SUSTAINABLE DESIGN IN PALM FRUIT BUNCH STRIPPER MANUFACTURING

Rufus Ogbuka Chime
Mechanical Engineering, Institute of Management and Technology, 400001 Enugu Nigerian
rufuschime@imt.edu.ng

Abstract
Sustainability in design is becoming a growing area where designers as well as engineers are needed by many companies with an experience of combining the impact on environment in considering development in their various project. Although, it may not be a strong pillar as a profession for a designer, it will nevertheless, become increasingly a component which is standard for the process of design, so to get ahead of the curve is the best thing to do. As an activity which is creative, design is aimed to develop objects whose qualities are multi-faceted, their processes as well as services, plus their whole life cycles systems. The fruit of the palms appears in bunches with weights ranging from 11 to 41 kg. The individual fruits which ranges from 7 to 21gm consist of an outer skin known as the exocarp, a pulp known as mesocarp which contains the palm oil in a fibrous matrix; a nut which is at the center consist of a shell called endocarp; and the kernel that contains the oil itself though different from oil palm which looks like oil from coconut. Freshly, the fruit bunch comprises fruit implanted in spikelets which grows on the main stem. Threshing manually can be done by the process of cutting the fruit-laden spikelets away from the bunch stem using an axe or machete followed by extricating the fruit by hand from the spikelet. This provides a source of income for villagers like the elderly and the children from being unplanned labourers. Mechanically, a drum that is revolving or drum that is fixed which is fortified with beater bars that is rotary to remove the fruit from their bunches, leaving behind the spikelet on the stem. The production rates have been improved by the modern methods of stripping. The components of the machine are: the stripping unit, the electric motor, and the speed reducing system, the flanges, the frame, the discharge outlets for stripped fruitlets, the Brower and the empty bunches. The advancement in results show that the stripping machine design has lower maintenance cost, reduced stripping time, and no special skill is essential for the operation of this machine hence the machine is safer and easier to operate. No noise and free of vibration, coupled with reduced loading and unloading energy. This research work is aimed towards designing, modelling, simulating, and analyzing the machine and its components.

Keywords: Design, Model, Sustainability, palm Fruit Bunch Stripper and Manufacturing

1. Introduction

Palm oil contents richly carotenoids, which is a pigment that are basically seen in plants and animals from which its deep red colour is derived. Its glyceride's major component is palmitic acid which is a saturated fatty acid. This acid is a viscous liquid which is semi-solid at tropical temperatures, and in temperate climates is a solid fat. Economically, oil palm is rich consequently it is now grown in most high rain falls countries of the world. The rainfall ranges of minimum 1 600 mm/yr. in tropical climates within 10° of the equator. The palm produces its fruit in bunches with weight variations between 11 to 41 kg. The discrete fruits, which range from 7 to 21 gm, are made up of an exocarp, the outer skin, the mesocarp, that is the pulp which contains the palm [1]

The oil palm, *Elaeisguineensis* is a perennial tree crop of the *Arecaceae* family [2], and was said to be native to the countries bordering the Gulf of Guinea [3], with the main belts running through the southern latitudes of Cameroon, Ivory Coast, Ghana, Liberia, Nigeria, Sierra Leone and into the equatorial region of Angola [4; 5; 6; 7; 8; 9). The oil palm which is cultivated frequently in the Southern as well as some parts of the Middle belt is considered in Nigeria majorly as a tropical tree crop [6]. Its fruits are produced in bunches with varying in weights of 5-40kg comprising of numerous oval-shaped drupe fruits of 6-20 grams, as well as new fruits of a regular length, width and thickness of 35.96 mm, 20.15 mm and 17.11 mm respectively [6; 9;10]. The sorts of oil palm fruit take place in two forms, known as *dura*(with a large kernel) and pisifera(having no shell and yet sterile) while *tenera*is a hybrid form of *dura* and *pisifera*, and the most cultivated variety because it produces fruits with higher oil content [11].The palm fruits processing starts with harvesting bunches, chopping and stripping, sterilization, digestion, extraction, palm kernel cracking and oil extraction, and ends with oil storage with each by means of different methods and machines [5; 8; 12; 9). [13] concluded that improved technologies that meet both growth and sustainability goals can be effectively used by oil palm processors. However, most know-hows are planned for developed rather than developing countries. [13] stated that Nigeria has enormous potential to increase her production of palm oil and palm kernel primarily through application of improved processing techniques.

Physical 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 labourers performing this activity at the factory site.

In a machineoperated system, a rotating drum or fixed drum fortified with rotary beater bars detach the fruit from the bunch, leaving the spikelets on the stem. Modern methods of stripping have significantly enriched production rates and lessen 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 [14]

Sustainable design is becoming a growing area, with many companies requiring initiators and engineers who have experience incorporating environmental impact considerations into product development. Even if it is not the central pillar of a designer's job, it will increasingly become a usual component of the design procedure. Companies are also finding that sustainable design is

just "good business." Through it, companies find new ways to decrease material and energy costs, and increase revenue through resulting new product innovations. Sustainable design is the term chosen to represent the intelligent application of the principles of sustainability to the realm of engineering and design. "sustainable design" is just one term used to describe the use of sustainability principles in the design and development of commercial and industrial products. Other often-used terms include sustainable engineering, environmentally sustainable design, eco-design, and green design. The idea of "Sustainable Design" is cropping up more and more in today's product design conversations. [15]

Sustainable design is not only known as the intelligent application of the principles of sustainability to the realm of engineering and design but also the use of sustainability principles in the design and development of commercial and industrial products. Other frequently used terms include sustainable engineering, environmentally sustainable design, eco-design, and green design. The first step to sustainable design is to consider a product, service or system in relation to eco-design and analyses its influence by means of life cycle analysis. The designer then and there grows these to reduce environmental influences recognized from the analysis.

