Design Innovation in Metal Fabrication of Industrial Palm Fruit Bunch Stripper Analysis

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Abstract
Palm oil production has advanced in recent years with new technological innovation to produce palm oil, survey results showed that 80 percent of Nigerians oil palm resource exists in smallholders who uses manual/traditional processing techniques and equipment for palm fruit by processing. Thus the nation's oil palm industry is still subsistent with very few large estate plantations that make large mills and imported mills relatively expensive and unaffordable by most farmers, thereby making the traditional method to predominate. The chopping of palm fruit bunch becomes imperative so as to remove the fruitlets located in the inner layer of the bunch and mechanical stripping which eliminates the use of human labor and work related injury to their fingers and bodies. Design 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. 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 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. The scope of this research is to design, model, sustainability analysis and metal fabrication of industrial Palm Fruit Stripper.
Keywords: *Design Innovation, Modelling, Simulation, Analysis Bunch Stripper and metal Fabrication*

BACKGROUND AND PROBLEM STATEMENT:

The chopping of palm fruit bunch becomes imperative so as to remove the fruitlets located in the inner layer of the bunch and mechanical stripping which eliminates the use of human labor and work related injury to their fingers and bodies. 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

RESEARCH OBJECTIVES:

To design and fabricate stripping machine that maintenance cost and stripping time will be reduced, operation of the machine will not require special skill, the machine will be easy and safe to operate, it will be noise and vibration free, the energy required for loading and unloading will be reduced since stripping chamber and discharge outlet are enlarge, the outcome of the research will contribute to sustainability analysis of palm fruit bunch stripper machine which will have the following contribution - Teaching aids, economic development and job creation for Nigerian farmers

STATEMENT OF THE PROBLEM:

Nation's oil palm industry is still subsistent with very few large estate plantations that make large mills and imported mills relatively expensive and high-priced by most farmers, thereby making the traditional method to outweigh. The chopping of palm fruit bunch befits imperative so as to remove the fruitlets located in the inner layer of the bunch and mechanical stripping which eliminates the use of human labor and work related injury to their fingers and bodies

PROJECT GOALS:

Our research goal is to analysis, develop a low cost, easy-to-use industrial bunch stripper machine which will be used comfortably, effectively, for rural dweller

JUSTIFICATE OF FABRICATION PROJECT

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.

In a mechanized system, a rotating drum or fixed drum equipped with rotary beater bars detach the fruit from the bunch, leaving the spikelets on the stem it is greatly improved production rates and reduced stripping time.

INTRODUCTION

The oil palm is a popular tree crop in West Africa that is described as the prince of the plant kingdom because virtually every part of it has economic importance. It plays an essential role in the agricultural and economic sectors of those countries where it is originated. Report revealed that 338 billion pounds was generated from the cultivation of oil palm thus amounting to about twice the level of production of any other fruit crop, making oil palm by far the world's number one fruit crop [1]. The palm oil and palm kernel oil have a wide range of applications, about 80 percent of the palm oil produced finds its way into food products while the rest is feedstock for a number of non-food application [2]. The byproducts of oil palm fruit processing such as empty bunches and fibres can further be process as raw materials for potash fertilizer, fibre, pulps and paper manufacture [3] Though the technology of palm oil production has advanced in recent years with new technological innovation to produce palm oil and palm kernel oil of superior quality [4], survey results showed that 80 percent of Nigerians oil palm resource exist in small holder plantations and wild groove [5], and thus the nation's oil palm industry is still subsistent with very few large estate plantations that make large mills and imported mills relatively expensive and unaffordable by most farmers, thereby making the traditional method to predominate . 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 tip is scooped off for clarification. Apart from the drudgery, time wasting and high labour requirement in this method, it gives poor quality oil as the period of fermentation increases the free fatty acid (FFA) content of the oil. According to Badmus [6], processing the fruit without delay or fermentation yielded the highest oil extraction of 87 percent and best quality oil with free fatty acid (FFA) of 2.31 percent. 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 affect the quality of crude palm oil [7]

As fruits ripen, they change from black (or green) to orange, but have varying degrees of black cheek colour depending on light exposure and cultivar. The fruit bunches are harvested using chisels or hooked knives attached to long poles. Processing of oil palm fruits bunches into palm oil is practiced using various methods which may be grouped into four categories according to their throughput and degree of complexity of the unit operational machinery. These are the traditional methods that can process less than 1 tonne of fresh fruit bunches (FFB) per hour; the small-scale mechanical units handling up to 2 tonnes of FFB per hour; the medium-scale mills handling between 3 to 8 tonnes per hour and the largescale mills which are able to process more than 10 tonnes per hour [8] [9] [10]

DESIGN

A design is a plan or specification for the construction of an object or system or for the implementation of an activity or process, or the result of that plan or specification in the form of a prototype product or process. The verb to design expresses the process of developing a design. In some cases, the direct construction of an object without an explicit prior plan (such as in craftwork, some engineering, coding, and graphic design) may also be considered to be a design activity. The design usually has to satisfy certain goals and constraints, may take into account aesthetic, functional, economic, or socio-political considerations, and is expected to interact with a certain environment. Major examples of designs include architectural blueprint, engineering drawing, business process, circuit diagrams, and sewing pattern sewing [11] illustrated in fig 1 &5

