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The Ada Beater: Improving the Quality of Handmade Paper in Ghana

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ABSTRACT
Handmade paper has been around for centuries. In Asia, Europe, and other parts of the world, the means of creating handmade paper depend largely on traditional equipment and other industrial machines. In Ghana, the means of creating handmade paper is through a tedious process of hand beating the bast fiber of the *Kyenkyen* tree. This resulted in the production of a proto-paper known as the bark cloth. This traditional method has almost become extinct with the influx of imported industrial papers. Therefore the purpose of this study was to seek a solution to this problem through the possible design and fabrication of a paper pulp-making machine daubed the Ada Beater. Thus getting vital tools for making art, print, and papermaking. The paper explored practice-based research methodology to fabricate a papermaking machine known as the Ada Beater. The results showed that the machine can be fabricated and made to produce improved papers of archival quality derived from various plant sources in Ghana. It is recommended that this homegrown know-how should be made available to artists and art teachers for the teaching and use of handmade paper for artistic purposes.

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INTRODUCTION
The making of Handmade paper is an age-old craft. This process even though has grown to very sophisticated levels with respect to industrial machines in contemporary times artists are still exploring the traditional ancient art of handmade paper. In Asia, Europe, and other parts of the world, the means of creating handmade paper depend largely on traditional equipment and other industrial machines such as the Naginata beater and the Hollander beater. In Ghana, the means of creating handmade paper is mainly done by the tedious process of hand beating of fiber using tools such as a mallet, pestle, and mortar. In view of the above, this study explores the design and fabrication of a beater for handmade paper. The aim of this article is to explore the possibility of building a beater with parts sourced locally to improve the making of handmade paper. The objective of the research is to fabricate the Ada Beating machine using primarily locally sourced materials. The second objective is to be able to make improved handmade papers and also lessen the time of production that results from using traditional tools such as the pestle and mortar for beating cooked fiber. To achieve the purpose of the project study, the study sought to answer the following research questions: How can a localized machine be built to perform the same function as those built abroad? Secondly, how can the expensive equipment cost of importation be avoided? Third, how can high-quality archival papers be produced for artistic purposes using local plant sources?

LITERATURE REVIEW
The Journey to Acquiring a Beater to Manufacture Handmade Paper in Ghana
Contemporary artists are still using the traditional types of equipment designed and crafted by the paper makers themselves for their industry. In the Orients, such old paper-making guilds still exist. Specifically in China and

Japan, the very process of making handmade paper is considered an art form that requires much practice and experience. One vital piece of equipment used for handmade paper in the Orient is the Naginata beater and in Europe, it is the Hollander Beater.[1] This machine is very important to the processing of fiber used in paper making. In the West, the Hollander beater is named after its country of origin, and in the East, the Naginata beater specifically originates from Japan.[2] The closest tradition in Ghana is the bark cloth which can be described as a proto paper since the process of obtaining the end product differs. In Ghana, the handmade paper tradition is a fairly new culture, unlike centuries-old tradition that has existed in Asia and Europe. The country abounds in botanicals that have only recently been explored for handmade paper at the Painting Department.

Ghana's first President Dr. Kwame Nkrumah as part of his goal of building a country that is self-sufficient set up various industries. To keep these industries running, he envisioned an educative system that would help achieve these goals. One of the reasons for setting up the then Kumasi Technical College which became the Kwame Nkrumah University of Science and Technology (KNUST).[3] It was to encourage homegrown ideas, as well as environmentally sustainable critical and creative ideas that will set the country on the path of greatness from the grassroots. So one can confidently say the now touted United Nations SDG was long envisioned and initiated by Ghana's first president in this country.

The College of Art, KNUST in the spirit of this goal specifically the Department of Painting and Sculpture set up an agenda that can be described as a gorilla-like tactic to usurp the colonial approach to teaching art by introducing a paradigm shift in the methods and processes involved in teaching and making art. The new and current pedagogy was created to teach art students to be experimental in their approach to making art. "Go to town", became the catchword, for students becoming sensitive to their immediate environment. The idea behind this quest was to break the cycle of romanticizing and fetishizing figures, still life drawings and painting with pigeonholed European industrial formats which over the years have been assumed to be the only way of doing and practicing art.[4] The challenge is to use new tools and materials as well as collaborate with other departments in the sciences in the making of art. This fresh approach to teaching also meant being creative in approach to helping students become practicing artists. In the area of teaching Printmaking and the art of handmade paper, providing requisite equipment to work will then take on an important role. Teaching students to learn this art would then require the provision of tools and materials to facilitate their work and be more creative.

