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THE DESIGN AND CONSTRUCTION OF A MELON PEELING AND SEPARATING MACHINE

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TITLE PAGE

THE DESIGN AND CONSTRUCTION OF A MELON PEELING AND SEPARATING MACHINE

A THESIS SUBMITTED TO THE DEPARTMENT OF VOCATIONAL TEACHER EDUCATION, UNIVERSITY OF NIGERIA, NSUKKA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTER OF EDUCATION IN INDUSTRIAL TECHNICAL EDUCATION

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DEDICATION

This Thesis is dedicated to my parents Late Chief Yellow Ikon Utin and Late Madam Sarah Titus Etukudoh, who initiated my education.

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First and foremost, I am most thankful to God for the health, inspiration and patience, which enabled me to successfully complete this research work.

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UTIN, ASUQUO YELLOW

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ABSTRACT

The absence of cheap and functional agricultural processing machines have been the bane of poor agricultural productivity in Nigeria. Besides, the few machines available are expensive and cannot be conveniently purchased or owned by local farmers. This situation therefore lent credence to the justification of this study, which resulted in the design and construction of a simple cheap portable electrically operated melon peeling and separating machine. Locally available materials, components, and devices were used to make the product cheaper, portable and affordable. The block diagram/components was designed to specification to reflect its purpose, while the assembly/mounting consisting of frame, electric motor, peeling chamber and rotor, the feeding hopper, the blower, the separating port and power cord were developed and constructed. The machine was tested for functionality with different samples of unpeeled melon seeds and unseparated melon shells. The result was satisfactory. Commerce and agriculture will experience a boost in Nigeria through the development of this simple but cheap electrically operated processing machine for peeling and separating melon seeds. This machine will also serve as models in school laboratories and workshops thus creating awareness in students, for the development of indigenous technology.

CHAPTER I

INTRODUCTION

Background of the Study

The development of human capital through education is an essential pre-condition for a country's economic, political and socio-cultural transformation.

Upon the inception of formal education in Nigeria, the aims of education in Nigeria have been the origin of man for work and for life-man-power development. It has been observed that owing to the administrative "bottle neck" which existed during the colonial era, the colonial master set up education programme geared towards training of typists and clerks to facilitate the administration of the districts colonies. This led to the development of intellectual giants, talkative elites but technologically dwarf.

It is obvious that the early secondary schools were grammar schools founded after the English system by the missionaries. No technical or vocational schools were originally established. Education increasingly came to be regarded as a means of avoiding manual work (Okoro, 1993).

In realization of the role played by vocational technical education in technological advancement in developed countries of the world, and in consolidation of the Ashby Commission Report of 1960 recommending vocational training in all schools both primary and secondary, the Nigerian government evolved a new system of education called the (6-3-3-4) in the country in 1988.

The ever increasing level of unemployment and the resultant need to provide youths with saleable skills that could make them enterprising and self-reliant economically justify the introduction of technical and vocational education into the new Nigerian education system. Technical and Vocational Education, according to the Federal Government of Nigeria (FGN, 2004) is a comprehensive term referring to those aspects of the educational process, involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, Thus, technical and vocational education enable youths to obtain practical based training in a wide range of technical courses, trades and occupations so that on completion, they can either take up paid employment in any establishment or start their own businesses and employ others. One lucrative area where technical education graduates particularly those in the mechanical courses/trades can easily establish their own enterprise is in the design and construction of tools and machines.

It is worthy to note that from the primitive era to the contemporary, man has always been confronted with the need for well designed tools and machines that will make his life more comfortable and more convenient. Design is essentially a process of inventing or planning physical things, which display a new organization or form in response to some function (Lindbeck, 1990). Yan (1998) posited that the term “design” is derived from the Latin word “designer” meaning to work out and that designing therefore mean the act of working out the form of something (as by making a sketch, outline or plan). According to Bamiro, Nurudeen and Akuru (1986), design also means the drawing or plan from which something may be made. They explained that the design of a product contains all the descriptive features essential for producing the product to specification. This position is shared by Nwachukwu (2001) who maintained that design is the graphic representation of ideas and concepts aimed at a follow–up development through the process of construction.

According to Yan (1998), construction is the act of building structure with many parts. Halpin and Riggs (1992) noted that construction makes possible the development of design and that it involves the combination of different kinds of material resources such as financial and human resources which may include skilled and unskilled labour like engineers, technicians and labourers. Construction, in the context of this study, is synonymous with fabrication, which means the making of an object or equipment from various different materials. They pointed out that the construction or fabrication of an equipment involves a lot of activities and operations such as measuring, making out, cutting and joining of the different parts through such process as welding, soldering, brazing, riveting and the use of bolts and nuts, screws and studs. They added that it also involve the use of many tools and machines.

Recent advances in technology has led to the development of many simple and sophisticated machines that perform almost all the activities that were hitherto carried out by man through his muscle power or through animal power and some natural phenomena such as fire, wind and tides. According to Wilken (1999) a machine is any mechanical or electrical device that transmits or modifies energy to perform or assist in the performance of tasks. Awe and Okunola (1984) view a machine as any device, system or arrangement, which enables work to be done more easily and more quickly. Pytlik, Lauda and Johnson (1985) defined a machine as an object that modifies the force applied to it by a human, an animal or another machine. They explained that the modification is in the form of a change of direction or an increase in the force applied to an object, allowing the human to do things he/she was unable to do using only human or animal strength. Their position is shared by Wilken (1999) who maintained that a machine usually requires an input as a trigger and that it transmits the modified energy to an output, which performs the desired task. In other words, a machine multiplies the small force applied to it several times to a much bigger force in order to do the required work (Elekwa, Bamiro, Oluyide, Layode, Nurudeen, Akum and Olopade, 1994). They noted that for this reason, a machine is often described as a force multiplier.

A lot of machines are being used nowadays in agriculture. Akinsanmi (1982) classified agricultural machines into six main groups based on their functions. These are tillage machines, cultivating machines, fertilizing machines, spraying machines, harvesting machines and processing machines or equipment. All these classes of agricultural machines are very important because their use improves agricultural production and make it more productive and more efficient (Benjamin, 1999). Of more importance and more relevance to this study are the processing machines. According to the Science Teachers Association of Nigeria (STAN) (1991), the processing machines or equipment are those equipment or machines used for processing harvested food crops into forms that they could be readily consumed, sold or stored for future cultivation. They maintained that without adequate and functional agricultural processing machines, many harvested food crops may become spoilt while awaiting processing by hand. STAN (1991) further listed the following as common agricultural processing machines used in Nigeria: grinding or milling machines, mixers, Shellers, Hullers and Ginnery. Other examples of agricultural processing machines locally fabricated by metal workers in Nigeria as reported by Udoudo (1990) includes kernel crackers, cassava mills, palm fruit digesters, palm oil press, cassava press and maize grinders. Infact, agricultural literature is replete with articles on several machines for processing various crops cultivated in Nigeria such as oil palm, maize, cotton, rice, groundnuts and beans. It is however not common to find machines (and literature on them) for processing several other crops grown in Nigeria particularly melon.

According to Falusi and Adeleye (1998), melon (*Citrullus Vulgaris*) is a common vegetable crop widely cultivated in Nigeria. Oni (2005) stated that melon is a legume crop, which can add nitrogen to the soil through the process of nitrogen fixation. Oni added that melon has the capacity of preventing or controlling the growth of weeds on the farm and that it is planted twice in a year: during the rainy season and dry season. Falusi and Adeleye (1998) noted that melon seeds are very useful for soup preparation and that they are the major ingredients of the popular delicacy called 'egusi' soup. Uzuegbu (1993) maintained that apart from being a soup thickener, melon seeds are very good sources of vegetable oil. Melon seeds are also used for the preparation of melon cake, which apart from being a popular delicacy for man, also serve as livestock feed (Akinsanmi, 1982).

It is worthy to note that before melon seeds are used for the preparation of soup or melon cake, the seed has to be peeled to remove the seed coat or shell. In other words, the processing of melon seeds ends in the seeds being peeled and separating them from the seed coats or shells. It is a well known fact that it takes several hours to peel a cup of melon by hand. Although there are several designs of melon peeling machines (or melon peelers) in existence, they are very expensive hence they cannot be conveniently afforded by many local melon farmers in Nigeria. For instance, Univex melon peeler manufactured by Restaurant Equipment World Incorporated, United Stated of America is sold at $863.50 which is approximately ₦93,680.00 (Restaurant Equipment World, 2002). It is also observed that present designs of melon peeling machines are relatively more sophisticated and heavy as such they cannot be carried about. In addition, existing designs of melon peeling machines do not have a mechanism for separating the seeds from the shells or seed coats after peeling.

Lindbeck (1990) pointed out that the design and construction of any product gradually changes with time as man's technical knowledge and aesthetics requirement changes. He added that contemporary designs of every product evolve from past forms and styles as man continually develop new ideas, techniques and materials. He pointed out, for instance, that the first set of tools was made of stones, wood and animal skin and bones. Later on, metals were used when they were later discovered. Thus, as man continues to develop new techniques, materials and ideas, he was able to evolve better designs of tools and machines, which meet his contemporary needs. Lindbeck (1990) therefore defined a contemporary design of a product as the one, which is planned and developed to meet the needs of contemporary human existence. Lindbeck further stressed that design always begin with a need and that the product is the device for satisfying that need. This fact is supported by Halpin and Riggs (1992) who stated that an engineering design is the recognition and understanding of basic need and the creation of a system to satisfy that needs.