The person who produces a design is called a designer, which is a term generally used for people who work professionally in one of the various design areas- usually specifying which area is being dealt with (such as a textile designer, fashion designer, product designer, concept designer, web designer (website designer) or interior designer), but also others such as architects and engineers. A designer's sequence of activities is called a design process, possibly using design methods. The process of creating a design can be brief (a quick sketch) or lengthy and complicated, involving considerable research, negotiation, reflection, modeling, interactive adjustment and re-design. [12]

INNOVATION

In its modern meaning is "a new idea, creative thoughts, new imaginations in form of device or method [13] Innovation is often also viewed as the application of better solutions that meet new requirements, unarticulated needs, or existing market needs [14] Such innovation takes place through the provision of more-effective products, processes, services, technologies, or business models that are made available to markets, governments and society. An innovation is something original and more effective and, as a consequence, new, that "breaks into" the market or society [15] Innovation is related to, but not the same as, inventions, [16]as innovation is more apt to involve the practical implementation of an invention (i.e. new / improved ability) to make a meaningful impact in the market or society [17]and not all innovations require an invention. Innovation often manifests itself via the engineering process, when the problem being solved is of a technical or scientific nature. The opposite of innovation is exnovation.

While a novel device is often described as an innovation, in economics, management science, and other fields of practice and analysis, innovation is generally considered to be the result of a process [18] that brings together various novel ideas in such a way that they affect society. In industrial economics, innovations are created and found empirically from services to meet growing consumer demand [19] [20] [21] Innovation also has an older historical meaning which is quite different. From the 1400s through the 1600s, prior to early American settlement, the concept of "innovation" was pejorative. It was an early modern synonym for rebellion, revolt and heresy. [22] [23] [24] [25]

LITERATURE REVIEW

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 [26]

DESIGN HISTORY ALSO EXISTS AS A COMPONENT OF MANY PRACTICE-BASED COURSES.

The teaching and study of design history within art and design programs in Britain are one of the results of the National Advisory Council on Art Education in the 1960s. Among its aims was making art and design education a legitimate academic activity, to which ends a historical perspective was introduced. This necessitated the employment or 'buying in' of specialists from art history disciplines, leading to a particular style of delivery: "Art historians taught in the only way that art historians knew how to teach; they switched off the lights, turned on the slide projector, showed slides of art and design objects, discussed and evaluated them and asked (art and design) students to write essays – according to the scholarly conventions of academia [27]

The most obvious effect of the traditional approach design history as sequential, in which X begat Y and Y begat Z. This has pedagogical implications in that the realization that assessment requires a fact-based regurgitation of received knowledge leads students to ignore discussions of the situations surrounding a design's creation and reception and to focus instead on simple facts such as who designed what and when.

This 'heroic/aesthetic' view – the idea that there are a few great designers who should be studied and revered unquestioningly – arguably instills an unrealistic view of the design profession. Although the design industry has been complicit in promoting the heroic view of history, the establishment of the UK government creative& cultural skills has led to calls for design courses to be made less 'academic' and more attuned to the 'needs' of the industry. Design history, as a component of design courses, is under increasing threat in the UK at least and it has been argued that its survival depends on an increased focus on the study of the processes and effects of design rather than the lives of designers themselves.

Ultimately it appears that design history for practice-based courses is rapidly becoming a branch of social and cultural studies, leaving behind its art historical roots. This has led to a great deal of debate as the two approaches forge distinct pedagogical approaches and philosophies. [28]

The following is a list and timeline of innovations as well as inventions and discoveries that involved British people or the United Kingdom including predecessor states in the history of the formation of the United Kingdom. This list covers innovation and invention in the mechanical, electronic, and industrial fields, as well as medicine, military devices and theory, artistic and scientific discovery and innovation, and ideas in religion and ethics. The scientific revolution in 17th century Europe stimulated innovation and discovery in Britain. [29] Experimentation was considered central to innovation by groups such as the Royal Society, which was founded in 1660. The English patent system evolved from its medieval origins into a system that recognized intellectual property; this encouraged invention and spurred on the industrial Revolution from the late 18th century. [30] During the 19th century, innovation in Britain led to revolutionary changes in manufacturing, the development of factory systems, and growth of transportation by railway and steam ship that spread around the world.[31]In the 20th century, Britain's rate of innovation, measured by patents registered,[32]slowed in comparison to other leading economies. Nonetheless, science and continued to develop rapidly in absolute terms. [33]

METHODOLOGY

Method of Fabrication

S/n	Operation	Description of Operation	Equipment/Tool	Time
1.	Sketching of the working drawing	- Rough Sketch On Paper - Further Sketch With Solid Works Student Licensed and AutoCAD Software on computer.	Pencil, ruler, paper, laptop computer and desktop- computer	8 hrs
2	Material preparation	The selected materials were bought and transported to the fabrication site	Vehicle	16 hrs
3	Marking out	Various component's dimension were marked	Scriber, divider, tri-square	24hrs
4	Cutting the mark out dimensions on the materials	Angle iron and rods were clamped on a vice and were cut into pieces required.	Hark saw Powered saw, Hand cutting machine	36 hrs
7	Punching, drilling and tapping	- The frame was coupled by tag. Positions were checked to ensure accuracy	Arc welding machine, electrode, try-square, spirit level and chipping hammer	8 hr – 24min
9	Spring coiling	- A spring material was attached to a cylinder of dimension. It was heated with flame and was coiled round the cylinder to produce a coiled spring.	Oxy-acetylene bench vice hammer	8hrs 36 mins
10	Heat treatment	- The coiled spring was taken to furnance and was heated to 900ºC and then it was quenched in water and oil.	Furnance and clamp	8hrs
11	Permanent welding	- The frame, flanged cylinder, rods were permanently joined each with an arc welding machine	Arc welding machine, electrodes, chippy hammer	7hrs
12	Coupling	- The main frame, electric motor, outlet, hopper, flanged ,cylinder shafts were coupled.	Bolt and nuts, arc welding machine	8hrs