Contemporary artists have continued to explore the process of making handmade paper. This is because of the flexibility it affords to the creative process and the versatility and malleability the material lends itself to when working with it. The making of handmade paper in Europe and the Orient has developed differing processes largely due to the materials or plant sources used in these regions. The Hollander beater was designed for pulping mainly cotton linters and rags which was the main material in making paper in Europe. In Asia, plant sources were mainly used even though cotton rag was used also. Over time though there have been adaptations and appropriations of techniques from each other which is of interest to the artist. These techniques themselves lend themselves to new exploratory ideas for experimentation in the Art of teaching handmade paper. Documented history shows that the knowledge of making handmade paper originated from Asia specifically China.[5] This know-how gradually spread from the East to the West and South. The art of papermaking has its own history in Ghana specifically in the Department of Painting and Sculpture Department. In Ghana, the art of handmade paper may be faintly related to the art of traditional bark cloth making culled from the tree called *Kyenkyen* (Antiaris toxicaria). This is faintly so, because of the similarities that exist in the process of beating the *Kyenkyen* fiber to make the bark cloth with a mallet *like Kozo*. However, unlike Paper Mulberry (*Kozo*) which may be cooked with alkaline and further beaten in the Naginata which is the fibrillation of its fibers, the *Kyenkyen* which can be described as proto paper stops short of that process. The *Kyenkyen* like the Paper Mulberry (*Kozo*) locally called *York* in Ghana is interestingly from the same family of plant species.

Kyenkyen can be found in the forest belt of Ghana. Due to urbanization one has to go far to find them. *Kyenkyen* thrives in the Ashanti, Bono, and Ahafo, Western and Eastern regions which are also cocoa grown areas of Ghana. The Paper Mulberry (*Kozo*) which going forward is referred to as *York* in this paper is an invasive plant that was brought into the country because the then Head of State General Kutu Acheampong in following Nkrumah's goal in setting up industries had in mind of setting up a Papermaking industry. However,

[1] D. Hunter, *Papermaking: The History and Technique of An Ancient Craft* (New York: Dover Publications, Inc, 1978), 341.
[2] T. Barret, *Japanese Papermaking: Traditions, Tools, Techniques*, 2006.
[3] Jerry Orhin Yorke et al., "An Overview of Kwame Nkrumah's Cultural Policies on Ghana's Visual Culture," *Res. J. Humanit. Cult. Stud* 3, no. 3 (2017): 12.
[4] Kari'kacha Seid'ou, "Gold Coast Hand and Eye Work: A Genealogical History," *Global Advanced Research Journal of History, Political Science and International Relations* 3, no. 1 (2014): 8–16.
[5] Hunter, *Papermaking: The History and Technique of An Ancient Craft*.

his plans were short-lived as he was forced to resign as the head of state and a new military junta took over the affairs of the country in the 1970s. The few York plants left on their own grew wild and spread wide causing challenges for the local farmers.

The field study revealed that there was a presence of *York* in the country through the information given by the forestry department in the Prah Anum headwaters reserve. It has the classification designated as an invasive plant due to its gregarious nature and rapid growth pattern.[6] *York Broussonetia papyrifera* has spread beyond its catchment areas in the dry semi-deciduous forest zone (latitude 7 º 0 N and 7 º 15 N. Longitudes 1º 46 and 1º 53 W) at Abofour in the Ofinso Forrest Ashanti Region, Ghana. (Figure map1 and 2) Pockets of this plant can be found in and around the University campus. Up until that time of the research, there have been efforts to experiment on its viability as a nontraditional timber species to add value to its usage in the local timber industry. It is also being used as matting in checking erosion and reclamation of soil in some mining areas in Ghana.[7] The York will then find additional value in using its bast fiber for the making of handmade paper in artmaking together with other botanicals being taught and are currently used by students for their art practice.