STAN (1991) emphasized that the use of adequate machines in agriculture has the advantage of reducing the hard work and drudgery always associated with farm work, reducing production cost and farm hazards as well as improving the quality of product through better processing equipment. This position is shared by Falusi and Adeleye (1998) and Benjamin (1999). Benjamin specifically noted that since muscular strength alone could never suffice to accomplish all the tasks that man has to do, it has become necessary to use simple and sophisticated energy saving tools and machines in order to increase the productivity, reduce labour and increase capital. He stressed that the productivity of agriculture could be substantially increased by the use of energy saving tools and machines. Against this backdrop, there is a compelling need for a contemporary design of a melon peeling and separating machine that will satisfy the need of contemporary human existence and at the same time, lead to a substantial improvement in agricultural productivity.

Besides, this will provide ample opportunity for Technical and Vocational Education students to increase their knowledge and skills in the design and construction of tools and machines.

Statement of the Problem

One of the goals of Technical and Vocational Education is to give training and impact the necessary skills to individuals who shall be self-reliant economically (Federal Government of Nigeria, 2004). There are numerous evidences in research literature showing that most products of technical and vocational education programmes in Nigeria are not proficient technically especially in the area of design and construction (Udofia, 2002; Unanaowo, 2005).

One of the greatest problems affecting technologically development and indeed agricultural development in Nigeria is the absence of cheap processing equipment (Falusi and Adeleye, 1998). They noted that the present agricultural processing machines or equipment are very expensive and can not therefore be conveniently afforded by many local farmers in Nigeria. Invariably, melon cultivation and processing is affected by this problem of non-availability of cheap processing equipment especially those for peeling the melon seeds. Although there are several designs on melon peeling machines (or melon peelers), it is observed that the present designs are relatively more sophisticated and expensive hence they cannot be affordable by many local farmers. For instance, Univex melon peeler cost as much as $863.50 (approximately ₦93,680.00) which is well beyond the reach of most local farmers in Nigeria.

It is also observed that the present designs of melon peeling machines are very heavy and cannot be carried about easily. Moreover, existing designs of melon peeling machines do not have a mechanism for separation the seeds from the shells or seed coats after peeling. The seed therefore has to be separated from the shells either by blowing with the mouth which may eventually injure the blower's eyes or by hand picking method which is very laborious and time consuming. Furthermore, Nigeria's economy has been adversely affected by its over dependency on imported item (Ogwo and Oranu, 2006).

The absence of cheap and portable machine for peeling and separating melon seeds accounts for the persistent use of the manual or hand method for peeling melon seeds despite its attendant problems of much time consumption, high energy consumption and lower rate of productivity. Besides, it is very laborious and enervating. Since the use of locally design and constructed machines can greatly reduce the hard work and drudgery associated with farm work, increase the productivity of agriculture, improve the nation's economy as well as enable technical and vocational education students to acquire more skills in the area of design and construction, it has become necessary to design and construct a simple cheap and portable machine for peeling and separating melon seeds.

Purpose of the Study

The main purpose of the study is to design and construct a simple, cheap and portable electrically operated machine for peeling and separating melon seeds. The study will specifically attempt to:

1. Design a simple, cheap and portable electrically operated machine for peeling and separating melon seeds.
2. Develop a working drawing of the designed machine.
3. Construct the different parts of the machine using metal pieces and other locally sourced materials.

4. Assemble the different parts and materials together using such processes as welding, soldering and the use of bolts, nuts and screws.
5. Test the machine to establish its functionality.

Significance of the Study

The result of this study will be of immense benefit to melon farmers, housewives, entrepreneurs vocational education students, agricultural research institutes and educational researchers. Melon farmers, traders, housewives and operators of hotels will find a cheaper, faster, energy saving and more hygienic product for peeling and separating melon seeds. The general public will also benefit from the result of the study as the cost of peeled melon in the market would be greatly reduced through the use of the machine. Vocational Education Students will also benefit from the result of this study as they will learn how to design and construct melon peeling and separating machines and other similar machines. Entrepreneurs and agricultural research institutes will also find the product of this study very useful as they can use the prototype of the designed machine for mass production. Lastly, the result of this study when published will provide literature on the design and construction of melon peeling and separating machines for educational researchers.

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of literature related to this study will be done under the following sub-headings:

1. Conceptual framework – the goal of technical education, the concept of technical education and the concepts of design and construction.

   - Principles and elements of design.

   - Steps involved in the design and construction of machines.

2. Historical development of tools and machines - Relative advantages of machines over human power.

3. Types of agricultural machines.

4. Melon cultivation and processing - Economic importance of melon.

5. Basic principle of operation of the melon peeling machine.

   -The principle of electromagnetic induction.

6. Theory of material separation - Seed and shell separating methods.

7. Review of related empirical studies.

8. Summary of reviewed literature.

Conceptual Framework

The conceptual framework upon which this study is built is the concepts of technical education as well as the concept of design and construction.

The terms vocational education and technical education are not synonymous. Most often one is mistaken or misinterpreted for the other either because of it's similarity on the other.

Vocational education means vocational/technical training which is offered in schools or classes under the public supervision and control. It refers to systematic learning experiences in schools or classes under the public supervision and control. It refers to systematic learning experiences in schools or classes to fit individuals for gainful employment in recognized occupations as semi-skilled workers or technicians or sub-professional (Osuala, 1999).

Vocational education is any form of education whose primary purpose is to prepare persons for employment in recognized occupation. It is the education that provides the skills, knowledge and attitudes necessary for effective employment in specific occupations (Okoro, 1993).

As recorded in the National Policy on Education (2004).

> *"Vocational education is that form of education which is obtainable at the technical colleges. This is equivalent to the senior secondary education but designed to prepare individuals to acquire practical skills, basic and scientific knowledge and attitude required as craftsmen and technicians at sub-professional level".*

Vocational education can therefore be seen as any form of training in any occupation in which an individual enters and progress and is likely to earn such individual a gainful employment for life and living.

Technical education is a post-secondary vocational training programme whose major purpose is the production of technicians. Technical education is a special grade of education which can be distinguished from other vocational education programmes because more Mathematics and science are required in the training programme (Okoro, 1993). Technical education is a one or two-year programme of preparatory instructions in manipulative skills, Mathematics science, communicative abilities and leadership skills which prepare an individual for entrance into employment (Osuala 1999). He stated that the main objective of technical education is to prepare the technician for employment opportunities between the craftsmen and engineer by:

1. Giving training in the use of instruments, gauges, applied science, Mathematics, common sense, initiative, analysis and diagnosis.
2. Learning to collect data, make computations, perform laboratory tests and prepare reports.
3. Provide experience in planning, repairing, supervising, and controlling machines.

Graduates of technical education programmes usually bridge the gap between the professional engineer and craftsman. These definitions by eminent scholars point to the fact that technical education is the education offered to produce technicians for industry and employment in engineering-related technology subjects/areas to close the gap between craftsman/Artisans and the professional engineer. Individuals in this class of manpower/labour force are often referred to as supervisors or foremen who relate between the Engineers and the craftsmen/artisans for effective and efficient production in the industry.

The success of a nation's economy depends on the quality of its workers. The quality of a worker on the other hand depends on the quality of education/training which the worker obtained. Technical education is education to earn a living in an occupation in which success is dependent largely upon technical information and understanding of the laws of science and principles of technology as applied to modern design, production, distribution and service.

Nigeria is a nation rich in natural resources. Some of these natural resources are not tapped or utilized because of lack of technical manpower. Technical education therefore, becomes the panacea in conserving and developing the nation's resources. Most Nigerian youths are under-developed as a result of lack of technical training. Technical education can help the Nigerians youth as well as adults acquire technical skills in relevant fields. It can also enable them to secure occupations/employment which will benefit both themselves and the society in which they live. The highest possible welfare for Nigerian citizens is achieved only when each individual produces to the unit of his capacity (Osuala, 1999). Consequently, an organized and carefully planned programme of technical education is essential if the above objectives are to be achieved in Nigeria.

Technical education is needed to help some adults to prepare for new vocations. In future due to technological changes, a majority of skilled workers will be displaced via automation – use of machines. Highly skilled engineering and science technicians will be required to cope with the new technology of the time. Employment with highly skilled fields will depend upon the availability of opportunities for acquiring new technical competencies. This calls for the need to establish technical schools, develop and expand technical education to cater for the future changes which may likely occur in the society.

The National Policy on Education (2004) defined technical education as that aspect of education that leads to the acquisition of practical and applied skills as well as basic scientific knowledge. The policy outlined the following as the aims or goals of technical education:

a) to provide trained manpower in applied science, technology and commerce particularly at sub-professional grade;

b) to provide the technical knowledge and vocational skills necessary for agricultural, industrial, commercial and economic development;

c) to provide people who can apply scientific knowledge to the improvement and solution of environmental problems for the use and convenience of man;

d) to give an introduction to professional studies in engineering and other technologies;

e) to give training and impart the necessary skills leading to the production of craftsmen, technicians and other skilled personnel who will be enterprising and self-reliant and

f) to enable our young men and women to have an intelligent understanding of the increasing complexity of technology.

Ogwo and Oranu (2006) noted that, in a sense, technical education forms only a fractional segment of vocational education.

In other words, it is a sub set of vocational education. They defined vocational education as the aspect of the general school curriculum concerned with the acquisition of knowledge, attitudes and skills necessary for securing and advancing in a given occupation. According to Okoro (1993), vocational education is any form of education whose primary purpose is to prepare persons for employment in recognized occupation. Okorie (2001) viewed vocational education as that part of the total process of education aimed at developing the competencies needed to function effectively in an occupation or group of occupations. Thus, vocational education is seen as a precursor of skills, knowledge and attitudes necessary for effective employment in specific occupations.

