SEED

ISSUE No. 1 SCIENCE ENGINEERING ENTREPRENEURSHIP DESIGN

MULTI-SOURCE TRANSFER LEARNING AND WEB SCRAPING

p. 8

REDESIGNED WOODEN STOOL

p. 18

MAKER SESSIONS

p. 34

BIOFUEL THAT RUNS ON SWEAT

p. 17

COTTON UNPICKED

p. 30

CONTENTS

SEED™ JOURNAL

Editorial

EDITOR'S NOTE

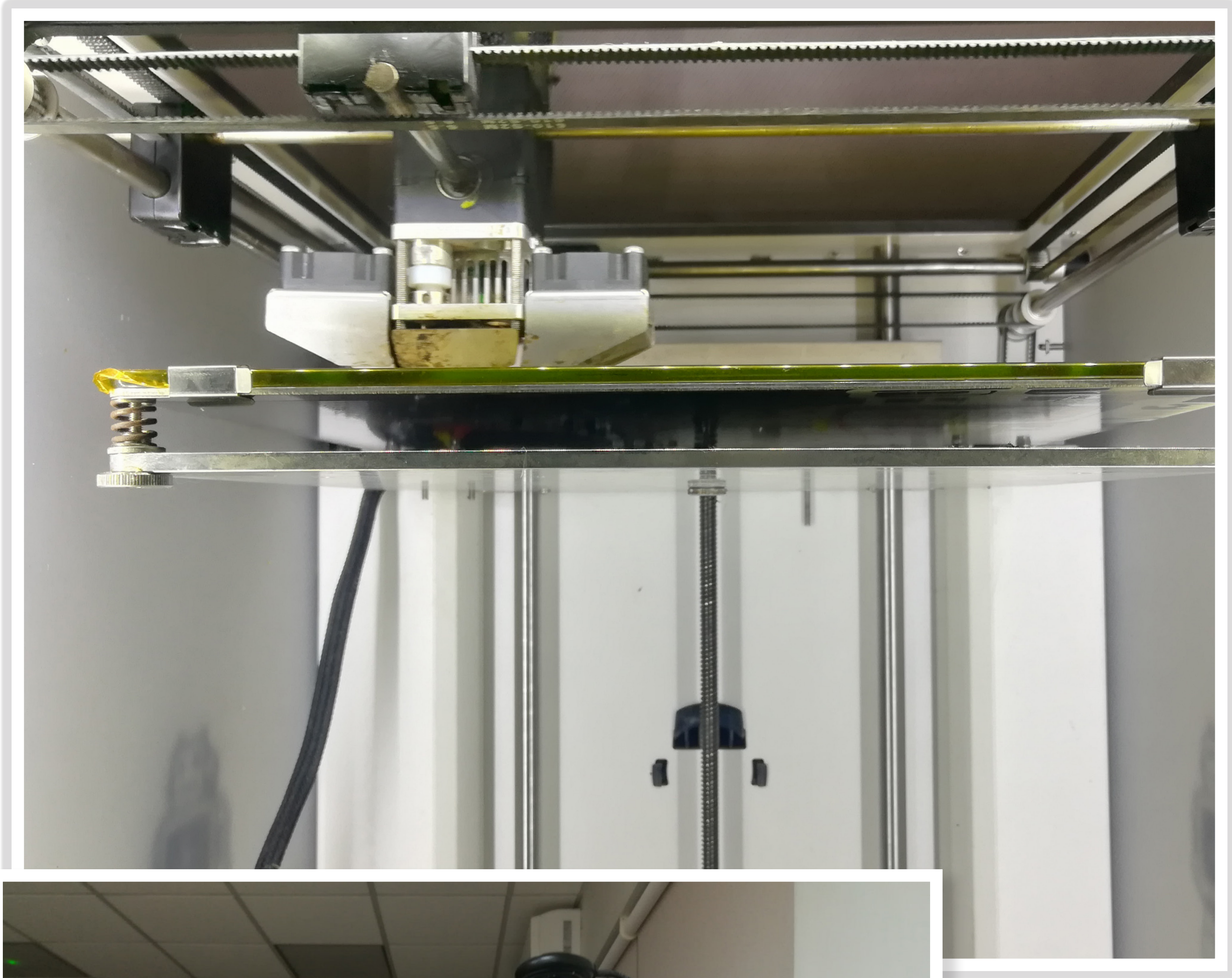
> A little rain each day will fill the rivers to overflowing.
>
> ~African Proverb from Madagascar

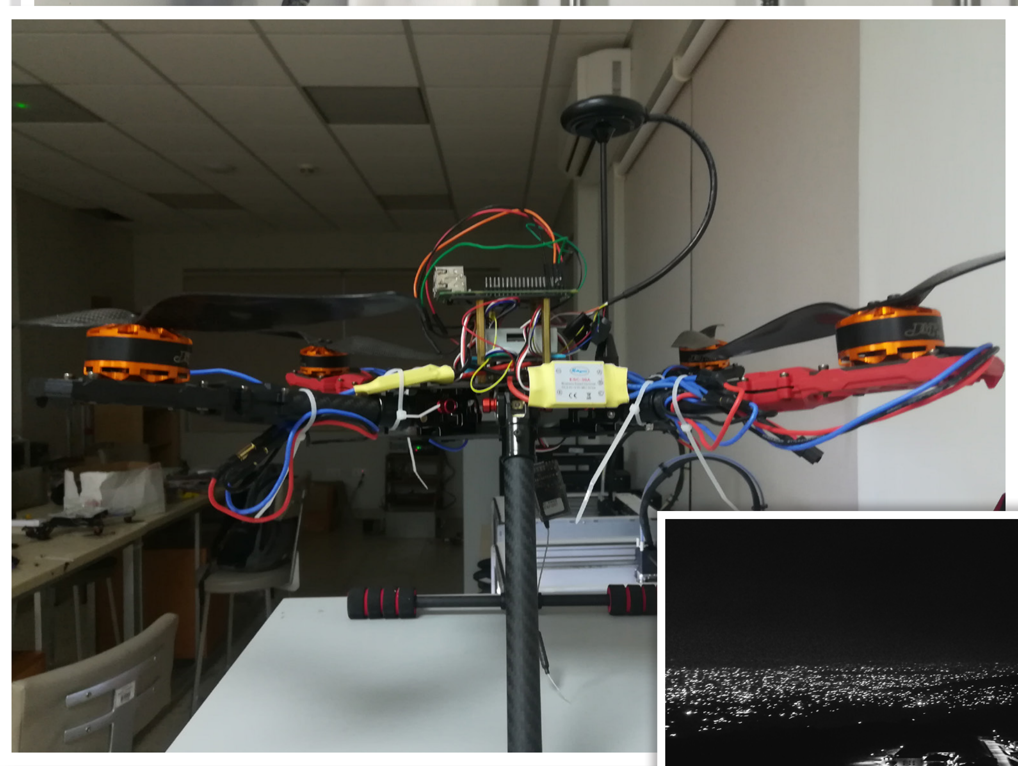
It is with pleasure that I present to you the first issue of SEED journal volume 1; seeing that it has transitioned from being an idea to reality. A report from Elsevier in 2018 showed that Africa generates less than 1% of the world's research. The African research potential is almost lost in the world's pool of knowledge due to the absence of information analytics and storage tools for personal and public usage. We believe Ashesi University can maximize thrilling research potential through the recognition for research outputs from class projects, individual projects and competitions.

The Ashesi SEED Journal was set up to serve as a repository for insightful information on Science, Engineering, Entrepreneurship and Design for the Ashesi community and the world.

We believe our inaugural issue is the best way to begin the year by engaging in something new – as small as a SEED. We present to you a foretaste of mind-blowing research, editorial pieces and news from pioneering contributors of the student populace. I hope you will be informed by these and inspired to contribute your quota in getting the world educated as well. Just like the opening proverb, a little publication of research work in the SEED each time, will fill the sacs of innovation and development in Africa, to overflowing.

Miquilina S. Anagbah





The Amazing Materials Technology of the Skateboard Deck

By: Nadine Iradukunda, Jean Roberts

Image from unsplash.com by Niket Nigde

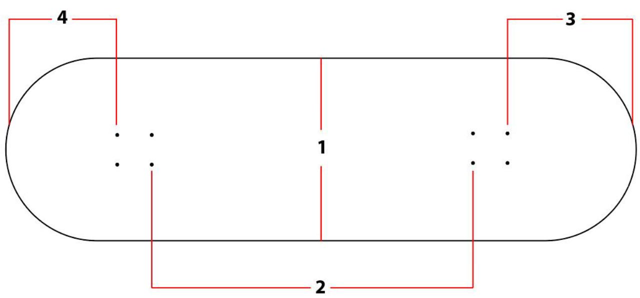
Cambridge dictionary defines a skateboard as "a flat, narrow board with two small wheels under each end, which a person stands on and moves forward by pushing one foot on the ground" (Cambridge dictionary, n.d). It is described as a surfboard with four wheels attached to it. The skateboard has three main parts such as the deck which is the essential and major part of the skateboard, the truck which is mostly made from metals, and whose role is to hold the wheel to the deck, and lastly the wheels made of polyurethane; they act as the legs or movement performers of a skateboard. The deck is considered as the part with a bigger dimension of about 32 in length while the wheels have the smallest dimensions range between 1.3-1.5 in (Petruso, 2019).

Skateboards are made from 7 layers of sugar maple veneers. These veneers are stored in a climate-controlled environment to optimize the moisture content of the wood. The veneer is then coated with a water-based glue for wood. Seven layers of veneer are used to make the skateboard. The first, second, fourth, second and seventh layer have the grain running from side to side. These stacks are put into a two-part mould inside a hydraulic press. The mould is used to make the nose, concave and tail of each skateboard. The laminate (resulting product) is left in the press for a long time to allow the wood and glue to set naturally. The skateboard deck is now ready. It takes about 300 psi to make about 3- 5 skateboards in a press. CCN routers or hand routers cut the final shape, trim the edge and paint the skateboard. Wood is the preferred choice for a skateboard because of its good toughness and elasticity in comparison to the epoxy, fiberglass and carbon loaded thermoplastic nylon. Maple wood, in specific, is used because it is durable and stable due to its slow growth process (Wanner, n.d).

Maple Wood is strong, does not split easily, and it is durable. It has high toughness, and it can be bent back and forth without breaking apart. It is not brittle; hence it provides a warning before fracturing in comparison to brittle glasses. Also, wood with higher stiffness and the absence of grains are easy to split. Therefore, maple wood is used since it has a higher resistance to splitting with low cleavability even though they hold screws on the deck to the wheels (Samuel, 2004). A skateboard deck needs to be rigid; it also needs to be flexible to be able to perform some tricks and manoeuvres. Also, materials that make decks rigid make them too heavy. Hence, a material is desired that will make the board rigid, flexible as well as light. This is why maple wood is used.

The skateboard is used by only one single person at a time who act as the driver or the controller of the movement of the skateboard using his feet. This object is used for street riding it can be used as a transportation means over short distances where students can ride them on campus or schoolyard, for instance, moving from one hostel to the other, or from one class to the other after class period, after school they can skateboard as a form of sport to reduce stress and fatigue, can be used at parking areas, market places, can be used during stunt competitions and used in the sport of skateboarding (Petruso, 2000).

Anything which involves movement encounters accidents and challenges. Although skateboarding has healthy, youth and economic benefits for any individual, it can cause various injuries. A study conducted showed that from 1995-1998 at the hospital which serves a population of 135,000, 139 people were injured during skateboarding. Some examples of these injuries include sprains, fractures, abrasions, contusions and lacerations. The injuries are usually caused by lack of balance, lack of control trying to perform different tricks of skateboarding which include jumping, getting your foot stuck between the skateboard and the riding surface, holding unto a moving car as a way of having a fun ride. Therefore, the police have set in place laws and regulations to prevent such injuries. These include as the establishment of skateboarding parks and laws to enforce the wearing of protective gear (Forsman % Eriksson, 2001).



1. Deck Width
2. Wheelbase
3. Nose
4. Tail

Overview of the deck

Through the years, many skateboard decks have been made with different materials. The maple wood skateboard deck has stayed. This is because of its durability and stability. The deck is the longest part of the skateboard; it ensures that the weight of the skateboard is balanced. It also helps to identify the direction that the skateboard is headed and provides a batter skateboard feel. (Skatedeluxe Blog, n.d)

A skateboard deck is 28 inches to 33 inches long. There are three parts of a skateboard deck, nose, wheelbase and the tail. The nose is slightly wider and steeper than the tail. The nose and the tail are rounded and are usually steeply curved upward. The steeper the nose or tail; the higher the pop. Pop is the effect of kicking the tail of the board against the ground in order to propel the board upwards and become airborne. (Skatedeluxe Blog, n.d). The wheelbase is 12” to 15” long and affects how the board handles. The stability of the skateboard increases with an increase in the skateboard deck width.

The concavity of a skateboard deck refers to the longitudinal curvature of the boars. A high concavity puts more pressure on the skateboard deck edges and improves steering and aids you to flip the board easier. Also, the stability of the skateboard ride increases with a decrease in the concavity of the skateboard deck.

Skateboards are used for different purposes such as street skating, bowl, vert, and cruising. These require a different shapes of the skateboard deck. For street skateboarding, a twin-tip skateboard is used. A twin-tip skateboard has both the nose and tail is the same shape. Skateboards for transition skating are wider with a width of 8.25 inches and higher. A shaped skateboarder deck has pronounced concaves. Hence, they are commonly used to perform tricks.

Through the research, we have realized that the skateboard deck is the essential part of the skateboard because of its amazing ability to carry different weights of individuals. Therefore, we are so excited to find how we can improve on the materials used to make a deck using the knowledge we gained from class. A material that will reduce the number of injuries encountered with the skateboard.

