

SLATT UNDERGRADUATE RESEARCH FELLOWSHIP FINAL REPORT

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| SCHOLAR NAME: | Matrika Franklin |
| FACULTY ADVISOR: | Dr. Abigail Mechtenberg |
| PROJECT PERIOD: | SP2022 – FA2023 |
| PROJECT TITLE: | Ugandan Wind Turbine |
| CONNECTION TO ONE OR MORE ENERGY-RELATED RESEARCH AREAS (CHECK ALL THAT APPLY): | <input checked="" type="checkbox"/> Energy Conversion and Efficiency <input type="checkbox"/> Sustainable and Secure Nuclear <input type="checkbox"/> Smart Storage and Distribution <input type="checkbox"/> Transformation Solar <input type="checkbox"/> Sustainable Bio/Fossil Fuels <input checked="" type="checkbox"/> Transformative Wind |

MAJOR GOALS AND ACCOMPLISHMENTS

Summarize your research goals and provide a brief statement of your accomplishments (no more than 1-2 sentences). Indicate whether you were able to accomplish your goals by estimating the percentage completed for each one. Use the next page for your written report.

| RESEARCH GOALS | ACTUAL PERFORMANCE AND ACCOMPLISHMENTS | % OF GOAL COMPLETED |
|--------------------------------|----------------------------------------|---------------------|
| Complete material testing | 3-point test via VSMT | 100 % |
| Model mechanical properties | via. MATLAB | 100 % |
| Explore current energy systems | via. Homer | 40 % |
| Model risk & entropy | In python via google collab | 40 % |
| Justify local sourcing | | 25 % |

RESEARCH OUTPUT

Please provide any output that may have resulted from your research project. You may leave any and all categories blank or check with your faculty advisor if you are unsure how to respond.

| CATEGORY | INFORMATION |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------|
| EXTERNAL PROPOSALS SUBMITTED | (Sponsor, Project Title, PIs, Submission Date, Proposal Amount) N/A |
| EXTERNAL AWARDS RECEIVED | (Sponsor, Project Title, PIs, Award Date, Award Amount) N/A |
| JOURNAL ARTICLES IN PROCESS OR PUBLISHED | (Journal Name, Title, Authors, Submission Date, Publication Date, Volume #, Page #s) In progress |
| BOOKS AND CHAPTERS RELATED TO YOUR RESEARCH | (Book Title, Chapter Title, Authors, Submission Date, Publication Date, Volume #, Page #s) |
| PUBLIC PRESENTATIONS YOU MADE ABOUT YOUR RESEARCH | (Event, Presentation Title, Presentation Date, Location) N/A |
| AWARDS OR RECOGNITIONS YOU RECEIVED FOR YOUR RESEARCH PROJECT | (Purpose, Title, Date Received) N/A |
| INTERNAL COLLABORATIONS FOSTERED | (Name, Organization, Purpose of Affiliation, and Frequency of Interactions) |
| EXTERNAL COLLABORATIONS FOSTERED | (Name, Organization, Purpose of Affiliation, and Frequency of Interactions) |
| WEBSITE(S) FEATURING RESEARCH PROJECT | (URL) N/A |
| OTHER PRODUCTS AND SERVICES (e.g., media reports, databases, software, models, curricula, instruments, education programs, outreach for ND Energy and other groups) | (Please describe each item in detail) |

RESEARCH EXPERIENCE

Please let us know what you thought of your research experience: Did this experience meet your expectations? Were lab personnel helpful and responsive to your needs? What else could have been done to improve your experience or achieve additional results?

FINAL WRITTEN REPORT

(Please use the space below to describe your research project and objectives, any findings and results you can share, and graphs, charts, and other visuals to help us understand what you achieved as a result of this research experience.)

The goal of this project is to explore basket woven wind turbine blades made by the local “weaving women” in Uganda from Fort Portal to Kampala. The woven blades are made using local fibers, hand-woven, and then covered in resin. Small-scale models of the blade were used for in the 3-point tests for this project. An example of what the blade would look like after testing its mechanical properties is shown in Figure 1, below.



FIGURE 1. MODEL OF UGANDAN HAND-WOVEN BLADE

Using the Vernier Material & Structures Testers (VMST), the model blades were tested for mechanical properties including, tensile stress, strain, yield force, and deflection. The data was collected and then modelled in MATLAB to be later compared with the data obtained by Janaya Brown in previous research. Figure 2 below shows an example of the results from the 3-point test.