Design as an integrated process, and a methodology (or a way of thinking) guides the synthesis of creativity, technology, scientific and commercial disciplines towards producing exceptional products, services, and communications. [16]

Manufacturing is merchandise production basically for use or sale with the application of labour, machines tools, biochemical processing, or formulation. The term may perhaps refer to a variety of human activity, ranging from handicraft to high tech, nevertheless is most usually find application in industrial design where raw materials are converted on a large scale into finished goods. Such finished goods are used to produce such complex products as aircraft, house hold appliance, furniture, sports equipment or automobiles when sold. Furthermore, it could be sold to retailers from wholesaler for onward sell to the end users (consumers).

- In its initial form, manufacturing was generally done by a single skilled artisan with assistants. Training was by apprenticeship. In much of the pre-industrial world, the guild https://en.wikipedia.org/wiki/Guild system protected the privileges and trade secrets of urban artisans.
- Previously the industrial uprising, best manufacturing happened in rural areas, where household-based manufacturing served as an additional non-commercial strategy to agriculture. Entrepreneurs organized a number of manufacturing households into a single enterprise through the putting-out system.

Toll manufacturing is an arrangement whereby a first firm with specialized equipment processes raw materials or semi-finished goods for a second firm [17]

2. Literature Reviews

The palm fruit matures in compact bunches weighing up 11 kilograms (kg) or more, as well as containing more than a thousand discrete fruits alike in size to a small plum. Palm oil is got from the flesh of the fruit and doubtless formed part of the food source of the native populations previously recorded in history. It possibly will also have been merchandised, ever since archaeological proof point out that palm oil was most probable obtainable in prehistoric Egypt.

The archaeological site of an early tomb at Abydos, dated to 3000 B.C., generated "a mass of more than a few Kilograms still in the form of the container which contained it" (Friedel 1897)

2.1 Processing Technology

Palm oil which was only processed by traditional methodologies that is loose fruits were taken from the ground or a little bunch were cut off from the tree until the beginning of the twentieth century. Started in the 1920s, though, the United Africa Company as well as British colonial representatives in Nigeria began investigating with steam cookers besides pressing with hand intended making production more efficient at the village setting with respect to usage of labour and yield in oil. So far financial draw backs avoided most of the farmers from embracing the new mechanism in the form of machinery, with the exemption of a few lucky beneficiaries of permitted models or subsidies from the government in the 1940s (Martin 1988: 64-6, 127-9

A discrete trial and error process necessitated the establishment of factories that are so sophisticated with a view of dealing with large volume of fruit produced in the recent palm plantations to produce high and standardized oil quality that would charm to food processors from western lands. According to [18] [19], such factories handle almost all the palm fruit of Southeast Asia, whereas in West Africa and Latin America, processing is carried out by a wide variety of methods, yielding oil for local consumption and for industrial as well as edible uses in the West. Oil in a traditional method is extracted by unsophisticated method in other to give generally products of poor quality. The palm fruit bunches are left to ferment for some days after harvest, and subsequently beaten with stick to bring out the fruit lets from the mother bunches. The fruits are gathered, cooked and digested to mash, mixed with water and later agitated in a pit like pot. Following proper mixing, the oil separated floats at the top where it is removed for clarification processes (Sanni and Adegbenjo, 2002). The oil so produced is of poor quality, inefficient technologically, consumes, strenuous and labourious. According to Badmus (1991), not delaying and or allowing the fruit to ferment during processing gave 87% oil of extraction of high quality with free fatty acid [FFA] of 2.31% and low amount of carotenoid. Henceforward, it is imperative fresh fruit bunches (FFB) be treated immediately to avert speedy rise in FFA that negatively affect the crude palm oil quality. [20].

2.2 *Mechanization of the Small-Scale Process*

Following the speedy twentieth-century development in West African trades there is an introduction of simple machineries to mitigate the requirements in labour and increment in the production yield of a fruit quantity given. Before and after the 1914-18 war, as explained by Hartley (1988: 694-703), initial machines comprised a cylinder fitted un- automated operated beaters, which hot water and softened fruit are fed into. Following the beating is the removal of the oil-water via a sieve. Other quite different system used a distinct cooker and presser as attachments to the soft-oil process.

Quite a few number of innovations have ensued from a scheme started by the Nigerian Institute for Oil Palm Research (NIFOR) throughout the 1950s in collaboration with the Food and Agriculture Organization of the United Nations (FAO) and the United Nations Development Program (UNDP). Amongst the machine established is a bunch stripper functioned manually, which comprises of a cylindrical slatthat turns horizontal on an axis that rotates the cooked bunch subdivisions up until the fruits individually detach themselves from the bunch and separately fall amid the slats [21]

In the recent year's palm oil production has been progressive lately with the inception of technological innovation for the palm oil production. According to Nigerian survey results, it is seen that 80 percent of oil palm come from subsistence holders whose processing techniques and equipment are manually operated. As a result, the nation's oil palm industry is in its subsistent level with scarcely available palm plantations estates that produce big mills and make imported mills relatively costly as well as exorbitant by many farmers, and as a result predominate traditional method. The splitting of palm fruit bunch turns out to be domineering so as to take away the fruit lets situated inside the layer the bunch and stripping mechanically to remove the of physical method and also injury to the body. [22]

2.3 *History of sustainable design*

Even though that industrially that design has been tied traditionally to industrial as well as commercial product growth, connecting it with subsistence aim have been done from the beginning of design [research] discipline definition. According to Archer who typifies design as indispensable cog in finding solutions to the problems facing the modern civilization as related with ecology problem, environmental, urban-quality life and others (Archer 1979: 18)

Besides, wider problems of facing sustainability really have occurred with the design work (remarkably by William Morris and his battle against mass production in the 19th century). Doing work in the research coherentarea publications of high repute were done in the 1970s, responding to the coming out of environmental issues that concerns books such as 'Silent Spring' (Carson 1962), as well as the Club of Rome's 'Limits to Growth' (Meadows et al. 1972). Some important examples in the area of design: 'Operating Manual for Spaceship Earth' (Buckminster Fuller 1969), and 'Design for the Real World' (Papanek 1971).