History of the Skateboard

The first skateboards were made with wooden boxes with wheels from roller skate shoes attached to the bottom. However, these skateboards had rigid axles which reduce the skateboard’s manoeuvrability. These skateboards were made of wood and were popular among surfers; who would use them to “sidewalk surf” when the tide was too high. The maker of the first skateboard is unknown. However, the first professional skateboard, the Makaha Phil Edwards model, was made in 1963 by Larry Stevenson. It was named after Phil Edwards, a prominent surfer. This skateboard featured a wooden deck shaped loosely like a miniature surfboard, Chicago trucks, and clay wheels. After the introduction of the first professional skateboard, many manufacturers searched for alternative materials for board construction.

An example of this is the Gordon and Smith “Fibreflex” skateboard produced for an initially short period and designed to flex using a fibreglass, epoxy, and a thin maple wood core. The skateboard was thin, light, extremely strong and lively with unbeatable torque, flex and snap. Another skateboard known as the kicktail was manufactured in 1969 by Larry Stevenson. In the 1970s, a skinny, flexible skateboard known as the banana board was manufactured. It was made of polypropylene with ribs on the underside for structural support. Also, in the 1970’s, some skateboards were made of fibreglass and aluminium, but the maple wood skateboard was still purchased more.

Currently, there are three main materials used to build a skateboard deck; Baltic Birch plywood, Canadian Maple Veneer and Bamboo. Solid wood for vertical laminated aluminium and foam filled carbon fiber composite boards can be used.

Density (lb/ft3)	Cell Size (inch)	Cell Configuration	Bare Compression Strength(psi)		Plate shear L Direction Strength(psi)		L Direction Modulus (ksi)	W Direction Strength (psi)		W Direction Modulus (ksi)
			Typ	Min	Typ	Min	Typ	Typ	Min	Typ
2	3/16	RH	120	88	90	68	4.3	50	38	2.4
2	3/16	OV	110	86	65	48	23.2	65	38	3.7
2.5	3/16	OV	190	162	90	59	2.7	95	55	5
3	1/8	RH	280	190	195	133	6.4	95	70	3.3
3	3/16	RH	290	190	175	133	5.8	105	64	3.9
3	1/4	RH	270	190	170	133	5.4	105	64	4.8
3	1/8	OV-20%	255	190	160	95	4.8	110	76	3.8
3	3/16	OV	270	238	110	71	3.2	130	71	6.3
4	1/8	RH	490	333	265	204	8.2	145	130	4.5
4	3/16	RH	490	333	220	204	7.8	160	106	5.2
4	1/4	RH	470	333	225	204	6.8	150	106	6.4
4	1/8	OV-20%	480	333	225	150	6.7	185	125	6.8
4	3/16	OV	470	333	150	95	3.9	185	114	8.9
5	1/8	RH	670	513	310	252	10.3	205	124	5.8
6	1/8	RH	880	665	340	304	12.3	235	143	7.1

Scientific Improvements to the Skateboard

Future skateboard decks may be made of a wooden exterior and an interior made of artificial materials. Nomex honeycomb can be used at its core, with Kevlar as one of the structural materivals and a maple wood exterior. This will reduce the lightness of the skateboard and improve it's characteristics. Kevar and Nomex belong to the same group of materials known as synthetic aromatic polyamide polymer.
Nomex honeycomb is also known as lightweight non-metallic composite honeycomb. It has a high strength to weight ratio, and it is formable (Core Composites, 2019).

From the table above, it is concluded that Nomex honeycomb as a moderate strength and can withstand a wide range of stresses being applied to it.
Kevlar is a tough and strong synthetic material. Its strength is due to the arrangement of its molecules in regular, parallel lines. Kevlar is also made into fibres knitted tightly together. Even though it is strong, it is relatively light. The specific tensile strength of Kevlar is eight times greater than that of steel wire. Kevlar should not be used on its own but in conjunction with Nomex since it has very poor compressive strength and will not be effective on its own.

Conclusion

A skateboard is used for sports activities, and this object has impacted the lives of different categories of people. There is room for improvement in the material for the interior of the skateboard deck; using Kevlar and Nomex Honeycomb, to enhance the functionality of this amazing sports equipment.

REFERENCES

1. Forsman, L., & Eriksson, A. (2001). Skateboarding injuries of today. British Journal of Sports Medicine,35(5), 325-328. Retrieved from https://bjsm.bmj.com/content/35/5/325
2. Core Composites. (2019). Lightweight non-metallic composite honeycomb. Retrieved fromhttps://www.corecomposites.com/products/honeycomb/nomex-honeycomb.html
3. Petruso, A. (2019). How skateboard is made-material, manufacture, making, history, used, parts, companents, dimesnsions, steps. Made How, 6. Retrieved from http://www.madehow.com/Volume-6/Skateboard.html
4. Record, J.S. (2004). The mechanical properties of wood including a discussion of the factors affecting the mechanical properties, and methods of timber testing. The project Gutenberg's The mechanical Properties of Wood. Retrieved from https://www.gutenberg.org/files/12299/12299-h/12299-h.htm#I_07
5. Rock West Composites. (2019). Kevlar/armid products. Retrieved from https://www.rockwestcomposites.com/materials-tools/fabrics-pre-pregs-tow/kevlar-aramid
6. Skateboard [Def. 1]. (n.d). In Cambridgedictionary.Retrieved April 4, 2019, fromhttps://dictionary.cambridge.org/dictionary/english/skateboard.
7. Skatedeluxe Blog. (n.d). Everything about skateboard decks- wiki. Retrieved from https://www.skatedeluxe.com/blog/en/wiki/skateboarding/skateboard-wiki/decks/#decks-general
8. Wanner, N.(n.d). The science and art fo skateboard design. Exploratorium Skateboard Science. Retrieved from http://www.exploratorium.edu/skateboarding/skatedesign.html
9. Woodford, C. (2018). Kevlar. EXPLAINTHATSTUFF!. Retrieved from https://www.explainthatstuff.com/kevlar.html

Employing Multi-Source Transfer Learning and Web Scraping to Enhance Model Accuracy Where Dataset is Limited

Mustapha Tidoo Yussif [1], Gbetondji Jean-Sebastien Dovonon [2] Samuel Atule [3]

Abstract

Machine learning and, more specifically, deep learning have recently driven many innovations. The availability of massive datasets and computation resources has made it possible to create deeper neural networks that are able to learn more meaningful representations of the data. Those new possibilities are not always accessible to the average African company trying to leverage on deep learning to increase profit. In that case, scarcity of data, especially, could be a limitation since neural networks are known to be data-hungry. When faced with the issue of unavailability of public data, a company can either increase the size of the dataset by collecting data themselves or increase the size and complexity of the model. The option studied here is to use web scraping to manage and clean a bigger dataset. In trying to increase the size and complexity of the model, to avoid overfitting, the transfer learning approach was used. This technique involves the transfer of weights from several datasets using model ensembling. All these methods were tested on a rice meal classification problem. The problem consists of classifying images of four rice-based dishes: jollof rice, fried rice, plain rice, and waakye. The dataset contains 60 trained images and 20 test images for each group making up a total of 240 training images and 80 testing images. The baseline of 75% was achieved using a dense net Convolutional Neural Network (CNN). The web scraping method used to increase the dataset size attained an accuracy of 87%. A multi-source transfer learning approach was also used where models were pre-trained on the Food-101 dataset and the Food-256 dataset. The multi-source transfer learning method achieved an accuracy of 90%. Using these two methods, we implement two ways to significantly increase the efficiency of a model when the original dataset is small.

1. INTRODUCTION

The size of training data plays a vital role in Machine Learning (ML), in learning useful representations that accurately predict the task at hand. Generally, it is common knowledge that a small dataset will result in a sparse approximation of the underlying regularity, resulting in a model with abysmal performance. Techniques have been proposed in ML literature to facilitate selecting the best model in the face of a small training dataset. Methods include employing a short model with fewer parameters, cross-validation [1], transfer learning [3], among others. However, too little data size does not often yield much improvement with these approaches. Very importantly, in the African context where data is often highly unstructured and available in minimal quantities, building models with high accuracy calls for a different approach.

This paper, demonstrates how to achieve models with high predictive accuracy, when faced with data that is highly unstructured or unavailable, using Multi-Source Transfer learning (Model Ensembling) or Web Scraping to assemble a structured dataset set for most ML tasks. Multi-Source Transfer is a common practice employed by participants in ML competitions to build winning models, while Web Scraping can be applied to create datasets in a context where no data infrastructure exists to facilitate dataset creation.

2. MATERIALS AND METHODS

2.1 Materials

The following are some of the technologies we used in the project.

PyTorch: Pytorch, is a deep learning package, which is known for its high-level tensor computations and building neural networks with less effort. Pytorch is Pythonic, and more importantly, highly optimized for computationally expensive operations, such as convolutional neural networks, recurrence neural networks, and complex tensor operations. Pytorch has many pre-trained models that enhance speedy model training with appreciable high accuracy. This package is still a young player compared to its competitors like TensorFlow. However, it gains momentum very fast due to its features above.

Floyd Hub: Training deep learning models is computationally expensive; it requires machines with high processing power. The cheapest way to train the models is to purchase cloud computing services if buying a GPU for your local device is expensive. Floydhub is a cloud computing option employed to train the model under study, because they already pre-installed TensorFlow, PyTorch, Keras, and many more dependencies. Quite apart from having an extensive collection of pre-installed dependencies, Floydhub is simple to use.

Google-images-download: This technology is a python package utility for conveniently scraping images from google. However, other powerful web scraping tools exist.

2.2 Multi-source Transfer Learning

Transfer learning consists of transferring knowledge from a more extensive database (source) to a smaller database (target) using weights learned from the bigger database as a starting point when training a model for the second database. The domain of the source and how closely it is related to the domain of the target is also relevant since it can increase the efficiency of the transfer. In this experiment, weights are transfered from several sources, which is known as multi-source transfer learning. One limitation of multi-source transfer learning is that multiple sets of weights cannot be used as a starting point. Hence the use of a model ensembling method to transfer knowledge from all the datasets [2].

Multi-Source Transfer or Model Ensembling consists of pooling together the predictions of a set of different models to produce better forecasts – where the final model is trained for each of the sources. To fuse the knowledge from these various models, we used an ensemble that concatenates features extracted using the models trained on the sources, and passed the concatenated features to a multilayer perceptron (MLP). The ensemble was then fine-tuned on the target. The models were pre-trained on four datasets: the original dataset, ImageNet, Food-101 [4], and Food-256 [5].

2.3 Web Scraping

Web Scraping or web data extraction is used for extracting human-readable data from websites. It is a handy technique used in scenarios where data for a specific ML task is complicated to come by. There are not a lot of data infrastructure that exists in most organizations in the African context. Furthermore, due to bureaucracy and the lack of trust of organizations exposing their data, this technique is powerful for collecting data for various ML tasks in the Africa context.

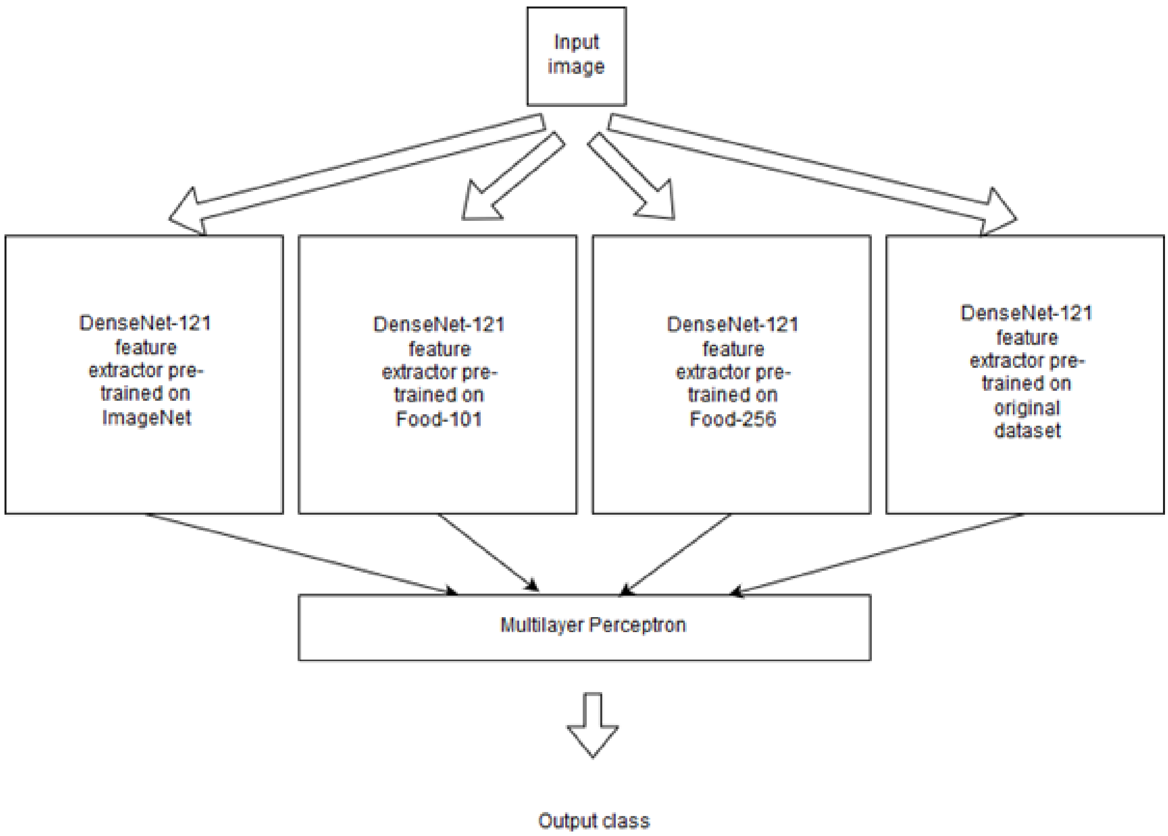


Figure 1: Diagram of the model ensemble used for multi-source transfer learning

Using this method, two thousand training images of local rice dishes were scrapped in less than thirty (30) minutes. Since a lot of junk images are often downloaded during web scraping, some manual work was done to remove unwanted files and clean up the data into a suitable format.

