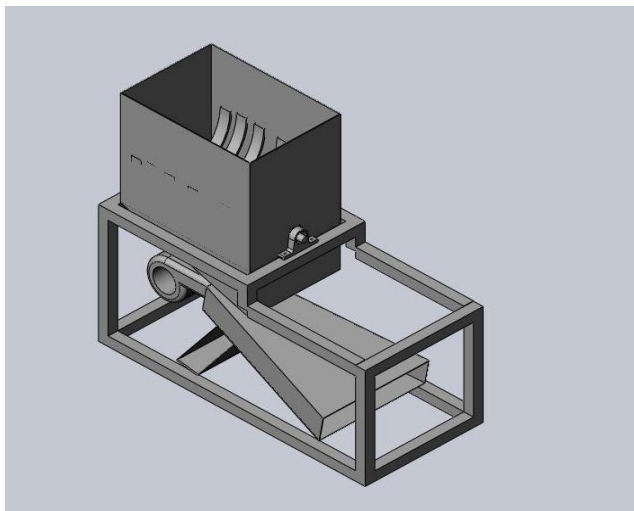
**Design for Recyclability).**The following guidelines will contribute to speeding up the disassembly process and recovering a larger proportion of system components: Avoid springs, pulleys, and harnesses which complicate the disassembly process. Minimize the use of adhesives and welds between separable components or between incompatible materials.

Adhesives introduce contaminants, can detract from quality due to the potential for bond failure, and increase the costs associated with disassembly. If adhesives are required, try to use adhesives that are with the joined materials. Use snap fits to join components where possible. Snap fits involve an undercut on one part, engaging a molded lip on a mating part to retain an assembly. Snap fits are relatively inexpensive to manufacture and have attractive mechanical properties. Avoid threaded fasteners (screws), if possible, because they increase assembly and disassembly costs. Use alternative bonding methods, such as solvent bonding or ultrasonic bonding. Such methods may be acceptable for bonding parts made from the same material and which will not be separated at end-of-life. Spring clips or speed clips can be an inexpensive and effective way of joining parts and materials. They permit easy assembly and disassembly, and do not introduce contaminants.

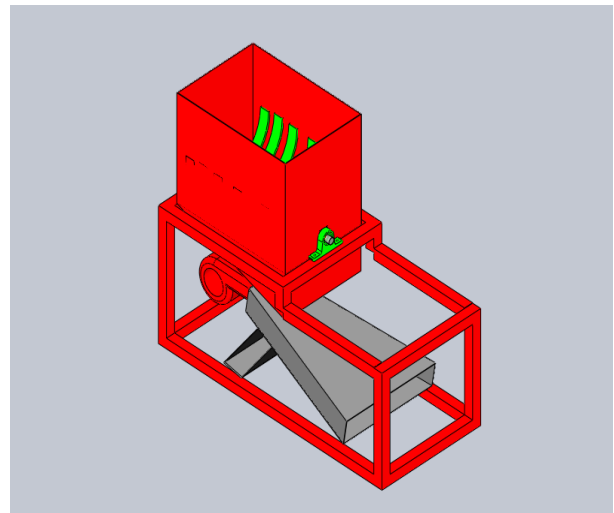
Sustainability software enables designers and engineers to perform real-time environmental assessment as part of the product design process “Solid Works Sustainability software is helping us document our achievements and develop even greener products in the future. This is good for our business and good for the planet.”

— Brian Kinnune, Engineering Manager, BetaLED (a division of Cree, Inc.)

### MACHINE VIEWS, SIMULATION AND DFE ANALYSIS



**Fig 1: Final Design.**



**Fig. 2: Sustainability of Palm Fruit Bunch Stripper Analysis.**

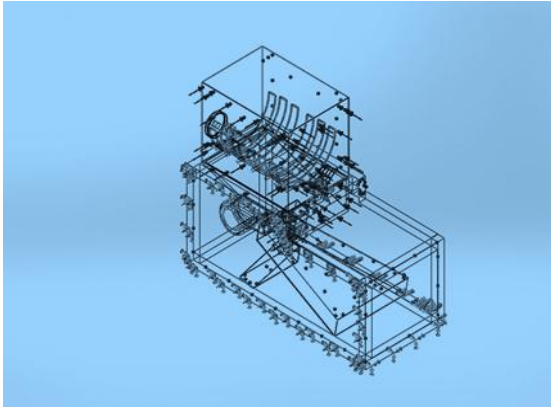


Fig. 3: Simulation Process.

