TECHNOLOGY IN THE CONSTRUCTION PROCESS OF THE LOUDSPEAKER SYSTEM

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ABSTRACT

A loudspeaker is a transducer that converts electrical signals to sound loud enough to be heard at a range or distance dependent on the power of such speaker. However, getting a good loudspeaker system seems impossible not because of its unavailability, but as a result of the economic meltdown the country is presently facing which has made a quality speaker non-affordable to an average citizen. This research thus explores the technology in the construction process of the Loudspeaker system as it is fabricated using our good but affordable local raw materials. The research method adopted for the purpose of this paper is the qualitative research method with data gathered through interview, library sources, and participant observation among other ethnographic sources. Findings reveal that, there are numerous materials that are available in our local markets which help producers of the loudspeaker system achieve great sounding speakers with proper acoustics but at a lesser production cost when compared with the imported ones. In conclusion, this research resolves that the technical knowledge of the construction of the loudspeaker using our local raw materials will further help the economy of the nation by helping create more work for the youths and as well serve the need of speaker users who will then get quality speakers at less cost.

Keywords: Loudspeaker, Electrical signals, Sound, Materials, Cost

Introduction

A Loudspeaker ultimately converts electrical signals to sound. They have certain components that move back and forth to fluctuate air pressures which will lead to fluctuating frequencies and different sound waves and cause velocity variations of the surface which can cause pressure variations and pressure waves.

Digital speakers have been the subject of experiments performed by Bell Labs as far back as the 1920s. The design is simple; each bit controls a driver, which is either fully 'on' or 'off'. Problems with this design have led manufacturers to abandon it as impractical for the present. First, for a reasonable number of bits (required for adequate sound reproduction quality), the physical size of a speaker system becomes very large. Secondly, due to inherent analog-to-digital conversion problems, the effect of aliasing is unavoidable, so that the audio output is "reflected" at equal amplitude in the frequency domain, on the other side of the Nyquist limit (half the sampling frequency), causing an unacceptably high level of ultrasonic to accompany the desired output. No workable scheme has been found to adequately deal with this.

The term "digital" or "digital-ready" is often used for marketing purposes on speakers or headphones, but these systems are not digital in the sense described above. Rather, they are conventional speakers that can be used with digital sound sources (e.g., optical media, MP3 players, etc.), as can any conventional speaker. Sound is a form of energy passing through a gas or liquid medium. Understanding sound is in the realm of physics. There are two main measurements in sound: frequency and decibels. Frequency is responsible for the quality of sound in a speaker, decibels measure the 'loudness' of the speaker. Humans can hear audio from 20 - 20,000 Hertz. Hertz is a measure of cycles per second. Sound is a wave ranging from 0 level of energy to infinity. A middle 'C' tone on an instrument is not a solid constant level of energy is it sounds to our ears, it is a wave which peaks every 278 times per second. The human ear does not hear all frequencies with the same sensitivity. It is most sensitive to the 2000 - 4000 Hz range. So a 100 dB (loudness level) sound at 20 Hz will not damage the ear as much as a sound at 3000 Hz.

Most sounds fall in the lower range of our audible frequency range, however sounds at 16,000 or 20,000 Hz are important. These upper frequencies give us other information about a sound, such as the environment of the sound. If someone is speaking in a small room or auditorium we can tell thanks to the high frequencies. Developing a speaker which could reproduce the low and very high frequencies was the greatest challenge in inventing the speaker. Since the 1921 prototype the speaker's abilities to reproduce frequencies got even better. Engineers continue to advance the

technology and improve our world by making speakers smaller, more efficient and more durable (Normandin, 2014). Technology has really advanced all sectors of life most especially scientific related phenomenon.
The recent advancements in technology (particularly Artificial Intelligence) are having a great impact on our day to day life (Mills, 2018). In a smart home scenario, multiple smart devices are interlinked and work in collaboration with each other to serve a common goal. Smart speakers are one amongst such smart devices that are being widely adopted by common users and becoming an integral part of smart homes.