More so, Thorpe (2010) pointed out the coming up of the sustainability in design as a notable research field 1990s. following is a focus on the recycling of material which is the using again of the rejected products in the beginning of 1990s, the initial demonstration of a more official approach in design is the sustainable design otherwise known as 'eco-design', that came to being in the ending nineties.

The analysis in industrial developments before now is where eco-design as a research efforts focused (e.g. Potter and Dewberry 1993, Roy 1994). Subsequently, 'end-of-pipe' shift was discovered towards considering the product entire life cycle. That type of scientifically proven eco-design tried to account for all the impacts on the environment as long as the product lasts from the first producer to the last disposal (Roy 1994: 364). After that, there is more prescription on publications as the Ecodesign Checklist by Brezet and Van Hemel (1997), which the UNEP described in their press release as 'the initial manual that offers establishments with a stepwise approach to ecodesign (UNEP 1997).

A product life-cycle in eco-design comprises the raw materials extraction phases, manufacturing, transport, usability, re-use, repairs, recycling as well as end disposal (Azapagic 1999). More especially appliances issues, where the energy and material consumption are felt during use, the use phase as accounting is focused on the life-cycle as highlighted as a major share of the impact on the environment. For instance, however, studies on life-cycle assessment (LCA) presented that 90% of the impact on the environmental by fridges cum washing machines is produced during

the phase in use (Simon et al. 2001, Rüdenauer et al. 2005). Though, there is still much life in eco-design as well as the associated field of LCA (e.g. European Commission Ecodesign directive 2009/125/EC, International Journal of Life Cycle Assessment), this recognition headed to the sustainable design approaches that are new precisely emphases on the reduction of the resource consumption by the products when in use in the house.

2.4 *Environmentally Sustainable Design*

The use of resources, modes of consumption and product life cycle and services are the designers' decisions. The object of environmentally sustainable design otherwise known also as 'green design 'or eco-design is to make sure that productions and services are done in such a way as to mitigate the use of non-renewable resources as well as lessen its impact on the environment. The importance is on the increase in some fields of architectural activities, urban design work as well as planning, plus in engineering design generally. In environmentally sustainable design some common noticeable principles are as follows:

1. Materials with low impact: these are the designs that its use are non-toxic, which are produced sustainably or reused materials with little or without natural resources, as energy cum water for transportation and processing, besides, the has no effect on bio-diversity;
2. Efficiency in Resource use: these are manufacturing processes design, produces and services with little natural resources utilization;
3. Durability and Quality: generating products that functions better and have longevity, or oldness in a way that does not lessen the product value, thereby bringing reduction in impact replacement;
4. Reuse, recycling and renewability: making products that can stand the chance of being reused, recycled or composted after first use. [23]

2.5 Engineering Design

The designing process whereby operating systems minimize the usage of energy and resources sustainably is referred to as sustainable engineering, that is at rate that does not endanger the natural environment, or making it impossible for the on coming generations to get satisfied with their needs. Conjoint engineering emphases rotate round the supply of water, the production and sanitation, pollution cleaning up sites of waste sites, and habitats restoration.

2.6 *Socio-economic Sustainable Design (Economic and Social sustainable design*)

The benefits of environmentally sustainable design is much felt especially when it works in collaboration with the other sustainable design as the economic and social sustainable designs. The 'triple bottom line' is the title of the three terms. It is vital to think about the value in economic or financial terms as well as in connection with the natural capital (that is the biosphere as well as the resources from the earth), the social capital (known also as the norms and networks that make integrated action possible), and the human capital (that is the totality sum of knowledge and experience, intellectual property, as well as the available labour to the society) [24].

The virtuously capital economy most people as well as organizations struggle for, besides creating decisions by, are regularly not all that conducive to these another capital forms. There is

every need for the inhabitants of the earth to think about the value of sustainable design. In some countries, however, sustainable design is referred to with other names as Eco-friendly design, green design or environmentally associated design. The designs embraced by Victor papa Nek are the social design, as well as the social quality plus the ecological quality, however, clearly did not put together all these design areas in one term. The sustainable design as well as the design for sustainability refers to as usually known term that are common, additionally the bottom line that is triple (as the people, the planet and the profit).
Eco-design is the name preferred when taking about the concept of design in the EU. Slight deliberations on the need for this concept is in among package for the circular economy which the European Commission looked into in 2015 ending.

2.7 *Design and Development*

Environmentally sustainable development precursor step is a design that is sustainable. Design is defined as purposeful planning, or something of intention which come to be or is believed to have come to be following a causative action, the fact, or the material object. In developmental activities, design is utilized as well as its execution, for the help of areas, the cities, or other places for advancement. The development that does not put the ecosystem and its services to danger is referred to as sustainable development. Design is worthless without development. Minus design, there is no usability in development." – Florian Popescu, Gap bridging amongst design and development. [25]

2.8 *Sustainable design theory*

Sustainable design is aimed at removing the negative impact on environmental totally by an integration of skillful, and design that is sensitive"[26]. For sustainable design to manifest, renewable resource is important, minimal effect on the environment as well as link people with the environment that is natural. "Design is the problem of human beings and not pollution. There would be provisions for abundance as well as endless reuse plus pleasure for good design." –the authors of up cycle by as Michael Braun art cum William McDonough, 2013.
The decision of design is on daily basis everywhere educating people on "sustainable development" as well as making provisions for the future generational needs of earthly life. There is intimate link between sustainability and design. The future is designed. The practices used in making services, business as well as innovation strategy is termed design. —these are all the form of sustainability. Continuance is what Sustainability is known and thought of as; futuristic in continuance. [27]

2.9 *Design Analysis*

The designing of this machine considers the following properties: geometric which are the length and width, thickness as well as geometric mean diameter, plus the sphericity; gravimetric includes real density, as well as the bulk plus the porosity; then the frictional as repose angle as well as the friction but of static coefficient, of the bunch of palm fruit , spikelet as well as the fruitlets such that acceptable efficiency is ensured.