Table ;1 fabrication process

Metal fabrication is the creation of metal structures by cutting, bending and assembling processes. It is a value-added process involving the creation of machines, parts, and structures from various raw materials. Typically, a fabrication shop bids on a job, usually based on engineering drawing engineering (see fig1-6), and if awarded the contract, builds the product. Large fab shops employ a multitude of value-added processes, including welding, cutting, forming and machining. As with other manufacturing processes, both human labor and automation are commonly used. A fabricated product may be called a fabrication, and shops specializing in this type of work are called fab shops. The end products of other common types of metalworking, such as machining metal stamping, forging, and casting, may be similar in shape and function, but those processes are not classified as fabrication [34] illustrated in table 1

MACHINE DESCRIPTION AND OPERATION

The machine consists of a hopper made from mild steel sheet of vertical height 430mm and slanted height 450mm, base width of 450mm and length 1250mm. The frame is also made from mild steel angle iron bar (2.5x2.5include) 950 mm heights. It has a stripping unit which consisted of the shaft 75mm diameter on which the beaters arms 22mm and 20mm diameters are welded in a spacing of 80mm in an auger like manner in order to ensure that the stripped bunches are pushed towards the bunch discharge outlet while the fruits are collected at the fruit discharge outlet beneath the machine. Palm fruit bunches are fed into the machine through the hopper to the stripping unit where the shaft with beaters arranged in an auger like form is located. As the shaft rotate through the power transmitted from the electric motor via belt and pulley mechanism, the bunch is thrown up against the housing and at the same time conveyed to the bunch discharge outlet while the fruit is collected beneath the machine. Figure-2 shows the wire frame of the palm fruit stripper while fig;6 shows multiply views of machine as shown below .

Determination of machine capacity Total weight of fruit stripped = 0.90kg

Total time taken for the operation = 0.083hr

This relationship gives the capacity of the machine = $\frac{\text{weight of stripped fruit + empty bunch}}{\text{time taken}}$

$$\text{Machine capacity} = \frac{Wfz + We}{Time\ (hr)} \quad (1)$$

$$\text{Machine capacity} = \frac{0.9 + 0.93}{0.083}$$

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

Determination of the rate of power consumption by the machine

Total power consumed = 1.1kW

Total time of the operation = 0.083hr

Power consumption in kW/hr is given by

$$= \frac{\text{power consumed(kw)}}{\text{time of operation (hr)}} \quad (2)$$

Power consumption =1.1kW 0.083hr

Power consumption = 13.25kw/hr

Determination of cost of power/hour

Power required per hour = 13.25kw,

Cost of power/hr in Nigeria = N4

Cost of power per hour = Power required/hr x cost of power per hour

Cost of Power/hr = 13.25 x 4 = N53

Determination of power required by the machine to strip 1 tonne of oil palm fruit

From the machine capacity determined (22kg/hr), 1 tonne will be stripped by 13.25kw, and therefore to operate the machine for 2hrs,

and power required is given as follows:

1 hour, power required = 13.25kw for 2 hours,

power required will be 13.25kw x 2 =26.5kw.

Determination of cost of power required for 1 tonne of oil palm fruit

1 unit (1kw/hr), cost N4 in Nigeria

Cost of power required/tonne = power consumed/tonne x cost per/hr.

Power required/tonne = 13.25kw x 4 = 53kw/tone

Determination of wages of the machine operator

The operator salary was assumed to be N10000 per month.

Therefore, the operator will be expected to collect N389.6 per day

(26 working days Saturday inclusive) or N48 per hour (8 working hours).

Performance evaluation

The machine was installed on a level and hard surface. Sixty-five kilogram of freshly harvested palm fruit was purchased from nearby farm. 7kg of oil palm fruit bunch was prepared for the machine test. Each experiment was carried out in five replicates. The stripper was evaluated at