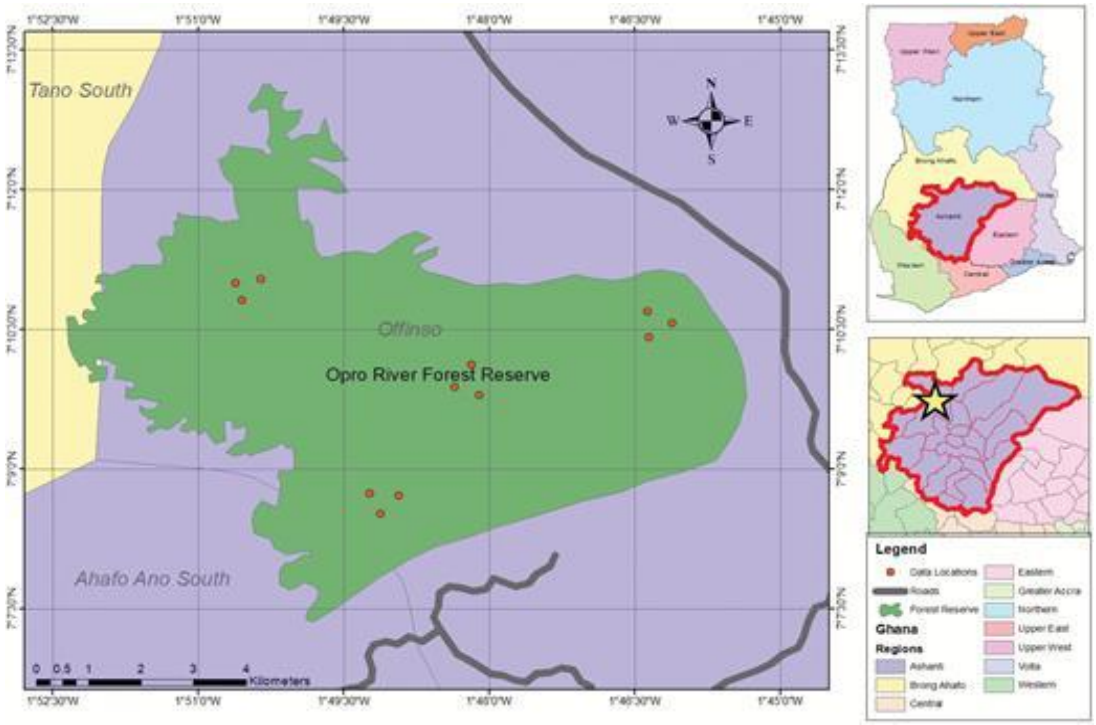

Fig. 1 - MAP 1 Pra – Anum catchment area Oporo River Forest Reserve Ashanti Region Where York Plantation is Picture credit: Anning, A. K et al.[8] retrieved Aug 19, 2023

[6] Alexander Kofi Anning, Bridget Gyamfi, and Angelina Tima Effah, "Broussonetia Papyrifera Controls Nutrient Return to the Soil to Facilitate Its Invasion in a Tropical Forest of Ghana," *Journal of Plant Ecology* 11, no. 6 (December 22, 2018): 909–18, https://doi.org/10.1093/jpe/rtx058.

[7] Paul Kofi Nsiah and Wolfgang Schaaf, "The Potentials of Biological Geotextiles in Erosion and Sediment Control during Gold Mine Reclamation in Ghana," *Journal of Soils and Sediments* 19, no. 4 (April 19, 2019): 1995–2006, https://doi.org/10.1007/s11368-018-2217-7.

[8] Anning, Gyamfi, and Effah, "Broussonetia Papyrifera Controls Nutrient Return to the Soil to Facilitate Its Invasion in a Tropical Forest of Ghana."

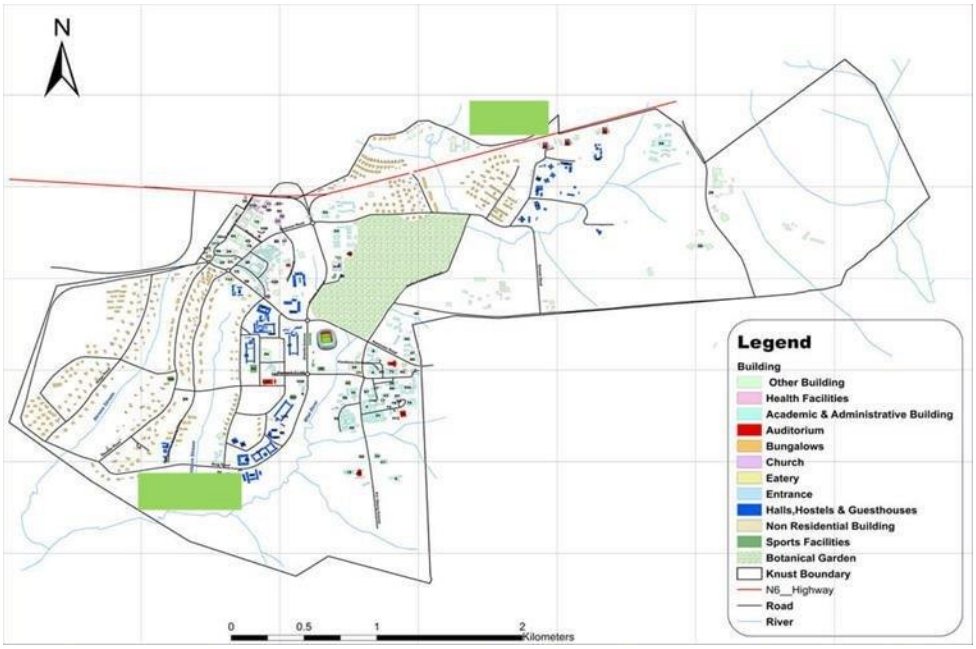

Fig. 2 - MAP 2 Kwame Nkrumah University of Science and Technology green areas showing where York (Broussonetia Papyrifera) can be found growing. Picture credit: Kwadwo Amoako,[9] retrieved March 4th, 2022 (with additions by author).