Stripper Gear speed: Khurmi and Gupta equation as recommended was used to determine the stripper Gear speed, (2005)

$$\frac{Tg}{Tp} = \frac{Ng}{Np}$$

Where Tg = Gear teeth number
Tp = Pinion teeth number
Ng = Gear speed
Np = Pinion speed

Machine capacity determination
Fruit stripped total wieght= 0.90kg
Operation's total time = 0.083hr
The capacity of the machine is given by this relationship

$$\text{Capacity of the machine} = \frac{\text{Stripped fruit weight + Bunch that is empty}}{\text{Used Time (hr)}}$$

$$\text{Capacity of machine} = \frac{wfs + we}{\text{Time (hr)}}$$

$$\text{Capacity of machine} = \frac{0.90 + 0.93}{0.083}$$

$$= 22.0 \text{ kg/hr}$$

Rate of power consumption determination used by the machine
Power consumed in totality = 1.1kW
Operation's total time = 0.083hr
Consumed Power in kW/hr is given by

$$\text{Consumed Power} = \frac{\text{Consumed power (kw)}}{\text{Operation's time (hr)}}$$

$$\text{Consumed Power} = \frac{1.1kw}{0.083}$$

Power consumption 13.25w/hr

2.10 ***Determination of requisite machine power for stripping 1 tonne of oil palm fruit***
From the capacity of the machined determined as (22kg/hr), 13.25kw is used to strip one tonne, for 2hrs of machine operation, and the required power is as shown below:
1 hr, required power = 13.25kw
For 2 hrs, required power :13.25kw x 2 =26.5kw

2.11 ***Wages of the machine operational determination***
The assumed operator salary is ₦10,000 per month. So it is expected for the operator to collect N389.6 per day (for 26 days of working including Saturday) or N48 per hr (8 working hrs).[28]