In more recent times, the terms technical and vocational education are used jointly or synonymously to mean education geared towards skill acquisition for gainful employment. For instance, the federal Government of Nigeria (2004) used technical and vocational education as a comprehensive term referring to those aspects of the educational process, involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in varies sectors of economic and social life. The Government maintained that technical and vocational education is further understood to be a means of preparing for occupational fields and for effective participation in the world of work as well as a method of alleviating poverty.

The term design has been subjected to various definitions and interpretations by several scholars depending on the perspective from which they view it. To Hornsby (2001), design means the art or process of deciding how something will look or work by drawing plans and making models. It can also mean a drawing or plan from which a product may be made. In other words, the design of a product or item contains all the descriptive features essential for the production of the object (Bamiro, Nurudeen and Akuru, 1986). Lindbeck (1990) defined design as a process of inventing or planning physical thing which display a new organization or form, in response to some function. He further defined designing as a creative planning to meet a specific need. He explained that by creative, it implies that there must be an original treatment of a problem or task and that there must always be something genuinely new and not an imitation of something already made. Simpson (1992) while stressing the importance of creativity in design maintained that a person is said to be creative when he does something in his own unique way. He pointed out for instance, that one may imagine an idea or remember an object he saw somewhere. The person could only be said to be creative when the idea is adapted, modified or altered to meet his specific needs. He therefore concludes that creativity in design is definitely not copying or lifting someone else's work although the work of other people might serve as a valuable source of stimulation and information.

While emphasizing the importance of planning in design, Lindbeck (1990) pointed out that planning in design means that there must be a purposeful, systematic and analytical approach which results in a logical blueprint to action. He added that by specific need, it implies that the designer must know what he is designing and why. In other words, the designer must address himself of a clearly defined problem or else he can wander aimlessly since a specific problem enables a person's effort to be spent in the direction of purposeful creative planning rather than in more or less random solutions because the exact nature of the task is not known. Lindbeck concludes that design begins with a need and that the product is a means or device for fulfilling that need.

From the foregoing, it could be deduced that design can refer to process, or drawing or the actual appearance of an item. Lindbeck (1990) maintained that the design of a product at a particular time is always limited to the styles, technical knowledge and materials available at that particular time. For instance, the first tools were made of stones and wood when metals were not yet discovered. He also stressed that design changes with time in accordance with technical, material and aesthetic requirements of the day. Lindbeck further stated that contemporary designs evolve from past forms and styles as man continually develops new techniques, materials and ideas. He finally defined a contemporary design as a term encompassing those kinds of products which are planned and developed to meet the need of contemporary human existence.

The term construction refers to the process of building or making something using many parts (Longman, 1995). Construction in this context will be taken to be synonymous with fabrication which, according to Bamiro, Nurudeen and Akuru (1986) mean the making of an object to specification from various different materials. Construction or fabrication involves a lot of activities such as measuring, marking out, cutting, welding, soldering, drilling and the use of bolts and nuts. It also involves the use of various types of hand tools and machine tools. Haplin and Riggs (1992) noted that construction makes possible the development of design and that it requires the application of a diverse palette of financial, materials and human resources to realize a finished facility.

Principles and Elements of Design

The aim of any design process is to create a product which not only works but also looks well (Lindbeck, 1990). To achieve this purpose, the design process must be guided by certain principles or elements. These principles as identified by Linbbeck (1990) are grouped into three namely functional, material and visual requirements.

Functional Requirements

The principle of functionality in design demands that the product should fit the purpose or need for which it is intended (Lindbeck, 1990). This implies that a well designed article should work as it should. Lindbeck emphasized that the designer must expend a good deal of effort in ensuring the efficiency of the product he designs. He pointed out, for example, that when designing a chair, the chair must fit the human frame comfortably before it can be said to be functionally correct.

Another important dimension of function in design is the durability of the product (Welch, 1998). Welch emphasized that the designer must consider the question. How long should the product function else the design will be poor. Another important consideration related to functionality is the aesthetic or form of the product. According to Welch (1998), an article may be perfectly adequate from the functional stand point but fail to be appealing to the senses. He advised that the designer must select from a variety of possible contours (each of which may be functionality and materially correct) that form which is aesthetically most satisfactory.

Material Requirement

This principle, according to Lindbeck (1990) demands that the product designed should reflect a simple, direct and practical use of the substance of which it is made. In other words, the designer should achieve maximum benefit from a minimum amount of materials. He added that if this element of wise utilization is present, the structure of the product will be sound and it will be as strong as necessary without any waste of materials or excess bulk. Welch (1998) noted that the designer must have a good knowledge of the properties and limitations of several materials in order to be able to select the most appropriate ones. For instance, he must know which metals can be bent, folded, formed, soldered, welded, riveted and glued.

Visual Requirement

Lindbeck (1990) stated that the product should have a pleasing appearance to the beholder. He stressed that this requirement translates as a concern for the visual arrangement of the elements of design: the lines, shapes, textures and the colours. Welch (1998) noted that since human being respond more positively to something pleasing to look at rather than an ugly object and since what one person view as beautiful may be visually unacceptable to another person, the designer must always be guided by the fact that visual requirement has to do with proper balance, correct proportion, compatible colours and textures and form.

Precepts of Modern Design

Kaufmann (1992) maintained that certain precepts of modern design have emerged. These, according to him, are that modern design should:

1. fulfill the practical needs of modern life;
2. express the spirit of our times;
3. benefit by contemporary advances in the fine arts and pure sciences;
4. take advantage of new materials and techniques and develop familiar ones;
5. develop the form, textures and colours that spring from the direct fulfillment of requirements in appropriate materials and techniques;
6. express the purpose of an object, never making it seem to be what it is not;

7. express the qualities and beauties of the materials used; never making the materials seem to be what they are not;
8. express the methods used to make an object, not disguising mass production as handicraft or stimulating a techniques not used;
9. blend the expression of utility, materials and process into a visually satisfactory whole;
10. be simple, in its structure, evident in its appearance, avoiding extraneous enrichment;

11. master the machine for the service of man;
12. serve as wide a public as possible, considering modest needs and limited costs no less challenging than the requirements of pomp and luxury.

Steps Involved in the Design and Construction of a Machine

The design and construction of a machine involves three basic steps. These, according to Bamiro, Nurudeen and Akuru (1986) are
(i) the design stage (ii) the working drawing stage and (iii) the fabrication or construction stage.

They explained that the design stage is the decision making stage. It is at this stage that the following important decisions will be taken

i. the size of the project
ii. the suitability of the project for the intended purpose
iii. the type of material that will be used
iv. the cost of the materials that will be used
v. the pattern, style or design that will be adopted
vi. the relative size of sections
vii. the type of joints to be used to enable it withstand necessary handling
viii. the type of finish that will given to the product
ix. the total cost of the project

After these decisions are taken, a simple sketch of the project is then produced and the total cost of the entire project is calculated. If the cost is reasonable, the project will be carried out but if the cost is too high, some adjustments or changes in the quality of materials used or quality of finish should be made in order to reduce the cost. The designer's creativity is very essential at this state. Creativity according to Oke (1998) is the ability and power to develop new ideas by perceiving new relationships between previously unrelated things. Creativity also means the application of once source of judgment to solve a problem.

The Working Drawing Stage

A working drawing is a drawing that shows may views of an object very clearly and completely (Bamiro, Nurudeen and Akuru 1986). They explained that a working drawing contains basically, at least two or three views of the object-the font view or front elevation, the side views or side elevations and the top view or plan.

The working drawing should contain many views as may be necessary so as to give a very close guide to whoever is fabricating the object. In short, the working drawing expresses the designer's wishes in respect of every item of the project from beginning to the end and it is the working drawing that is taken to the workshop for use in making the product or given to someone else to make the product. They noted that there are times when it is not possible to indicate all the necessary information on the working drawing. In such case, additional information are given on separate sheets which are referred to as specifications. Ezeji (2004) defined a specification as a detailed description of a hand tool, machine or piece of equipment. Ezeji maintained that a specification shows, among other things, (a) a general description of the tool, or equipment showing its size, details of construction, input and output, etc. (b) details of motor and electrical controls (c) intemfication of accessories (d) safety standards and guards. For a practical project, the specification may include the culling list, list of materials to be used, joints to be used and type of finish (Bamiro et al 1986).

The Fabrication Stage

This is the stage at which the working drawing together with the specification, if any, are utilized to fabricate the item as designed (Bamiro et al 1986). They maintained that particular attention is paid at this stage to dimensions, types of finish, available machinery, skill required and available manpower. This stage involve a lot of activities ranging from measuring, making out, cutting and joining of the different parts through such processes as welding, soldering, riveting and the use of bolts and nuts.

In other words, the fabrication stage involves the use of different tools and machines and it is at this stage too that the designers' skills is put to test. Bamiro et al (1986) pointed out that although every effort must be made to fabricate the item as initially designed, problems such as unavailability of the specified material may sometimes arise. In such cases, adjustments have to be made such as changing the specified material and dimensions so as to achieve the purpose of the design.

HISTORICAL DEVELOPMENT OF TOOLS AND MACHINES

According to Miller (1995), it is extremely difficult to state with any degree of precision at what time the pre-historic man first attempted to make and use a rudimentary tool of some kind in order to make a task more simpler for himself. Pytlik, Lauda and Johnson (1985) defined a tool as an artifact that is used to supplement or augment man's ability to act upon the physical world. Miller (1995) maintained that man's first effort in making a tool might have been imitative as he copied the effort of an animal in catching a fish or building a house or cracking a nut. He added that man later came to realized that his physical endowment in this respect were less than perfect and that he could not chew down a tree as would a beaver. Instead, he had to invent some kind of tool which would aid him in that task. Miller went on to state that at first, he probably gave little thought to the aesthetics of these rudimentary tools but instead, was primarily concerned with their proper functioning. Moreover, he was restricted in the materials he could use, at first, having only stone and wood, bone and leather.