Determination of feed rate

$$\text{Feed rate} = \frac{\textit{quantity of bunch feed in}}{\textit{Time taken to feed}}$$

$$Fr = \frac{Qbf}{Tf} \qquad (1)$$

Determination of the output capacity

$$\text{Output capacity} = \frac{\textit{weight of palm fruit stripper weight of empty bunch}}{\textit{Time taken to feed}}$$

$$Qc = \frac{WFz + We}{TB} \qquad (2)$$

Determination of machine efficiency

$$\text{Machine efficiency} = \frac{\textit{weight of palm fruit stripped + weight of empty bunch x100}}{\textit{Total weighty of fruit in the bunch prepared for stripping}}$$

$$M_E = \frac{WFz}{WEb} \times 100\% \qquad (3)$$

Determination of quality performance efficiency

$$\text{Quality Performance efficiency} = \frac{\textit{Weight of stripped fruit}}{\textit{weight of empty bunch + weight of fruit unstripped}}$$

$$Q_{PE} = \frac{WFE}{WEb} \times 100\% \qquad (4)$$

Determination of percentage of damage fruits

$$\text{Percentage of damaged fruit} = \frac{\textit{feed rate – output capacity}}{\textit{Total weight of fruit in the bunch prepared for}}$$

$$P_{DF} = \frac{Fr - Qc}{WFT} \times 100\% \qquad (5)$$

CONCEPTUAL FRAMEWORK

CAD / VIEWS AND SUSTAINABILITY ANALYSIS OF MACHINE BUNCH STRIPPER

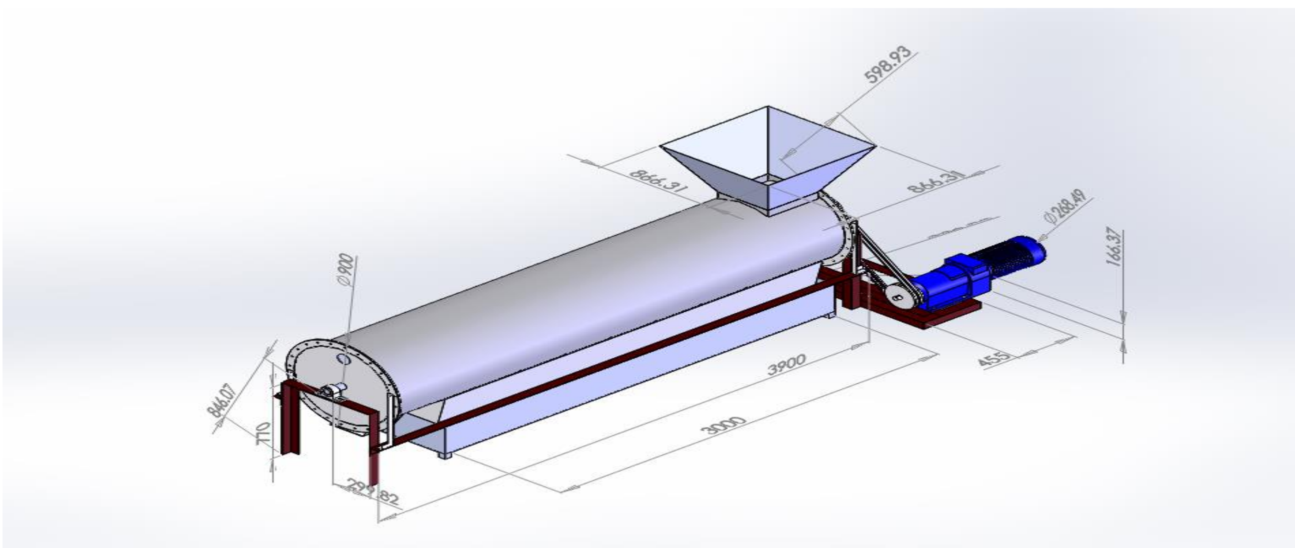


Fig 1: CAD model

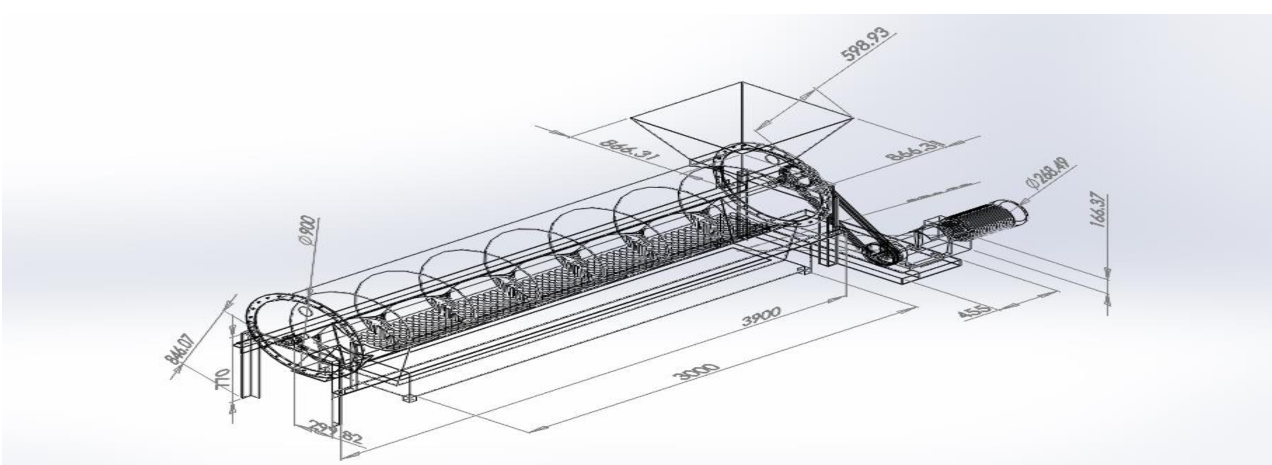


Fig 2: wire frame

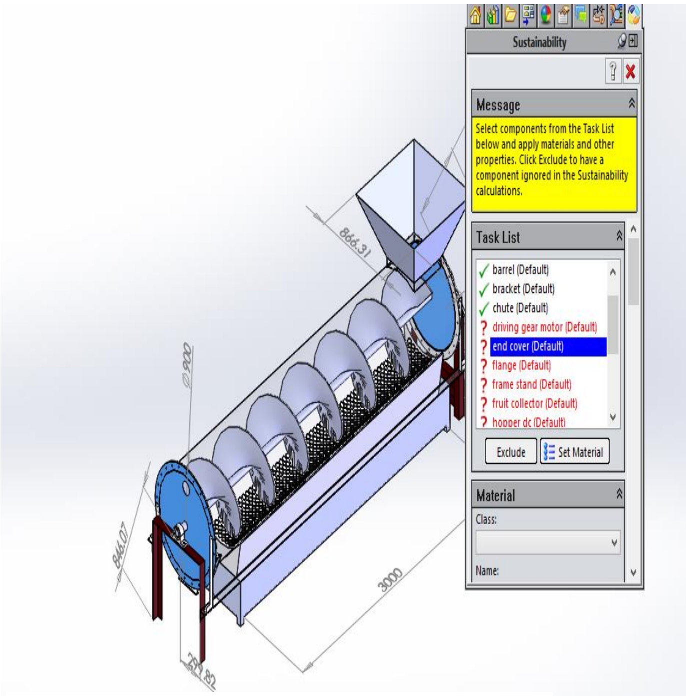


Fig 3: Material selection process

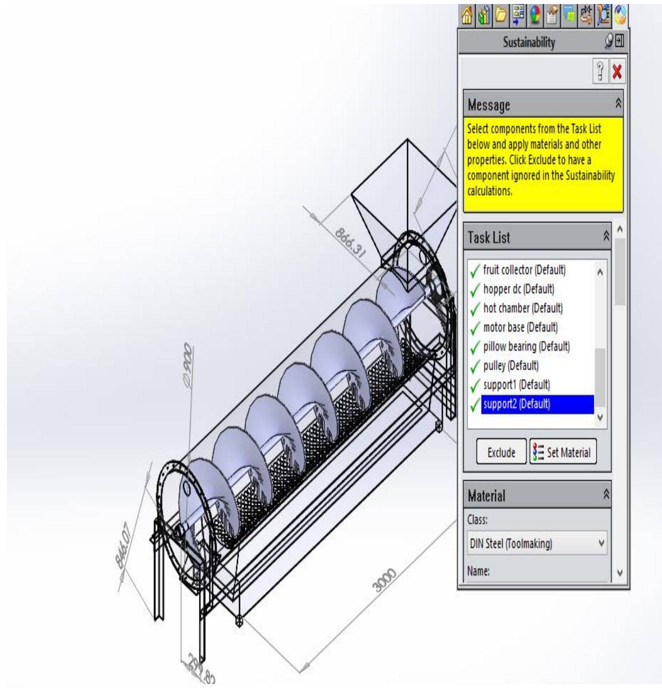


Fig 4: materials selected

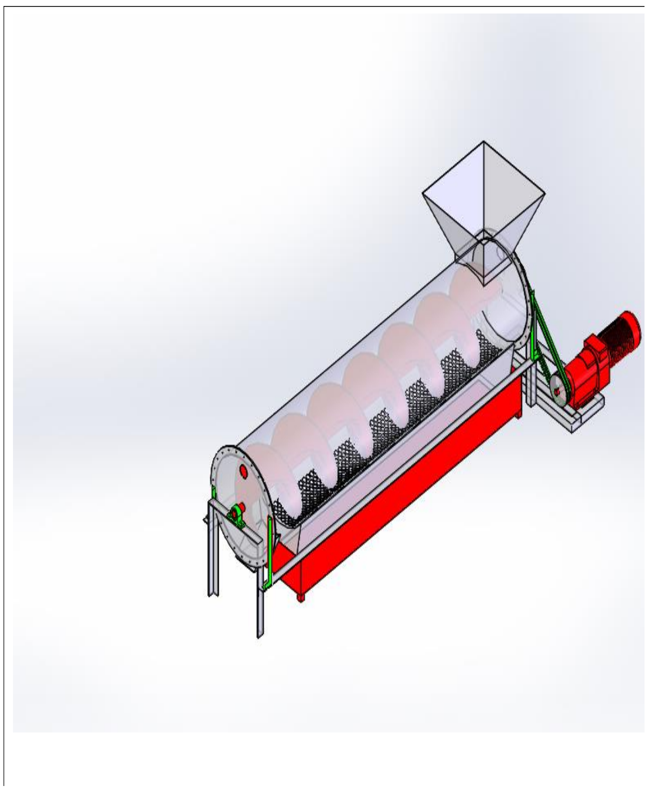


Fig 5: Sustainability analysis of bunch stripper(Result)