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DESIGN, MODELLING AND ANALYSIS OF PAILM FRUIT BUNCH STRIPPEER

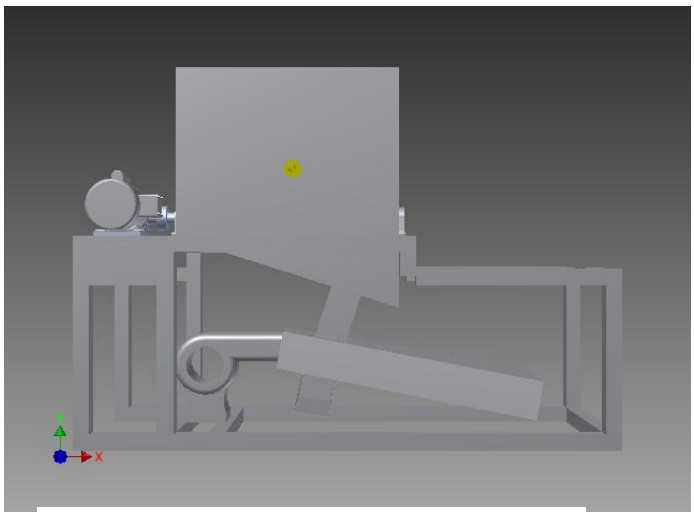


Fig: 1 CAD Model

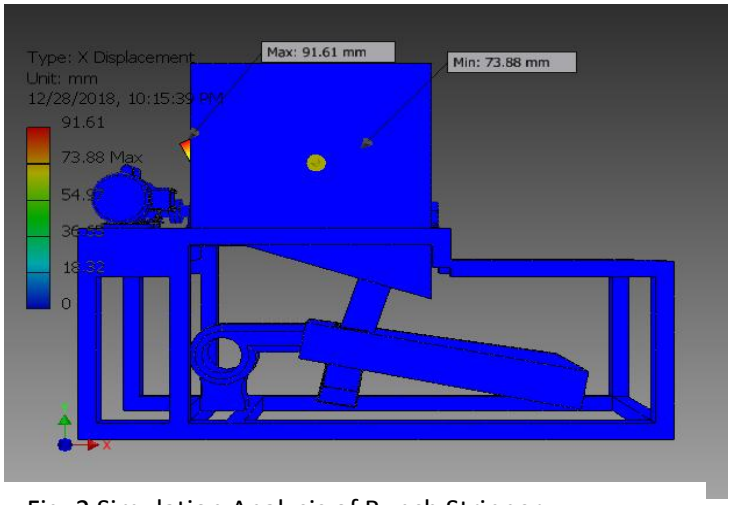


Fig: 2 Simulation Analysis of Bunch Stripper

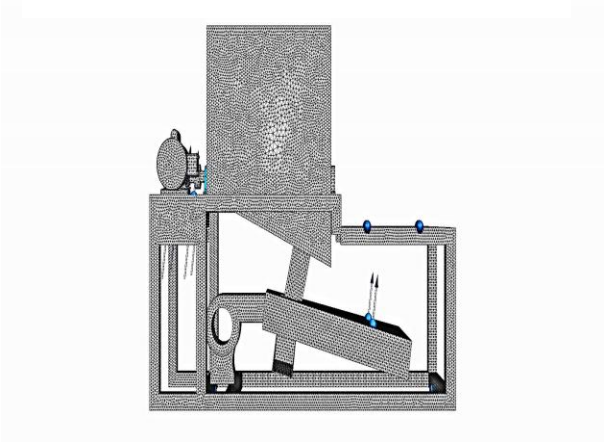


Fig: 3 Mesh

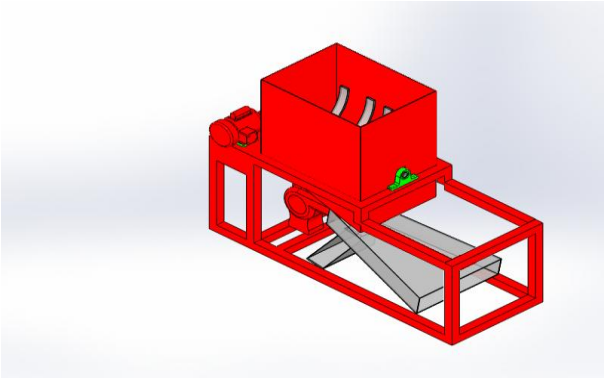


Fig : 4 Sustainability Analysis of the Machine

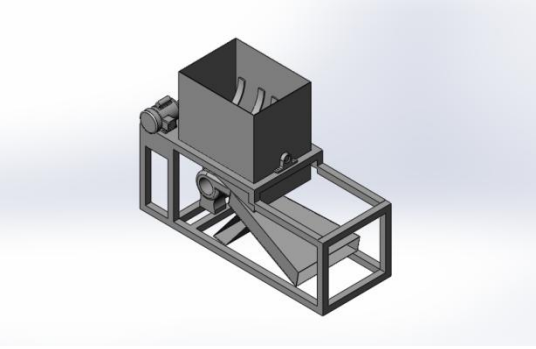


Fig : 5 Isometric Drawing of the Machine

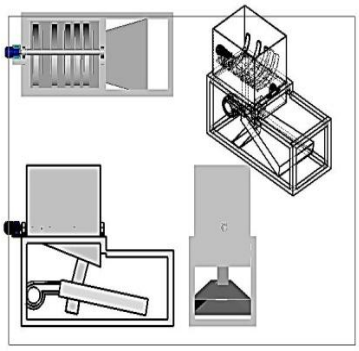


Fig: 6 multiply views of the machine

3. Principal Sustainable Design

In disciplines, practical application varies and some shared principles are such as follows:

1. Materials of low-impact: non-toxic is chosen, produced sustainably or materials recycled that need required little amount of energy for processing
2. Energy efficacy: the usage of production processes and manufacturing products with less energy requirement.
3. Emotionally durable design: reduction in the rate of consumption as well as waste of resources by an increment in the long lasting relationships among people as well products, via design
4. Reuse and recycling design: There should be design for commercial performance afterlife of the Products and the processes involved as well as the systems. [29]
5. Durability as a target ought to be a design objective and not the immortality [30]
6. Multicomponent products material diversity ought to be reduced to enhance dismember ship as well as value preservation. [31]
7. Total carbon footprint and life design impact measures –increment in the requirement and availability of the cycle valuation life-cycle whatever resourceused [32]. The complex ones are many, however some of them produce fast as well as clear total earth impacts estimation. One measured and found out that the estimationof the spending in the consumption of an average economic share of the world energy use is of 8,000 BTU (8,400 kJ) per dollar as well as manufacturing CO2 at rate average of 0.57 kg of CO_2 per dollar (that is US dollars in 1995) as seen from DOE figures [33]
8. The standard in sustainable and project designs guides are also progressively obtainable as well as dynamically being manufactured by a large array of nonpublic establishments and persons. There is also a gigantic body of recent merging methodology via the speedy development of already known thing as ‘sustainability science' enhanced by various governmental as well as educational institutions
9. Bio mimicry: "this means to redesign industrial systems basically on biological lines ... making it possible the consistent materials reusein closed cycles that are continuous..." [34]
10. Substitution in service: this entails having a shift of the mode of consumption from individual ownership of produce to services provision that offers similar purposes, e.g., from a noncommercial automobile to a car filled with sharing service. Such kind of system enhances less resource usage for a unit of consumption (e.g., per trip driven) [35].
11. Renewable resource: these materials ought to come from close (local or bioregional), renewable sources that are sustainably managed suitable for compost especially when their usability is used up.
12. Robust eco-design: this is principles find application in the design of pollution sources [36]

4. Sustainable Design in Palm Fruit Bunch Stripper Manufacturing

Generally, it is seen that those people that are involved in agriculture activities tend to be poor comparing with those other economic sector in Nigeria. This means that they have low standard of living, which is so low that there is insufficient funds to facilitates their development. Studies

has is that little available small scale equipment processing are inefficient. This inefficiency in processing equipment make farming activities difficult for farmer. The illustration above showed the derivation of research paper theme as emphasized in united nation sustainable development goals. Everyone needs to do their part in other to attend the goals. The people involved are the governments, private sector, civil society groups as well as individual like you [37]

Concurrent involvements are required in the design of sustainable manufacturing systems. Those required concurrent considerations are economic, environmental, as well as social factors. In the years back, different methods as well as various approaches were formed to help sustainable system design. [38]

Nearly half of the sustainable Development Goals SDGs in the environment is focusedand addresses natural resources sustainability. Such address is focused on the poverty level, health care, food provisions, agricultural activities, water and sanitation, the esettlements of human beings, energy, change in climate, sustainability in production consumption, oceans, and earthly eco systems. [39]

Environmental impacts characterization of the process of manufacturing will serve as a beginning area for the effortsto lessen the environmental process footprint [40]. Up till date the widely used (and questionably the most precise) technique for piloting the characterization of the environmental is the assessment of the life cycle (LCA) [41,42]. The environmental impacts are found by LCA to be in association outlining the inputs and outputs connecting all the stages of the life cycle of the product life. Stating the given focus on the manufacturing activities, it means that LCA will be able to calculate the impact on the environment by the resources in association (see fig 3 above) ingesting as well as the process emission (both materials and energy). [43]

