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Electric Throwing Wheel from Repurposed Bucket, Ceiling Fan Motor, and Sewing Machine Regulator for Pottery Demonstration

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ABSTRACT: The cost of electric potters' throwing wheel keeps soaring high even when throwing yet a course that firmly exists and is valued in the ceramic production process besides other forming techniques in art/design schools. The challenge herewith is the need to look for cheaper alternative electric throwing wheels through local fabrication to alleviate the impending high cost of imported ones and the general scarcity of potter's wheels for demonstration in a simple ceramic studio setting by improvising available materials. The experimental-based methodology was deployed by sourcing and assembling the required components – an electric potter's wheel using a sewing machine regulator, iron bucket and basin, German plywood ½ inch, 1inch screw nails, bolts, and nuts, and 3 pin plug head. The principles of the 'development cycle' and the 'rotational kinetic energy (RKE' were adopted. The results of the study revealed that: the electric has the capacity speed of 200rovulation per minute (rpm) sufficient to center a-2kg of a well-prepared mass of leather hard clay - 50 rpm cylinders and bowls of various heights and widths up to 6" (height) and 5" (width) are viable; the repurposing of the conventional functions of the water bucket and fan the provision of air into an electric throwing wheel was successful. In conclusion, the study showed some success. The recommendations of the study include thus: further improvement as the focus of this one (project) is primarily to proffer a concept even though the topic is relevant to both product and service design; adoption of improvisation through repurposing for the mass construction of wheels as an alternative to the costly imported ones should be encouraged.

KEYWORDS: Repurposing, electric throwing wheel, electric fan motor, sewing machine regulator, pottery demonstration

INTRODUCTION

Ceramic wares forming methods include casting, jiggering and jollying, hand building, and throwing. The throwing is the process of forming a shape from a soft material such as clay using the wheel; a device known as a throwing wheel or a potters' wheel. John (1974) asserted that the definition of potter's wheels by scholars has been conventionally either placing greater emphasis on the device's design or the speed/length of rotation. However, the author said that the potter's wheel is a machine for molding clay into pottery by hand, consisting of a horizontal rotating disc that holds and turns the clay between the potter's hands. Berg (2020) conversely enumerated the enormous advantages of using the potter's wheel over other methods of pottery production as thus: production of even and symmetrical vessels; fast and maximized turn-over as a wheel can make production between twice and five times faster than a turntable or mold. Jonathan (2014) avowed the advantages of electric wheels compared to manual wheels viz: none demand any manual interference as the potter can concentrate completely on the work his hands are doing; lighter than kick wheels and some are portable to move from a location to another. And smaller in size to many be accommodated in a small space, throwing is faster, and are less noisy.

The concept of repurposing being key to study refers to a wide set of practices such as recycling or upcycling, all to make better use of or, give new life to physical materials and artifacts; with an obvious interest in sustainability issues (Simbelis, Ferreira, Vaara and Laaksolahti, 2016). Repurposing according to Aguirre (2010) is the transformation of products or their components to suit a second purpose after their first has expired, or creating a new or second life for an existent product by making some changes to it. The author further said it is a phenomenon that goes far back in history; the beginnings of object culture; at least as early as the Stone Age, people started using materials found in nature with the strategic goal of improving their chances of living.

Despite the importance of potter's wheels for simple classroom demonstrations, their costs are still high thus, the need for concepts such as improvisation. Daniel, Gadzama, Abubakar, and Mbdomti (2021) for instance suggest synergy and improvisation be among the design concepts to be encouraged for optimal design results. Improvisation according to Melanie and Satu (2018) has several temporal dimensions such as extemporization, meaning 'the time of inspiration'; a process of learning and inquiry, 'learning-in-organizing' that works by drawing on 'knowledge and personal experience, and the provision of alternatives to all things. While Hornby (2010) averred that improvisation means to make or do something by using whatever is available, usually due to what is in need; interestingly, Gerber (2007) held the same view of it as a creative act composed without prior thought completed through what Aguirre (2010 refers to as batch production and individual level through Do it Yourself (DIY).

Historical development of the potter's wheel

Historically, pot-making techniques in Mesopotamia gradually changed during the third millennium BC as more potters adopted the turntable for making and decorating (Jonathan, 2014). This is in line with Atkin (2013)'s claim of throwing been developed first in Egypt in 3000 BC.