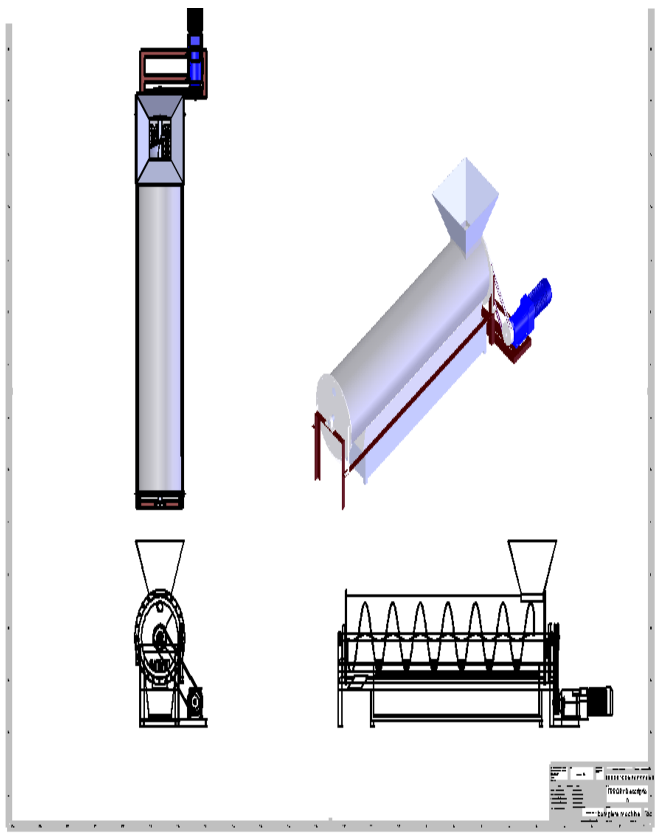


Fig 6: multiply views of bunch stripper

Component	Carbon	Water	Air	Energy
Stand	780	0.607	4.7	9100
Part2	500	1.6	2.6	5300
Part1	120	0.413	0.664	1300
Blower	170	0.036	0.480	2400
Part3	44	0.020	0.282	530
bunch motor	25	5.7E-3	0.172	300
Basket	15	0.058	0.	170

Environmental Impact Comparison

New Design:
Better Worse

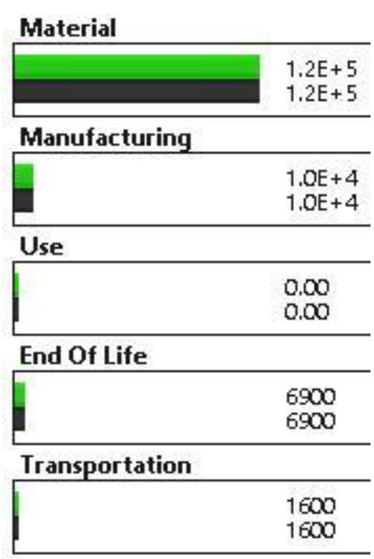
Original Design:
Baseline

Carbon Footprint – Comparison

Total : 1.4E+5 kg CO_2e
: 1.4E+5 kg CO_2e

Total Energy Consumed – Comparison

Total : 1.3E+6 MJ
: 1.3E+6 MJ



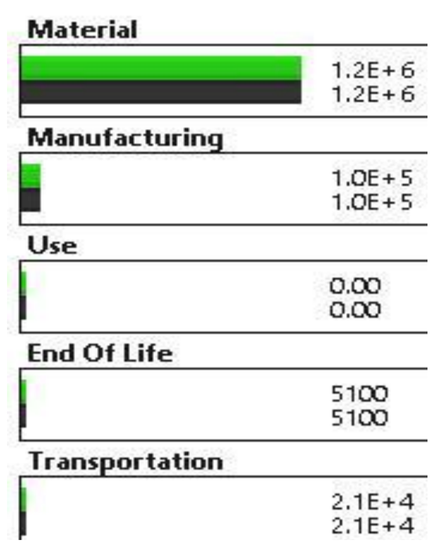


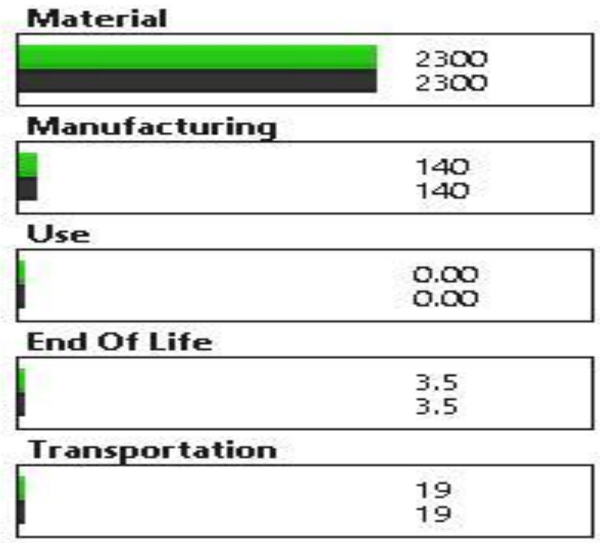
Table 2: **Environmental Impact Comparison**