As part of its printmaking course at the then College of Art - KNUST, handmade papermaking was introduced in the 1980s through to 1999. During this time students were mainly working with recycled paper and cotton rags. The primary technique was through the process of retting the rags and beating them in a traditional mortar using a pestle. In 2006 students were introduced to exploring local plant fiber sources for paper making This has been done to some limited degree as student thesis research shows. In the history of paper making in the Painting section of the Department, it could be said that handmade paper saw a rebound when in collaboration with the Wisconsin University as part of a Fulbright scholarship the researchers worked with the infusion through a grant, bringing in equipment for the making of handmade paper. One such machine that was first introduced and used was the 'Little Critter' by Mark Lander from New Zealand and subsequently the Valley laboratory pulp beater. This essential equipment was unfortunately taken away unceremoniously.

Since then, the research into building this equipment so that the department will become self-sufficient has shown there are other well-known beaters such as the Oracle beater, Reiner Beater, and the *Naginata* Beater to mention a few. All these existing beaters are built and fabricated outside the country, there is no existing engineering center in Ghana doing this. This may perhaps be attributed to the nonexistence of a well-established papermaking industry in the country compared to other countries in Europe and Asia. The Hollander beater was originally developed by the Dutch in 1680 and it was called to replace the water mills of Europe.[10] Since they are built to last they are not machines that are readily available on the market. They are often made on order and quite expensive add shipping cost and it is a whooping sum.

However, the machine is not available in Ghana since handmade paper is not a widespread tradition or culture. Even so, the enthusiasm stirred amongst the students for making handmade paper was and is still very high and palpable due to the possibilities of producing archival-quality sheets for book art, use for textiles, packaging design, and making art with the paper itself. For the most part of this process, students have been using the traditional tools of mortar and pestle and also resorting to the use of kitchen blenders (**Plate 1**). This requires a lot of manpower and makes the process tedious since it involves extracting some very tough fibers. Important equipment such as the mechanical beater is missing. Further, although the Department built a small hand wooden press and has been using a book press, these have been mainly inadequate also due to the large number of students and their enthusiasm for the course. The beater is needed to process large amounts of fiber into pulp to form sheets which are then packed in posts for pressing.

[9] James Kwaku Awelia et al., "The Use of Seismic Refraction Technique for Geotechnical Investigation: A Case Study of KNUST Campus, Kumasi, Ghana," n.d.

[10] Prerna Jain and Charu Gupta, "A Sustainable Journey of Handmade Paper from Past to Present: A Review," *Problemy Ekorozwoju* 16, no. 2 (July 1, 2021): 233–44, https://doi.org/10.35784/pe.2021.2.25.

Fig 3 - Plate 1 and 2 Students seen here using the traditional equipment of pestle and mortar in beating fibers for papermaking in the open-air studio space

Fig 4 - Plate 3 Close view of Kyenkyen after beating using a round-headed mallet in the studio at Old Tech. Sec. May 2022. Image Courtesy: student Irene Piloya.

Pulping

Pulp is the material produced when processing fibers into sheets of paper. It is a semi–liquid mixture where one or more plant fibers and other materials with its solvent in this case water. Various mechanical or chemical treatments are given to the raw materials to make clear pulp suitable for handmade paper. The process of beating and shearing by mechanical means helps in removing the lignin and parting the fibers from each other. Other processes can also be used to do this such as retting, fermentation and cooking, and delamination in the case of cotton by shearing. The use of manpower is the most ancient technique used. This was done using differing

approaches by using wooden battens with the hand which made it very laborious, less forceful, and tiring, lifting and dropping heavy rods, repeatedly on the fibers. Wooden Stampers were also used in beating powered by water.[11] The Hollander beater was invented in 1660-1667 and used wind power and a metal drum with blades rotating repeatedly breaking the fibers to the required consistency to pulp. This innovation led to the making of finer paper products such as bond and tissue papers that require different beating times. In Japan, the Naginata beater used fibers such as Kozo, Gampi, and Mitsumata to make different washi with different qualities, mostly used for calligraphic writing, architecture, fashion spinning them into yarns, etc. Beating fibers mechanically makes much stronger paper. Long fibers interlock and absorb water which creates more chemical bonds between the fibers