The word "sound" refers to the frequencies of 18-20,000Hz that a normal human can hear. Frequencies are "created by the fluctuation of air pressure caused by the movement and/or vibration of a given object" (Juslin, Sloboda, 2010). When the ears of a human being can perceive anything through the sensation and vibration of the ear drum, it is referred to as sound. The oscillation (vibration) of sound can either be in high or low frequencies. Slower vibrations have lower frequencies and faster vibrations have higher frequencies. When an object vibrates, it creates mechanical kinetic energy. This energy gets transferred to the air particles surrounding the object, creating acoustical kinetic energy. This creates air pressure variations, which is what people perceive or hear through.

In view of the aforementioned, this research is thus aimed at knowing the step by step construction process of the loudspeaker system using good local raw materials that are available and affordable. The objectives that guide this research are as enumerated below.

RESEARCH OBJECTIVES

The general objective of this research is to discuss the construction process of the loudspeaker system using available local raw materials. The specific objectives of the study are to:

(i) discuss the construction processes of the loudspeaker.
(ii) identify the materials used for the construction and design of the loudspeaker.
(iii) investigate the effects of the materials used in the construction of loudspeaker on its acoustics.
(iv) examine the equipment used for the construction and design of the loudspeaker.

Research Questions

The following are the research questions:

(i) How is the loudspeaker fabricated?
(ii) What are the materials available for use in constructing the loudspeaker?
(iii) To what extent does the choice of materials affect the sound of the loudspeaker?
(iv) What tools and machines are used for an effective production of the loudspeaker?

Statement of Problem

In every sound system setup, smart speakers are supposed to complement the effect of sound mixing at any setup to enhance the general production of sound. But, how can this be a reality? Even, if at the availability of such smart speakers, when they are not properly fixed or connected might not actually give good sound production.

The quality of speakers in regards to the sound production (frequency range) is majorly determined by the component materials used in the construction of such speakers. Often times and recently, preference of non-indigenous instruments over locally made instruments has been on the high rise. This is owing to the fact that, over the age, it has been of general opinion that imported equipment are of better quality than equipment made locally because of the quality of materials put together, the tools used in order to achieve accurate measurements, and the construction process till the complete production is attained.

DATA PRESENTATION AND ANALYSIS

Constructional Design

The constructional design of the loudspeaker explains the shape of the box, and how it affects sound production directly or indirectly. The movement of air pressure in the sound box describes how sound resonates in the enclosure. This therefore brings about the difference in resonance within different enclosure (box shape). The way a circular-framed box resonates will be definitely different from that of a rectangular-framed box; it will also be different from a trapezoid-shaped box.

In ported monitors, sound ports are always crested on it to allow for air pressure. The reverberation of air pressure in the enclosure has a way of affecting the sound produced. It fine-tunes the pitch of the sound produced to a definite frequency.

Size of the Speaker System

When a speaker system is big, its inner chamber is big and vice versa. This implies that the size of the speaker system also goes a long way to affect its acoustic nature. The size of the speaker small, big or medium determines the resonating pitch of the speaker system. The inner space (chamber) of the loudspeaker system is what determines its resonating pitch. The smaller size produces higher resonating frequency while bigger size produces lower resonating frequency.

This is highly significant in the construction of a loudspeaker to fit a specific purpose for which it will be designed. For instance, subwoofers are always big in size having a large size frame because of its low-pitch production, while monitors are not necessarily big or large in size.

Wood Type

There are varieties of woods used in the woodwork construction. Several types of wood are used for several purposes in woodworks this is because woods are of different quality and durability. These woods also differ one from another because of the different purposes for which they are significantly used. The types of wood which are used for construction purposes are basically categorized into Hardwood and Softwood. Example of Hardwood are Oak, Walnut, Mahogamy, Cam wood and Opepe. Whereas Softwood are of the following types Cedar, Spruce, Redwood, Fir and Pine

The loudspeaker is an equipment which requires wood majorly for the erection of its framework. The type of wood required for the construction of the loudspeaker is the plywood. The plywood is suitable for the construction of the loudspeaker because it is only the plywood that can be made into a large board which may later be cut into smaller desired sizes.