2.4 Implementation details

The methods tested were implemented using PyTorch and run on a virtual machine with a Tesla V100 GPU (16 GB ram) and 8 CPUs. All models were trained with a learning rate of 1e-3. The pre-trained models for Food-101 and Food-256 were trained for five epochs. The models (baselines and ensemble) were trained for 30 epochs.

3. RESULTS

As a baseline method, a randomly initialized densenet-121 model on the initial dataset was trained. Using this method, an accuracy of 87% was achieved. Table 1 provides a summary of the results obtained.

Method	Accuracy
Baseline (randomly initialized densenet-121)	75%
Increased dataset	87%
Multi-source Transfer Learning	90%

Table 1: Summary of results

The pre-trained ensemble model achieved the highest accuracy and had a consistently high accuracy across epochs.

N0	Pre-trained models ensemble
N1	Pre-trained on Food-101 only
N2	Pre-trained on Food-256 only
N3	Pre-trained on ImageNet only
N4	Baseline (no pre-training)

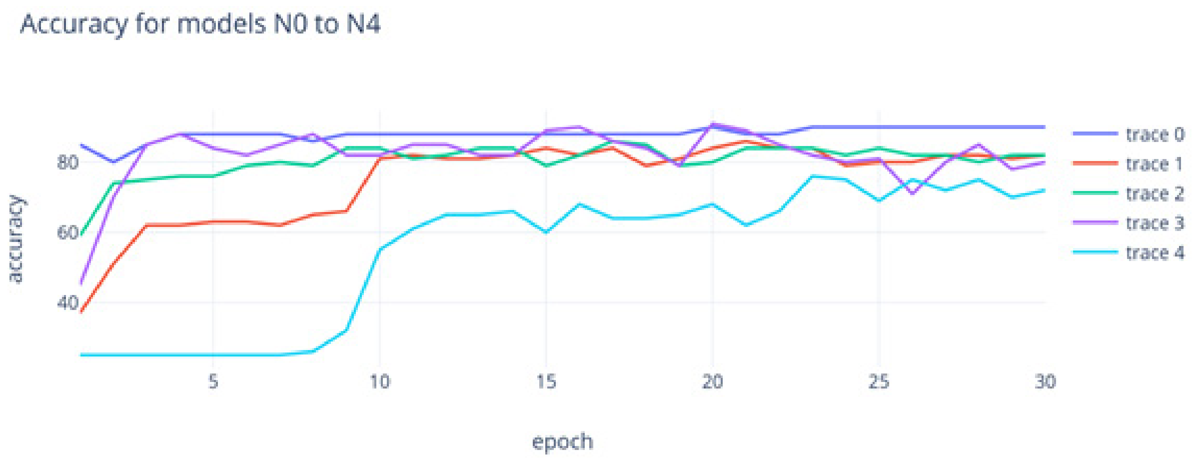


Figure 2: Accuracies for models N0 to N4

4. DISCUSSION

After increasing the size of the dataset, with the same method, there was a substantial increase in the level of accuracy. This improvement shows the importance of large data sets, and the limitations of deep learning techniques when dealing with small data. Therefore, for deep learning to be used to its full potential in Africa, it is important that quality local datasets are made public, in order to foster research and make it easier for companies to profit from the deep learning advancement. It also showcases how useful web scraping can be as a data science tool for dataset creation.

Multi-source transfer learning resulted in a model that was able to reach high accuracies quite fast. The proposed ensemble also seems not to overfit and shows a stable increase in accuracy. Sharing pre-trained models can greatly help when faced with limited data, especially with pretrained models on various datasets. Our approach could have been made easier to implement if all the pre-trained models were already available. Also, so far this approach would not be suited for all types of inferences because of the big size of the models and their high latency. This can, however, be solved using model distillation and model compression.

5. CONCLUSION

In summary, this study showed has how easy it is to obtain a significant improvement in accuracy (up to 15%) over the baseline results, using Multi-Source Transfer Learning. The study also showed how to achieve a significant improvement in accuracy (up to 12%) over the baseline results by employing Web Scraping technique to acquire more dataset for a specific task. There is still a great avenue to improve upon these accuracies. We estimate that we can achieve a very high overall accuracy when these two techniques are combined. In our future work, we hope to test this hypothesis by combining these two techniques.

ACKNOWLEDGEMENT

We acknowledge Dennis A. Owusu, our ML lecturer at Ashesi University for the guidance and support during this project. The experiment of this model made possible by FloydHub and their cloud platform.

REFERENCES

[1] R. Kohavi, "A Study of Cross-Validation and Bootstrap for Accuracy Estimation and Model Selection", Research gate, 2001. Available: https://www.researchgate.net/profile/Ron_Kohavi/publication/2352264_A_Study_of_Cross-Validation_and_Bootstrap_for_Accuracy_Estimation_and_Model_Selection/links/02e7e51bcc14c5e91c000000.pdf. [Accessed 12 June 2019].

[2] S. Christodoulidis, M. Anthimopoulos, L. Ebner, A. Christe and S. Mougiakakou, "Multisource Transfer Learning With Convolutional Neural Networks for Lung Pattern Analysis", IEEE Journal of Biomedical and Health Informatics, vol. 21, no. 1, pp. 76-84, 2017. Available: 10.1109/jbhi.2016.2636929.

[3] Ng. Hong-Wei & Nguyen, D. Vonikakis, V. Winkler, Stefan. " Deep Learning for Emotion Recognition on Small Datasets Using Transfer Learning". Available: 10.1145/2818346.2830593.

[4]L. Bossard, M. Guillaumin and L. Van Gool, "Food-101 -- Mining Discriminative Components with Random Forests", Vision.ee.ethz.ch, 2019. [Online]. Available: https://www.vision.ee.ethz.ch/datasets_extra/food-101/. [Accessed: 13- Jun- 2019].

[5]L. Bossard, M. Guillaumin and L. Van Gool, "Food-101 -- Mining Discriminative Components with Random Forests", Vision.ee.ethz.ch, 2019. [Online]. Available: https://www.vision.ee.ethz.ch/datasets_extra/food-101/. [Accessed: 13- Jun- 2019].

GENIUS
in 21 Days

41,000
Students So Far

200+
Certified Mentors

BOOK YOUR FREE TASTER SESSION TO FIND OUT MORE!

40+
Genius Offices

5
Different Countries

NOT ENOUGH HOURS IN A DAY? IMPROVING YOUR MENTAL EFFICIENCY WILL HELP!

CONTACT

GH: +233571492669
UK: +447459743541

yaw@geniusin21days.co.uk
martina@genuisin21days.co.uk

Cement-Plastic Based Composites as the building blocks of future Ghanaian Mega Structures

Major T Kadonzvo [1], Mumuni Mohammed [2]

Abstract

Civil engineering is one of the oldest fields of engineering that recently has begun to investigate the sustainable management of the environment. Research in this field is focusing on moving away from old methods of construction to new approaches that are environmentally friendly. Construction that has minimum negative impact on the environment is termed green construction. On the other hand, poor management of plastic waste poses a threat to the environment. Plastics like polyethylene tetraphthalate are non-biodegradable and very hard to handle as waste in the world and especially in Ghana. This paper describes how the need for better plastic waste management can be harmonized with the quest to find greener methods of construction. Traditional cement blocks are compared to a new breed of cement blocks that contain waste plastic as part of reinforcement. The mechanical and thermal properties of conventional blocks and those of the new blocks with different plastic compositions are compared using statistical methods and tools. There were statistically significant differences in the compressive strength, flexural strength, hardness and thermal conductivity of the newly engineered blocks.

Keywords: Cement blocks, Polyethylene Tetraphthalate (PET), Composite, Green construction

Department of Engineering, Ashesi University, Berekuso, Ghana

1. INTRODUCTION

There is an increasing demand for housing in Ghana due to the increase in population growth [1]. Consequently, millions of tons of materials go into the construction process. With the current population growth rate of Ghana and a population of 29.7M in 2018[2], one can predict that efforts required by the civil engineering and construction industry to meet infrastructural demand. The high population growth rate means that more land space and building materials needs to be churned into this ever-growing industry. This idea raises concerns over the need for efficient use of land and construction methods that point towards environmentally sustainable practices in construction. Research is ongoing in the field to look for better ways of building with the least possible negative impact on the environment. These better methods will define a new form of construction - green construction – which will be more environmentally friendly. On the same note of being ecologically conscious, several researchers have been raising awareness on the adverse impact of poor plastic waste management. Plastics are synthetic organic hetero-atomic polymers that are often synthesized in large quantities from oil, coal, and natural gas [3]. They are generally non-biodegradable in the presence of enzymes or microbes [4]. This raises environmental issues, since approximately 30% of worldwide production of plastics goes into food packaging and the making of detergents and chemicals, with the annual global economic growth of this industry being around 12% [5]. One of the most commonly used forms of plastics is polyethylene tetraphthalate (PET). According to Albertson, approximately 140 million tons of human-made polymers, including PET, are manufactured around the world annually, with a utility rate of around 12% [6]. Ghana Times argues that 250 tons of plastic packaging waste are produced daily in Ghana alone [7]. Although PET can be degraded by chemical, photodegradation, thermal, and some sophisticated biodegradation techniques [8], there is a need to recycle it into other functional materials [9]. To harmonize the ideas of green construction and sustainable waste management this study seeks to create a new breed of blocks that contains PET granules as part of the reinforcement. These new blocks would replace the traditional cement blocks, which are composites with cement as the matrix and sand as the reinforcement, and clay-based bricks. The conventional blocks and bricks are used for their aesthetic nature, high flexural strength, high compressive strength, fire protection, good porosity, sound attenuation, insulation, wear-resistance, and durability. The incorporation of PET into the blocks would go a long way to improve plastic waste management as plastic waste will be recycled into something useful. Moreover, the new breed of blocks will replace vitrified clay bricks thereby reducing carbon dioxide emissions that are associated with the vitrification of clay bricks. On the construction side, the question is; will the addition of PET significantly alter the mechanical and thermal properties of the blocks. This is a crucial question as any small change in these properties will affect the applicability of the blocks in construction. Therefore, this study will investigate whether the changes in the properties of plastic-cement brick will be better than those of the standard cement brick.

2. METHODS

Processing the Low-Density PET

Plastics commonly used in the packaging of water in Ghana were collected in the form of empty sachets from Berekuso, a small town in the Eastern region of Ghana. They were washed in water to clean off dirt and cut into pieces of dimension 1cm by 1cm. The pieces were added to kerosene (fig 1. a), which was being heated at 140°C until the saturation point was reached. The slurry produced was cooled by dipping the metallic containing vessel into ice, while maintaining the temperature at approximately 5°C. The resulting mixture of plastic condensate and the kerosene was separated by filtration (fig 1. b), leaving the plastic component on a filter paper to be dried. A white granular substance was obtained after 24 hours of drying. The particles obtained were in a fine powdery state.

Molding the blocks

A rectangular molder was designed that had the dimensions l = 65±0.5mm, w = 55±0.5mm and h=20± 0.5 mm.

The standard blocks were made from a mixture of one-part cement and three parts sand, with each part weighing 280 ± 0.1g. The cement-plastic based composites (CPBC), block P, was made by adding approximately 8.5g of PET per 1120g, mass of the brick. The subsequent CPBC blocks, Q, R, S respectively, had 1.5% PET, 2.25% PET, 3.00% PET by mass. The mortar was poured into the molders (fig 1. c), and the blocks were allowed to dry for seven days, after which the following tests were carried out:

Hardness test, Triple point bent test, Compressive strength test, Thermal conductivity test.

Hardness Test

An electronic hardness tester (fig 1. d) was used to test the surface of three blocks from each sample, and the results were recorded. The method used was to follow the manufacturer's instructions.

Triple Point Bent Test

Using the universal MTS machine (fig 1. e), the triple point bent test was carried out on three blocks from each sample and the data was recorded. The specimens were loaded under displacement control until they failed. The flexural strength was calculated using the relation [10]:

$$\sigma_f = \frac{3F_o L}{2BW^2} \qquad (Equation\ 1)$$

Where

σ_f is the flexural strength,

F_o is the force at failure,

L is the distance between the pivoting points,

B is the breadth of the specimen,

W is the width of the specimen.

Compressive Strength

Using the Universal Mechanical testing machine, the compressive strength tests were carried out under displacement control at a displacement rate of $0.01mms^{-1}$ and a strain rate of $0.01s^{-1}$. The specimens were monotonically loaded until they failed. Using the dimensions of the block measured with a pair of Vernier calipers, the compressive strength was calculated from the relation [10]:

$$\sigma_c = \frac{F}{A_o} \qquad (Equation\ 2)$$

Where:

σ_c is the compressive strength,

F is the force at failure,

A_o is the cross-sectional area of the specimen.

Thermal Conductivity

The blocks were all placed on a hot plate at the same time (fig 2. b), each having 10mm x 55mm in contact with the hot plate for the same period, 10 minutes. From the conductivity formula [11]:

$$\lambda = \frac{\dot{Q}L}{A\Delta T} \qquad (Equation\ 3)$$

Where:

λ is the thermal conductivity W/m K,

$\dot{Q}$ is the amount of heat transfer through the material in J/S or W,

A is the area of the body in m^2,

ΔT is the difference in temperature in K.

Based on the assumption that negligible energy was lost in the heating process, the wattage of the hot plate was approximated as the amount of heat energy transferred (Q) and the area of contact was estimated as the size of the blocks. The length traveled through each block was estimated from the infrared photographs (fig 2. C-S), and the change in temperature was also read off the infrared photographs. The difference in temperature can be clearly seen in fig 2 where the red color represents the area with the highest thermal conductivity. The thermal conductivity of three blocks from each sample was calculated and stored for data analysis.