From the above-stated factors, it is clear the important role of having a Beater is to improve the quality of handmade paper being taught. This existing problem necessitated the designing, fabricating, and local manufacturing of the *Ada* beater. This attempt is a novelty for the Department and the University as a whole due to the fact that gaining the know-how allows for the transfer of appropriate technology locally that will support future individuals or groups who would want to set up their own handmade paper houses for the book arts and printmaking. Secondly, in many places, the beater and press are pieces of very expensive equipment to acquire even for some studios not to mention the amount in cost that is being saved due to manufacturing this equipment. The beater has been built in collaboration with the Engineering Department workshop - KNUST. The use of the kitchen blender over the period did not satisfy the operation of making good archival papers since it cuts the fibers leaving most often only a small amount of pulp to work with. On the other hand, the beater macerates, cuts, and fibrillates the fiber making it more flexible with increased density as the fiber is flattened during the beating process. The pulp is forced through and between the roller blades and bed plate depending on the timing for beating the fiber. If the timing is too short it would cause the fiber to flocculate with knots thus producing weak sheets. Many times these blenders break down in the process.

Basic Components of a Beater

- Drum – This consists of a cylinder with blades horizontally attached to its surface. It can be either fixed or movable.
- Bed plate – This is a set of blades on a block that is set counter to or at an angle to the drum. This is set beneath the drum and can be either fixed or movable.
- Backfall – This is the curved dam that water and pulp flow over that sustains the circulation when beating is ongoing.
- Cover – This is a curved structure that covers the operating parts of the beater keeping the pulp in the tub and also protecting the user when the beater is turned on.
- Tub – The trough that holds the water and other components of the machine.

METHODOLOGY

The study employed a practice-based research methodology experimenting with the design and fabrication of the Ada Beater machine. Adopting the studio-based research experiment, the study engaged students, investigated sites for materials, explored the potential of fiber for handmade paper, and used the resultant material in art production.

RESULTS

Designing the Ada Beater

In designing and making the beater the researchers looked at the objectives being

1. How this machine be built and fabricated since they are specialized machines that are not readily available on the market unless ordered?
2. How can the expensive equipment cost of importation be avoided?
3. How can high-quality archival papers be produced for artistic purposes using local plant sources?

The study resorted to the internet and fellow researchers. They were able to work out a particular design which they have named the "*Ada* beater". **(Plate 8)** The materials for making a beater are vast and varied. Sealed

[11] Hunter, *Papermaking: The History and Technique of An Ancient Craft*; Barret, *Japanese Papermaking: Traditions, Tools, Techniques*.

wood, cement, stainless steel, iron, bronze, aluminum, and fiberglass can all be used in the making of the beater. In the design, a combination of stainless steel and iron was used for the making of the beater. All these materials were and can be locally sourced as well as other components that are needed for the manufacture of the beater. By doing this the researchers achieved the first two objectives they set for themselves. Other parts were also locally sourced from the used second-hand mechanical parts dealer market and the garages at Suame Kumasi.

These parts comprised of the motor a three-phase electric motor, 3.7 kilo-watt 1440 rpm, steel plates, angle bars, pipes, springs, and bearings. The critical component of the beater is the tub that holds the water and fiber needed to make the pulp. Then there is the mid feather that divides the space within the tub into the pulping area and the flow area (Figure 4) showing the dimensions. At the pulping area or section is the dam which has a Backfall. In this same area is another critical component the roller and the bed plate. It is between these two that the fiber is macerated (Figure 5). In most beaters, the roller is fixed and the bedplate is adjustable by a counterweight that pushes the bedplate up thus reducing the space between it and the roller. This pressure causes the maceration of the fiber into pulp as shown in Figure 6. The design of the Ada Beater has a fixed bedplate or base plate and an adjustable roller this has an added advantage when it comes to cleaning the beater after use. **Plate 4&5** shows the construction of the beater roller and the setting of the blades on the roller.