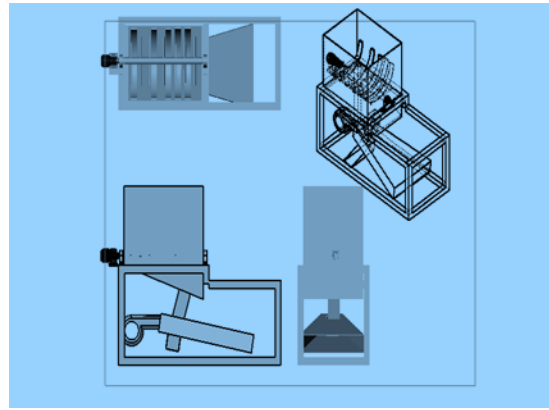


Fig. 3: Multiply views of the machine.

**Top Ten Components Contributing Most to the Four Areas of Environmental Impact**

Component	Carbon	Water	Air	Energy
stand	700	0.252	3.8	7000
Part2	260	0.092	1.4	2600
blower	58	0.039	0.303	570
Part3	52	0.036	0.274	510
pulley 1	16	3.7E-3	0.108	190
basket	9.9	3.6E-3	0.054	99
Part4	5.6	2.0E-3	0.030	56

**Table 1: Component Environmental Impact**-The above illustrated the material selection which provides the most environmentally-friendly impact for the design.

## Environmental Impact

### Carbon Footprint



4800 kg CO<sub>2</sub>

Material:	610 kg CO <sub>2</sub>
Manufacturing:	520 kg CO <sub>2</sub>
Use:	0.00 kg CO <sub>2</sub>
Transportation:	970 kg CO <sub>2</sub>
End of Life:	2700 kg CO <sub>2</sub>

### Total Energy Consumed



3.4E+4 MJ

Material:	8000 MJ
Manufacturing:	5200 MJ
Use:	0.00 MJ
Transportation:	1.2E+4 MJ
End of Life:	8500 MJ

### Air Acidification



45 kg SO<sub>2</sub>

Material:	1.8 kg SO <sub>2</sub>
Manufacturing:	7.3 kg SO <sub>2</sub>
Use:	0.00 kg SO <sub>2</sub>
Transportation:	31 kg SO <sub>2</sub>
End of Life:	4.9 kg SO <sub>2</sub>

### Water Eutrophication



4.2 kg PO<sub>4</sub>

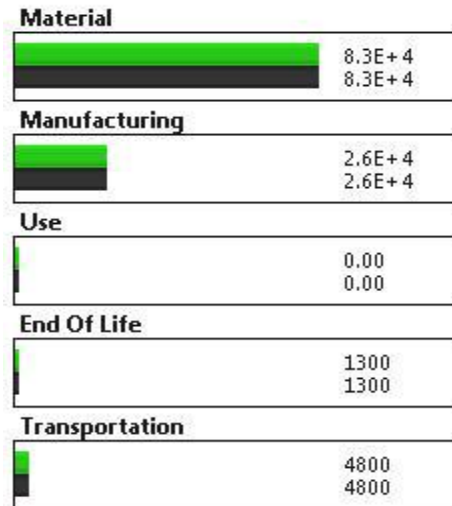
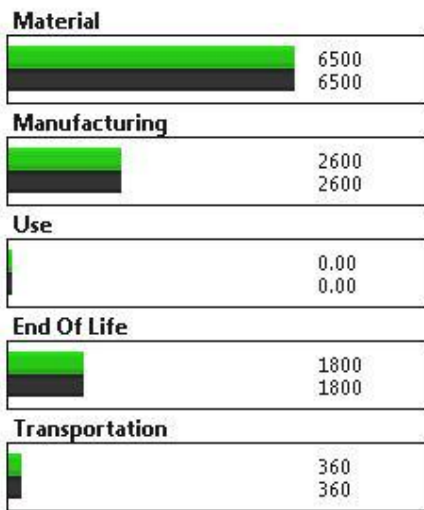
Material:	0.197 kg PO <sub>4</sub>
Manufacturing:	0.282 kg PO <sub>4</sub>
Use:	0.00 kg PO <sub>4</sub>
Transportation:	2.9 kg PO <sub>4</sub>
End of Life:	0.778 kg PO <sub>4</sub>

### Comments

Table 2 illustrated environmental impacts of designs, reduce material and energy usage, and incorporate sustainable design practices which save time and money.