Figure 1. Procedure (a) Melting of plastics, (b) Drying of the plastic granules, (c) Molding of blocks, (d) Testing Hardness, (f) Microscopic surface analysis of different samples

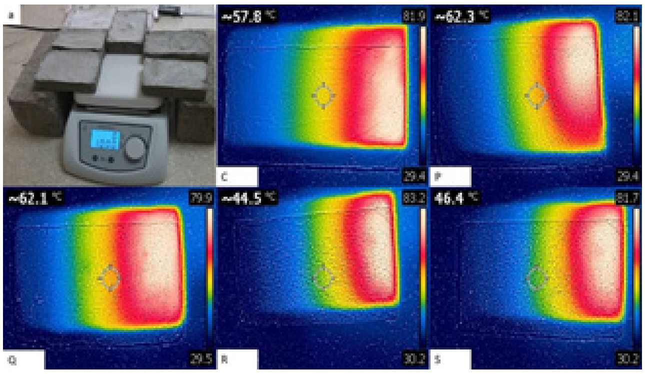


Figure 2. Thermal conductivity test (a) Heating the blocks, (C-S) Infrared heat signature of each block.

Surface Analysis

The surface was analyzed using an electronic microscope. The surfaces were different for each sample as shown in (fig 1. f).

3. RESULTS AND DISCUSSION

Hardness Test

The measured hardness ranged from 88.98 for the 0.75% PET sample to 94.23 for the 3.00% PET sample. The average measurement is depicted for the hardness of each block type. The error bars show the standard deviation. Each group is as a result of n=4 replicates (fig 4).

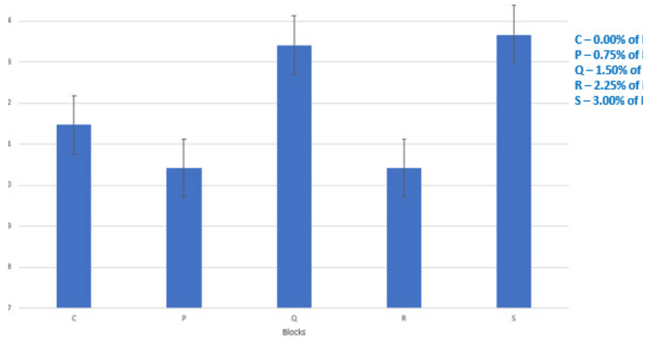


Figure 3. Hardness of Each Sample

Flexural Strength

From the results of the triple point bent test, the different block failed to varying forces with the control bearing the highest load (fig 4).

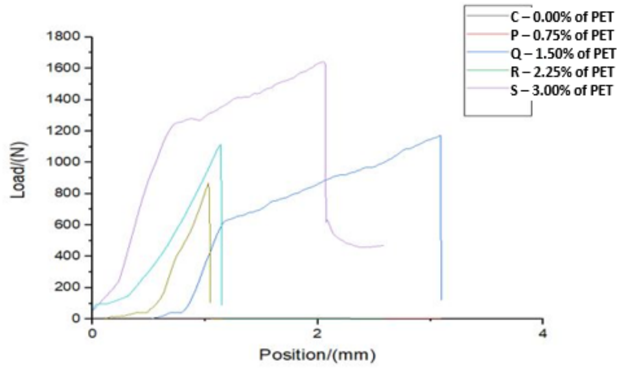


Figure 4. The breaking force for each sample for flexural strength.

Compressive Strength

The compression test carried out for each block type is shown in (fig 5). The figure also shows the failure point in the compression test for each specimen.

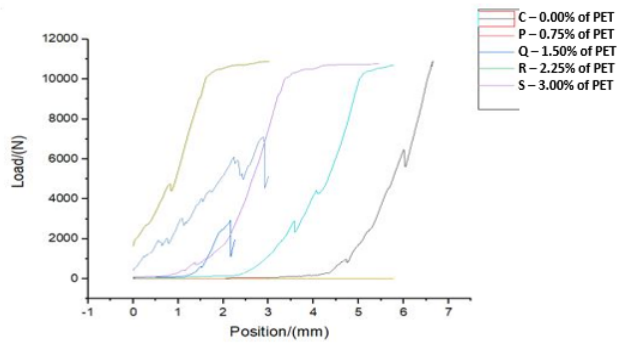


Figure 5. The breaking force for each sample for compressive strength

Thermal Conductivity

The thermal conductivity decreased as the content of the PET increased in the samples. The average measurement is depicted for the thermal conductivity of each block type.

The error bars show the standard deviation. Each group is as a result of n=4 replicates (fig 6).

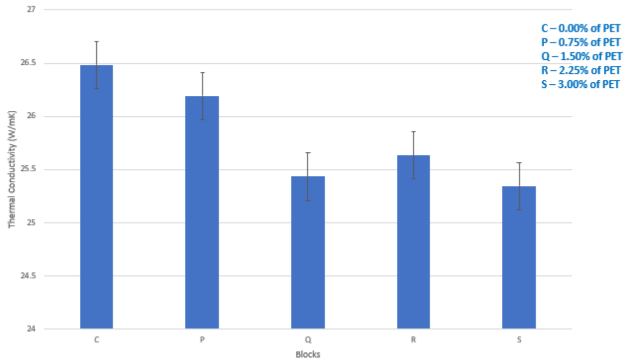


Figure 6. *The thermal conductivity of each sample*

v

Surface Analysis

The surface of the blocks changed notably under the microscope as more grains of the PET were added (fig 1. f). This change, however, is not notable by the human eye. The specimen surfaces appear to be the same when examined using the naked eye.

Statistical Analysis

After carrying out the tests on three specimens from each composite sample, the data obtained were used to calculate the mean values for each sample. From the scientific hypothesis, statistical hypotheses were made, which are summarized in fig7.

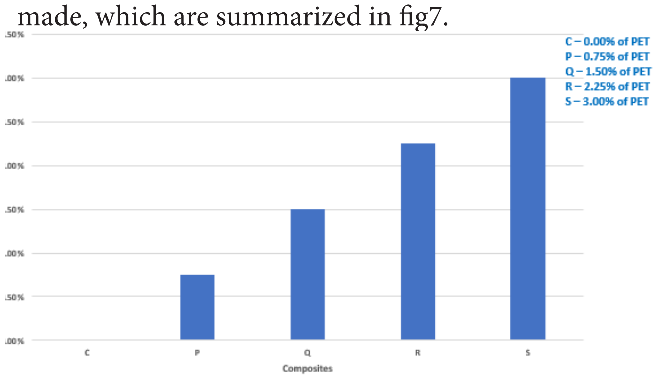


Figure 7: *Composites made with % PET*

The normality of the data was checked using the Shapiro-Wilk test. Based on its results, an ANOVA test or a Kruskal Wallis test was performed on each category. In the cases where the ANOVA test showed that there were differences, the Tukey test was performed to pinpoint the differences. The results of the tests are summarized in the table below:

Property	Shapiro Test	Kruskal Wallis	Anova
Hardness	0.1147		5.21E-0.6
Flexural Strength	0.0342	0.0091	
Compressive Strength	0.0043	0.0073	
Thermal Conductivity	0.2580		0.0256

From the Tukey tests performed on the hardness and thermal conductivity data, it was noted that all except 2.25% of PET and 0.75% of PET, and 3.00% of PET and 1.50% of PET were different for Hardness and also all except 0.00% of PET and 3.00% of PET were similar for Thermal Conductivity.

4. CONCLUSION

From the statistical analysis and tests carried out, it can be concluded that there are statistically significant differences in the compressive strength, flexural strength, hardness, and thermal conductivity of the blocks.

From the Kruskal Wallis test, both compressive and flexural strength for all the block types were similar.

From the Tukey tests, there are statistically significant differences in the Hardness and Thermal conductivity of the blocks. For the hardness test, all except 2.25% of PET and 0.75% of PET, and 3.00% of PET and 1.50% of PET were different from the Tukey's test. For the thermal conductivity, all except 0.00% of PET and 3.00% of PET were similar from the Tukey's test. This shows that the mechanical properties are changed by the introduction of PET.

The differences in mechanical properties of the blocks of different PET contents show that the amount of PET granules does change the structure of the material significantly.

Scientifically, PET reinforced blocks could be used in low-stress bearing applications where aesthetics, durability and low thermal conductivity are of paramount importance.

ACKNOWLEDGMENTS

Much appreciation and thanks go to Dr. E Rosca, Dr. D Yiporo, Mrs. Miriam Abade-Abugre, Mr. Aaron, and Mr. Nicholas Tali for making this project a success.

REFERENCES

[1] I. Yeboah, "Demographic and housing aspects of structural adjustment and emerging urban form in Accra, Ghana.," Africa Today, vol. 10, pp. 106-109., 2003.

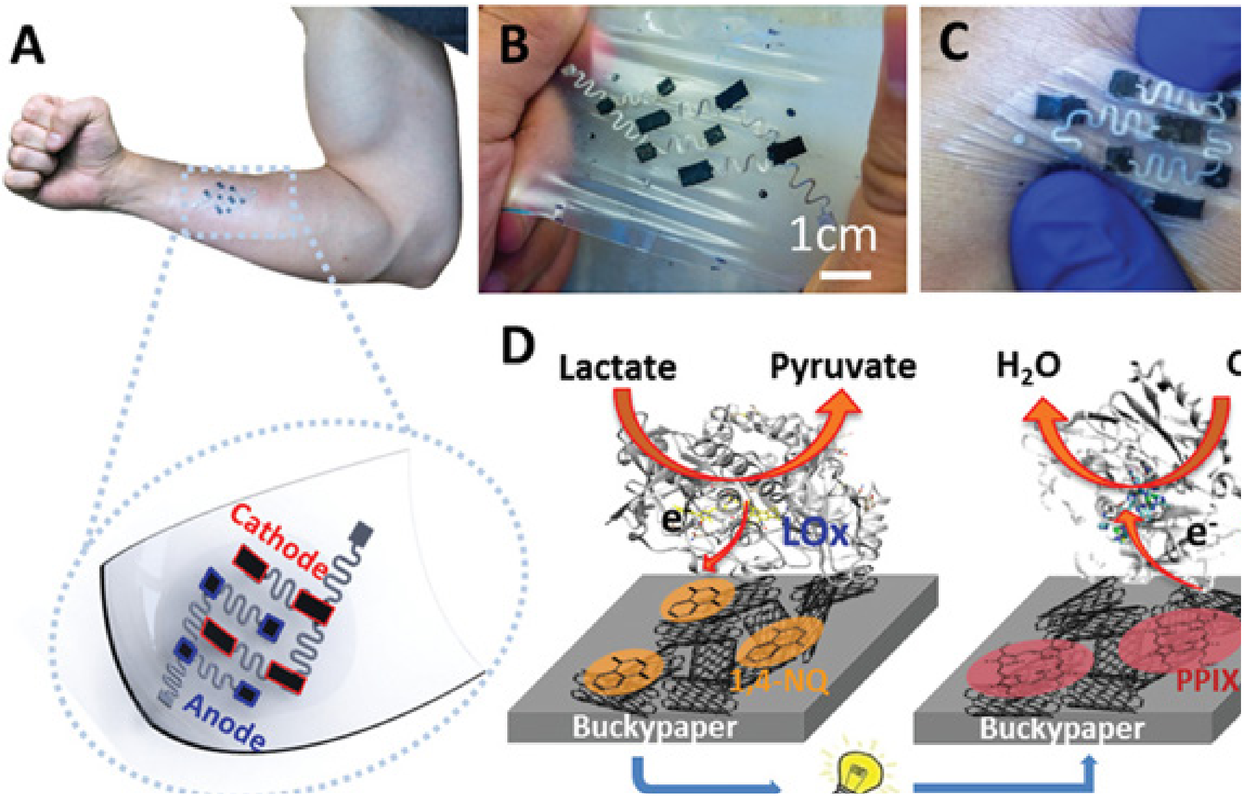
[2] "World Bank," Ghana Data, 2017. [Online]. Available: https://data.worldbank.org/country/ghana?view=chart. [Accessed 28 October 2018].

[3] R. B. Seymour, "Polymer science before & after 1899: Notable developments during the lifetime of

Maurtis Dekker," J. Macromol. Sci. Chem, vol. 26(8), p. 1023–1032, 1989.
[4] R. J. Mueller, "Biological degradation of synthetic polyestersenzymes as potential catalysts for polyester recycling," Proc. Biochem, vol. 41(10), pp. 2124-2128, 2006.
[5] Y. a. B. H. Orhan, "Enhancement of biodegradability of disposable polyethylene in controlled biological soil.," Int. Biodeterior. Biodegrad, vol. 45(1–2), p. 49–55, 2000.
[6] A. C. Albertsson, "The shape of the biodegradation curve for low and high-density polyethylenes in prolonged series of experiments.," Eur. Polym. J., vol. 16(7), p. 623–630, 1980.
[7] "The Plastic Waste Business In Ghana, How Far?," Ghanaian Times, 2015. [Online]. Available: http://www.ghanaiantimes.com.gh/plastic-waste-business-ghana-far. [Accessed, 2017].
[8] U. E. T. Y. M. K. I. D. W. D. a. M. R. J. Witt, "Biodegradation of aliphatic-aromatic copolyesters: Evaluation of the final biodegradability and ecotoxicological impact of degradation intermediates.," Chemosphere, vol. 44(2), pp. 289-299, 2001.
[9] B. X. P. K. P. X. G. Q. a. G. S. H. Yang, "Mechanical reinforcement of polyethylene using polyethylene-grafted multiwalled carbon nanotubes," Adv. Funct. Mater., vol. 17(13), p. 2062–2069, 2007.
[10] W. D. J. Callister, "Materials science and engineering: An introduction," New York, Wiley, 2007, p. 415–459.
[11] D. R. $. P. P. P. Askeland, "The science and engineering of materials," Toronto, Thomson, 2006, p. 198.

A Stretchable And Flexible Biofuel Cell That Runs On Sweat

by Christopher Anamalia



In the area of technology and medicine, research in dermatology is making advances as scientists are getting close to replicating the human skin to augment the interactiveness of devices such as smartphones, watches, etc. Other area of research is aiming to dive deeper into extending the functionalities of the skin. This work by scientists from the Département de vchimie moléculaire (CNRS/Université Grenoble Alpes) innovatively converts sweat to electricity in simplest terms.