There are different types of plywood which exist, yet, not every kind of plywood can be used for the construction of the loudspeaker. The kinds of plywood which exists are—Imported plywood, MDF (Medium-Density Fibreboard) plywood, Medium-Density Fibreboard HDF plywood, where the HDF and MDF have a coated surface (water proof), particle board, and the Nigerian plywood. However, among diverse types of plywood Nigerian plywood are most suitable.

Wood Size - The wood size which is the most suitably fit for the construction of the loudspeaker is the ¾`` (inch) of the Nigerian plywood. Other sizes include ½`` (inch), ¼`` (inch), $^{1}/_{8}$`` (inch). The reason for this selection is so that it will be easier for one to work on the plywood as a project material; for easy driving of nail and screw into it; to reduce the weight of the loudspeaker. If the weight is more than ¾`` (inch), it may be too heavy to carry. On the other hand, if the weight is less than ¾`` (inch), the object constructed will be fragile.

Inner chamber - another factor which affects the acoustics nature of the loudspeaker system is the inner chamber. Recalling that the bigger the inner chamber the lower the resonating frequency of the loudspeaker and vice versa. The inner chamber of the speaker box can also be worked upon in a way that it affects the sound production. If a substance is used to pad the inner part of the loudspeaker's frame, it compacts and makes surround the output of the loudspeaker sound system because such substances absorbs the air pressure therefore lessen the pressure of reverberation.

Materials and Equipment

These are the materials, tools and machines used in experimenting and following the procedural steps in the construction of a loud speaker.

The materials used in the process of construction are:

- ¾`` plywood: This is a wooden material manufactured from thin layers or "plies" gotten from wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another.
- Speaker cone (diaphragm): This is the main active area of the loudspeaker. When activated by the coil, it pushes the air backwards and forwards to create the sound waves.

- Tweeter: This is a special type of speaker cone that is designed to produce high audio frequencies up to 100kHz.
- Crossover: This is a type of electronic filter circuitry that splits an audio signal into two or more frequency ranges, so that the signals can be sent to loudspeaker drivers that are designed to operate within different frequency ranges.
- Handle: This is a metallic substance that is used to carry the loudspeaker.
- Corner edge: This is usually a plastic object used to cover the sharp edge of the loudspeaker
- Screws: These are short, slender, sharp-pointed metal pin with a raised helical thread running round it and a slotted head, use to join things together by being rotated so that it pierces wood or other material and is held tightly in place.
- Nails: These are small object made of metal (or wood, called a tree nail or "trunnel") which is used as a fastener, as a peg to hang something, or sometimes as a decoration (Oxford Dictionary, 2009). Generally, nails have a sharp point on one end and a flattened head on the other, but headless nails are available. Nails are made in a great variety of forms for specialized purposes (Wikipedia.com)
- Net: This is a fancy metallic substance used to cover the face of the speaker.
- Rug: This is used to protect the frame of the loudspeaker from being exposed to varying weather conditions. It also serves aesthetic purposes.
- Foot stand: This is attached to the base of the speaker to prevent it from having a direct contact with the floor.
- White Glue: This is a white substance used to fasten wooden edges or surfaces together.
- Evo-stik Glue: This is a strong adhesive used to glue two substances together
- Connection cable: This is a substance made of thin coiled led or copper wire covered with rubber used to link the speaker to the amplifier.