Also, the development of the slow, or hand-turned wheel as an adjunct to pottery manufacture led to the introduction of the kick wheel rotated by foot by the 18th Century. However, by the 19th-century motive power found application in throwing wheels and, since the 19th century, the motive power has been mechanical. Berg **(**2020). The author conversely said that throwing wheels were invented in the 5th millennium BC in the Near East and spiraled transversely to the Mediterranean into southern and eastern Europe during the late Bronze and early Iron Ages before reaching Asia and, finally, the American continent.

The potter's wheel utilized new technological principles, namely, rotational kinetic energy (RKE) combined with manual force, to shape vessels (Berg, 2020). Initially, however, it seems that the wheel was only used to make small shapes or medium-sized and larger pots in stages and was not used for wheel-throwing but for hybrid techniques. Similarly, it is important to note that the potter wheels are powered either electrically or manually potter's wheels as being traditionally divided into two categories: simple and double (or kick) wheels and when utilized to its full potential, this invention can speed up production significantly.

Types of Wheels and How They Work: The Principle

Jonathan (2014) said two types of foot-powered wheels exist: kick wheels and treadle wheels. And that each of them: the kick wheel works by kicking the flywheel in a specific rhythm, which powers the wheel head, and uses a heavy flywheel that stores energy as it speeds up when propelled by your foot. The treadle wheel uses a lever with a mechanism that turns a shaft with a weighted flywheel. The main components of most kick wheels include a steel frame, an adjustable seat, reinforced cast concrete flywheel, cast metal wheel head, and wood metal or composite work surface. The author said though the wheels can be powered by foot, some models come with an electric motor option, however, flywheels weigh between 120 and 140 pounds, and the motors easily maintain momentum after the flywheel is turning.

Conversely, the treadle pottery wheel is easier to operate than the kick pottery wheel as the left foot is used to rock a treadle, rather than in a kicking motion, which rely on a foot-powered treadle mechanism to drive a flywheel. They once were common in English and American potteries and more lately mass-produced for both school and private studios (Jonathan, 2014). The author further said that the ubiquitous type is a sit-down version based on a design refined by Bernard Leach at the beginning of the 20th century; a legendary among potters who prefer the nonelectric wheel, probably because of the body exercises achieved while throwing compared to the electric wheel that is propelled by an electric motor; though does not need any manual meddling, but requires concentration completely on the work while the hands are doing.

Berg (2020) averred that wheel coiling RKE is applied to a vessel originally made of coils and can be introduced at different stages of the forming process. And while pots are made by coiling and then thinned or smoothed on the potter's wheel at its most basic, a coil is added and 'thrown' at its most advanced. Common features mirror those of wheel-thrown pots, nonetheless are less nonstop and regular. The potter's wheel runs at speeds sufficiently high to develop RKE which is used by the potter to pull up and shape the clay with bilateral movements the author added. Although most potting activities fall within a range of 50–120 rpm, however, the author attested that both can reach a maximum speed of 220–230 rotations per minute (rpm). The author went further to say that a simple wheel consists of one single, a heavy wheel that serves both as the flywheel and the putting surface, which is activated by either a stick or hand – either by the potter or an assistant. And the momentum is stored in the heavy wheel and steadily slow down as the potter works; a pivoting axis is set in the ground, depending on its length, which may also need stabilizing.

Although improvisation is often viewed as the second-best solution to design problems according to the foregoing authors, however, it is still crucial to developing nations such as Nigeria, whose technology is hitherto at an infant stage. The problem of the study includes thus: the theoretical knowledge with no hands-on experience by a significant number of ceramic students who despite the advantages of using electric throwing wheels are deprived of due to their short in supply, the high cost due to the harsh policies on importation by the Federal Government of Nigeria, and the lack of synergy among the departments (for example, mechanical engineering, electrical engineering, and industrial design) in the school of technology that disfranchises productive alliances such as leveraging the fabrication of local machines.

Electric Throwing Wheel from Repurposed Bucket, Ceiling Fan Motor, and Sewing Machine Regulator for Pottery Demonstration

The main aim of the study is to repurpose a bucket, ceiling fan motor, and sewing machine regulator for the construction of an electric potter's wheel for studio demonstration, to alleviate their scarcity for demonstration in formal institutions of learning apprenticeship. Improvisation of a prototype potter's electric wheel (PEW); inspire the lifeforce of improvisation through conceptualization; provide wheels that are affordable and operational by a simple generator when electric supply (national grid) fails during the demonstration; revalidation of some principles: rotational kinetic energy (RKE) by Berg (2020) and Development Cycle by Lidwell, Holden, and Butler (2015); motivate and enhance entrepreneurial development among ceramics and engineering graduates that might explore it as means of livelihood. This will reduce unemployment, which in turn minimizes restiveness as well as other vices among especially the youth; and enhance local technology which is achieved through the following objectives:

i. conceptualize design via drawings of an adaptable prototype design of electric wheel;
ii. identify bucket, sewing machine accelerator/pedal, and ceiling as viable components;
iii. assemble of the components; and
iv. Assess the performance of the electricity of the prototype PEW.

