NASENI RESEARCH COMMERCIALIZATION GRANTS PROGRAMME (NRCGP)
PROPOSAL SUBMISSION

1. **Project Title:**

Development and Commercialization of a Sustainable Unmanned Aerial Vehicle (UAV) from a Novel Hybrid Biocomposite from *SterculiaSetigeraDelile* fibre, *Pterocarpuserinaceus* particle and Epoxy Matrix for Sustainable Nigerian Aerospace and Surveillance Applications.

2. Principal Investigator (PI):
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3. Executive Summary:

This proposal seeks funding to commercialize a Novel material used to produce an Unmanned Aerial vehicle wing to produce a fully functional Unmanned Aerial vehicle made from Wood fibre and particle. The research is a result of an outcome from my PhD: the development of a fully functional Unmanned Aerial Vehicle (UAV) wing constructed primarily from a novel, hybrid biocomposite material. The material was made from the combination of *Sterculia setigera Delile* fibre (SSD) and *Pterocarpus erinaceus* (PTE) wood particle in an epoxy matrix. It offers a sustainable, low-cost, and high-performance alternative to imported carbon and glass fibres. The optimized composite demonstrates a **105.9% improvement in tensile strength** and a **94.91% improvement in flexural strength** over pure epoxy, with a significantly lower density (1.093 g/cm^3) than conventional composites. Finite Element Analysis (Abaqus) and physical structural testing have already proven that a wing made from this material can withstand ultimate load factors exceeding **20g**, far surpassing the FAA's 5.7g requirement. This project will transition this proven technology from the lab to a market-ready prototype, establishing a new value chain for Nigerian natural resources in the high-tech aerospace and surveillance sectors, directly supporting the **Renewed Hope Agenda** through job creation, technological sovereignty, and economic diversification. The Unmanned Aerial Vehicle would be locally made and would aid in the improvement of Surveillance and Security in Nigeria.

4. Alignment with NASENI's Thematic Focus Areas:
This project aligns directly with multiple NASENI thematic areas:

- **vii. Defense and Aerospace:** The primary output is a functional UAV platform with applications in border surveillance, infrastructure monitoring, and agricultural mapping.
- **ii. Health and Biotechnology:** Potential for rapid, low-cost deployment of medical supplies to remote areas.
- **iii. Agriculture and Food Manufacturing:** Enabling precision agriculture through crop health monitoring and field analysis.
- **i. Renewable Energy and Sustainability:** The use of natural, biodegradable fibres significantly reduces the environmental footprint of UAV manufacturing compared to synthetic composites.
- **v. Information Technology and Software Development:** The UAV platform will integrate with data collection and analysis software.

5. Innovativeness & Novelty:

- **World's First UAV from SSD/PTE Composite:** To the best of our knowledge, this will be the first fully functional UAV airframe manufactured from this specific hybrid biocomposite.
- **Sustainable Material Sourcing:** Utilizes underutilized Nigerian natural resources (*Sterculia setigera* and *Pterocarpus erinaceus* waste dust), transforming them into high-value engineering products.
- **Superior Performance-to-Weight Ratio:** The optimized material properties challenge the dominance of expensive imported composites for specific non-critical aerospace applications.
- **Reduced Carbon Footprint:** The production process of natural fibres consumes less energy and generates less pollution than synthetic fibre production.

6. Commercial Viability:

- **Target Market:** The global UAV market is projected to exceed USD 100 billion by 2030. Our initial target segments include:
  - Nigerian Security and Defense Agencies (surveillance, reconnaissance)
  - Agricultural Sector (farm monitoring, crop spraying)
  - Infrastructure and Construction Companies (site surveying, inspection)
  - Academic and Research Institutions (low-cost research platform).
- **Cost Advantage:** Local sourcing of primary materials (SSD fibre, PTE wood dust) will drastically reduce production costs compared to UAVs built from imported carbon fibre, making this technology highly accessible.
- **Path to Market:** We propose a two-phase commercial rollout:

1. **Phase 1 (0-18 months):** Prototype refinement, certification, and pilot projects with government agencies.
2. **Phase 2 (18-36 months):** Establishment of a spin-out company or partnership with existing aerospace/defense contractors for scaled manufacturing and sales.