In supporting the above fact, Lindbeck (1990) stated that the first set of tools were crude and all purpose tools which provided a measure of assistance to the early man in acquiring the basic necessities for existence. He pointed out for instance, that the pre-historic man used stones in their natural and crude shapes as aids in cutting, scraping and clubbing.

In their own account, Pytlik, Lauda and Johnson (1985) reported that the development of tools and machines from pre-historic times to the present passed through seven important stages which historians have labeled s the stone, Bronze, Dark, Industrial Revolution, Atomic and Space ages. They added that man's first set of tools in the Stone Age were made with bits of wood, stone and animal skin and bone which he learned to fashion into useful shapes. They classified the primitive tools used by the pre-historic man into three broad groups namely natural, adapted and manufactured tools. They explained that a natural primitive tool is an artifact upon which the user has made no modification. Examples include the stone used to break open a nut; the fallen tree branch used to knock fruit from a tree and the large animal bone use as a club.

Pytlik et al (1985) defined an adapted primitive tool as an artifact which the user has modified but only in size and shape. Examples include stones that have had pieces chipped or flaked off so that one edge is sharpened for cutting or piercing; a wooden stick sharpened to a point and used as a spear; and a piece of wood carved into a flattened semi-circle for hunting (boomerang). Thy further defined a manufactured primitive tool as an artifact created by the user's combining two or more natural or adapted artifact to form a new artifact. Examples are bows, arrows, spears, harpoons with bone or stone heads and a stone hammer or axe with a wooden handle. Pytlik et al further stressed that the primitive tools which were made during the Paleolithic and Mesolithic periods (that is, within two million years of human existence) formed the foundation upon which future tools and machines were made.

Linddbeck (1990), in support of the above fact, state that as time went on, man was able to improve his tools of stone, wood, root, hide, ivory, horn and bone by adding a wooden handle fastened with strips of hide or root, to produce a more effective and efficient hammer, axe or hoe.

Pytlik, Lauda and Johnson (1985) categorized the machines developed from the pre-historic era to the present into three levels of technological development namely low level or primitive machines, intermediate level machines and high-level machines. The primitive machines which were of six basic types – lever, wedge, inclined planed, pulley, wheel and axle and screw and which were mostly human and animal powered machines were developed during the Neolithic and metal (Bronze and Iron) periods of civilization (that is, from about 3500 BC to 1000 BC). The intermediate level machines were a compound or complex machine (combining two or more basic machines) that has interrelated parts with separate functions. They include all the human, animal or prime mover powered machines that do not have incorporated within its function human, thought-like processes. Examples of these are the steam engine developed by Thomas Newcomer in 1712; the electric motor invented by Michael Faraday in 1821 and the internal combustion diesel engine invented by Rudolph Diesel in 1893.

The high level technological machines are those complex machines whose functions are combined with special facet of human activity to form a unique third process. In other words, high-level technological development machines include those utilizing human thought-like processes within its function as well as hand machines which are no longer powered by the person using them. Examples of high level technological machines are the assembly line, automation, cybernetics and computers which are the most recently developed. Today in this space age, man's technology includes not only his hardware made from tangible materials but also his analytical techniques, his mathematics, his computer programems and even his thinking processes (Pytlik et al, 1985). Thus, as Lindbeck (1990) noted, man's progress from pre-historic times to the present therefore depend largely on his success in developing those primitive tools with which he build shelter for himself, till the soil, hunt, fight and produce food. He stressed that without these tools, present machines would not have evolved and present societies would not have endured.

RELATIVE ADVANTAGES OF MACHINES OVER HUMAN POWER

Pytlik, Lauda and Johnson (1985) posited that mechanization (the use of machines to do what human beings formerly do with their muscle power) has several advantages over the use of human power. First, machines enable human beings to perform their work easily and it also reduce considerably, the number of hours one spends working. This position is shared by Awe and Okunola (1984) who maintained that machines enable work to be easily and more quickly done. Pytlik et al (1985) also stated that the use of machines always results in large scale mass production of goods and materials. They mentioned automation (the automatic, centralized control of an integrated production system to the point where humans are no longer needed, except to watch and maintain the machines) and the assembly line as some of the features of mechanization that result in mass production of goods and which also substitute mechanical for human handling of materials.

The use of machines also lead to a rapid solution to problems that otherwise would have taken years of human effort to solve (Pytlik et al, 1985). Thus, machines save human labour (Elekwa et al 1982). The application of machines in agriculture specifically results in speedy and efficient farming operations and also free man from frightfully, boring, dangerous and inhuman labours (Lindbeck, 1990). This position is shared by STAN (1991) who maintained that the use of machines in agriculture has the advantage of reducing the hard work and drudgery associated with manual farm work, reduce production costs and farm hazards and also improve the quality and quantity of agricultural produce.

TYPES OF AGRICULTURAL MACHINERIES

Several types of simple and sophisticated machineries are being used in agriculture nowadays. Aknsanmi (1982) classified these machines into six groups based on their functions as follows: tillage machines, cultivating machines, fertilizing machines, spraying machines, harvesting machines and processing machines. The tillage machines or equipment are those used for land preparation and tilling. Examples include disc ploughs, harrows, ridgers, tractors, bulldozers and rolivators. STAN (1991) explained that cultivating machines or equipment are those used for planting crops. These include planters, cultivators and specialized drills used for planting different types of crops. According to Falusi and Adeleye (1998), fertilizing equipment are those specifically used for applying fertilizer to crops.

Akinsanmi (1982) noted that spraying equipment are used for spraying herbicides and other chemicals that protect crops against insect attack and diseases. Examples are dusters and sprayers. Harvesting equipment or machines are used for harvesting crops. STAN (1991) maintained that each crop has its special harvesting machine or harvester. For example, maize harvester, rice harvester, cassava harvester and combined harvesters. Processing equipment refer to those equipment or machines that are used for processing food crops. STAN (1991) listed some of the agricultural processing machines as follows:

(a) Grinding or milling machines which grind wet or dry grains into pulp or powder.

(b) Mixers which are commonly used in feed mills to mix feed-stuffs in their correct proportion.

(c) Shellers: These are machines used for breaking and separating seeds such as cowpeas and groundnuts from their pods.

(d) Hullers: These are machines used for removing husk from grains such as rice.

(e) Ginnery: These are machines or equipment used for separating cotton seeds from lint.

MELON CULTIVATION AND PROCESSING

Melon whose botanical name is Citrullus Vulgans, according to Falusi and Adeleye (1998) is a common vegetable crop which is widely cultivated in Nigeria. Melon is also classified as a legume crop (Oni, 2005). Oni stated that it is classified as a legume crop because it has the capacity of preventing or controlling the growth of weeds on the farm. Oni also added that melon can add Nitrogen to the soil through the process of Nitrogen fixation.

Akinsanmi (1982) and Falusi and Adeleye (1998) contended that melon is propagated seed. Oni (2005) maintained that it is normally planted twice in a year – during the rainy season and during the dry season and that it is most common in Northern parts of Nigeria particularly Kano, Kaduna and Jos. After harvesting melon, the seeds are carefully removed from the pod and washed very well with water. Solar energy is then used in the conventional way to dry them (Carter, 2002). Oni (2005) reported that two (2) modern methods of drying melon have been developed. These are (a) cabinet drier and (b) rotary drier. In the cabinet drier, a metal box cabinet is constructed with tray provision. The trays are slotted into the cabinet and within intervals. Oni further explained that in the rotary system, the melon seeds are put into a round drum which is either electrically or mechanically rotated so that the dry melon seeds will be falling out. Oni advised that with whichever method, the seeds should be properly dried so as to prevent moisture formation which could damage the seeds and reduce their economic value. Oni (2005) further warned that melon seeds should never be heated directly on fire because the seed colour will turn brown and oil will be oozing out thus reducing its economic value.

Economic Importance of Melon

Melon seeds are of great economic importance in Nigeria. They are used for soup preparation (Akinsanmi, 1982). Thus, melon seeds are the major condiments in the popular egusi soup in every part of Southern Nigeria. In other words, melon seeds are soup thickeners (Uzuegbu, 1993). Akinsanmi (1982) maintained that melon is also used for the preparation of vegetable oil. This position is shared by Uzuegbu (1993) and Oni (2005). In further support of this fact, Falusi and Adeleye (1998) stated that melon seeds contain about 45% oil. Melon is also used for the preparation of melon cake which serve as livestock feed as well as food for man (Akinsanmi, 1982). Moreover, melon seeds are now exported (Oni, 2005). Oni noted that the seeds can be exported either shelled or unshelled (i.e. peeled) and that they are packaged in bags of 25kg or 50kg.

BASIC PRINCIPLES OF OPERATION OF THE MELON PEELING MACHINE

The melon peeling machine converts electrical energy supplied to it into mechanical energy which is used to peel the melon seeds. It has an electric motor which utilizes electrical energy to produce mechanical energy required for peeling. The machine therefore works on the principle of electromagnetism. In other words, it is the process where electric current is produced as a result of moving conductors through magnetic fields (Awe and Okunola, 1984). For a better understanding of the principle of electromagnetism, it is expedient to have an insight of the construction and working principles of an electric motor.

According to Williams (2002), an electric motor is a device for transforming electrical energy into mechanical energy. Nice (2001) noted that its operation is based on simple electromagnetism. That is, when a current carrying conductor generates a magnetic field and is then placed in an external magnetic field, it will experience a force proportional to the current in the conductor and to the strength of the external magnetic field. He further explained that the internal configuration of the electric motor therefore harness the magnetic interaction between the current – carrying conductor and the external magnetic field to generate rotational motion. In other words, electric motors contain a wire coil in a magnetic field (Williams, 2002). These coils, according to Bamiro et al (1986) are called armature in dc motors or rotors in ac motors. They explained that when electrical energy is fed into the set of coils, the current will produce a magnetic field like an electro-magnet. This field opposes that of a surrounding electro-magnet resulting in the rotation of the armature or rotor. Thus, the electric motor converts the electrical energy supplied to it unto mechanical energy of the rotating armature or coil.