MATERIALS AND METHODS

The materials used in this project include a ceiling fan motor, sewing machine regulator, iron buckets, German plywood ½ inch, 1inch screw nails, bolts and nuts, and 3-pin plug heads sourced from within the Yola metropolis.

METHODOLOGY

The experimental method was deployed for the setup given the idea of repurposing via assemblage while adopting the principles of the *Development Cycle* by Lidwell, Holden, and Butler (2015), which advocates four stages of creation known as requirements, design, development for any successful product, and testing, and the principle by Berg (2020) that states that the potter's wheel runs at speeds sufficiently high to develop RKE for the potter to pull up and shape the clay with two-sided movements.

First Step: Concept Development – The fabrication procedures began with design as planning and making that determines the success via how product design (Webster's Comprehensive Dictionary, 2013); see Figure I. This was attained through concept development - from brainstorming on the selection of viable component parts to their assemblage into an electric wheel prior testing the final experimental setup as opined by Lidwell, Holden and Butler (2015).

Second Step – The freehand drawings were drawn and redrawn using a computer for better clarity. The drawings include the labeling and dimensioning of the different parts of the components (see Figure 2). Also, a design that an iterative process and design thinking and client brief to finished work (Ambrose and Harris, 2010) was adopted how ideas are translated to the stages of the decision on the material to be used for the electric wheel.

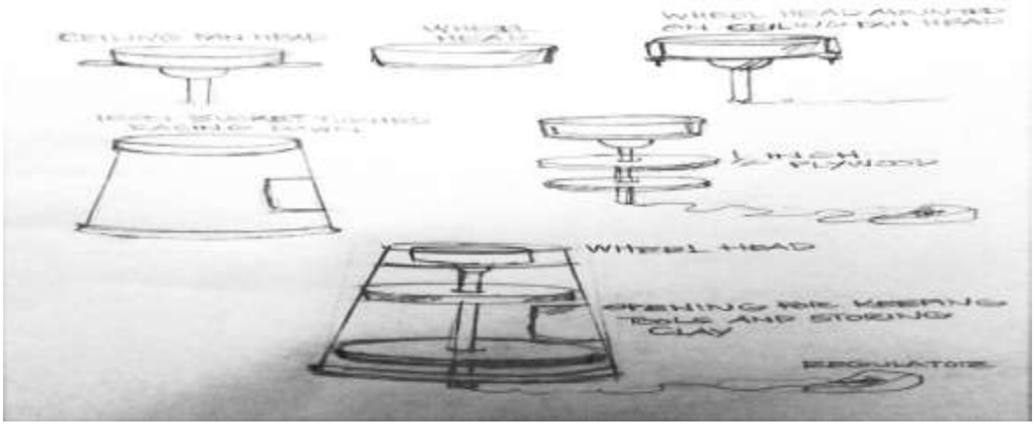

Figure 1: Freehand drawing of parts

Third Step: Assemblage – The stage of development culminates with the adoption of design specifications transformed into an actual product in accordance to Lidwell, Holden, and Butler (2015) as seen in Figure 2a-f by selecting components in a detailed and meaningful way from product concepts, concept testing applied to the developed product concepts in line with Gurbuz's (2018) adopted for this project by the researchers who were exposed to the components (a: ceiling fan head (motor); b: wheel head; c: wheel head mounted on ceiling fan head; d: iron bucket turned facing downward; e:1 inch plywood; and f: assembled parts that formed the electric potter's wheel) based the selection of appropriate ones for this project. The Plates 1-3 were finally composed into an electric potter's wheel as seen in Plate 4, translated from Figure 2f.