- **Letters of Intent/Interest:** (To be secured upon grant shortlisting). Initial discussions have indicated strong interest from departments within NASRDA and the Ministry of Agriculture for pilot use cases.

7. Preliminary Results & Technology Readiness Level (TRL):

- **TRL 4 (Component Validation in Lab Environment):** Achieved. The material has been extensively tested (Tensile, Flexural, Compression, TGA) and optimized. A prototype wing has been successfully fabricated and structurally tested under load, validating the simulation models.
- **Peer-Reviewed Publications:** Three first-author journal publications (provided) form a robust scientific foundation for the technology:

1. Optimization of Hybrid Biocomposite (Wood Industry and Engineering)
2. Optimization of SSD Fibre Composite (TIJMET)
3. UAV Wing Performance Evaluation (Research on Engineering Structures & Materials)

- **Proof-of-Concept:** Finite Element Analysis (Abaqus) conclusively shows the UAV wing design meets and exceeds international airworthiness standards (FAR Part 23).

8. Project Plan and Deliverables:

- **Duration:** 24 Months
- **Key Milestones:**

  - **Month 1-3:** Detailed design of full UAV system (airframe, avionics, propulsion).
  - **Month 4-9:** Fabrication of all composite components (fuselage, wings, empennage).
  - **Month 10-12:** Assembly and integration of avionics, power systems, and payload.
  - **Month 13-18:** Ground testing, system calibration, and controlled flight tests.
  - **Month 19-21:** Performance optimization and refinement.
  - **Month 22-24:** Final demonstration to stakeholders, comprehensive reporting, and development of a full business plan for commercialization.
- **Final Deliverable:** A fully functional, flight-tested UAV prototype, a detailed technical report, and a comprehensive commercialisation strategy.

9. Potential for Scale & Sustainability:

- **Scalability:** The hand lay-up process can be scaled to automated pre-preg and compression moulding techniques for mass production. The raw materials (wood dust and fibres) are abundant and renewable.
- **Economic Impact:** Creates a new manufacturing niche in Nigeria, reducing reliance on imported aerospace components. It will generate jobs in material processing, composite manufacturing, and UAV assembly.
- **Environmental Impact:** Promotes a circular economy by utilizing agricultural and wood processing waste. The end-product is lighter, leading to lower energy consumption during UAV operation.
- **Continuous Improvement:** Future work will focus on enhancing fire retardancy, moisture resistance, and exploring other Nigerian natural fibres for different applications.

10. Budget Outline (Summary):
A detailed budget is provided. Funding is sought for:

- **Materials & Consumables:** Epoxy resins, hardeners, fibres, wood particle, mould fabrication materials.
- **Equipment Access & Usage:** For advanced fabrication and testing.
- **Avionics & Systems:** Flight controller, motors, batteries, sensors, communication systems.
- **Personnel:** Support for a research assistant and technical staff.
- **Prototyping & Testing:** Costs associated with multiple iterative prototypes and flight tests.
- **Commercialization Activities:** Patent filing, business development, and stakeholder engagement.

11. Conclusion:
This project represents a unique opportunity to leverage cutting-edge Nigerian research to create a commercially viable, sustainable, and strategically important technology. By supporting the transition of this PhD research from the laboratory to a functional aerospace product, NASENI will not only fund a project with high commercial potential but also firmly position Nigeria as an innovator in sustainable advanced manufacturing, directly contributing to the nation's industrial development and security. We are confident that our proven research foundation and clear commercial pathway make this proposal a strong candidate for the NRCGP grant.

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