Types of Electric Motor

Schwaller (1980) maintained that electric motors are classified according to the type of current used to operate them. Thus, there are basically two basic kinds of electric motors – Direct current (Dc) motor and Alternating current (Ac) motors. Irvin (1992) noted that a wide variety exists among the two groups. Dc motors as the name implies, operate on direct current. Irvin (1992) stated that it is the oldest type of motor but it is used infrequently today because alternating current is more commonly available. He explained that this stems from the fact that direct current cannot be transmitted over long distances as high voltage alternating current can be. Irvin further stated that because of the limited demand, dc motors are very expensive and often hard to obtain. Moreover, they do not hold a constant speed as ac motors, they cause radio and television interference and they require regular maintenance of commutator and brushes. Furthermore, they are larger than the more common ac motors of the same horsepower rating.

Ac motors on the other hand, are operated with alternating current. An alternating current is current that reverses its direction at regular intervals. That is, the power fluctuates (at a fast rate) causing an instant peak of power followed by an instant loss of power (Irvin, 1992). Alternating current can be of single phase, or three phases. Thus, there are single phase ac motors and three phase ac motors. Which operate on single phase and three phase alternating current respectively (Schwaller, 1980). Schwaller explained that in a single phase ac motor, there is a momentary loss of power when the voltage changes polarity and the current reverses whereas in the three phase ac motor, each current 'peaks' at a different time, resulting in a smooth, continuous power. This is because in the three phase alternating current, there are three surges or phases of current going through the wire simultaneously and the fluctuations are timed so that one peak occurs when another phase is at a lower power period (Irvin, 1992).

According to Irvin (1992), there are three types of single phase ac motors, each one having a starting characteristic adapted to a certain kind of load. These are:

1. The repulsion start – introduction – run motors which has no switch nor capacitor but uses a lever to reverse the motor.
2. The split – phase – induction – run motors which have both a starting winding and a running winding and are the least expensive of the three types of single phase motors.

3. The capacitor start – induction – run motors which uses a condenser connected in series with a starting winding, has a high starting torque and a high breakdown torque.

Schwaller (1980) noted that a dc motor can also operate on alternating current if the ac is adapted to dc. Likewise, an ac motor can also be operated with direct current if the dc is converted to ac through the use of a power inverter. However, there are electric motors that could run on both direct current and alternating current. These motors, according to Irvin (1992) are called universal ac/dc motors. Universal motors are used for stationery equipment accessories like a knife grinding attachment, a vacuum cleaner type of dust collectors and in portable electric tools.

The internal construction of dc and ac motors are basically the same except for a few differences. Nice (2001) stated that every Dc motor has six basic parts namely the axle, rotor (or armature), stator, commutator, field magnet(s) and brushes. The stator is the stationary part of the motor – this includes the motor casing as we know as two or more permanent magnet pole pieces. The armature together with the attached commutator rotate with respect to the stator. The rotor consists of windings (generally on a core), which are electrically connected to the commutator. Nice (2001) further explained that the arrangement of the brushes, commutator contacts and rotor windings are in such a way that when power is applied, the polarities of the energized winding and the stator magnet(s) are misaligned and the rotor will rotate until it is almost aligned with the stator's field magnets. As the rotor reaches alignment, the brushes move to the next commutator contacts and energize the next winding. Thus, in a three pole Dc motor, one pole is fully energized at a time while the other two are 'partially' energized. As each brush transitions from one commutator contact to the next, one coil field will rapidly collapse as the next coil's field will rapidly charge up. This occurs within a few microseconds. Nice concluded that the rotation of the rotor reverses the direction of current through the rotor winding leading to a 'flip' of the rotor's magnetic field, driving it to continue rotating.

According to Schwaller (1980), the ac motor is basically a transformer in which a voltage and current in one coil called the primary induces another voltage and current in a nearby coil called the secondary. As with a transformer, the following relationship exists between the primary and secondary coils.

$$\frac{\text{Number of turns (primary)}}{\text{Number of turns (secondary)}} = \frac{\text{Voltage (primary)}}{\text{Voltage (secondary)}}$$

Schwaller added that in the ac motor, the primary coil which is called the stator is stationary while the secondary coil which is known as the rotor is free to move. He further added that three principal parts make up the stator: an outlet frame, a steel core and the windings. The frame supports the stator core which is mounted on the motor base. The stator core contains the stator windings and are fitted aside the stator frame.

Irvin (1992) explained that when the stator windings are energized by ac voltage, it create a magnetic field inside the rotor. He maintained that the rotor has three main parts: a core, windings and a shaft. The rotor core is made of many round, flat, steel punchings which are stalked together for mechanical strength. Metal or wire windings are inserted into holes in these punchings to make up the rotor windings or bars.

THEORY OF MATERIAL SEPARATION

According to Holderness and Lambert (1982), our environment is filled with mixtures of all forms of matter hence men has always been, and still is, pre-occupied with the separation and purification of useful components from each mixture for his own benefit. They defined a mixture as a substance which contains two or more substances physically combined together. They further stated that mixtures of substances can be separated by physical means and that there are a great variety of physical methods used to separate a wide variety of mixtures. In addition, they maintained that the particular method employed for any given mixture depends upon the nature of the constituents such as the relative sizes and shape of the constituents, the weight, boiling point, melting point and density of the constituents. This position is shared by Henderson and Perry (1981) who started that the choice of a separation method depends on the size, shape, specific gravity and surface characteristics of the materials.

Henderson and Perry (1981) identified four common methods used for separating a mixture of grains/seeds from their shells or husks. These are: handpicking, sieving, inclined surface and blowing. By the hand picking method, the components that are bigger in size are first hand-picked leaving the ones that are smaller in size. For example, a mixture of maize and sand, rice and beans, palm kernels and its shells, beans and its shells, etc. This method can also be used for separating melon seeds from its shells after peeling. This sieving method involve pouring the mixture on a sieve and shaking it so that the constituent that is smaller in size will pass through the sieve leaving the other constituent on top of the sieve. Sieving can be used to separate a mixture of rice and sand, beans and rice, oil palm fruit and its husks, etc.

The inclined table method, according to Henderson and Perry (1981), involves the pouring of the mixture on an inclined surface so that the seeds will roll down leaving the husks, shells or debris on the upper part of the inclined surface. This method is mostly used for separating seeds that are round or oval in shape from their shells. For example, it is widely used for separating palm kernels seeds from its shells and oil palm fruits from its husks or debris. The last method, blowing involves blowing the mixture either by mouth or through a mechanical or electrical method so that the lighter constituent in the mixture will be blown off leaving the other constituent behind. This method is very good in separating melon seeds from its shells as well as for separating rice from its husks.

REVIEW OF RELATED EMPIRICAL STUDIES

It was not possible to find literature on the design and construction of the melon peeling and separating machine. Therefore, review of literature on the design and construction of other mechanically and electrically operated agricultural processing machines was done. Obasi (2004) while working on the design and construction of palm kernels and shells separator for developing countries was able to design and construct a mechanically operated machine capable of separating palm kernel seeds from its shells after grinding. The machine was designed and constructed for the Department of Vocational Teacher Education, University of Nigeria, Nsukka.

Akintunde (2005) worked on the design and construction of palm fruit digester for palm oil production in Osun State of Nigeria. Akintunde was able to design and construct an electrically operated. Palm fruit digester which could pound oil palm fruits for the oil palm farmers in Osun State of Nigeria. The design and construction of the machine was done at the Department of Vocational Teacher Education, University of Nigeria, Nsukka.

SUMMARY OF REVIEWED LITERATURE

The literature reviewed has revealed that from time immemorial, man has always designed and constructed tools and machine in response to his needs and that design changes as man's technical knowledge, material requirement and aesthetics requirement changes. It has also been found that the use of machines can improve agricultural productivity. The review has also revealed that there are several types of agricultural processing machines which have been designed and constructed for the processing of most of the crops cultivated in Nigeria.

Literature revealed that most electrically operated agricultural processing machines which have electric motors convert electrical energy into mechanical energy. Thus, they work on the principle of electromagnetic induction. However, empirical studies on the design and construction of melon peeling and separating machines could not be found. Therefore, empirical studies on the design and construction of other manually and eclectically operated agricultural processing equipment were made. This study therefore intends to bridge the gap by focusing on the design and construction of an electrically operated melon peeling and separating machine.

CHAPTER III

METHODOLGY

This chapter presents the different steps and procedures to be adopted in the design and construction of the melon peeling and separating machine. It is organized under the following sub-headings.

Design of the Study

The study used the Research and Development (R&D) design. This design is considered most appropriate since the study involve the design and development of a product. According to Borg-Borg and Gall (2003), research and development design consist of a cycle in which a product is first developed, field tested and subsequently revised on the basis of field test data. This position is shared by Nworgu (1991) who maintained that Research and Development design is aimed at developing and testing more efficacious educational products such as textbooks, equipment or curricula to ensure their effectiveness.

Design and Construction Considerations

For optimum performance and easy maintenance of the melon peeling and separating machine, the following factors given by Starkey (1988) will be taken into serious consideration.

I. Simplicity of design to meet the required standard and specifications like size, weight, input, output and power consumption.
2. Mechanical strengths of the materials used to ensure their durability and reliability.
3. Cost of the materials used.
4. Construction method used to ensure reliability and durability of the product.