Turning raw Material into a product that is updated or a Product that is new in the greatest effective, efficient and economical way possible is the manufacturing or production Engineer's primary interest. The merchandise production for using or for selling using efficient labour as well as machines, tools, chemical as well as biological processing, or formulation is manufacturing. The term basically is referred ranges of the activities of human , from handiwork to great technology, however, it is in industrial production that is most commonly find application on a great scale raw materials are changed into completed goods. Such transformed great goods really are sold for the manufacturers to use for other more complex goods production. Such complex goods are airplanes , appliances used in the house, furniture, sports apparatus or automobiles, or wholesalers will purchase them, and later sell them to retailers, who finally have them sold to end user and final consumers. There is dual responsibility for manufacturing engineers. Fundamentally, products are enabled for manufacturing for manufacturing engineers by providing the tooling equipment, sequence of the operation as well as other technical provisions. Secondly, from a manufacturability perspective, onus is on them to make sure that there is satisfaction from the design given to the manufacturing organization. Manufacturing engineers another function is on the reduction of which needs comments separately. At the cost involvement in the manufacturing a product, manufacturing cum industrial engineers as well as other engineers involved in under industrial manufacturing since the starting of the product process prepared away whittlingpractice. Affluences in such activities have been made without sparing any aspect of manufacturing cost. No way of cost reduction were considered. In a personal point of view as well as experience, the most profitable channel is a situation where, for low cost alternatives, there is analysis for the design of the product. (analysis of the value). [44]

4.1 Sustainable manufacturing Design

The manufactured product formation via simultaneous advancement in the factories resultant effect as well as the sustainability of the product is known as sustainable manufacturing.The sustainable manufacturing concept needs a transformed product system's design so that there will be a conditional relationship between product sustainability on its life cycle as well as factory operations.

- sustainable production systems design implies, on one side, the intra-factory aspects based on analysis and optimization that have connections with manufacturing plants. The aspects of such can be known as the restrain in the consumption of resource, the efficiency in the process, the factory worker's ergonomics, hazardous substances annihilation, the reduction in emissions from the factory as well as emissions from within, in production facilities the combined management of information, and the machines and plants updating technologically.
- Inter-factories other sustainable design areas of concern of products manufactured are dematerialization of product chain, background management as well as the supply chains of the foreground, round paradigm in economy support, as well as sustainability labeling.

Valuable explanations that make companies to resort to manufacture either their products sustainably or apply the use of a manufacturing process that is sustainable includes:

- Costs and waste reduction which brings about operational efficiency increase
- Rise in competitive advantage by responding and well as reaching new customers
- Guard and toughen brand as well as the reputation and also public trust building.
- Long-lasting viability in business as well as the achievement
- Supervisory constraints responses as well as prospects in manufacturing sustainability [45]

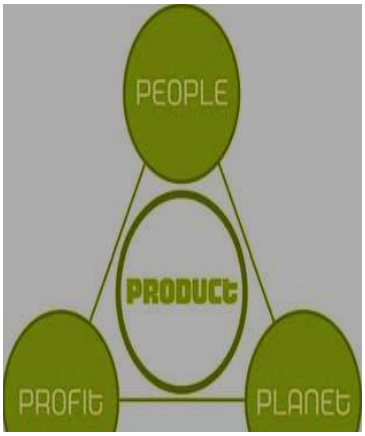
4.2 Products and Sustainability

Increase in worldly interest concerning the problems of the environmental which includes changes in climate, pollution as well as loss in biodiversity, besides such the problems of the society relating to shortage of food, healthcare needs, circumstances surrounding working environment, security and inequality, have actually nurtured industrial sustainability approaches. In the global policy showground, just as exemplified for Sustainable Development by global summit, the governments, the industry as well as the civil society together have accepted sustainability in consumption as well as in the production. Enhanced design in the product which adopted thecriteria principleof sustainability as Designing for Sustainability (DFS) - is among the greatest tools accessible to governments as well as establishments to treat the concerns. (DFS) comprises eco -system concept or environmental design. In western developed economies (DFS) is in close connection to larger concepts as product and service systems that are sustainable, innovations on systems as well as other efforts based on life cycle. In growing economies, stumbling block remains inadequate awareness.

The definition of (DFS) which is wide is that industries imbibe the concern of the environment as well as social as basic in in their long-lasting strategy on product innovation. This means that integrating by the companies the factors of the environmental as well as into the product

The life cycle of the product development, during the course of the source chain given respect to their surroundings that is socio-economic (that is to the worldly market for a worldwide company from the indigenous communal for a lesser company, (TNC)).

Planet, people as well as profit are the major component of sustainability.
The 3 subjects and 3 colours are the elements the graphic design used for illustration:
The illustrative expressions from different cultures and races of Human beings **PEOPLE**.
The various elements of the nature as the water, the rocks, the trees, the sand as well as plants is represented as **PLANET**
The development of the design of the graphic was done by the SUSDESIGN, which is a devoted, for sustainability, body design promotion and is photographically. shown in fig 7



(Carmen van der Vecht and SUSDESIGN)illustrate

Fig 7 People, Profit, Planet and Product

There are many names for these gain-driven strategies. Product design that is sustainable, known as well as Design for Sustainability or DFS, which includes Eco design concept, is one worldly known avenues used by most companies to enhance efficiencies, quality of the product as well as the opportunities in the market (indigenous and export) and at the
same time improving the performance of the environmental concurrently. In western economies, due to high publicity of the importance of the efficiency and the concern of the environmental, the efforts of DFS is connected to conceptsas mixes in product and service, innovation in systems and efforts based on life cycle. In growing economies, the introduction of DFE concept requires closer technical support.
More societies and organizations have created equipment and assisting avenues for companies (as well as company workers) think again on design methods and for producing products for profit enhancement plus competitiveness and for environmental impact reduction alongside. Consequently, and based on gain on experienced, Eco design came up to comprise wider issuesas the social part of sustainability as well as the importance attached to the development of the latest ways of meeting consumer satisfaction in a low utilization of resource. DFS is not limited to making green product, which has adopted ways of satisfying socially, economically and environmentally on a level that is systematic. The 3 important elements of sustainability known as people, planet and profit are connected to product innovation as shown in
(see Figure 7).
Product innovation connected to sustainability directly. They are both interested in change as well as future. The future's well-being is the concern of sustainability. The paramount concern of

product innovation is developing products that are new as well as services towards generating value for the future. [46]