Tools used in the construction processes are:

- Cutting machine: This is an electronic machine used to slice large-sized woods into small bits or desired sizes
- Jack Plane:A **jack plane** is a general-purpose woodworking bench plane, used for dressing timber down to size in preparation for truing and/or edge jointing.
- Files: These are used to remove hard edges and to smoothen wooden surfaces
- Ruler: This is used to measure any object for marking or setting out.
- Clamp: This is used to hold substances or materials together in close grip in carpentry and welding.
- Saw: This is a tool with a blade or sharp cutting points, used for cutting hard materials such as wood or metal.
    - Hand Saw: Also known as "panel saws", are used to cut pieces of wood into different shapes.
    - Hack Saw: This is a hand-powered, small-toothed saw used for cutting metal pipes, rods, brackets, and so on.
- Hammer: This is a tool consisting of a solid head, usually of metal, set crosswise on a handle, used for beating metals or driving nails into a wooden substance.
- Screwdriver: This is a tool, either manual or powered, which is used for driving screws.
- Drilling Machine: This is defined as an electronic machine which is used to make a circular hole, a tool used to drill the holes of different size and other related operations using a drill bit.
- Hand Drilling Machine: This is a primitive drill consisting of a shaft carrying a point of stone, bone, shell, or metal and revolved usually by the palms of the hands used to bore holes in a substance.

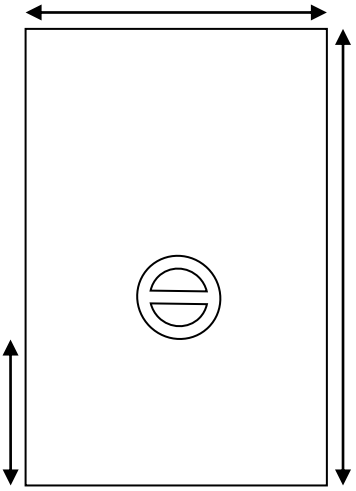
- Pillar drilling Machine: Pillar drills are free-standing machines that use a motor to rotate a bit with variable speed range as it bores hole on a substance usually wood.
- Circular Sawing Machine: A circular saw is a power-saw using a toothed or abrasive disc or blade to cut different materials using a rotary motion spinning around an arbor. A circular saw is a **tool** for cutting many materials such as wood, masonry, plastic, or metal and may be hand-held or mounted to a machine.

DESIGN AND CONSTRUCTION PROCESS OF THE LOUDSPEAKER SYSTEM

Separate Sides

The first step to observe is the cutting of the sides from the plywood which forms the frame of the loudspeaker. This depends on the size of the loudspeaker to be constructed.

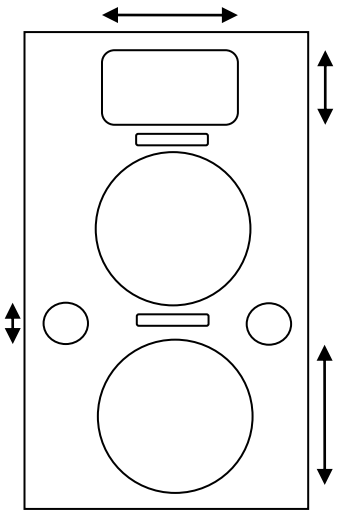
Left and Right Sides



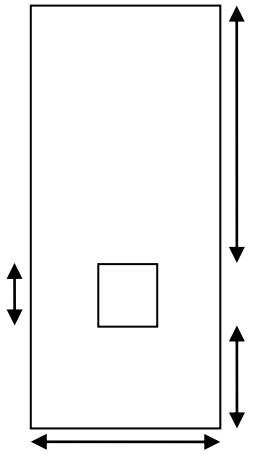
The left and right sides of the loudspeakers have the same size and measurement. The length of both left and rights sides is 114.5cm while the breadth is 52.6cm. The handle port is to be cut out of the plywood according to the handle desired.

Front Side

loudspeaker is constructed in a bigger than the back side. The inches diameter, a tweeter, and 2 on the front sides are: 2 speaker distance of 5cm from the frame same between the upper cone of 4cm each. The tweeter also the tweeter used for this



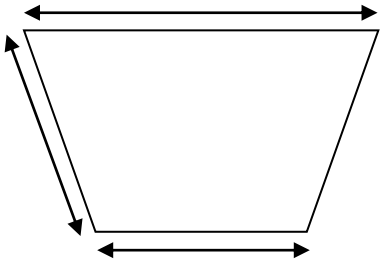
In the course of this construction, the trapezoid shape, thereby making the front side front side consists of 2 speaker cones of 15 sound ports. The measurements of the partitions cones of 15" diameter (38.1 cm) each having the (bottom) and 5cm in between the cones and the and the tweeter. The sound ports have a diameter depends on the shape and size. But the size of construction is square in shape of 18.3cm.