**Table 3: Illustrated the Reducing manufacturing costs related to material and energy usage by conducting environmental impacts assessments.**

**Environment Impact Comparison**

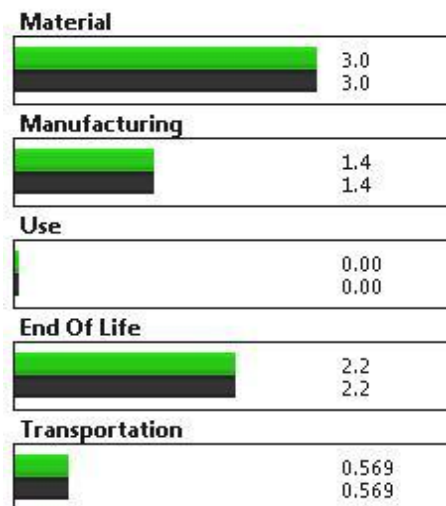
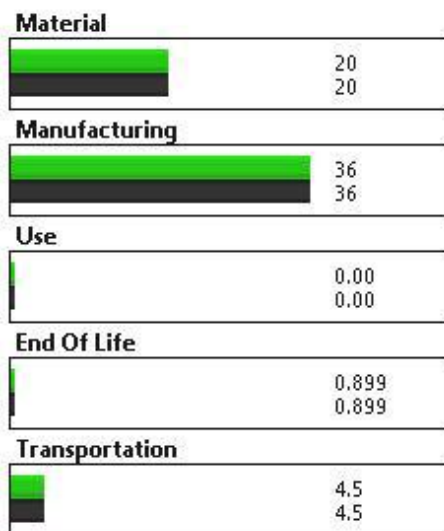


**Air Acidification - Comparison**

Total : 61 kg SO<sub>2</sub>e  
: 58 kg SO<sub>2</sub>e

**Water Eutrophication - Comparison**

Total : 7.2 kg PO<sub>4</sub>e  
: 8.9 kg PO<sub>4</sub>e



**Material Financial Impact Comparison**



**DESIGN FOR ENVIRONMEN** (DFE) Accordingly, the goal of DFE is to enable design teams to create eco-efficient and eco-effective products while adhering to their cost, quality and schedule constraints for a company to be successful in this goal, DFE must be integrated seamlessly into the development process, requirements to the verification that these requirements have been fulfilled.

Catalogue of DFE Guidelines The guidelines are divided into four principal strategies,

- ✓ Design for dematerialization seeks to reduce the required amount of material throughput, as well the corresponding energy requirements, for a product and its associated processes throughout their life cycle.
- ✓ Design for detoxification seeks to reduce or eliminate the toxic, hazardous, or otherwise harmful characteristics of a product and its associated processes, including waste streams that may adversely affect humans or the environment.
- ✓ Design for revalorization seeks to recover, recycle, or otherwise reuse the residual materials and energy that are generated at each stage of the product life- cycle, thus eliminating waste and reducing virgin resource requirements.
- ✓ Design for capital protection and renewal seeks to ensure the safety, integrity, vitality, productivity, and continuity of the human, natural, and economic resources that are needed to sustain the product life cycle. There is considerable overlap with other DFX disciplines such as Design for Manufacture and Assembly. Indeed, one strength of DFE is its synergy with other design disciplines. For example, reducing design complexity leads to fewer parts, lower assembly costs, and easier disassembly, resulting in reduced energy and material use as well as increased recyclability a principal strategy for improving sustainability is dematerialization, defined as the reduction of material throughput in an economic system. Dematerialization includes a variety of techniques, such as increasing material efficiency in operations; designing products with reduced mass, packaging, or life-cycle energy requirements; replacement of virgin materials with postindustrial or post-consumer wastes; reducing transportation requirements in the supply chain, thus reducing fuel and vehicle utilization; substitution of electronic services for material-intensive services; and substitution of services for products. These techniques are complemented by other DFE practices, such as recovering value from obsolete or discarded products.