4.2 DesignProcess

`Design is the most exciting area in engineering because of the ability to develop something out of nothing. A wide set of talents is required for a design engineer to be successful. Such talents as creativity in knowledge, skill of the people as well as ability to. CAD is used by Engineers for creating dimensional drawings that are two− and three−dimensions, which is like those of automobile parts as well as parts of the airplane, the floor plans, as well as maps and the how to assembly machines. As long as it will be easier engineer to develop the first stage of hand drawing, efficiently the use of computer for change and adjustment to drawings is much better. In the stage of design, the drafting and the graphics of the computer techniques are integrated towards producing different machine models. The use of computer to performing the step- six which entails the process of 'art−to−part'. The use of sketching software for the capturing of the first ideas of design is the first step, and for accurate production in engineering drawings. The step three is actually the rendering of the real image of the likelihood of the part. Subsequently software analysis is employed by the engineers to make sure on the strength of the parts as shown in fig;1-2; . Fifth step is the prototype production, and start the CAD model as a drafting board that is electronic, which replaces the local use of paper as well as pencil method of drafting. It has come up over years ago as surface that is sophisticated and modeling tool that is solid. Products can not only be characterized correctly as models that are solid, but the shop floors of the factory will be able to have modeling and simulation in 3D. It is a tool which later engineers cannot do without as shown in fig1-6

4.3 Modelling

The process of making a model is known as modeling.; by a model we mean how a construction is represented as well as the operation of approximately system with much interest like shown in fig 5. A model is undoubtedly alike but more simpler in comparing with the system it appears to represent. The fundamental aim of the model is to make it possible for the prediction of effect brings about by changes in the system by the analyst. On the first Part, a model ought to be in intimate approximation to the actual system as well as have an incorporation of its features that are salient. On the second part, it should be simple to understand that is not being a complex that possess difficulty in understanding and
conducting experiment with it. A model that is good is actually a thoughtful balance amongst reality and straightforwardness. Practitioners of simulation commend increasingly the complex nature of a model iterative. Model validity is the most significant issue when it comes to modeling. The techniques for the validation of model, is under known input conditions, is having the model simulated and have the model output compared with that of the system. Usually, a developed model an intention of using it for study in mathematics must be a model for mathematics which is developed with the assistance of software made of simulation. The classification of mathematical model is stochastic and the deterministic(that is the variables are fixed values for the input and the output) [47]

4.4 The Finite Element Analysis (FEA)

This is a method of analysis that is computerized to envision the reaction of a manufactured product to the real world. In the analyzing, it comprises getting the product to be in close contact with the force, the heat, the vibration, the flow of the fluid as well as the other conditions that are physical. It has the capacity of predicting whether there is tendency of the product breaking, tearing, wearing or behaving in the way it is produced to initial development in the year 1943 according to Courant.R. The finite element analysis is partly the process of manufacturing so that the reaction of an object to the real world conditions are predicted during used. Thescientist thatdeals on the solid-state is encourage by the FEA to have an improvement on the quality as well as the object function. The single component behavior is essentially computed by FEA and add them together in other to predict the total behavior of the product manufactured. Currently FEA usually applies computers for object modelling, thereafter it is then stressed up and also analyzed to give required results. In a situation where there is a product that is faulty or result that is not desired, a design that is new is created to be in turn with the conditions that are necessary by FEA.illustrated in Fig:3

The following information is necessary for a real finite element analysis basically on a software system- the spatial areas of the Nodal point (the geometry), the elements in connection with the nodal points, the properties of the mass, the conditions or limitation of the boundary, the Loading or the forcing of the function details, the options for analysis.

4.5 The Procedures

The structures are divided in pieces' form (the elements using nodes), (the discretization/ the meshing), Fixing or nodal connection of the elements in other to have a system that is approximated with equations for the entire structure (the forming of matrices of the elements), Solve equations of the system which involves quantities that are unknown at the nodes (like the displacements). The quantities that are desired are calculated (such as the strains as well as the stresses) for the elements selected.

4.6 *Basic Theory*

Lessing of the functional energy is the wat the finite element analysis gets its temperatures, the stresses, the flows, or unknown parameters that are desired in the finite element model. The functional energy comprises other in association withthe finite element model that are specific. According to the law of energy conservation, the functional finite elemental energy needs to be equal to zero. Finite element method acquires the solution that is exact for it by reducing the functional energy. The reduced level of the functional energy is discovered through the derivative setting in reverence to potential of the grid point that is not known towards zero.

Discretization

The coarse meshing: computation that is fast; unconcerned about the concentrations of the stress, individualities, or distorting. Far geometry changes or the constraints of the displacement or material changes like the thickness.

The fine meshing: the approximation that is the best, however, at the cost during the time of computation. Searching for the level of the stress that is disproportionate it has nodal changes or plate wise, as well as big end-to-end nodal differences in displacement in other to find out the

need for the mesh refining. The definition of the nodes should be done at areas where there are geometrical changes or the loading to occur. There are geometrical changes as related to the thickness, the material as well as the curvature. For a simple check possibly is to reduce the size of the mesh through 50%, run again the analysis, as well as the compares of the change between the stresses of the magnitude and the strains. Then ok it when there is no remarkable change. In many companies, all the size of the mesh knowledge ought to be known and have a file control set as FEA as fig.3. [48] is illustrating.