Back **Side**

The back side, because of the shape of the loudspeaker (trapezium) is different from the front side. It has the length of 114.5cm and breadth of 32cm. The back side has a port in it which is for the crossover which is 15cm length and 10cm breadth of 24cm away from the frame (bottom).

Top and Bottom Sides



The top and bottom sides of the loudspeaker are placed on top of the sides like a lid and not fixed like a joint. They both have the same measurements where the front sides of them measure 49.5cm and the sides measure 54.5cm.

Joining of the Sides

The back, right and left sides

The next step of the construction is to join the sides of the loudspeaker together with the use of the white glue and nails. The essence of adding the white glue before nailing it together is to ensure firmness and no leakage in joints. But firstly, the left and the right sides must be joined to the back side. The joining must be in a way that the edges of both the left and right sides and the back side where they connect are shaped into a slanting edge form so that it can lay on each other forming the inward shape of the loudspeaker.

The Top and Bottom sides

Having joined the left and right sides to the back, the next is to join the top and bottom sides to the frame. The top and bottom sides is laid over the structure (at the top and bottom) and connected directly to the tops of the already connected sides.

Inner braces

When all the sides have been fitly joined, before the front side is fastened to the frame, there is need for one to form braces that supports the frame internally. The brace is therefore constructed diagonally inside the speaker box touching from the back to the front sides of the speaker box. Also, on the exterior parts of the left and right sides, towards the edge, braces are also attached to give support to the front side when placed against pressure.

Front Side

The front side of the speaker box which houses the speaker cones and tweeter(s) is thus connected to the speaker box.

Outer brace

After that the front side has been fixed to the speaker box, braces are thus fixed to the speaker box at the edges of the top and bottom sides and the spaces in between the woofer ports upon which the net which would be used to cover the face of the speaker will be laid.

Rugging the Loudspeaker box

The next step to take after all the sides of the speaker box has be fitly joined together with the use of glue and nails, is rugging. Rug is used for two main purposes in the loudspeaker construction:

- To cover the frame of the loudspeaker and to prevent it from quick dent or damage, thereby prolonging the lifespan of the speaker box.
- The rug also beautifies the loudspeaker adding to its aesthetics.

For a firm and neat work, the rug must be fastened to the speaker box with the use of adhesive. In most cases, evo-stik (or any other strong adhesive) is preferable. After that the adhesive is applied to both surfaces of the frame and the rug, it should be left for a little time before the rug is glued to the speaker box.

4.3.4 Fixing the component parts of the loudspeaker system

Fixing the component parts of the loudspeaker system is the next step to take in the construction of the loudspeaker. The component parts are—crossover, speaker cones (woofer), tweeter, and handles. The crossover is screwed to the

back of the speaker box through the crossover ports; the speaker cones are placed in their ports and tightened to the box with the use of screws; the tweeter is also placed in its port and screwed to the box; while the handle also will be screwed to the sides of the speaker box.

CONCLUSION

This research concludes that the significance of loudspeaker in the art of music production cannot be overemphasized. Yet the improvement on the music industry and the art of music production, with the aid of science and technology, has brought about the invention of smart speakers. This is because for every sound generated, the propagation is amplified with the use of a loudspeaker system. Regardless of the type of loudspeaker, its main purpose is amplification in a very good quality. The issue efficiency and effectiveness must be paramount in the production of loudspeakers.

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APPENDIX



Pic 1: Measuring the plywood for cutting



Pic 2: Smoothening the edges of the woofer port



Pic 3: Before joining the three sides



Pic 4: After joining all the sides except front



Pic 5: Completed Speaker Box



Pic 6: Rugging Process.