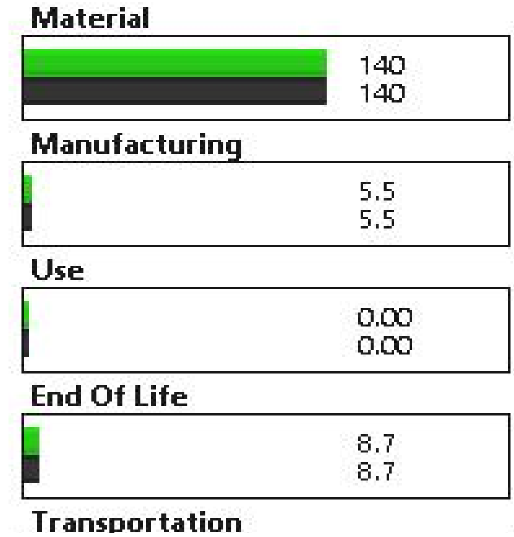
Air Acidification - Comparison

Total : 2500 kg SO_2e
: 2500 kg SO_2e

Water Eutrophication - Comparison

Total : 160 kg PO_4e
: 160 kg PO_4e





Material Financial Impact Comparison

Table 3 **Material Financial Impact**

DISCUSSION

Modeling and simulation (**M&S**) is the use of models (e.g., physical, mathematical, or logical representation of a system, entity, phenomenon, or process) as a basis for simulation to develop data utilized for managerial or technical decision making decision. [34] [35]

In the computer application of "**Modeling and simulation**" a computer is used to build a mathematical model which contains key parameters of the physical model. The mathematical model represents the physical model in virtual form, and conditions are applied that set up the experiment of interest. The simulation starts – i.e., the computer calculates the results of those conditions on the mathematical model – and outputs results in a format that is either machine- or human-readable, depending upon the implementation. Illustrated in fig 1

The use of M&S within engineering is well recognized. Simulation technology belongs to the tool set of engineers of all application domains and has been included in the body of knowledge of engineering management. M&S helps to reduce costs, increase the quality of products and systems, and document and archive lessons learned. Because the results of a simulation are only as good as the underlying model(s), engineers, operators, and analysts must pay particular attention to its construction. To ensure that the results of the simulation are applicable to the real world, the user must understand the assumptions, conceptualizations, and constraints of its implementation. Additionally, models may be updated and improved using results of actual experiments. M&S is a discipline on its own. Its many application domains often lead to the assumption that M&S is a pure application. This is not the case and needs to be recognized by engineering management in the application of M&S. The use of such mathematical models and simulations avoids actual experimentation, which can be costly and time-consuming. Instead, mathematical knowledge and computational power is used to solve real-world problems cheaply and in a time efficient manner. As such, M&S can facilitate understanding a system's behavior without actually testing the system in the real world. For example, to determine which type of spoiler would improve traction the most while designing a race car, a computer simulation of the car could be used to estimate the effect of different spoiler shapes on the coefficient of friction in a turn. Shown in fig 3 - 4 Useful insights about different decisions in the design could be gleaned without actually building the car. In addition, simulation can support experimentation that occurs totally in software, or in human-in-the-loop environments where simulation represents systems or generates data needed to meet experiment objectives. Furthermore, simulation can be used to train persons using a virtual environment that would otherwise be difficult or expensive to produce. Technically, simulation is well accepted

VERIFICATION AND VALIDATION OF COMPUTER SIMULATION MODELS

It is conducted during the development of a simulation model with the ultimate goal of producing an accurate and credible model. [36] [37]"Simulation models are increasingly being used to solve problems and to aid in decision-making. The developers and users of these models, the decision makers using information obtained from the results of these models, and the individuals affected by decisions based on such models are all rightly concerned with whether a model and its results are "correct".[38]This concern is addressed through verification and validation of the simulation model. Simulation models are approximate imitations of real-world systems and they never exactly imitate the real-world system. Due to that, a model should be verified and validated to the degree needed for the model's intended purpose or application. [38]

The verification and validation of a simulation model starts after functional specifications have been documented and initial model development has been completed. [39] Verification and validation is an iterative process that place throughout the development of a model. [36] [39]

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 is 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 biodiversity;
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 [40][41] illustrated in fig 5 ,table 2&3

Design for the Environment

The U.S. Environmental Protection Agency created the Design for the Environment (DfE) program in 1992 to decrease pollution and the human and environmental risks that it entails. It recognizes consumer and industrial & institutional products deemed to be safer for human health and the environment through an evaluation and product labeling program. Furthermore, the program defines best practices in a variety of industries, and identifies safer chemical alternatives. [42]

Design for the Environment Life-Cycle Assessments

A life-cycle assessment (LCA) is a tool that can be used to evaluate the potential environmental impacts of a product, material, process, or activity. An LCA is a comprehensive method for assessing a range of environmental impacts across the full life cycle of a product system, from materials acquisition to manufacturing, use, and final disposition. LCA study results help to promote the responsible design and redesign of products and processes, leading to reduced overall environmental impacts and the reduced use and release of more toxic materials. LCA studies identify key materials and processes within the products' life cycles that are likely to pose the greatest impacts, including occupational and public toxicity impacts. These assessments allow businesses to make product improvements through environmentally sound process, material, and design choices,

Using SolidWorks Sustainability, the ideas of sustainability and sustainable design are a growing part of today's product design conversations. But exactly what is sustainable design, and how do you create a greener product? We'll answer these questions through this Guide to Sustainable Design with rich content and detailed examples illustrated in fig 2-4 and table 1 &2

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 development [43]. 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. Simulation tools enable us to be creative and to quickly test new ideas that would be much more difficult, time consuming, and expensive to test in the lab. (Jeffrey D. Wilson, Nasa Glenn Research Center) It also help us reduce cost and time-to-market by testing our designs on the computer rather than in the field it was against this background that our research topic was derived and the benefits are summarized in simulation – driven design [44]

The Benefits of Simulation-Driven Design

The benefits of simulation-driven design are compelling, resulting in more innovative products developed faster, meeting time-to-market, quality, and cost targets.