Sweat is made up of chemical compounds. Backed by principles of electrochemistry and application of concepts of reduction and oxidation, the cell produces electrical energy by reducing oxygen to water and oxidising lactate present in sweat to pyruvate. In the process of doing this, electricity is generated. The electricity produced is capable of continuously lightening an LED using voltage boosters. "It is relatively simple and inexpensive to produce, with the primary cost being the production of the enzymes that transform the compounds found in sweat".

The piece of technology developed consists of a "flexible, conductive material consisting of carbon nanotubes, cross-linked polymers, and enzymes joined by stretchable connectors that are directly printed onto the material through screen-printing".

In the area of boidevices, this technology comes in useful in helping to power wearable electronic devices such as mobile phones, smartwatches, wireless earbuds, medical and athletic wearable devices, etc through an autonomous and environmentally friendly way.

This biofuel cell delivers an open circuit voltage of 0.74 V, a maximum power of 450 μW and a high-power density of 520 μW cm-2. With this window of research exposed, researchers are currently looking to amplify the voltage that the cell produces to power large portable devices.

REFERENCE

Science daily link: https://www.sciencedaily.com/releases/2019/09/190925123431.htm

Actual research paper: https://onlinelibrary.wiley.com/doi/full/10.1002/adfm.201905785

Ahuod3n – A Redesigned Low-cost Foldable Wooden Stool

Ronny P.K. Panford [1], Opanin K. Akuffo [2], Edinam K. Klutse [3], Timothy Charles-Debrah [4]

Abstract

This project delves into the experimental and statistical analysis of material selection factors such as availability, cost efficiency, and durability, tensile strength, and sagginess of materials that could be potentially used to build the seating area of a foldable wooden stool. In the course of the experimental process, paper, plastic, and leaves were used as the experimental groups for the analysis. A further test was carried out to test if weaving patterns of the materials affected tensile strength. The mechanical properties of the experimental groups are statistically analyzed to decide on the material's usability. Conclusively, plastic straws had the highest tensile strength and least sag per unit mass, making it the most suitable material amongst the three to withstand the higher load placed on the seating area. In attempts to reduce the sagginess of the plastic straw, two weaving patterns, rustic plait, and, three-strand braid, of equal length underwent a repeated sagginess test. The rustic plait weaving pattern resulted in the least sag per 700g loaded on it. With these results the seating area of the stool was fabricated from rustic-plaited plastic straws.

The empathic motive behind this project is to redesign simple household furniture from repurposed materials for less privileged homes in the rural areas of Sub-Saharan Africa.

KEYWORDS: material selection; strain sensor; furniture; ultimate tensile strength; stool

Department of Engineering, Ashesi University, 1 University Avenue, Berekuso, Ghana.

INTRODUCTION

In this project, experiments are performed to explore cost-effective materials in the designing of the seating surface of a stool. Conventional materials were considered, such as paper, naturally occurring substances, and plastics for fabrication to minimize cost.

According to Garside, the global production of paper stood at 411 million metric tons, as of 2016, rating paper as one of the most used materials in the world [1]. Paper is defined as a material manufactured in thin sheets from the pulp of wood or other fibrous substances, which can be used for writing, drawing, or printing on and as well as wrapping material [2]. Paper was selected because it is easy to come by due to its mass production. The thickness of a paper can be measured with a pair of vernier calipers. The strength and durability of paper are based on the type of material used to make it and the length of it, respectively. For this experiment, A4 sheets were selected for use, since they are ubiquitous.

Next, leaves from the Brahma Edulis tree were chosen for this project because they are ubiquitous .The Brahma tree is like a palm tree with its leaves in the shape of a fan. The tree grows to a height between 4.5 -13 meters tall. This plant was the best choice at our disposal because of its proven strength and durability, which were some of the features in our design.

Finally, plastics were chosen to curb the problem of plastic waste pollution. Plastic straws cannot be easily recycled, and hence they are littered everywhere and typically end up in the ocean. According to Ocean Conservancy's Tides system, straws made up a considerable portion of the trash in the sea, in early 2018. Five hundred million straws are used daily in the USA. This number is enough to circle round the earth 2.5 times [3]. Based on this problem, this experiment considered it as one of the materials, with the aim of recycling plastic straws to reduce plastic waste pollution.

The mechanical properties of the three materials were compared to find the best. A one-way ANOVA, along with a linear regression model, was carried out in selecting the material with the highest tensile stress and least sagginess, respectively. Theoretically, a material with a high tensile strength would perform better in a sagginess test. The best material was further passed through a sagginess test comparing two different weaving patterns for the one that gives the least sag. In concluding which model results in the least sag for the strongest of the three materials, a student's T-test was employed. This material selection process is visualized in Fig 1.

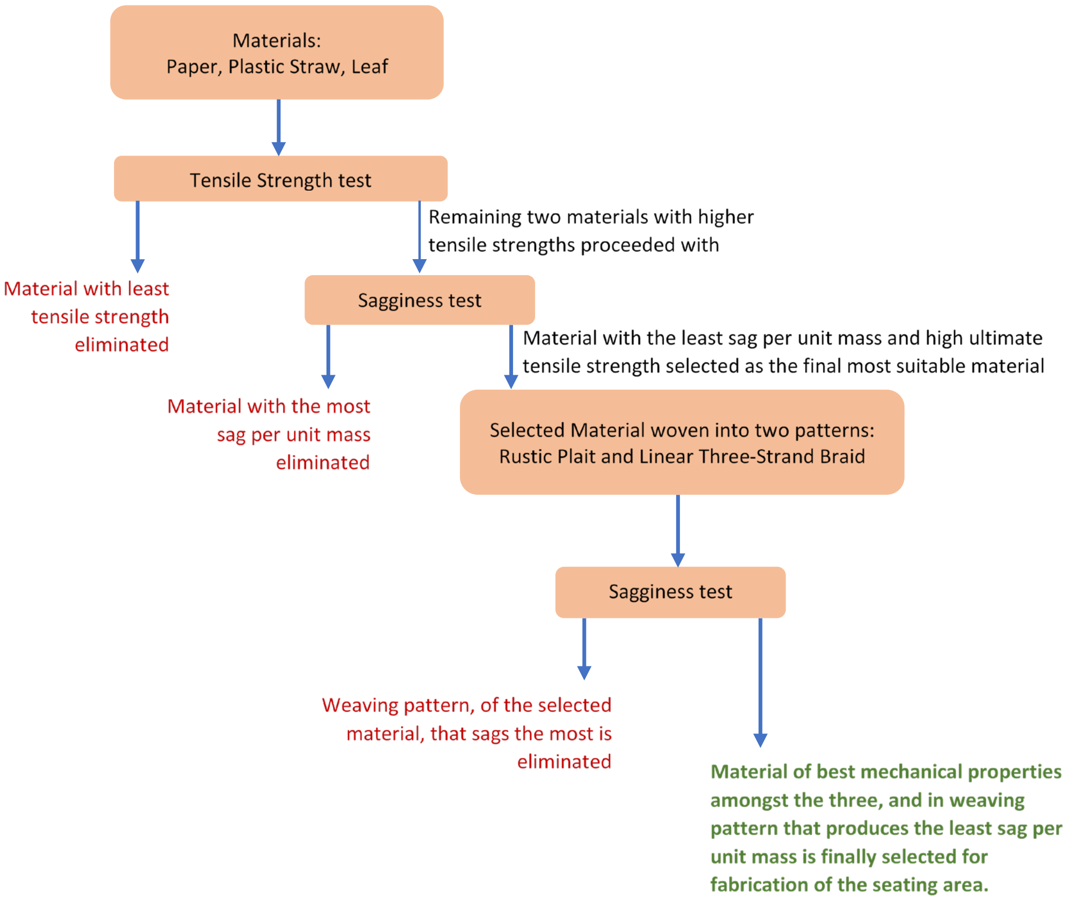


Fig. 1 Material selection process for the seating area of the stool

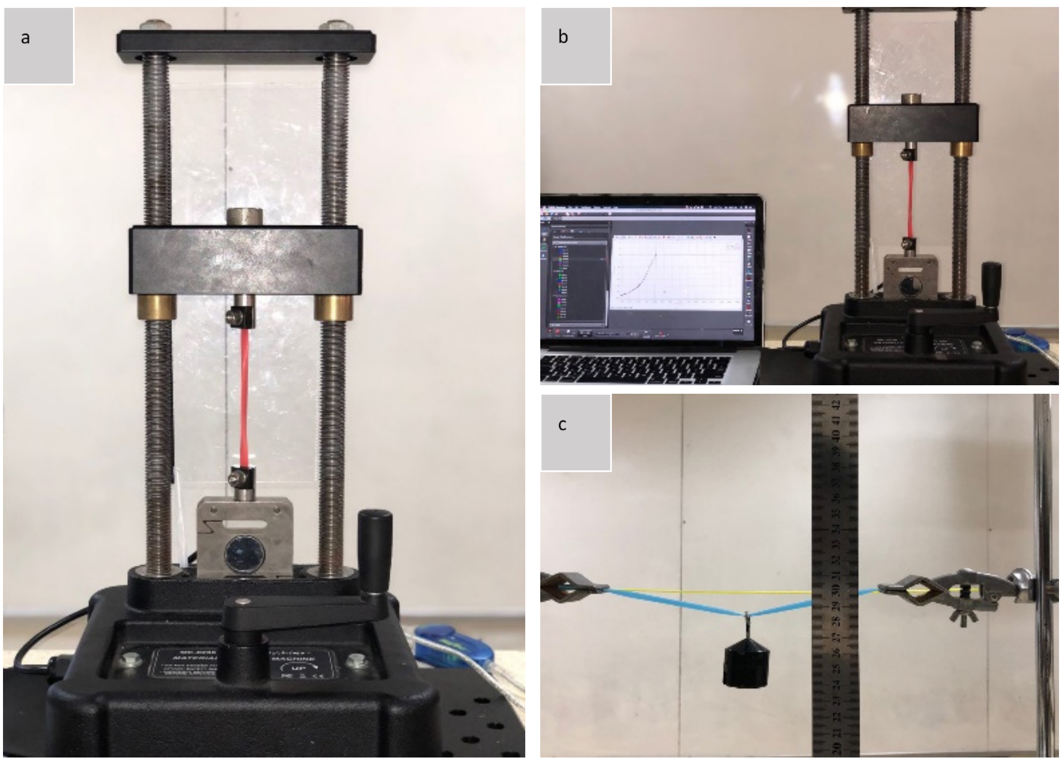


Fig. 2. (a)Extensometer with straw clasped and being extended. (b)Extensometer with PASCO Capstone Software to record force and position data as materials are being extended and (c) Sagginess Test experimental setup .

Ultimate Tensile Stress Test of Strips (Test A)

Five (5) strips of straw, paper, and the Brahea Edulis leaf of similar length, width, and thickness (11cm × 1cm × 0.1cm) were used for this test. The test was conducted using an extensometer and the PASCO Capstone Software. The software generated Fforce against versus eExtension graphs (Fig 2a & 2b) for each material were generated by the software. Based on the length (measured using a ruler) and area (measured using a micrometer screw gauge) of each strip, tensile stress against versus strain graphs were was produced. Consequently, the Ultimate Tensile Stress (UTS) for each material was obtained from the peaks of the graphs generated.

The stress was calculated using the relation:

$$\sigma = \frac{F}{A}$$

where:

σ is tensile stress

F is force applied

A is the cross-sectional area

The strain was calculated using the relation:

$$\varepsilon = \frac{\delta}{L}$$

where:

ε is the tensile strain

δ is extension

L is original length

Sagginess Test of Strips (Test B)

Five (5) strips of straw, paper, and the Brachia Edulis leaf of similar length and width (25cm × 1cm × 0.1cm) were used for this test. The test was conducted by clamping the ends of each strip using two retort stands, hanging a range of masses (200g, 400g, 500g, 700g) in the middle of each strip and measuring the extension from the horizontal baseline (Fig 2c). These measurements were used to plot a mass against extension graph for each material.

Sagginess Test of weaving patterns (Test C)

Based on the results from Test A and Test B, the material with the highest tensile strength and lowest sagging was chosen. Two weaving patterns (4 Strand Rustic Plait & Linear 3 Strand Braid) were created from that material, and a sagginess test from Test B was performed on five (5) strips of each weaving pattern.

RESULTS AND DISCUSSION

Table 1 summarizes the mean mechanical properties obtained from test A and test B for the three material strips used.

Material	Mean Ultimate tensile stress / Pa	Mean sag per unit mass / m kg^{-1}
Double layered paper strip	2.94×10^8	N/A
Brahea Edulis leaf strip	4.01×10^8	0.04
Straw	9.72×10^8	0.03

Table 1. Summary of Mechanical Properties

Ultimate Tensile Stress Test of Strips (Test A)

Ultimate tensile stress point is the breaking point of the material when undergoing a forced extension. This property is indicated for each of the materials of straw, leaf, and paper in the stress against versus strain graph (Fig. 3a) as the point where there is no change in extension, thus no increase in strain for an increase in stress (increase in force) – the . This is indicated on the graph as the sharp turning point of each line for each of the materials. Conclusively, the ultimate tests resultsresults of the ultimate test showed the straw strip had the highest ultimate tensile stress of 9.72×10^8 Pa ($p<0.05$), followed by that of the leaf at 4.01×10^8 Pa ($p<0.05$) and the lowest being that of paper at 2.94×10^8 Pa ($p<0.05$) (fig. 3b). Straw is the most suitable material to be used for the seating area of the stool as per this test, due to it having the highest ultimate tensile stress (thus can withstand a larger more significant extensive force before breaking).