## DESIGN FOR ENERGY AND MATERIAL CONSERVATION

Reducing energy and material consumption is the most direct way to improve eco-efficiency, i.e., utilizing fewer resources to deliver equivalent or greater value. decreasing resource intensity results in higher resource productivity, provides immediate reductions in operating costs, and, thus, is synergistic with business goals. In other words, the quantity and costs of purchased energy and materials are reduced by increasing operating efficiency. Moreover, energy reduces overall material consumption in the supply chain, since generating energy requires some type of fuel and/or equipment. Although energy management is often pursued as a separate program, energy and material resource conservation should, ideally, go hand-in-hand. Finally, energy conservation that reduces fossil fuel use will also reduce greenhouse gas emissions.

## LIFE-CYCLE RESOURCE INTENSITY REDUCTION

DFE needs to consider the full life cycle of a product, including all of the processes involved in sourcing, production, distribution, use, and recovery of the product. Thus, the investigation of opportunities for energy and material conservation should consider both supplier and customer processes. Depending on geographic locations and type of facilities, certain companies in the supply chain may have much better opportunities than others for energy and material conservation. The following types of opportunities should be explored:

**REDUCE THE PROCUREMENT FOOTPRINT**—Many companies have begun to examine the environmental practices of their suppliers and encourage greater energy and material efficiency. This can reduce the life-cycle footprint of their own products and potentially lower their costs. The most prominent example is Wal-Mart, which has developed sustainability scorecards for packaging and energy use and is requesting environmental performance improvements from all of its suppliers.

**REDUCE THE OPERATIONAL RESOURCE FOOTPRINT**—Companies have found a great deal of “low-hanging fruit” by tightening up energy management practices, e.g., heating, cooling, and lighting systems, and materials management practices, e.g., maintenance, inventory, and waste management. Newer facilities are being designed with recycled materials and advanced energy-saving features, as interest in “green building” has mushroomed. But the largest gains in resource conservation come from redesigning production processes to reduce throughput requirements and install more efficient equipment.

**Example:** From 2005 to 2007, General Electric (GE) conducted a “Lean and Energy”

initiative that identified over \$100 million in potential energy savings through over 200 “energy treasure hunts” at GE facilities worldwide. This effort resulted in 5,000 related kaizen projects, most of which are funded and in various stages of implementation. GE was able to reduce greenhouse gas emissions by 250,000 metric tons and realized \$70 million in energy cost savings from implemented projects.

### **INNOVATION IS MORE THAN JUST TECHNOLOGY**

It is a common misconception that innovation refers only to research and development and technology. Internationally accepted definitions consider the scope of innovation to include the implementation of new or significantly improved products, processes, marketing or organisational methods. This includes improvements to all types of operational processes within a business, such as production lines, financial systems or human resource management, as well as business model innovation (i.e. structural changes, new strategic partnerships or financial models). Innovation may allow existing markets to evolve with better value, allowing firms to compete against and build upon each other’s improvements. This type of innovation is described as sustaining innovation. Sustaining innovation does not disrupt existing markets. Examples include: the early automobile (which was considered a luxury item and did not disrupt the horse drawn vehicle market); and fuel injection. While sustaining innovations are typically innovations in technology, disruptive innovations can have far reaching consequences for existing markets. Disruptive innovation explains the process by which a new product or service transforms an existing market or sector by increasing the simplicity, convenience, accessibility, and/or affordability of products and/or services thereby irrevocably changing the status quo in the market. Examples include: the mass-produced automobile; personal computers disrupting the mainframe and minicomputer market; and mobile phones disrupting fixed line telephony.

The principles of disruptive innovation can be applied across all sectors. The increasing availability of online learning and access to online courses is another example.

Disruption can be a positive force, transforming sectors to make products affordable and convenient, thereby making them available to a much larger population. Such innovations challenge the conventional market through the creation of new markets. New ideas and processes also have different degrees of novelty and risk associated with implementation. The scale of change, novelty and risk classifies innovation into two main categories:



Radical – leading to fundamental changes in processes or products. This usually involves new technology, high risk or uncertainty and a focus on processes, products or services that are untried or untested; or Incremental – involving smaller-scale adaptations of existing products or processes. Innovations of this type usually involve existing technology and low risk or uncertainty. They focus on improvements to existing processes, products or services and improve the business competitiveness within established markets or industries.