To capture these benefits, and dissipate mounting manufacturing pressures and challenges, Aberdeen Group recommends that design engineers meet their goals through simulation-driven design:

➡ **Deploy Simulation-driven Design for Product Innovation,**

The reason the Best-in-Class decreased their physical prototypes by 27 percent, is because they switched to virtual prototypes and virtual testing. This allowed them to explore hundreds of design iterations (or more), freeing them up to identify and concentrate on the most innovative designs with the highest breakthrough potential.

➡ **Deploy Simulation-driven Design for Improved Time-to- Market**

Best-in-Class designers improved their length of development time by 29% - six times the rate of improvement by All Others. Best-in-Class organizations also met their time-to-market targets 76% of the time, a 17% higher rate than All Others,

➡ **Deploy Simulation-driven Design for Higher Quality.**

Seventy-seven percent of Best-in-Class firms met their product quality targets. Plus, Best-in-Class products were more likely to work right the first time and less likely to require rework, as the Best –in-class improved their ECOs after release to manufacturing by 2%

➡ **Deploy Simulation-driven Design to Reduce Costs.**

Seventy-one percent of Best-in-Class designers met their product costs targets, versus 63 percent of All Others.

Innovation begins with accepting that the world has changed, and is becoming open to new ways of doing things.

The Best-in-Class have made the leap to simulation-driven design, and others should consider doing the same,

Thomas Edison once said that genius was "One percent inspiration and 99 percent perspiration." Simulation-driven design updates Edison's maxim for design genius, allowing design engineers to innovate through iteration via virtual prototyping and virtual testing. This new way of doing things eliminates the "perspiration" of physical prototyping. And designers are now free to test hundreds (or thousands) of design alternatives until they are "inspired" by the most innovative product design choice.

Edison tried over 1,000 physical prototypes of the incandescent light bulb, before discovering that the lowly bamboo-based carbon filament yielded a bulb that lasted over 1,200 hours. In choosing simulation-driven design, engineers get the best of both worlds: innovative product that also meets time-to-market, cost, and quality targets. [45]

Government has a large role to play in supporting modeling and simulation, whether it be supporting research, setting appropriate standards, or disseminating information. Here are the challenges and some recommendations from the workshop participants for modeling and simulations.

Recommendations:

Develop guidelines for accuracy, precision and transparency in simulations and models to ensure high-quality products. ("If you can't measure it, you can't manage it.")

Develop standards, regulations and guidelines to promote high quality, accurate data in models and simulations to help determine the risk, cost and inherent problems in product development.

Create economic stimuli, tax breaks and government funding to make modeling and simulation affordable to small manufacturers.

Develop a standard, consistent interface that contains certain concepts regardless of the tool (such as the cut/paste feature in all word processing programs).

Promote standards for building and validating models, including a focus on best practices and harmonization.

Provide funding for research projects that can have important ramifications for small businesses, which, alone, are unable to make such investments.

Challenges in and Recommendations for Creating and Using Models and Simulations

Government

More research and development are needed to develop pilot programs in simulation and modeling to support the manufacturing processes.

Accessibility of modeling and simulations to small manufacturers is limited because of high costs.

Developing sophisticated models, simulations and creating virtual designs often depends on accurate, high quality and precise data and validation, which are lacking.

How something is modeled is not always transparent to the user. [46]

Conclusion

Simulation is an important and useful technique that can help users understand and model real life systems. Once built, the models can be run to give realistic results. This provides a valuable support in making decisions on a more logical and scientific basis. Simulation has been one of prime methods used as a decision support tool in industry. It is a powerful tool for designing and analyzing complex and dynamic systems to predict their behavior under different conditions on a time scale. Simulation is a highly cost-effective method of testing new processes without having to carry out actual experiments. This can save enormous amounts of money, which would otherwise be spent on pilot programs, yet can produce better results much faster. [47] Though the technology of palm oil production has advanced in recent years with new technological innovation to produce palm oil, survey results showed that 80 percent of Nigerians oil palm resource exist in smallholders. [48] Thus the nation's oil palm industry is still subsistent with very few large estate plantations that make large mills and imported mills relatively expensive and unaffordable by most farmers, thereby making the traditional method to predominate

[49]

Depending on the application, sheet metal offers advantages, not just over nonmetal alternatives but over other types of metal fabrication as well. Compared to machining, it generally has a significantly lower material cost. Rather than starting with a block of material, much of which will be machined away, sheet metal lets you buy what you need and use what you need. The remainder of a metal sheet is still usable, while swarf-the shavings removed in machining-must be recycled. As with many modern fabrication techniques, sheet metal manufacturing can be automated and parts produced directly from CAD model. Computers function in the design process through geometric modeling capabilities, engineering analysis calculations, testing procedures, and automated drafting, from the result of testing and affordability in term of cost, it can be concluded that the project is successful, therefore software design should be encouraged in our institution of higher learning base on the following facts, long product development, countless trial and error, accountability and limited profitability.

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