Sagginess Test of Strips (Test B)

From the results of the sagginess test, the different materials exhibited different extensions per each mass hung on it. A graph of mass hung against versus the extension (Fig. 3c) showed straw had the least extension per unit mass placed on it, at 0.03m/kg ($p<0.05$), whereas that of leaf was 0.04m/kg ($p<0.05$). This estimate was obtained by calculating the gradients of each best fit line for each of the materials and comparing their values. The use of paper in this test was discontinued as paper tore when 400g was hung on it - it. This presented us with too few data points to obtain conclusive results for paper. Another reason for eliminating the use of paper was due to it outrightly not dissatisfiedying our goal of the experiment objectives, which is to arrive at the strongest of the three materi als. , thus with paper breaking at 400g concludes it is not suitable material for the seating area of the stool, per this test. Straw is the most suitable material to be used for the seating area of the stool as per this test, due to it havingbecause it possessed the lowest extension of sag per unit mass.

Sagginess Test of weaving patterns (Test C)

The determining factor for this test was the weaving pattern of the chosen material. Thus the load applied on the strip was kept constant at 700g. The analysis showed that the rustic plait weaving pattern of straw had the least extension per unit mass as compared to the linear three-strand braid of straw. For the 700g hung in the middle of the rustic plait weaving pattern of straw, there was a mean extension of 0.0526m ($p<0.05$), giving the rustic plait an extension per unit mass of 0.0751 m/kg. Whereas the linear three-strand had a mean extension of 0.075m ($p<0.05$), when the 700g mass was hung on it, giving it an extension per unit mass of 0.107 m/kg. Consequently, the rustic plait weaving pattern of straw is the most suitable as compared to the linear three-strand braid weaving pattern for the seating area of the redesigned stool as it sags the least per unit mass placed on it.

D. Statistical Analysis

The data obtained from the three materials being tested (plastic straws, Brahea Edulis leaves and double-layered paper strips) and the two weaving patterns (rustic plait and linear three-strand braid) were used to calculate the mean ultimate tensile stress' and the mean extensions needed to draw conclusions in test A, B and C. The sample size used in Test A was 5 of each of three materials, giving a total sample size of 15 strips. Each of the five strips of straw was randomly selected from 50 identical straws. Each of the five strips of double-layered paper was randomly chosen from 150 sheets of standardized A4 paper, then cut and folded once into a double layer of equal length and width dimensions to the strips of the other materials. Each of the five strips of leaves was cut from 5 randomly selected leaf blades out of 10 leaf blades. Eighteen straws were randomly chosen from 500 straws and used for each of the 16 woven strips for the rustic plait weaving pattern laid on the stool. Giving the total number of randomly selected straws for the rustic plait at 288. 15 straws were randomly chosen from 500 straws and used for each of the 16 woven strips for the linear three-strand braid weaving pattern laid on the

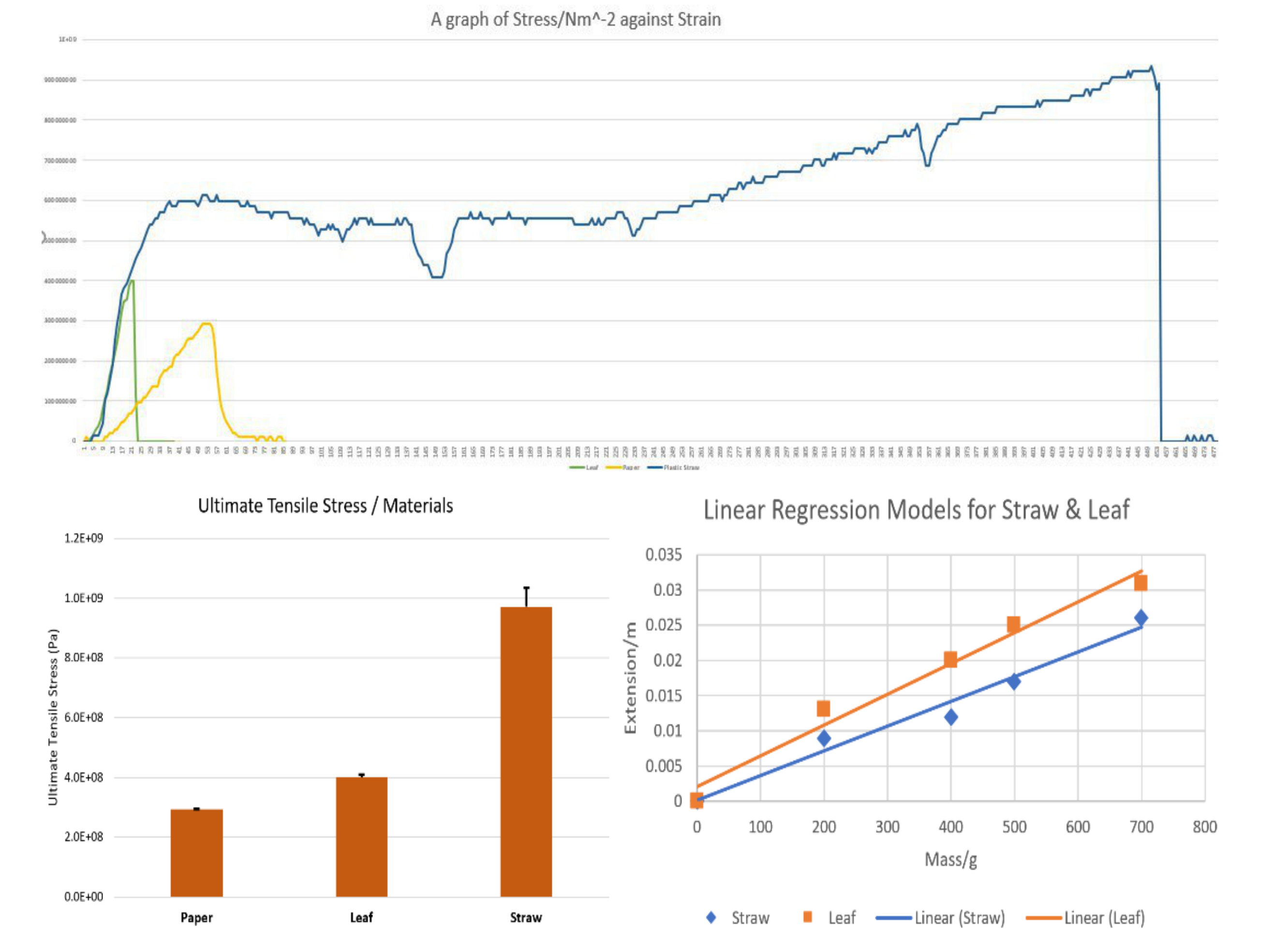


Fig. 3 (a) Tensile stress against strain graph. The blue curve representing straw, green representing Brahea Edulis leaf strip and yellow representing double-layered paper strip. (b) Bar graph of mean ultimate tensile stress of each material. Error bars represent standard deviation. (c) Graph of mass against extension with lines of best fit plotted for each material. The orange line represents the Brahea Edulis leaf strip, and the blue line represents the plastic straw.

stool. Giving the total number of randomly selected straws for the linear three-strand braid at 240.

The scientific hypothesis of one material having the highest ultimate tensile stress as a strip, least sag per unit mass as a strip and the least sag per unit mass dependent on the weaving pattern, were converted into statistical hypotheses and summarized in table 2.

Property	Null hypothesis (H_0)	Alternative hypothesis (H_a)
UTS	$UTS_P = UTS_L = UTS_S$	$UTS_P \neq UTS_L \neq UTS_S$
SES	$SES_S = UTS_L$	$SES_S \neq UTS_L$
SEW	$SEW_R = SEW_L$	$SEW_R \neq SEW_L$

Table 2. Statistical Hypotheses

Where UTS is the mean Ultimate Tensile Stress of strip, SES is the Sagginess Extension of Strip, and SEW is the Sagginess Extension of the Weaving pattern.

In table 2, UTS_P, UTS_L and UTS_S, represent the mean ultimate tensile stress of paper, leaf, and straw respectively. SES_S and SES_L mean the sagginess extension of a strip of straw and leaf respectively. In comparing the mean sagginess extension for the weaving patterns, SEW_R and SEW_L represent the mean sagginess extension for the Rustic Plait weaving pattern and the Linear Three-strand braid weaving pattern respectively.

For Test A, a Shapiro-Wilk test was performed on each material's ultimate tensile stress data to check for normality. The results for the normality test on the data points for each material are summarized in table 3.

Materials	Shapiro-Wilk Value	Normal
Double-layered paper strips	0.2011	Yes
Brahea Edulis Leaf Strips	0.4685	Yes
Straws	0.6995	Yes

Table 3. Shapiro-Wilk Normality Test Results

Upon concluding the data for each material is normal as data for each material had a p-value greater than 0.05, the statistical difference between the ultimate tensile stress materials was checked by performing a one-way ANOVA test and a Tukey posthoc analysis to identify the differences if any. This tested the null hypothesis for UTS detailed in table 2, and the results are summarized in Table 4.

Material Comparisons	ANOVA Test p-value	Tukey test p-values	Statistical Difference
Paper-Leaf	2.48×10^{-2}	0.0014404	Yes
Straw-Leaf	2.48×10^{-2}	< 0.0000001	Yes
Straw-Paper	2.48×10^{-2}	< 0.0000001	Yes

Table 4. ANOVA and Tukey P-value Results

These test results conclude there is the statistical difference between the ultimate tensile stress results of the three materials, as each Tukey test comparison resulted in a p-value of less than 0.05, using a 95% confidence interval.

For test B, a linear regression test was carried out on each material's mass against extension plot, and correlation was checked for. The results from the linear regression test are presented in table 5.

Residual Standard Error	50.6 on 2 degrees of freedom
Multiple R-squared	0.9825
Adjusted R-squared	0.9649
F-statistic	56.03 on 2 and 2 degrees of freedom
P-value	0.01753

Table 5. Linear Regression Test Results

The linear regression model generated resulted in an adjusted R-squared value of 0.9649 and a p-value of 0.01753. These indicate the curves are an extremely good fit to the data points obtained and 96.49% of the variance in the extension can be calculated from the variance in masses hung (independent variable). The p-value of less than 0.05 indicates a correlation between mass and extension for that of paper and for that of straw. With these two models generated with an adequately good fit, there is a visible difference in their gradient. It can be concluded then that their gradients are statistically different, and straw extends the least per unit mass, as it has the lowest extension per unit mass gradient.

For test C, a Welch Two Sample T-test for rustic plait and linear three-strand braid was carried out with a 95% confidence interval to compare their mean sagginess when 700g was hung on each strand. The Welch Two Sample T-test allowed for analysis to cater for the possibility of the two patterns having unequal variances, although they were made from the same material. The null hypothesis for this test was that of SEW aforementioned in table 2. The results of this test are shown in table 6.

Rustic Plait (Tyrolean) vs. Linear 3 strand braid	
t = -16.885, **df** = 5.3462, **p-value** = 7.635×10^{-6}	
Alternative Hypothesis: true difference in means is not equal to 0	
95 percent confidence interval:	
-0.02574489	-0.01905511
Sample Estimates:	
Mean sag of Rustic /m	**Mean sag of 3-strand /m**
0.0526	0.075

Table 6. Welch Two Sample T-test

This test concluded with statistical difference between the mean sag for rustic plait and the mean sag for the linear three-strand braid, as a p-value of 7.635×10^{-6} was obtained, which is less than 0.05.All statistical analysis tests were carried out using R-Studio.

4. CONCLUSION

There was statistical significance obtained in the ultimate tensile stress tests as well as the sagginess tests, indicating the mean ultimate tensile stress' of the three materials, as well as the mean sagginess of the three materials, are not equal, rejecting their null hypotheses. Thus, enabling the selection of a suitable material for the designing of the seating area of the stool. A material with the highest tensile strength, as well as the least sag per unit mass placed on it, is the preferred material to be used for the seating area of the stool to be able to withstand a higher load placed on the stool than the others. With these preferences, plastic straws concluded in being the most suitable material to be used for the seating area of the stool.

Still with an aim to achieve the least sag per unit mass placed on the stool, the rustic plait weaving pattern of the plastic straw was used, as from tests conducted had sagged the least per 700g placed on it as compared to the linear three-strand braid. Based on this material and weaving pattern selection the foldable wooden stool was built as shown in Fig. 4 and Fig. 5 with its seating area being plastic straws woven in rustic plait patterns.he durability of the seating area is the primary factor in the experiment; hence, the plastic deformation that the straw goes through is not convincing enough. Nevertheless, a potential solution for increasing the durability of the seating area is to bind the straw strips with an adhesive.

Fig. 4. Detailed zoom on plastic straw rustic plait weaving pattern.

Fig.5. Resulting foldable wooden stool with seating area made out of plastic straw woven in a rustic plait.

The prototype above is still under iterative research and redesigning process, as things stand, Ahuod3n is suitable for the average child between the ages of 3-10 years old due to the low elastic limit of straw strips.

5. ACKNOWLEDGMENTS

We acknowledge Dr. E. Rosca for supervising this project and Ashesi University for providing necessary material testing equipment and tools.

6. REFERENCES

[1] Garside, M. (2019). Paper Industry - Statistics & Facts. Retrieved from Retrieved from Statista: https://www.statista.com/topics/1701/paper-industry/

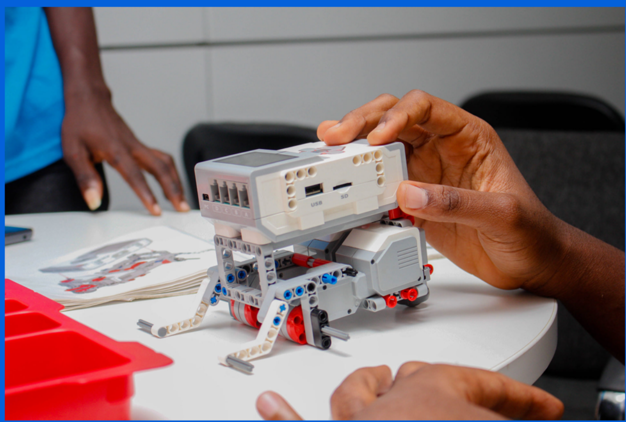
[2] Jewell, E. (2006). The Pocket Oxford Dictionary and Thesaurus. Oxford University Press.