Tool and Materials

The following hand tools will be used in the design and construction of the melon peeling and separating machine: steel rule, measuring tape, scriber, try square, center punch, hacksaw, bench shears, cold chisels, assorted files, taps and dies, a pair of pliers, screw drivers, bench vice, hammer and spanners. The machine tools to be used will include welding machine and their accessories, drilling machine and spraying machine.

The consumable materials that will be required for the project includes mild steel sheets, 1 inch and 1½ inch angled iron bars, 2 inches pipes, welding electrodes, soft solders, soldering flux, emery cloth, assorted bolts, nuts and screws, varnish, paint, 1.5 gauge coil wire, belts and flexible wires.

Design Procedure

A sequential constructional procedure as presented in the steps shown in the block diagram in fig I will be used in the design and construction of the project.

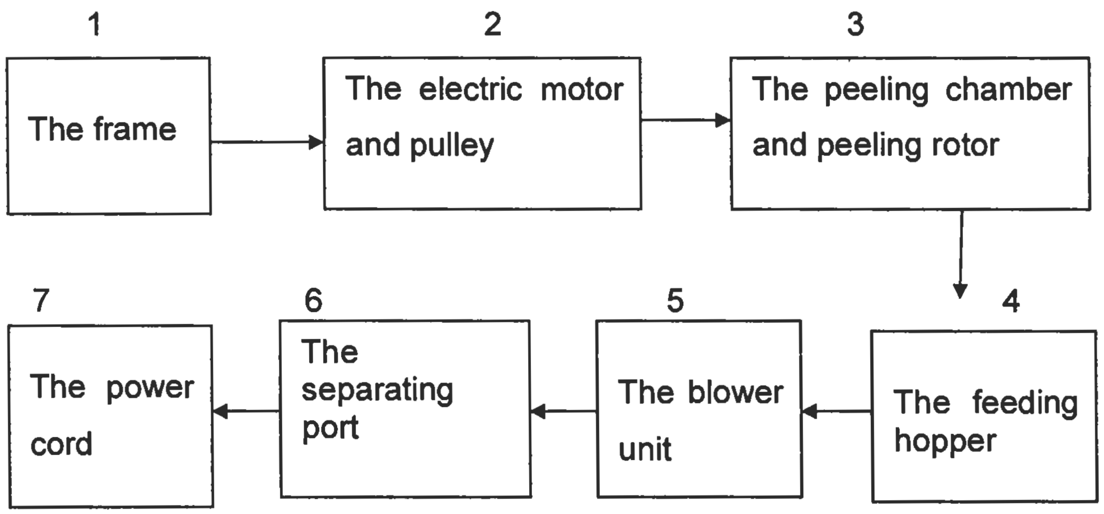


Fig 1: Sequential constructional procedure for constructing the melon peeling and separating machine.

Detailed explanations of the constructional procedure for each of the above components are as follows:

A: **Main Frame Construction**

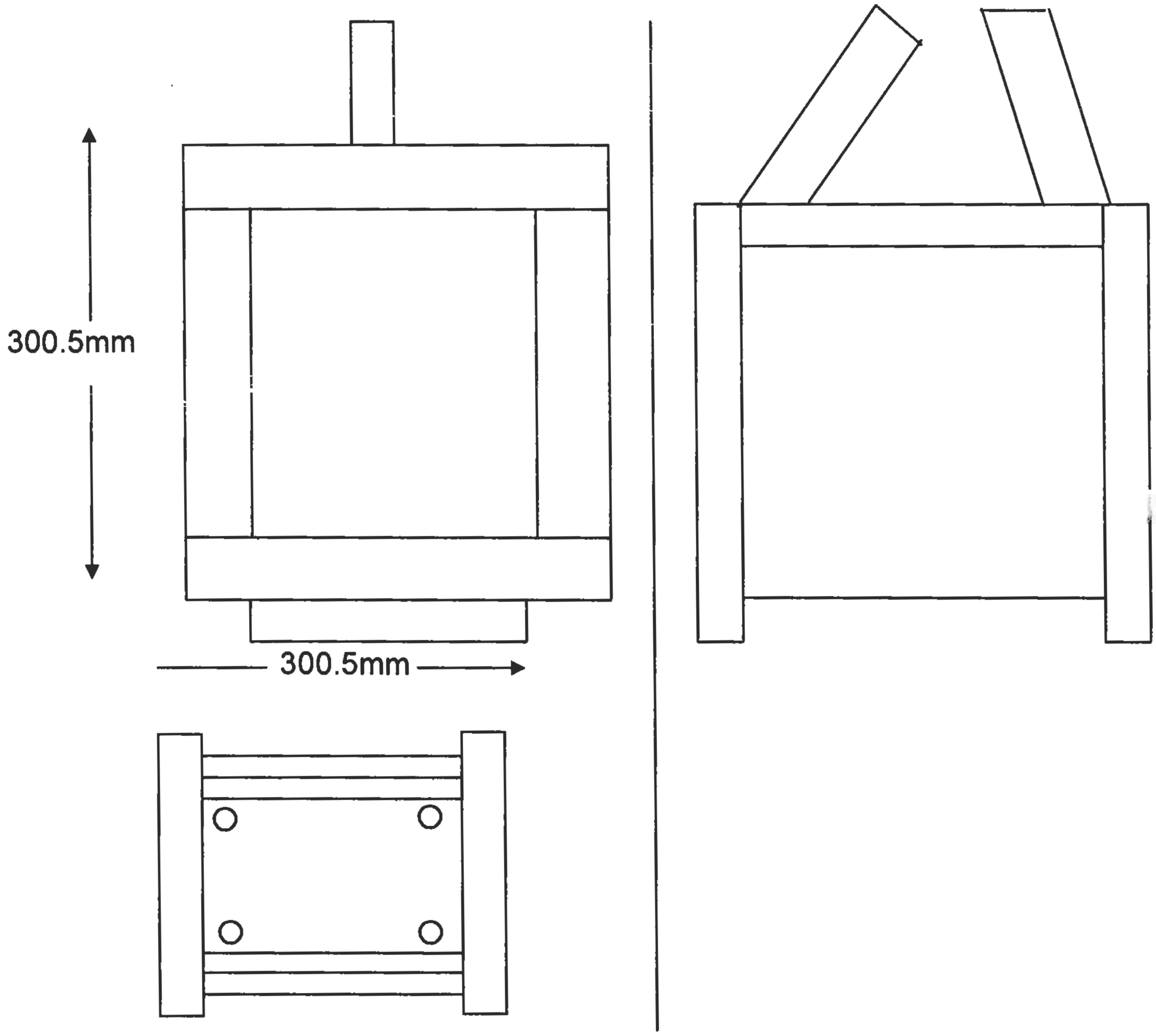


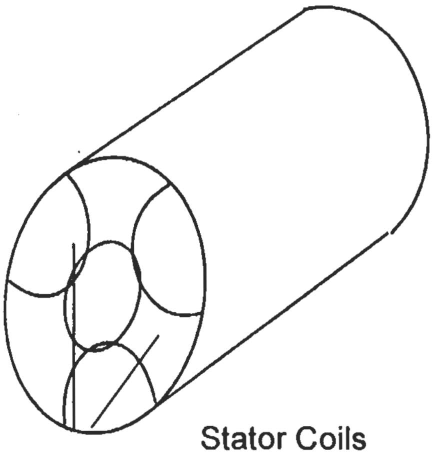
Fig. 2: Orthographic views of the main frame in 1st angle projection

The front elevation, plan and end elevation of the main frame will be as shown in fig. II. It will be made of 10 pieces of 1½" angled iron of length 300.5mm (1 feet). The various pieces will be joined together by welding. This is to ensure it is strong and studded and does not shake nor wobble. A rectangular iron pipe 200.3mm (8 inches) long will be welded at the base to provide a foot for the product. Also, a mild steel plate measuring 25mm (10 inches) long and 127mm (5 inches) wide will be welded at the bottom of the frame. Four holes will be drilled on the mild steel plate for bolts which will hold the electric motor firmly in position.

B: **Construction of the Electric Motor**

A one-way speed electric motor having a speed of 1400 rpm was constructed and used for driving the peeling rotors and the blower through a V-belt connected to their respective pulleys/shafts. 1.5 gauge coil wire will be used for both the primary and secondary windings of the electric motor. The stator (primary coil) will consist of two parts: the outer frame and the stator windings. The stator windings will be fitted inside the stator frame as shown in fig. 3(a).

The rotor (secondary coil) was made of three parts: the core, the windings and the shaft. The rotor core was made with many round flat steel punchings which was stacked together for mechanical strength. The rotor windings was made by inserting copper wires windings into holes in the steel punchings. The completed rotor was as shown in fig. 3b.



Stator Coils
(Primary windings)
Fig. 3(a)

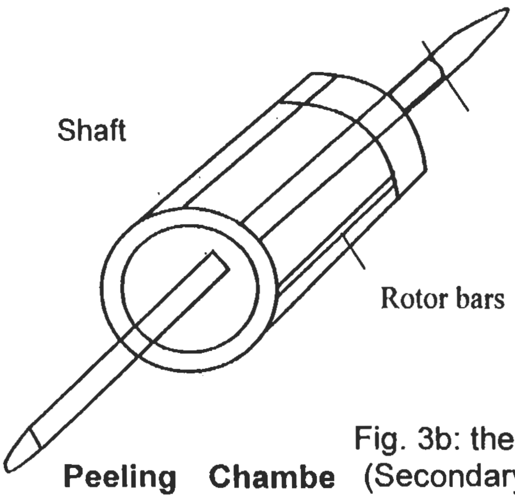


Fig. 3b: the rotor
(Secondary windings)

C: (the **Peeling Chambe**

Rotor

The peeling chamber was constructed with mild steel sheet. A rectangular piece of mild steel sheet measuring 66cm by 45cm will be marked out. With the scriber, try square and dot punch. It will be cut out with the cold chisel and welded edge to edge to form a cylindrical chamber. Two circular pieces of radius 12cm was also marked out and cut out from the same material to form the front and bottom covers of the peeling chamber. The development of the peeling chamber is as shown in fig. 4.