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Mr. Ochai to Perfect this: The head was fixed by placing the plywood on the electric fan motor head (Fig…). The rod extending from the ceiling was fixed in the center of the two flying wheels to enable the balance for the centrifugal force to take place while throwing. The pedal of the sewing machine is connected to the base frame by positioning both the frame and the pedal on the same axis. The hole in the pedal meets the frame hole, both are connected by fastening them with the nuts and bolts. The connecting link which connects the sewing machine pedal and the wheel is fixed by using the fasteners between the wheel and the pedal. The electric motor is fixed with a separate mild steel angle which is welded with the base frame to carry the motor. The steel angle is drilled for holding the motor. The fasteners are used to fix the motor into the mild steel angle. …is fixed with the horizontal shaft. fixed with a vertical shaft for the r pottery wheel's rotary motion. Both the wheel head and the two flying wheels are fixed with the shafts ,,, The angle between both the bevel gears is fiat with 90 degrees. After all the arrangements the wooden wheel which is used for the pottery-making process is fixed by using fasteners. All the components are arranged according to the drawings in Figures 1 and 2.

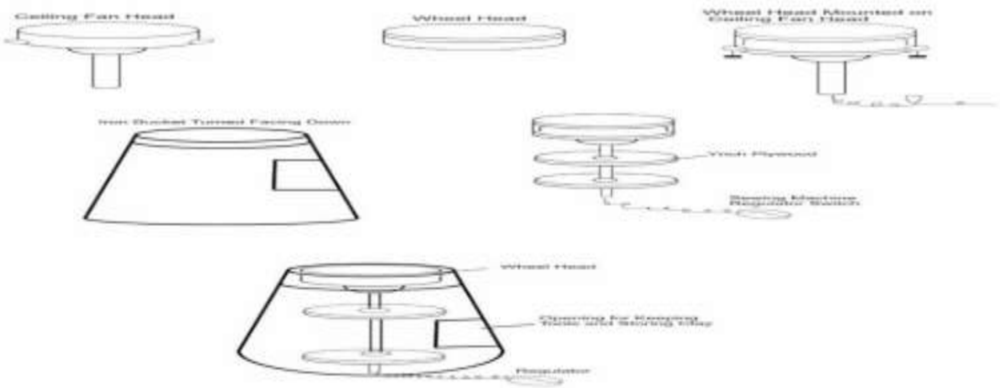

Figure 2a-f: Computer-Aided drawing of parts

Fourth Step: Testing – The prototype electric potter's wheel was tested after it is been assembled in accordance to the design procedures. The testing involved the use of 2kg mass of leather-hard clay to throw cylinder and bowls.

Plate 1: Ceiling Fan Motor

Plate 2: Metal basin fixed on a metal bucket

Plate 3: Wheel head

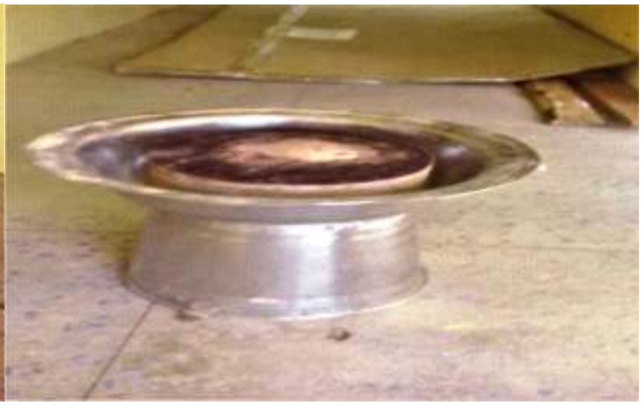

Plate 4: Complete Electric Potter's Wheel

RESULTS AND DISCUSSIONS

The results obtained from the concept of improvisation of an electric throwing wheel from the repurposed bucket, ceiling fan motor, and sewing machine regulator (pedal) for pottery demonstration is very satisfactory for the people who never had a hands-on experience of an electric wheel for the pottery making process revealed, thus:

The concept of improvisation showed it could remove abstraction(s) in learning theories as it is tangible, handy, and concrete as it clears the issue of unavailability of the materials in the school system; teachers and learners get a better understanding of the concept being taught; involving critical thinking, creativity; encourages teamwork, provide teaching materials from immediate locality when in shortage or lack of the standard ones (Babatunde and Aguemeka, 2020 and Spontaneous Education LLC (Sponted.com) (2015). This is revealed in the study of Eweka and Okwuba (2016) which suggests schools of arts and design exploit and explore the foregoing concept - who fabricated throwing wheel heads from the discarded can (containers). This is in line with Simbelis, Ferreira, Vaara & Laaksolahti (2016) who see the reusing of materials as a strategy to deal with the mass consumption of goods and the elimination of waste besides recycling; and the repurposing or upcycling of different artifacts. The yielded results also confirmed to the efficacy of the principle of cost-benefit by Lidwell, Holden, and Butler, (2015), which states that the value of a thing is a function of its cost of acquisition and use versus the benefits it.