Radical innovation is less common than incremental innovation. A recent survey of over 2,000 Australian businesses found that 70% of innovation investment was incremental, while the remaining 30% was radical. This suggests Australian businesses are not just focussed on investment in the next generation of product or service but on ‘a more systematic approach to innovation and improvement’.

### **DESIGN INNOVATION IN PALM FRUIT BUNCH STRIPPER: A CONTRIBUTION TO SUSTANIABLE DEVELOPMENT**

It is general knowledge that those who are engaged in agriculture are the poor in comparison with those who engaged in other sector of the economy in Nigeria that is to say their standard of living is so low that shortage of funds to enable them facilities has been a major handicap in the develop .Investigation shows that the few available small scale processing equipment are not very efficient. This lack of efficiency small scale processing equipment to farmers has increased the inability of their farming activities.

**Agricultural productivity** is measured as the ratio of agricultural outputs to agricultural inputs. While individual products are usually measured by weight, their varying densities make measuring overall agricultural output difficult. Therefore, output is usually measured as the market value of final output, which excludes intermediate products such as corn feed used in the meat industry. This output value may be compared to many different types of inputs such as labour and land (yield). These are called partial measures of productivity. Agricultural productivity may also be measured by what is termed total factor productivity (TFP). This method of calculating agricultural productivity compares an index of agricultural inputs to an index of outputs. This measure of agricultural productivity was established to remedy the shortcomings of the partial measures of productivity; notably that it is often hard to identify the factors cause them to change. Changes in TFP are usually attributed to technological improvements.

God has been so kind to Nigeria, but Nigerians have not been kind to Nigeria. Our country has been exceptionally favored with natural, mineral, and human resources. Our lands are so fertile that if you plant a finger, a human being can grow but we lack leadership skill and management.

**It is against this background that our research theme was derived and the BENEFITS are summarized in Sustainable development goals-**The Official Agenda for Sustainable Development adopted on 25 September 2015 has 92 paragraphs, with the main paragraph (51) outlining the 17 Sustainable Development Goals and its associated 169 targets. This included the following seventeen goals:

- **Poverty** – End poverty in all its forms everywhere.
- **Food** – End hunger, achieve food security and improved nutrition and promote sustainable agriculture.
- **Health** – Ensure healthy lives and promote well-being for all at all ages.
- **Education** - Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- **Women** – Achieve gender equality and empower all women and girls.
- **Water** – Ensure availability and sustainable management of water and sanitation for all.
- **Energy** – Ensure access to affordable, reliable, sustainable and modern energy for all.
- **Economy** – Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all.
- **Infrastructure** – Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.
- **Inequality** - Reduce inequality within and among countries.
- **Habitation** - Make cities and human settlements inclusive, safe, resilient and sustainable.
- **Consumption** - Ensure sustainable consumption and production patterns.
- **Climate** -Take urgent action to combat climate change and its impacts.
- **Marine-ecosystems** – Conserve and sustainably use the oceans, seas and marine resources for sustainable development.
- **Ecosystems** – Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

- **Institutions** – Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels.
- **Sustainability** – Strengthen the means of implementation and revitalize the global partnership for sustainable development.

## CONCLUSION/RECOMMENDATION

“A course which does not use a professional software is preparing our students for a type of work which does not exist anymore” (Paris, 1991) .Finally, in a truly integrated approach, DFE must be balanced against other cost and quality factors that influence design trade-off decisions. The mark of a successful team is the ability to innovate under pressure, rather than compromising product quality. A “win-win” outcome is the introduction of environmentally beneficial innovations that also improve the cost and performance of the product when viewed as part of an overall system. Ideally, single design innovation may contribute to achieving several, different types of goals. For example, reducing the mass of a product can result in (1) energy and material use reduction, which contributes to resource conservation, and (2) pollutant emission reduction, which contributes to health and safety. Making trade-off decisions is the most challenging part of the process because of the need to simultaneously consider so many different criteria. Based on this discussion the following policy are necessary, efforts should be made to adopt and popularize the design-**DFX, DFA, DFE** ETC especially for the benefits of mankind who make up a great percentage of the Nation’s population. If, the use of machine design innovations is adopted, the problem in oil and other agricultural processing equipment will be minimized and hunger and poverty will be eradicated. Detailed experiment of palm fruit bunch stripper will be presented in the future work

## ACKNOWLEDGEMENT

This Research was Sponsored by Tertiary Education Trust Fund (TETFUND).

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