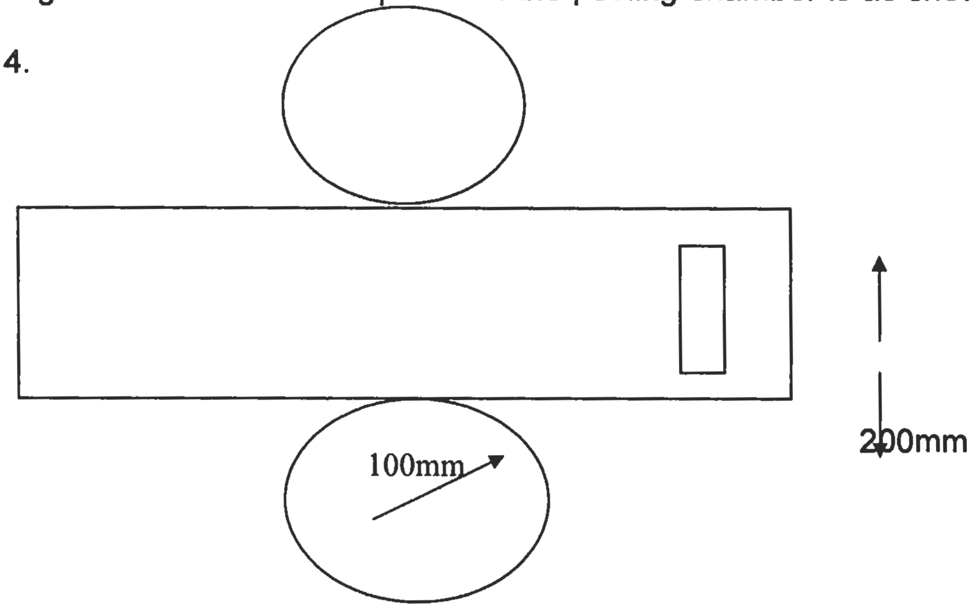
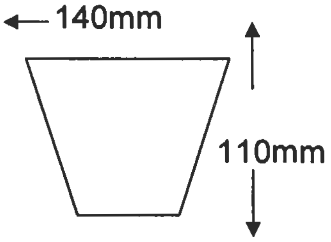


Fig. 4: Development of the cylindrical peeling chamber

The peeling chamber encloses the peeling rotor. The peeling rotor had a cylindrical shape and also has a shaft which is held in position by two bearings. At the end of the shaft is a pulley through which the belt drives the rotor. As the rotor rotates, the centrifugal force exerted on the melon seeds peel the shells of the melon. The peeling chamber had two openings – a feeding channel at the top and an emptying channel at the bottom.

D: **Feeding Hopper Construction**

The feeding hopper will be made by welding four pieces of mild steel sheets having the shape shown in fig. 5a to form a four-sided funnel as shown in fig. 5b.



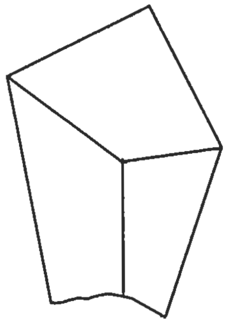


Fig. 5a **Fig. 5b**

The feeding hopper will be welded to the top of the peeling chamber

E: **Construction of the Blower Unit**

The blowing chamber had a cylindrical shape and will be made from mild steel sheet. It will enclose the blower which is a small fan – like mechanism with a shaft held by two bearings. A pulley will be attached at the end of the shaft for the belt to pass and drive the blower. The blower unit had a rectangular channel at the top through which the air blown by the blower is directed to the separating unit.

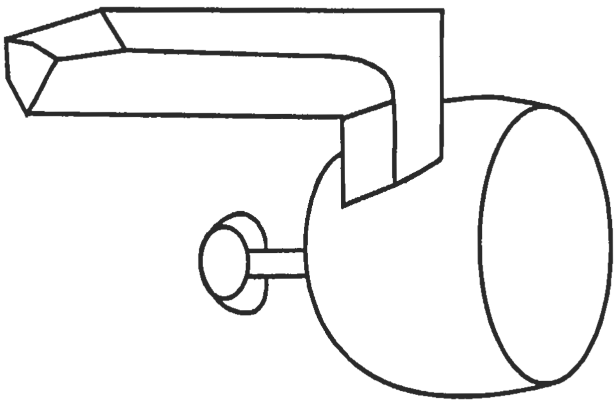


Fig. 6 Blower unit construction

F: **The Separating Port Construction**

The separating port was directly below the peeling chamber and in front of the blower unit. It is made of mild steel sheet 240mm long and 120mm wide. It is tilted at an angle of 45^0 so as to enable the melon seeds slide down into the container while the shells was blown off by air delivered by the blower.

G: **The Power Cord**

The power cord was made by fixing a three-prong plug at the end of a cable and connecting it to the electric motor.

The three main component parts of the melon peeling and separating machine namely the peeling chamber, the blower unit and the electric motor were fixed to the main frame with bolts and nuts. The use of bolt and nuts is to facilitate easy detachment of the parts during maintenance operations. The feeding hopper and the separating unit was however, welded to the top and bottom of the peeling chamber respectively. The pulleys of the peeling rotor, the pulley of the blower and that of the electric motor was connected together with an A – 40 V- belt.

Testing Procedure

In order to ascertain the functionality of the product after construction, the machine was connected to the mains and switched on. Then a sample of unpeeled melon seeds was fed into it through the feeding hopper. The peeled melon seeds coming out from the outlet was closely examined to see whether there were unpeeled seeds and unseparated shells among them. The procedure was repeated with various known quantities of unpeeled melon seeds such as 1 cup, 2 cups, 3 cups etc. In each sample, the number of unpeeled melon seeds as well as the number of unseparated shells will be recorded. Thereafter, the percentage of unpeeled seeds and unseparated shells was calculated in each case. A percentage of 5% and below meant that the machine is functional while any value above 5% was taken to mean that the machine is not functional.

CHAPTER IV

PRESENTATION OF DESIGNED AND CONSTRUCTED MACHINE AND TESTING RESULTS

In this chapter, the designed and constructed machine is presented. The assembling procedure, the safety precautions observed during its construction as well as its method of operation is also explained. Furthermore, the testing result obtained are presented, analyzed and discussed.

Assembling of the Final Product

Assembling of the final product was done after the different component parts of the melon peeling and separating machine were constructed using the sequential constructional procedure shown in fig. 1. Two types of joints were used during the process. These were permanent joints and temporary joints. Permanent joints were used in joining the feeding hopper to the top of the peeling chamber through the process of welding. The separating port was also welded to the main frame.

Bolts and nuts were used to fasten the three main components of the machine namely the electric motor, peeling chamber and blower unit to the main frame. The electric motor was first mounted on its base with four bolts. The peeling chamber and the blower unit were also mounted on the main frame with screws bolts and nuts. The need to use bolts and nuts for these components was to produce temporary joints which could facilitate easy detachment of any of these component parts during maintenance operations.

Thereafter, pulleys were fitted on the shafts of the three main components (the electric motor, peeling rotor and blower unit) with screws to facilitate easy detachment. The three pulleys were then connected together with a V-belt. Lastly, the power cord was connected to the electric motor and its free end was fitted with a three-prong plug.

After the assembling, the machine was cleaned with emery cloth and wire brush to remove dirt and dust. Thereafter paint was applied to it to give it a smooth furnish and a beautiful appearance. The completed product is as shown in fig. 7.

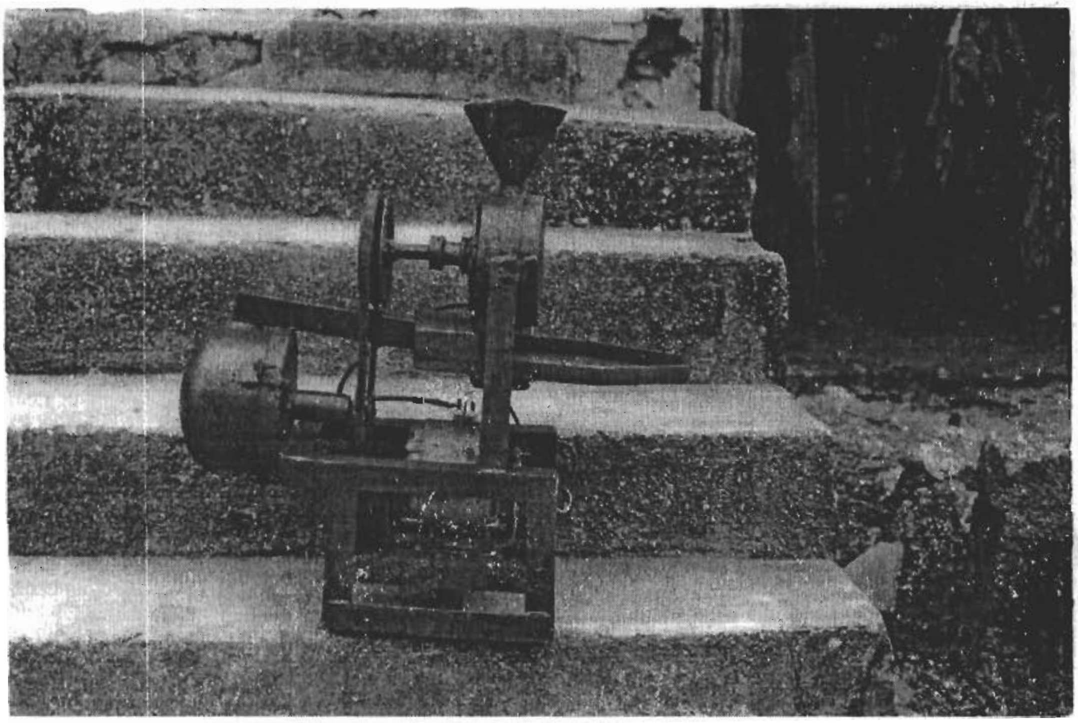


Fig. 7: Pictorial view of the finished product

Safety precautions taken during the design and construction of the machine.