[3] Hugh. (2018). The Environmental Impact of Plastic Straws – Facts, Statistics, and Infographic [Blog]. Retrieved from https://get-green-now.com/environmental-impact-plastic-straws/

[4]Walker-Morison, A., Grant, T., & McAlister, S. (2007). Strategies and Resources for Material Selection. Environment Design Guide,1-8. Retrieved from http://www.jstor.org/stable/26148743

Want to make a difference?

Join Us!



***Tech Era** Organisation is a registered non-profit in Ghana (D.S.W. /7720) which is a company limited by guarantee registered in Ghana (CG072852018). The organisation is an award winning social enterprise which seeks to empower persons with disabilities (PWDs), schools and corporate organisations.*

Our Model:

Tech Era provides opportunities and trains youth from universities to make impact in their communities. We create affordable assistive technologies and serve children & youth with disabilities through competency and capacity building programs.

Contact Us

***website:** techera-gh.org*
***email:** info@techera-gh.org*
***telephone:** 0302944570 / 024880087*

A Statistical Analysis of Sisal, Nylon and Rubber For A Drying Line

Emmanuel Nimo [1], Kofi Anweara [2]

Abstract

This project investigates the application of different materials used as drying lines. It statistically analyzes three types of ropes: rubber, nylon, and sisal, to identify which of them would be the best for a dry line. The study primarily focuses on the experimental data of the force, displacement, tensile strength and elastic modulus of the rope samples obtained using smart technological devices, to draw a conclusion on which one has the least expansion and the highest tensile strength. The data is collected with modern technological tools such as Pasco testing machine and analyzed using MATLAB and Microsoft Excel. The result of the statistical analysis obtained includes sisal with a tensile strength of 8.46×10^7 psi standard deviation and error of 31.7±15.8, followed by nylon 1.407×10^7 psi and 5.0±2.5, and rubber with 5.32×10^6 psi and 1±0.5, respectively. As sisal tends to have the least expansion with highest tensile strength, a well-designed sisal rope is recommended for dry lines.

Keywords: Sisal, Nylon, Rubber, Drying Line

Department of Engineering, Ashesi University, Berekuso, Ghana

1. Introduction

Ropes are primarily useful in our domestic activities. They are ubiquitous, mostly found inside and or outside of our houses. They come in various forms and sizes, thus, big or small and twisted or braided, and with different materials such as nylon, rubber, sisal, leather, cotton, etc. However, some of these ropes, those typically used for dry lines, lose their capacity for supporting a high load after a short period due to weather conditions, the heavy weight of clothes, etc. They often sag or tear, dropping items hung on them on the ground. This problem translates into making the clothes dirty by bringing them closer to the ground and rendering the ropes useless after a period. Hypothetically, it could be that ropes with high elasticity sag faster than those of low elasticity.

1.1 Background

Sisal

Sisal is a strong natural fiber obtained from the sisal plant called Agave sisalana. It offers almost 80% of its strength due to the high proportion of cellulose. It is durable, inelastic, and sturdy, but has low resistance to wear or tear. The application of sisal can be seen in the textile industry: for making cloth. It is also used together with fiberglass to form a composite in the automobile industry. Some carpets used in various homes are all made from sisal. The shipping industry uses sisal ropes to moor small craft. In a research article published by Gupta et al., the tensile strength of sisal was found to be 132.73MPa [1].

Nylon

Nylon is a synthetic polymer consisting of Hexamethylenediamine. It was first made in DuPont Chemicals laboratory, USA, by passing the polymer through solutions to increase its plasticity. Nylon did not have a market base until 1940, when it was first introduced in the production of clothing, especially stockings for women's wear [2]. Fortunately, the increase in demand for these ropes has led to a keen competition between synthetic products and biodegradable products. Most of the ropes produced are usually nylon, rubber, and sisal. Laird Plastic, a renowned plastic company, recorded 82.7MPa as the tensile strength of nylon. Nylon has good elasticity but degrades over time when exposed to the sun. This property causes it to stretch, eventually making it elongated and weak. It is however, durable and has excellent resistance to damage from oil and many chemicals [2].

Rubber

Synthetic rubber is a polymer obtained from a petroleum product and has good elasticity. The natural rubber also exists, derived from a concentrated liquid colloidal suspension called latex found in plants. According to history, ancient inhabitants in Mexico and Central America used rubber to make balls used in a game called Mesoamerican ball game. Later, Germany made the first synthetic rubber during the World War I to be used for automobile tires [3]. After this event, further research was conducted by the Massachusetts Institute of Technology to find the different properties of rubber when combined with various chemicals. Today the USA is the leading producer of synthetic rubber. Rubber has excellent elasticity properties; it is ductile and has a tensile strength of 15-22MPa [3].

1.2 Objectives

1. To experimentally measure and determine the best rope for a dry line using statistical analysis.
2. To learn how statistical techniques fit into the general process of solving engineering problems.

1.3 Problem statement and Research findings

In researching the application of ropes as dry lines, Berekuso, a town in the Eastern Region of Ghana, was used as a case study. Over 20 houses were visited, and some observations were made on the types of ropes used in these houses. The data collected revealed that 90% of the ropes used for dry lines were made of nylon, whereas 4% were made from rubber and 2% from sisal, but not used for dry lines.

Observations

1. 100% of the houses visited use synthetic ropes for dry lines.
2. 40% of these houses have sagged dry lines that left clothes touching the ground

Selection of Ropes For Dry Line

Based on these observations, the proposed hypothesis was that the sagging of the ropes was due to the heavy weight of wet clothes and high expansibility of the rope material; hence, there could be a superior substitute for dry lines. This hypothesis informed the decision to gather an available sample of ropes for experimentation.

Figure 1. A picture of the three samples: nylon(deep green), rubber(orange), and sisal white).

2.1 Design of experiment

The experiment aims to statistically select the best rope material amongst the identified group with low elasticity. A further investigation will be conducted on the best material chosen to determine which braiding style increased the toughness of the rope. The strand of sisal and rubber were twisted to form a rope in the same way as nylon is twisted to ensure uniformity in the rope samples being tested. Again, the three ropes were cut into an equal length, and their diameters were measured.

Collection of data

Using the Pasco machine, a force was applied to each of the materials. The force applied, and displacement (change in length) were recorded. After measuring the original length of each sample, the strain was calculated by dividing the displacement by the original length. The stress was also calculated by dividing the applied force on each rope by its area of the sample.

2.2 Statistical Analysis

Normality test: Before choosing ANOVA or Kruskal-Wallis, a normality test was performed to ascertain whether the data was normally distributed or not. With the help of Graphpad, nonparametric tests such as the D'Agostino & Pearson normality test, the Shapiro-Wilk normality test, and KS normality test [6] were performed to provide analysis that will not rely on assumptions that the data are drawn from a normal distribution.

D'AGNOSTINE & PEARSON NORMALITY TEST		
K2	18.49	12.18
P-value	<0.0001	0.0023
Passed Normality Test (alpha = 0.05)?	No	No
P value Summary	****	****
SHAPIRO WILK NORMALITY TEST		
W	0.9212	0.953
P-value	0.0026	0.0454
Passed Normality Test (alpha = 0.05)?	No	No
P-value Summary	**	**
KS NORMALITY TEST		
KS Distance	0.09932	0.07109
P-value	>0.1000	>0.1000
Passed Normality Test (alpha = 0.05)?	Yes	Yes
P-value Summary	ns	ns

Table 1: Results on normality test.

From the table above, the D'Agostino & Pearson normality [5] test yielded a p-value (0.0001), which is less than the confidence interval (CI) value (0.05), Shapiro-Wilk normality test also yielded a p-value (0.0026) which is also less than the CI value. Since the p-values are less than the estimated CI value, it implies the data is not normal. Although the KS normality test gave a p-value (0.09932), which is higher than the CI value, the other two tests were enough to ignore the result obtained by the KS test. This difference occurred because KS based its p-value on the most significant discrepancy of the distribution, which is efficient for accessing two samples, and not the three samples.

Performing the Kruskal-Wallis Test (nonparametric):
A nonparametric test was performed using the GraphPad software, and the table below depicts the results obtained:

TABLE ANALYZED	KRUSKAL-WALLIS DATA
Kruskal-Wallis Test	
P-value	<0.0001
Exact or approximate p-value?	Approximate
P-value summary	****
Do the medians vary significantly (P<0.05)?	Yes
Number of groups	3
DATA SUMMARY	
Number of treatments (columns)	3
Number of values (total)	336

Table 2. Kruskal-Wallis Test Results.

The results from the table infer that the mean values of the samples are different, hence different expansibility. Besides, the null hypothesis can be rejected since the p-value in the Kruskal-Wallis test (0.0001) is significantly smaller than the CI value. However, the highest expansibility remains unknown.

Post Hoc Test
To investigate how far the difference of expansibility is, a Post Hoc Test was performed. This test is a stepwise multiple comparisons procedure used to identify sample means that are significantly different from each other. It is used often as a post hoc test whenever a significant difference between three or more sample means has been revealed by an analysis of variance.

Number of families	1				
Number of companies per family	3				
Alpha	0.05				
Dunn's multiple comparisons tests	Mean rank diff	Significant?	Summary	Adjusted P-value	
Sisal vs Nylon	-132.5	Yes	****	<0.0001	A-B
Sisal vs Rubber	-117.8	Yes	****	<0.0001	A-C
Nylon vs Rubber	14.63	No	ns	0.8403	B-C
Test details	Mean rank 1	Mean rank 2	Mean rank diff.	n1	n2
Sisal vs Nylon	100.1	232.5	-132.5	122	122
Sisal vs Rubber	100.1	217.9	-117.8	122	122
Nylon vs Rubber	232.5	217.9	14.63	122	122

Table 3. Post Hoc Results

From the table above, when the mean value of sisal was compared to that of nylon, the p-value obtained was 0.0001. This value is smaller than the given CI value, which implies that there is a statistical difference between the two mean values. Hence, those two are not related. Moreover, when the sisal mean value was compared to that of rubber, the p-value was also 0.0001 which is likewise smaller than the CI value. Therefore, proving the statistical difference between the two. However, when nylon was compared with rubber, the p-value was 0.8403 which is higher than our CI value. This result implies that there is no statistical difference between the two. This test shows that statistically, sisal is different from nylon and rubber.

Material Science Analysis
It is seen that sisal is statistically different from the other materials. With knowledge from material science, we can look at the tensile strength and elastic modulus of the three examples to tell which one has the least expansibility.

Sample	Ultimate Tensile Strength (MPsi)	Elastic Modulus (MPa)
Sisal	84.6	3084
Nylon	14.07	516
Rubber	53.2	14.5

Table 5. Ultimate tensile strength and elastic modulus of three samples

From the above table, sisal has the highest ultimate tensile strength, which is followed by nylon and after that, rubber. The order is still the same in terms of the elastic modulus. This finding, therefore, implies that sisal is better than nylon in terms of using it as a dry line because it has the least expansibility. Again, we recorded data on the stress obtained at the same strain points using Microsoft Excel.

Samples	Sample Size	Mean	Median	Variance	Standard Deviation	Standard Error
Sisal	5	51.78	53.7	992.367	31.501857	15.75092
Nylon	5	9.1	10.8	25.31	5.030904	2.515452
Rubber	5	4.14	4.3	0.988	0.993982	0.496991

Table 6. Table showing significant statistical variables

Second Statistical Test

After inferring that sisal has the least expansion and, therefore, suitable for making a dry line, it was decided to find out how it can be put together to create a stronger rope. As such, two samples of sisal were made. One was designed by twisting two strands of sisal, and the other was made by putting two strands together side by side. Using the Pasco machine, the tensile strength was tested. As previously described the stress and strain of each were calculated.

Table Analyzed	Unpaired T-test data
Column B vs Column A	Twisted vs Joined
Mann Whitney test	
P value	0.8035
Exact or approximate P-value	Exact
P-value summary	ns
Significantly different (P < 0.05)?	No
One- or two-tailed P value?	Two-tailed
Sum of ranks in columns A, B	2489, 2562
Mann Whitney U	1214
Difference between medians	
Median of Column A	0.08167, n=50
Median of Column B	0.08363, n=50
Difference: Actual	0.001959
Difference: Hodges-Lehmann	0.001954

Table 7. T-test results

T-Test

For the two sisal groups, we performed a t-test. Since the data from each sample was independent of each other, an unpaired t-test is appropriate. It was assumed that the mean values of their strain would be the same – the null hypothesis.

After the t-test, the p-value obtained was 0.8035, which is higher than the confidence level, therefore, implying that there is no statistical difference between the two designs. So, either way of designing a rope for a dry line using sisal will still have the same strength, statistically.

4. Conclusion

4.1 Limitation.

The experimental data though revealed sisal to be the toughest material, failed to predict whether sisal remained the best material for dry lines when subjected to different factors, such as heat. Further experiments could have been done to collect and analyze data on sisal when exposed to weather conditions and mechanical strain. Also, the computed values in this paper were slightly higher as compared to literature values, which could be attributed to operational errors while using the Pasco machine. The Pasco machine required thin strands of the rope samples, thus, disallowing the performance of tests on ropes with a large thickness.

4.2 Conclusion and Future Works

To conclude, sisal has the least expansion; hence, it can be suggested as the best rope for making dry lines. Due to the lack of materials, we could not determine the behavior of sisal when exposed to various conditions, for example, higher temperatures and moist conditions. However, it should be noted that, even though we have declared it as the best for making a dry line, we cannot guarantee how durable it may be when exposed to different conditions. As such, we intend to research the performance of sisal in weather conditions in our future works, and we will, in this manner, consider structuring our analysis to discover the quality of sisal when exposed to a few weather conditions.

5. Acknowledgments

This project would not have been possible without the significant support of Elena Rosca (Ph.D.), Fred McBagonluri (Ph.D.), and the pioneering engineering class of Ashesi University.

We are very grateful for the insight obtained during our research in Berekuso township; they served as our case study for the project. A special note to our friends, families, and the MasterCard Foundation for their investment in us, without them, we would not have acquired the needed skills to embark on this experimental project.