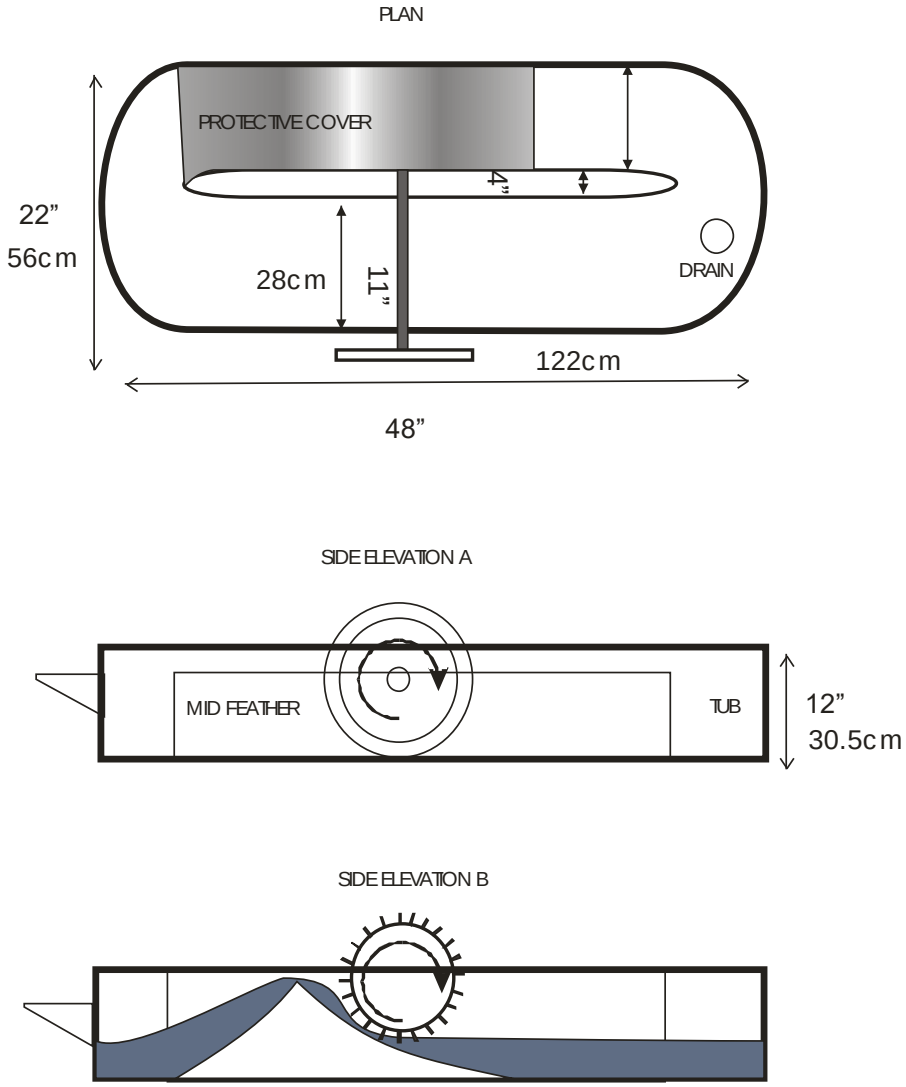

Fig 4 – Design Drawings of the Ada Beater

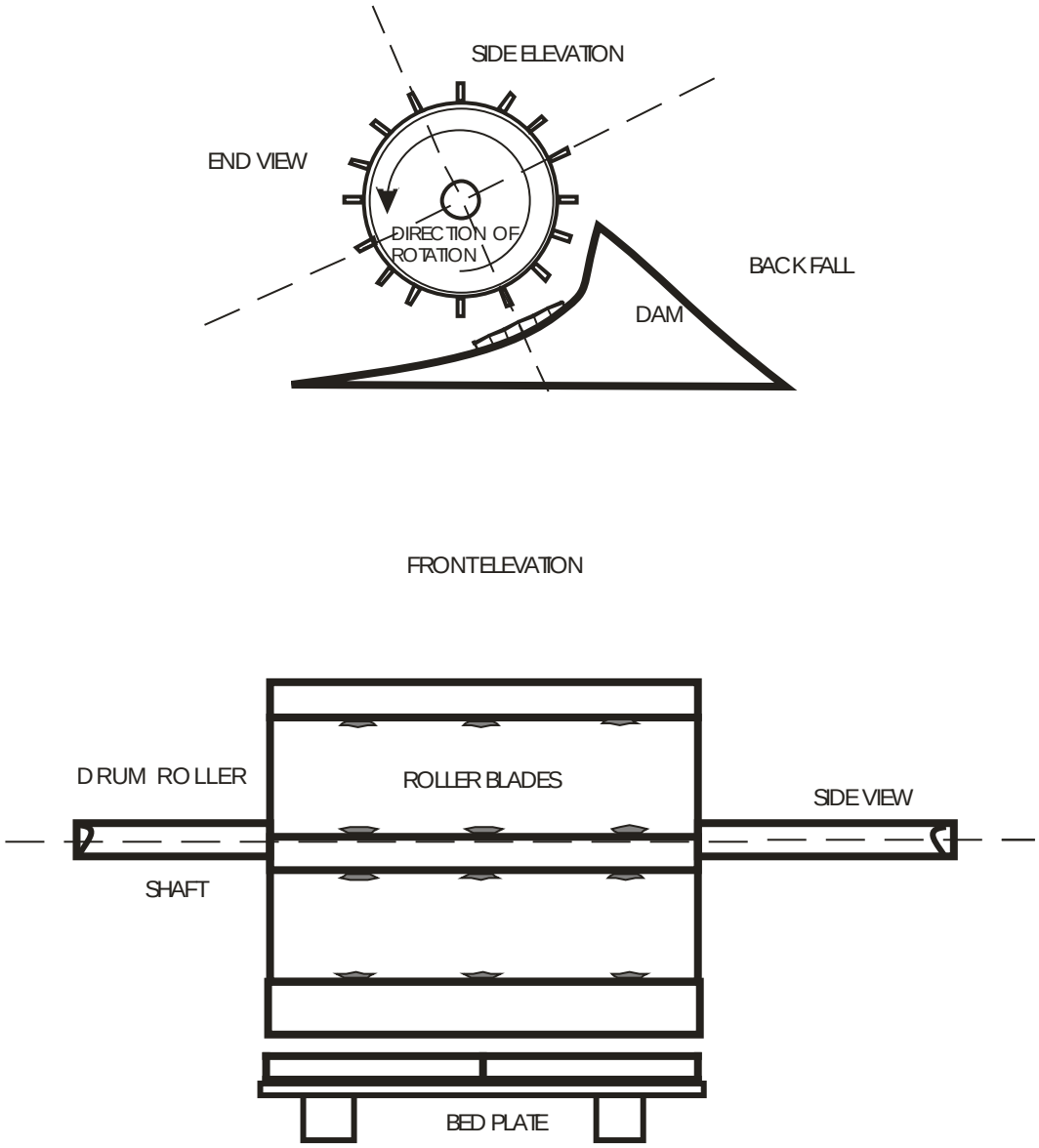

Fig 5 - Diagram of Ada Beater showing a fixed bedplate design component and a movable Drum roller

Fig 6 - Plate 4& 5 showing the fabrication of the tub for the Ada beater at the Mechanical Engineering Department workshop K.N.U.S.T.

Fig 7 - Plate 6 Showing the almost completed beater (notice the detail showing the roller)

Fig 8 - Plate 7 Ada Beater showing the hood over the roller Plate 8 Testing the modified Ada Beater at the engineering workshop with York fiber