The results from the developed concept by freehand drawings (see Figure I) as a requirement which is a specification the developers used to create (Iaksch, Borsato, Schmidt & Vaine, 2019 and Morar & Kemper, 2016), which is based on facts collection via market research, customer feedback, focus groups, and usability testing (Lidwell, Holden and Butler, 2015) was successfully done. However, the design requirement selected for this study was derived from direct knowledge or experience encountered by researchers (Daniel, Ochai, Abubakarr and Ibrahim); the conversion of the process to the design specification used by Wei, Liu, Lu and Wuest (2015) idea of the electric device, which conforms to standards with CAD (Velling, 2020 and Lopol.org., 2020) as seen in Fig 2.

Likewise, results from using the sewing machine accelerator provided the needed acceleration, the ceiling fan motor turned in accordance to the envisaged speed. The splashing while throwing was minimized with aid of the metal bucket. The wheel head fitted well on the ceiling fan motor metal with the aid of the bolts and nuts, and the rod that runs through that connects the components at that center provided the centrifugal movement. The opening created as storage on the bucket though not compulsory, helps in space management and safety for tools. Therefore, the assemblage of the components was successful as the nuts-and-bolts principle was adopted.

Also, the results showed that the speed of 50 revolution per minute (rpm) for throwing cylinders and bowls of various heights and widths up to 6" (height) and 6" (width) can be thrown. The result of the electric wheel showed its capacity to speed 200 rpm. which is sufficient to center a-2kg of a well-prepared mass of leather hard clay. Though generally, the throwing of a single pot is nearly 15 to 20 minutes for 1 kilogram, by using this wheel, the time taken is reduced to 10 to 15 minutes, hence the rate of production is increased. Also, the manual work needed for pottery wheel rotation has been reduced by the motor. While the number of beakers produced is dependent on factors viz: potter’s or thrower’s dexterous skill and the workable consistency of the clay lump. However, with all things being equal, at least a beaker was produced in 4 - 5 minutes. Therefore, in comparing the results of the electric throwing wheel from the repurposed bucket, ceiling fan motor, and sewing machine regulator for pottery demonstration, with the existing kick-wheels, it is obvious that the wheel from the repurposed components has advantages viz: cheap and faster.

While the results gave a glimpse into the possibilities of alleviating the current situation of the scarcity of potter’s wheels (especially the electric types) for pottery demonstration in art and design schools/studios, it also revealed one of the ways of achieving it, thus repurposing of local contents. Similarly, the result showed the potential of reducing the reliance on importation. Also, the drawings could serve as templates should there be a need for mass production.

CONCLUSION AND RECOMMENDATIONS

The project was successful by providing a hands-on prototype electric potter’s wheel for those that knew them only theoretically, without a hands-on experience of it. Also, the study can serve as a reference for future works that are in line with the concept of improvisation. In addition, the experience of using the manual wheels and electric ones is good exposure for potters when needed. The cost-effectiveness of this repurposed compared to the imported ones is laudable. The eco-friendliness of the project is inspiring as some of the components are salvaged from some metal dumps, hence reducing the environmental pollution. Also, the production of pottery items with lesser time and manual effort is accorded with this type of wheel as using it is likely to increase the rate of pottery production besides demonstration purposes.

The recommendations of the study include the adoption of an improvisation concept for the construction of the wheels as an alternative to the costly imported ones. Also, given the human's continuous generation of wastes that need to be managed (Abubakar, Daniel and Bakare, 2013), repurposing wastes into product design (Aguirre, 2010) seeing the high cost of the industrially made electric wheels is advised. This agrees with the study of Eweka and Okwuba (2017) which advocates the use of wastes for functional equipment in ceramic studios. Likewise, furthering this research project is recommended as synergy between the students of industrial design and engineering for productive alliances.

Although the assembled electric wheel seems not better compared to the industrially manufactured ones, the aim to provide a demonstration one for those with only the theoretical knowledge of it with no hands-on experience was achieved.

The bigger motor could be used for higher capacity and the speed when throwing larger clay lump. Equally, the fact that the components are readily accessible at affordable cost is a benefit to reckon with given the performance assessment of the prototype electric wheel (PEW). Similarly, the design calculation as per the requirements should be included in the next attempt as this is just a concept of a prototype; to explore the possibility of improving the project for mass production.

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