6. References

[1] M. Gupta et al. "Tensile and flexural properties of sisal fiber reinforced epoxy composite: A composite between unidirectional and mat forms of fibers." P. 2439. 2014 Retrieved from http://www.sciencedirect.com/science/article/pii/S2211812814008542

[2]Laird Plastics. 2016. Retrieved from https://www.lairdplastics.com/product/materials/nylon/3350-nylon-101

[3] R. Kaufman. "Aztec, Maya were rubber-making masters?" 2010 Retrieved from http://news.nationalgeographic.com/news/2010/06/100628-science-ancient-maya-aztec-rubber-balls-beheaded/

[4] T. Renner et. L. Pék. Comparing the strength properties of natural and synthetic rubber mixtures. 2011. Retrieved from www.scad.ugent.be/journal/2011/SCAD_2011_2_1_134.pdf

[5] Normality test. Graph pad. 2010. Retrieved from https://www.graphpad.com/support/faqid/959/

[6] P. Royston, "Remark AS R94: A Remark on Algorithm AS 181: The W-test for Normality" Journal of the Royal Statistical Society. 1995.

Cotton Unpicked

An immaculate expanse of light, new-fallen snow[1]

By: Tamisha Dzifa Segbefia, Kristen Agyeman-Prempeh

Have you ever wondered why t-shirts are referred to as "t"- shirts? Has it ever crossed your mind as to why cotton is the most favored material for making t-shirts? Well, apart from being absorbent, cotton fabrics are also durable, weatherproof, and hypoallergenic. Egyptian cotton especially has a high thread count, which makes it among the most durable materials.

Nobody would want to wear a t-shirt that falls apart after being worn only a couple of times. In the same vein, the materials that make-up t-shirts should be durable, absorbent, resistant to wear and tear, and long-lasting. Cotton checks all these boxes by exhibiting the following characteristics that make it the best choice for t-shirts.

- **Absorbency** – It absorbs heat and sweat from the body. Also, a cotton t-shirt can retain up to 27 times its weight in water .
- **Durability** – It is highly resistant to wear and tear due to its toughness .
- **Wash and wearability** – The molecular structure of cotton shows that instead of becoming weak-er when wet, it becomes stronger. Therefore, even after numerous washing cycles, the shape of the cotton t-shirt does not change .
- **Custom printing** – Cotton provides an excellent screen-printing surface, making it the preferred fabric of many custom apparel decorators .
- **Environmental friendliness**

– as a sustainable, renewable, and biodegradable material, cotton is an excellent choice for an environmentally-friendly fabric .

The material under the lens of scrutiny, therefore, is none other than cotton.

Cotton is the world's number one non-food crop, and it makes up half of the world's market in textiles, explosives, oil, cattle food, and even tooth-paste. Cotton is a versatile material, as it is both an oil and crop and a fiber crop . It is a perennial herb/shrub that is pollinated by insects and is mainly found in Asia and Africa; however, it is cultivated in over 90 countries. Cotton makes up 2.5% of the world's cropland. Also, a quarter of the world's pes-ticides is used on cotton, rendering it one of the most expensive crops in terms of crop production.

There are 40 known species of the cotton plant. Now, however, only four of these are being cultivated for their fiber and seed (to produce cottonseed oil). These four are:

- *Gossypium herbaceum* (Herbaceous cotton): originating from Pakistan, India, and Africa
- *Gossypium arboretum* (Cotton tree): originat-ing from Pakistan, Sri Lanka, and India
- *Gossypium hirsutum* (Upland cotton): origi-nating from Mexico
- *Gossypium barbadense* (Extra-long staple cot-ton): originating from Egypt, USA, Brazil, Sudan, and Peru.

The first two species of cotton are mainly found in the Old World, which is made up of Africa and Eur-asia (Europe + Asia). The last two are mostly found in the New World, which is made up of the Ameri-cas and Oceania.

Figure 1. Image of cotton species Gossypium barbadense (Extra-long cotton) originating from Egypt, USA, Brazil, Sudan, and Peru. Image from luirig.altervista.org

The earliest usage of cotton dates back to 3000 BC when the Egyptians were using cotton clothing. It was mostly cultivated by slaves, further sparked by the slave trade. Although cotton was found in Africa initially, traders took it to Europe, and it gained recognition quickly.

At the beginning of the 20th century and through the end of World War II, out of the fibers used on a global scale, cotton accounted for 81% of fiber consumption.

When human-made fibers were first introduced in the 1940s, a slight shift away from cotton usage be-gan, and cotton usage dropped to 75 percent. In 1960, cotton accounted for 68 percent of all fiber usage, and in 1970 cotton accounted for 57 percent of all textile usage. Since the beginning of the 21st century, cotton has been used in about 39 percent of the world's fibers. While about 58 percent of fibres use synthetic materials, cotton is still the most used fiber among naturally produced, non-synthetic materials.

DID YOU KNOW?

The cotton lint from one 227 kg bale of cotton can produce 215 pairs of denim jeans, 250 single bed sheets, 750 shirts, 1,200 t-shirts, 3000 nappies, 4,300 pairs of socks, 680,000 cotton balls, or 2,100 pairs of boxer shorts!

Cotton is cultivated for its fiber and seed from which cotton fibers and cottonseed oil are obtained . There are various types of cotton fibers. Some include:

- Fleece (jackets, hats)
- Lace (embroidery, dresses)
- Khaki (military uniforms, trousers)
- Denim (jeans, denim skirts)
- Sateen (bed linen, curtains)
- Muslin (napkins, handkerchief)
- Terrycloth (bathrobes, towels)
- Velvet (upholstery fabric, clothing)

The cottonseed oil contains Vitamin E and is cholesterol-free which gives it a long shelf life. It is used in making soaps, rubber, paint, candles, and so on. Also, some unexpected uses of cotton are tents, car tire cord, fishnets, and bookbinders. They are mixed with other materials such as polyester.

A significant advancement in the field of cotton clothing would be the development of cotton that is fully water-repellent, not just water-resistant. Water-repellent fabrics are hydrophobic, which means that they repel water on contact. Imagine standing in the rain with a cotton hoodie that deflects the raindrops as they fall on you. Alternatively, imagine spilling a drink on your shirt and just using a paper towel to wipe off the drink without it staining your clothing? The possibilities are endless for water-repellent cotton clothing.

One of the existing ways of making cotton water-repellent is a non-toxic water-repellent coating developed by a team at MIT . Off the back of this idea, a significant milestone would be to produce cotton clothing and apparel that is inherently water-repellent without the need to spray it with an external coating. Employing the concept of biomimicry, one could look at how the lotus leaf manages to repel the water with which it comes into contact. On the surface of the lotus leaves, there are nanoscale hairs – this means that the hairs are microscopic – that facilitate the repelling of water . In this vein, cotton t-shirts (for example) could be produced with nanoscale hairs like those found on the surfaces of lotus leaves. The advantage of this is that the presence of the nanoscale hairs repels not just water but dirt as well. Imagine wearing a clean white cotton shirt that stays white from when you newly buy it to when you are ready to throw it away.

In a nutshell, cotton is among the most versatile fabrics. Although it is currently making waves, there is a world of possibilities to improve how we use cotton in our daily lives.

And by the way, the answer to our first question is that the sleeves and the body of the shirt make up a 'T' shape.

REFERENCES

1. *Solomon Northup*. Retrieved from https://www.brainyquote.com/quotes/solomon_northup_611070?src=t_cotton
2. Department of Electrical Engineering, Ashesi University, Berekuso, Ghana
3. Department of Computer Engineering, Ashesi University, Berekuso, Ghana
4. Retrieved from https://www.livestrong.com/article/59826-advantages-cotton-clothing/
5. Retrieved from https://sewguide.com/best-fabrics-for-shirts/
6. Retrieved from https://visual.ly/community/infographic/other/different-types-t-shirt-fabrics-and-more
7. Retrieved from http://info.fabrics.net/fabric-facts/cotton/
8. Retrieved from https://www.entripy.com/blog/why-cotton-is-the-most-popular-fabric-used-worldwide
9. Retrieved from https://www.entripy.com/blog/why-cotton-is-the-most-popular-fabric-used-worldwide
10. Retrieved from https://www.entripy.com/blog/why-cotton-is-the-most-popular-fabric-used-worldwide
11. Retrieved from http://www.cottoncampus.org/Cotton-Environmentally-Friendly-Sustainability
12. Retrieved from https://cordis.europa.eu/project/rcn/100484/reporting/en
13. https://www.livestrong.com/article/1001371-much-worlds-clothing-made-cotton/
14. Retrieved from https://www.livestrong.com/article/59826-advantages-cotton-clothing/
15. Retrieved from https://cottonaustralia.com.au/cotton-library/fact-sheets/cotton-fact-file-cotton-properties-and-products
16. Retrieved from https://cottonaustralia.com.au/cotton-library/fact-sheets/cotton-fact-file-cotton-properties-and-products
17. Retrieved from https://scitechdaily.com/mit-develops-non-toxic-alternative-to-water-repellent-coatings/
18. Retrieved from http://kidpid.com/lotus-ef-fect/#Lotus_Effect_How_are_lotus_leaves_able_to_clean_its_leaf_by_itself

SEED™
JOURNAL

GET YOUR PAPERS & ARTICLES PUBLISHED IN THE JOURNAL.

Maker Sessions

It is typically arduous for students to acquire industry-required technical skills during lectures. Though students learn all the theories and apply them in their final projects, there is still something missing. Most engineering students, after their first internships, say they wish they knew more before the placement. For this reason, "Maker Sessions" are organized to equip students with the necessary industry skills.

The main goal of the Maker Session is to introduce students to vital engineering skills, software, and hardware tools that the 21st-century engineer needs to be successful in any chosen engineering field. The session seeks to primarily help engineering students acquire hands-on skills that they may never obtain from regular class activities. To ensure the coverage of relevant content, all the skills, software and hardware tools explored are tailored towards real-world engineering problems. Not only does this expose young engineers to these necessary tools and skills, but it also helps students obtain project ideas, discover their passion in engineering, and, most importantly, experience and enjoy engineering in a fun and practical way.

"Since I joined the maker session in my first year, it has helped me learn some essential engineering skills like 3D modeling, electronic and electrical simulation with software like Proteus, working with microcontrollers and development boards such as Arduino, among other engineering tools. Most importantly, the maker session has made me very versatile in adapting to and using new technologies."

-Francis Aweenagu

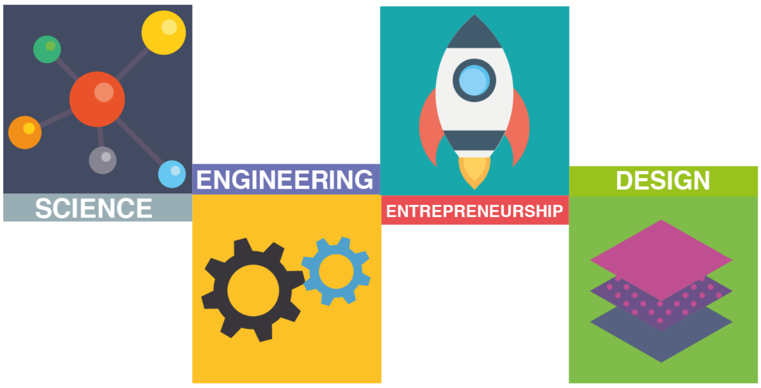
The sessions introduce students to Solidworks, Arduino, simple electronic components, 3D printing, workshop etiquettes, etc. These sessions are geared towards creating a "cool" introduction to engineering for freshmen as well as aid them to learn some fundamental skills needed for future engineering projects and class activities. Meanwhile, continuing students are also exposed to critical skills and software/hardware tools needed for capstone projects, end of semester projects and engineering outside school. Students receive trainig to use software tools like Proteus and Eagle (for PCB designs), work with Microcontrollers, ArmCortex development boards, and many more.

Since the inception of these sessions, three years ago, we have trained over 150 students across various major. These sessions are occasionally student-led and supervised by some engineering faculty. The student tutors stem from previous participants of the training sessions who have developed their skills to be able to transfer their mastery to their colleagues.

The Maker Session is open to students across all majors who believe in their passion to change the world by making things happen!

SEED JOURNAL

SEED stands for Science, Engineering, Entrepreneurship, and Design. It is a student-led science journal aimed at creating a platform for students and faculty in the Ashesi Community and beyond to share their research with the world. SEED seeks to be a great kickstarter for students who want to pursue research in graduate school, keep the community abreast with innovation happening in Ashesi and around the world, as well as to foster collaboration between students, lecturers and other institutions.



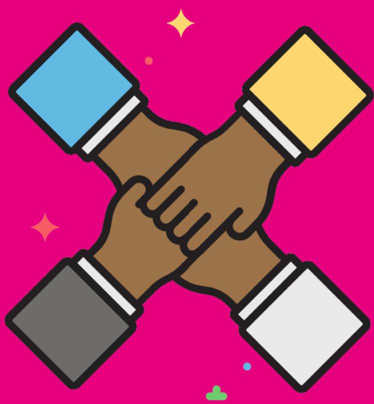
AFRICA-IN-SCOPE

Africa currently contributes only 1.1% to global scientific knowledge despite having about 17% of the world's population. SEED wants to pave the way for, especially researchers, innovators and tech entrepreneurs to increase their contribution to this global body of scientific knowledge.

FEATURES

The journal features scientific research papers, articles, news items, interviews, et al. that highlight scientific and technologically related information. All entrepreneurship and design features in the journal will have strong links to science and technology.

WE'D LIKE YOU TO CONTRIBUTE



Do you have any:

- Scientific Papers (from school projects, personal projects, capstones, etc)
- News
- Articles
- DIY projects
- Opinions

you want to share?

We have a wonderful team of dedicated peer reviewers with years of experience from various disciplines who will support you tomake your work reach world-class standards.

contact us or make your submission to:

seedjournal@ashesi.edu.gh

SCIENCE

ENGINEERING

ENTREPRENEURSHIP

DESIGN

SEED™ JOURNAL