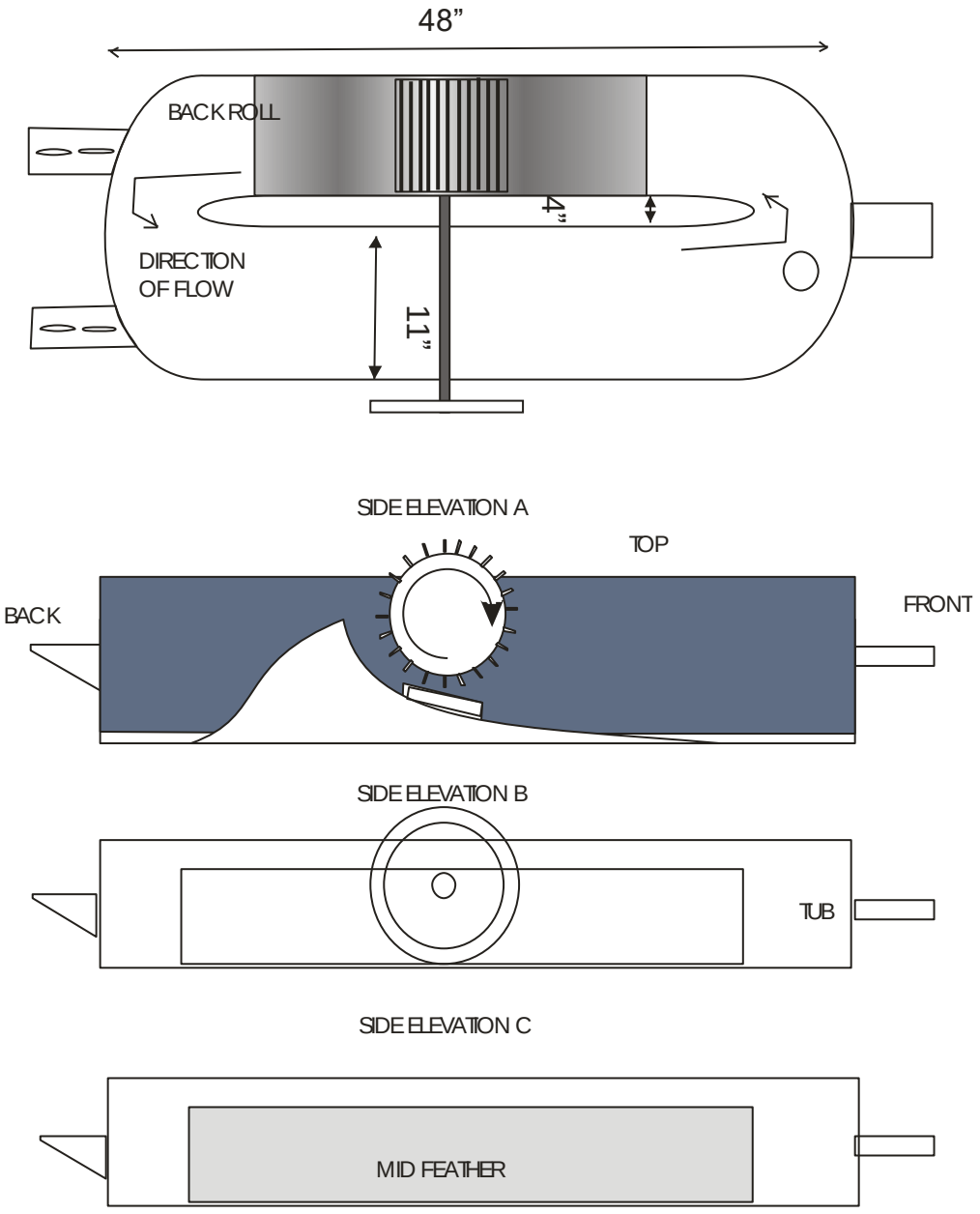

Fig 9 – Plan Drawings of the Ada Beater

Fabrication Process

Collaboration with the engineering department workshop led to the successful building and fabrication of the Ada Beater. The department made available its technicians who the researchers brainstormed with. Using the design of the Ada Beater that was submitted to them, the researchers went about locally finding and purchasing the materials needed to build the critical components. Some of these components have to be fabricated such as the roller drum and blades, the bed plate, and the dam, These cannot be bought ready-made it has to be built from scratch. Some modifications were made to the original design they started working on. After building the machine it was tested and run to make sure it was working as it should the results of these tests were

1. Check for leaks as the machine runs largely on water to turn the fibers into pulp.
2. Check the raising and lowering of the drum that regulates the finesse of the pulp.

With some adjustments and plugging, the leakages on the machine to correct the effectiveness of the tub, these all worked as they should have successfully. The researchers concluded that with some creativity and tenacity, it is possible not always to be dependent on foreign importation. The successful fabrication of the Ada Beater has resulted in a good acquisition of home-grown knowledge that can be the bedrock of the start of a new small-scale industry to encourage the growth and culture of handmade paper in the community and the country as a whole.

Finishing

The Ada beater was successfully fabricated and built. The machine was tested at the engineering workshop for water run and leakages and then with fiber. Both tests passed successfully as a modification was made to the first design as can be seen in the images. Note in **plate 7** the motor was placed on top of the tub with a seat attached to a bar that allows the drum to be lifted. However, as shown in the modified design the motor was shifted below the table with the pulley and belt attached from the mid-feather section of the tub. The modification also involved the bedplate which was properly lathed as the first bedplate was not thus producing poor beating results in the first test. The Ada Beater has been a successful project. In that the third objective was also achieved that of making quality archival papers that can be used for artistic purposes. It is working beautifully. It will go a long way in reducing the laborious time spent beating the fibers by hand. It will further open the way for the students to do more ambitious creative artwork using handmade paper. (**Plates 10 – 12**)

Fig 10 - Plate 9 Students operate the Ada Beater at the papermaking Studio for their projects

Fig 11- Plate 10 and 11 Beating York (Broussonetia Papyrifera) with the Ada Beater drying big sheets by Students

Fig 12 - Plate 12 Artworks(a), a print piece by Students on Kyenkyen paper, and (b) an installation of an art piece using Broussonetia papyrifera beaten with the Ada Beater. Photo credit (a)courtesy Irene Piloya (b) author

CONCLUSION

The building of the Ada Beater has worked to create a model "cottage-industry" paper mill within the Department of Painting and Sculpture. This project intends to support the Forest Research Institute of Ghana's (FORIG) efforts to control the invasive York plant and to produce high-quality handmade paper for local artists and other interested parties. The department intends to invite local farmers to train them as papermakers and to teach them how to harvest and process the York for the local and international markets. They can make use of the free abundant botanical materials to create papers for sale. Slowly, each year the Department has built its inventory of tools and adapted and refined its technique with the view to making it more appropriate to the climate and fit for the economy of Kumasi. The availability of this bast fiber which is imported by most countries that manufacture paper is a boon to building a vibrant industry here in Ghana.[12]

[12] Josep Asunción, *The Complete Book of Papermaking* (Lark Books, 2003).

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