4.7 The LCA and the Product Life

The assessment of the Life cycle is the total investigation of extracted materials, its transport, its processing and the refining, the manufacturing, the maintenance, the use, the disposal, the reuse, and the stages of recycle. It assists in putting into area to ascertain whether a particular design is really conforming with the environmental sustainability in the years ahead. For instance, products as aluminum with reuse capability for many times have high intensive mining energy andrefining makes it not to be favorable. LCA is used to do information as that thereafter is taken such is considered during designing. [49]

4.8 Life-cycle assessment (**LCA**, otherwise known also as the life-cycle analysis, the eco balance, also the analysis of cradle-to-grave[50] is an environmental impact assessment technique which is in association with the product's life stages beginning from the extraction of raw material via the processing of materials, manufacturing, distribution of materials, using of the materials, repairing as well as the maintenance, plus the disposal or the recycling. This process is used by designers to aid in product critique. In environmental concerns as the narrow outlook, LCAs offers immeasurable help by:

- The compilation of relevant energy inventory, the input of materials and the releases of the environment;
- The potential impacts evaluation in association with the known inputs as well as the releases;
- Making a more informed decision by the result interpretations. [51]

Life cycle impact evaluation

In this phase, the aim of LCA is the assessment of the importance of the impacts of environmental potentials basically on the results of the flow of LCI. The following compulsory elements are what Classical life cycle impact assessment (LCIA) composed of:

- The impact categories selection, the indicators of the category, and also the models of characterization;
- the stage of classification for sorting of the parameters of the inventory as well as designating it to an impact category that are specific; and
- the measurement of the impact especially where there is flow of the characterized LCI with the of one out of the numerous methodologies of LCIA, into the units that is equivalence and common followed by the summation towards the total category impact provision.

In various LCAs, classification ends the analysis of the LCIA; the stage is compulsorily the last with respect to ISO 14044:2006. But besides, compulsory LCIA phases above , other LCIA elements that are: the normalization, the grouping, as well as the weighting, depending, perhaps be conducted on the objective as well as the scope of the study of LCA. In the normalization, the impact category results as got in the study usually resort to comparism in the interest region, with

the overall impacts as the United States of America as an example. Comprising in Grouping is sorting process and the categories of the impact ranking possibly. During the weighting process, the various impacts on the environment are weighted with respect to every one of them in other that there would be addition so that single numbers are got for the overall impact on the environment. The **ISO** 14044:2006 usually gives advices as against the weighting which states that in **LCA** studies, the usage of weighting is unacceptable which has an intention of being used in the comparative proclamations intended for publication. Most times there is ignorance in the advice for the use which results in the comparisons which reflects subjectivity in the high degree as a consequent of theweighting. Illustrated in fig 4:

The impacts of the Life cycle, under many phases of development, is possibly categorized as: the production, the use, as well as the product disposal. Generally speaking, the divisions of the impacts are "the First Impacts, [52], the use impacts, as well as the impacts for the end of life .in the First Impacts there is raw material extraction, the manufacturing (the turning into products of the raw materials), the transporting to the market the product or the site, the construction and or the installation, and the occupancy and or the use begins. The use impacts consist the impacts that are physical for the product operation or the facility operation (as the energy, the water, etc.), the maintenance, the renovation as well as the repairs (which is required for the continuation on the use of the or the facility). The impacts of the end of life comprises destruction as well as waste processing or materials recycling as shown in fig 3 above

5. Conclusion/recommendation

The simulation apparatuses develop creative mind in us and also assist very fast in testing ideas that are new that is difficult, takes much time, and so cost for lab testing (Jeffrey D. Wilson of the Nasa Glenn Research Center). It aids in cost reduction as well as conveyance time to the market by having computer designs instead of being in the field.

Through the management of supply chain, the reporting that is corporate, and embracing related worldwide standards, there is improvement in the efficiency by companies of the resent production as well as new products and services design for customer'ssatisfaction [53]. In other to imbibe sustainability, innovation in product essential to meeting more challenges that people are linked with, the planet and the profit: societal anticipations as well as equal value dissemination via worldwide worth chain, and the eco systems that are supportive, innovation have to work in its capacity. Most of the ideas of the product innovation will be difficult to be effected assuming they are required to meet the criteria above. Thus, the objective as well as the elements of DFS project that are targeted should be defined clearly. A (**DFS)** project that is prepared carefully has a powerful contribution to the future of the company. Sustainability matters should be addressed by a good business which wants to keep on with being competitive. Big companies, and the customers, the governments and global organizations, are progressively erection sustainability desires in their supply process chains. Investing in products that are sustainable, strategy on innovation will offer immediate and benefits that are long term. There is connection between innovation on product and sustainability: they are both focusing on change and future wise. The well-being of the future is what sustainability is the interested in. The Product innovation basically is making products as well as services that are new towards value generation for the future. The shortfall in the technology of processing required processing of palm fruit processing is passed on to physical method as well as the machinery of processing used by individual. As a result of this there is need to develop multidimensional machine for

efficiency increment, reduction in time, the space as well as the associated drudgery [54]. In no distant time, designs will turn out to be sustainable (the solid work). Design is worthless without development. Development is not usable without design as stated by Florian Popes cu in his "How to bridge the gap between design and development" [25]. The following policies are important with reference to the discussion, there should be great efforts adoptable for popularizing design: the FEA, the DFM, the DFE the DFS etc., basically to benefit mankind that constitute greater percentage of a country's population. Adopting the design that is sustainable, there will be reduction in agricultural problem in equipment processing alongside eradication of poverty and hunger (the development goal of UN). In the work coming in the future, there will be exhaustive experiment on the stripper of palm fruit bunch.

Chief Engr.Rufus O. Chime is Staff of Institute of Management and Technology (IMT) Enugu. He Graduated from Enugu State University of Science and Technology ESUT 2001.Currently a Chief Mechanical Engineer and formal Chairman Professional Co-odinator Committee ,School of Engineering at Institute of Management and Technology. He received a professional Diploma of Education from Nigeria's Enugu State College of Education (Technical) .He received four- Month training in Solid Work Modeling and CAD/CAM from Scientific Development Institute SEDI-Enugu and also got his PGD TECHMGT atNational Centre for Technology management Abafemi Awolowo University Ile-IFE Osun State 2015. In 2007 he became the first Chairman of Chapter ofNigerian Institution of Mechanical Engineers shortly after the approval of change of name from Division to Institution in may 27th 2007 at NSE(NigerianSociety of Engineers) meeting .He also recorded as the pioneer Chairman of Enugu Chapter of Nigerian Institution of mechanical Engineers the same year(2007). He served as the financial secretary of Total mandate for good governor Nance in Awgu Chapter 2008-2010 in His local Government Area, He is doing his MSc in Engineering Management at Enugu State University of science and Technology

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