A lot of safety precautions were observed during the design and construction of the melon peeling and separating machine. These include the following:

1. correct protective devices were worm during the construction. These include overall, hand gloves, goggles and safety boots.
2. The work pieces were securely held in place.
3. Operation was restricted to authorized personnel.
4. Quantities of melon were fed at specified interval.
5. Separated and unseparated melon and shells were observed.
6. Appropriate calculations were made.
7. The machine was cleaned after usage and the power cord removed from the mains.

Operation of the Melon Peeling and Separating Machine

The power cord of the machine is first plugged into the mains and the machine is switched on. The melon seed to be peeled is first sprinkled with water to make the seed coast softer to facilitate easy peeling. The wet melon seeds are then fed into the machine through the feeding hopper. As the melon seeds enter the peeling chamber, they come in contact with the rotating blades of the peeling rotor. As the peeling blades continue to rotate, it causes the melon seeds to bombard with it on the walls of the peeling chamber. As the melon seeds continue to bombard with the walls of the peeling chamber and the peeling blades, the seed coast or shells are removed. The peeled melon seeds together with the shells drop into the separating port which is directly below the peeling chamber and directly in front of the blower unit. Air from the blower unit is directed into the separating port. As the air enters the separating port, it blows off the melon shell which is lighter or less dense than the seeds leaving only the peeled seeds in the separating port.

Testing Results

According to Udofia (2002), every new product requires thorough testing in order to ensure that it will function properly and safely. To this end, the constructed machine was tested with different quantities of melon seeds to ascertain its functionality and efficiency: the results of the tests are presented on Tables 1 and 2.

Table 1: Quantity of Melon Seeds and the Number of Unpeeled Seeds in each Sample Tested

Quantity of Melon (kg)	Number of unpeeled seeds
1	3
2	5
3	9
4	13
5	17
7	20
10	25

The data on Table 1 showed that there were only 3 unpeeled seeds when only 1kg of melon seeds was peeled. There were 5 unpeeled seeds in the 2kg sample, 9 in the 3kg sample and 13 in the 4kg sample. The data also showed that there were 17, 20 and 26 unpeeled melon seeds in the

5kg, 7kg and 10kg sample respectively. Based on this result, it could rightly be inferred that the machine is very effective in peeling melon seeds since the ratio of the number of unpeeled seeds to the quantity in each sample is very negligible.

Table 2: Quantity on Melon Seeds and the Number of Unseparated Shells in each Sample

Quantity of Melon (kg)	Number of unseparated seeds
1	2
2	4
3	7
4	11
5	14
7	19
10	24

The result on Table 2 revealed that when 1 kilogramme of melon seeds was peeled, there were only 2 unseparated shells. The corresponding figure for the 2kg, 3kg, 4kg, 5kg, 7kg and 10kg samples were respectively 4, 7, 11, 14, 19 and 24. On this basis, since the number of unseparated shells in each sample is very negligible as compared to the quantity of melon peeled, it could be said that the designed and constructed melon peeling and separating machine is very efficient in separating melon seeds from its shells after peeling.

DISCUSSION OF RESULTS

The result of the tests conducted to ascertain the functionality and efficiency of the designed and constructed melon peeling and separating machine are presented on Tables 1 and 2. The result on table 1 showed that the number of unpeeled melon seeds in each sample was very negligible compared to the quantity. In other words, the machine is capable of peeling a large quantity of melon seeds in a short time. This implies that the machine could greatly enable the user to perform the desired work easily and in a lesser period on time. This is in agreement with Awe and Okunola (1984), Pytlik, Lauda and Johnson (1985), STAN (1991) and Falusi and Adeleye (1998) who all contented that the use of machine reduces the hard work and drudgery associated with farm work, reduce production cost and improve the quality of agricultural product.

The result in Table 2 showed that the number of unseparated shells in each sample was very negligible compared to the quantity of melon in each case. This implies that the machine is capable of separating the melon shells from its seeds after peeling. The few shells that were unseparated could have been caused by the fact that they were too large to be blown off by air from the blower unit or that they were still partly attached to the melon seeds. This result proves Henderson and Perry's (1981) assertion that blowing is one of the best methods for separating two materials that have considerable difference in their densities or weight.

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter contains the summary, conclusion and recommendations of the study.

Re-Statement of the Problem

There is preponderance of evidence in educational literature showing that most students and products of technical education programme in Nigeria do not acquire the necessary skills that could make them self-reliant economically. This deficiency is most notable in the area of design and construction (Udofia, 2000; Unanaowo, 2005). The study therefore become imperative since design and construction of machines such as the melon peeling and separating machine could provide ample opportunity for technical education students to acquire the necessary skills and competencies that would enable them to be enterprising and self-reliant on completion of their training programmes.

Moreover, there is a problem of non-availability of locally made, cheap and portable machines for peeling melon seeds and for separating the seeds from the shells. Furthermore, Nigeria's economy has in recent years been adversely affected by its citizens' overdependence on imported manufactured goods. The study therefore became necessary in order to find solutions to these problems.

Summary of the Method used in the Design and Construction

The study adopted the Research and Development (R&D) research design. The final design of the melon peeling and separating machine was produced after series of attempts and careful consideration of drawings of many locally fabricated machines. Thereafter, the sequential constructional procedure was adopted and the construction of the machine was executed in steps as follows:

1. The main frame was first constructed using 1½ inch angled iron. The various pieces were joined together by the welding method.
2. The electric motor was constructed using 1.5 gauge coil wire.
3. The peeling chamber was constructed next with mild steel sheets. This was followed by the construction of the peeling rotor which carries the peelings blades.
4. The feeding hopper was made by welding four pieces of mild steel sheets together to form a rectangular-shaped funnel.
5. The blower unit was fabricated by enclosing a small blower in a cylindrically shaped chamber.
6. The separating port was constructed next by welding a piece of mild steel sheet to the main frame at an angle of 45^0.
7. The power cord was made last by fixing a three-prong plug at the end of a cable and connecting the other end to the terminals of the electric motor.

These components were assembled by using bolts and nuts and welding in some cases. The finished product was sand with emery cloth and wire brush after which it was painted. Lastly, a V-belt was used to link the pulleys of the electric motor, peeling chamber and blower unit.

Summary of Tests Carried out and Results Obtained

On completion of the construction, the finished product was tested with various quantities of melon seeds and the peeled melon seeds coming out were closely examined and the number of unpeeled seeds as well as the number of unseparated shells was recorded in each sample. The result showed that the number of unpeeled melon seeds as well as the number of unseparated shells in each sample was very negligible. Based on this, the melon peeling and separating machine has been proved to be very functional and efficient in peeling melon seeds as well as separating the seeds from the shells.

Implications of the Study

Today, in this space age, man's technology includes not only his hardware made from tangible materials, but also his analytical techniques, computer programmes and his thinking process.

The success of developing indigenous tools and machines can only be obtained through the design and construction of such tools or hardware. This study is intended to fill this gap and enhance technology and economic growth by imparting necessary skills to students of Vocational

Technical Education, through the design and construction of machines which enable humans to perform their task easily.

In this way, rapid solution to problems is enhanced. It is in this regard that the agricultural processing machines, like the designed and constructed melon peeling and separating machine becomes inevitable.

The implication here is that the hard work and drudgery associated with farm work is reduced, hence an improvement on the quality and quantity of the product.

Besides, the production cost will be chapter, since more units will be produced in less time. Once again, this study became imperative because design and construction could provide ample opportunities for technical education students to acquire the necessary skills and competencies that could make them enterprising.

Besides, the over dependence on imported goods will be reduced as most of the machines will be fabricated locally at a reduced cost thereby improving the welfare and well-being of the citizens, through better, quality and cheaper products.

Conclusion

The just concluded design and construction of the melon peeling and separating machine using locally available materials is a bold attempt by students of the Department of Vocational Teacher Education of the University of Nigeria, Nsukka to respond to Nigeria's clarion call to help in the development of her indigenous technology. If the design and construction on this machine and other similar products is encouraged by government in terms of incentives and increased patronage, it is hoped that technical education students in Nigeria will acquire the needed skills in design and construction which world help them to raise the level of technological development on the country.

Recommendations

In line with the purpose and result of this study, the following recommendations are made:

1. A compulsory course in design and construction should be included in the curriculum of all technical education programmes in Nigeria. This will provide the students with opportunity to enhance their knowledge and skills in design and construction.
2. Technical exhibition should be regularly organized for technical colleges in the country. This will enable them to display their locally made products and also provide a forum for exchange of ideas.
3. This locally designed and constructed machine is recommended for us throughout Nigeria. It is the best substitute for the imported ones.
4. Government, private entrepreneurs and agricultural research institutes should help in the mass production of this machine.
5. Technical college workshops should be well equipped to enable students practice design and construction of machines and tools.

Suggestions for Further Studies

The following topics are suggested for further research and development.

1. Design and construction of a manually operated melon peeling and separating machine.
2. Design and construction of a solar-energy operated melon peeling and separating machine.
3. Design and construction of a larger melon peeler and separator.

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