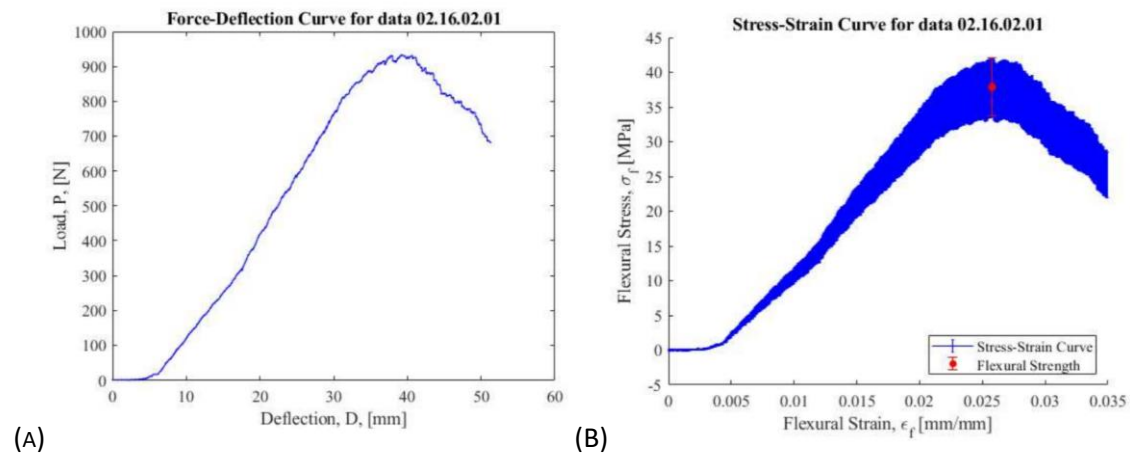


FIGURE 2. EXAMPLE OF MATLAB MODEULING RESULTS.(A) FORCE-DEFLECTION CURVE (B) STRESS STRAIN CURVE WITH VARIATION

To explore the realities of using this device for energy crisis interventions, Matrika collaborated with Christina Urrea’s entropy project. Data online from HOMER was systematically collected for different energy systems in various African countries, including Uganda and Rwanda. The energy systems were simulated under a scaled power load increase from a factor of 1.0 to 3.9 times the initial energy load. Numerous factors, including time shortage and entropy, were analyzed in Google Collab. A sample of the results obtained is shown in Figure 3 below.

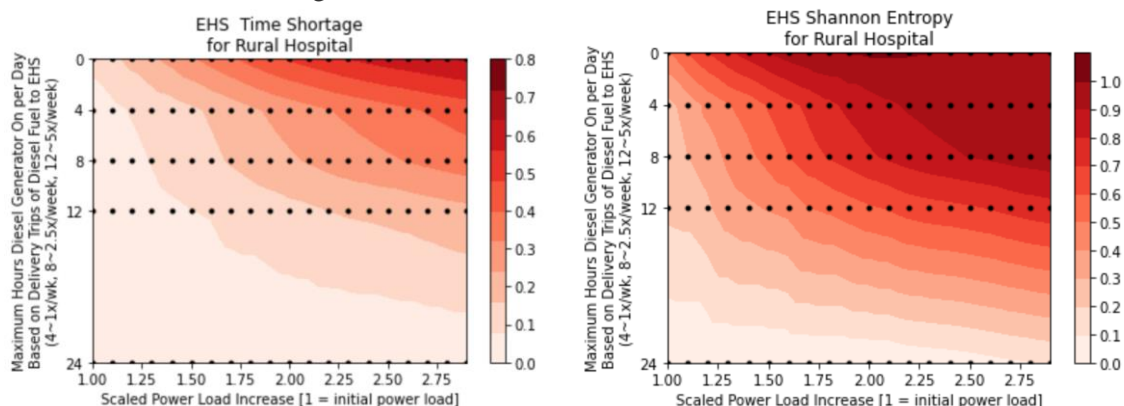


FIGURE 3. SAMPLE OF EHS SCALED POWER LOAD RESULTS FOR RURAL HOSPITAL (A) TIME SHORTAGE VS. SCALED POWER LOAD INCREASE (B) ENTROPY VS. SCALED POWER LOAD INCREASE. FIGURE TAKEN FROM *HEALTHCARE DURING ELECTRICITY FAILURE: HIDDEN ENTROPY* BY A. MECHTENBERG, C. URREA, L. OMEBOH, M. OGUNLOWO, E. ETWALU, L. NANJULA, M. MUSAAZI, M. FRANKLIN, H. FRANCOIS.

The next step of this project is to formally write out the justification for an implementation of hand-woven wind turbine blades. Currently, Matrika is interested in taking an engineering ethics approach and is hoping to be able to add to the relatively new conversation of engineering ethics. She plans to focus her discussion on the importance of incorporating of local work and communities. Matrika will continue to work on this project into the Spring of 2023.