1. **Research Title:** Bio-inspired, multi-functional hybrid material systems
2. **Individual Sponsor:**
    i. Dr. Katie E. G. Thorp, AFRL/MLBC,
    ii. AFRL/MLBC Bldg 654, Room 208; 2941 Hobson Way ; WPAFB, OH 45433-7750
    iii. Katie.Thorp@us.af.mil
3. **Academic Area/Field and Education Level:** Materials Engineering, Mechanical Engineering, Chemical Engineering, Civil Engineering, Engineering Mechanics, and Computer Science (BA/BS, MS or Ph.D. level)
4. **Objectives:** Hierarchical morphologies and complex assemblies are goals of many advanced materials research programs today. These structures are commonplace in biological materials. Nature offers numerous examples of exquisite morphologies that provide for self-healing, morphing, multifunctionality and new property trade spaces in load-bearing structures that parallel the capabilities currently desired from materials for Air Force systems. The study of morphologies and structure-property relationships of materials found in nature can provide inspiration for, and guide the design and development of, new materials and material systems. This is truly an exciting time for bio-inspiration and bio-mimetic research in the materials community, as today we have characterization capabilities, computational tools, and nanoscale-to-macro scale material control that did not exist twenty years ago when early researchers began investigating this area.

5. **Description:** Materials scientists have a calling today to investigate new directions and opportunity space of development in the face of the non-traditional and unanticipated warfare of the future. No longer is evolutionary improvement sufficient in structural and non-structural materials: revolutionary capabilities are sought. History has shown that the impact of emerging technologies is typically underestimated, and that game-changing technologies, such as stealth, are not always 'pulled' by the warfighter until the benefit has been demonstrated. The ability for natural materials to respond to complex environments may be a key attribute for materials for the disruptive and unanticipated warfare of the future. Multiple examples appear in nature where natural systems have adapted unique and complex mechanisms, structures, or processes for load transfer and energy absorption. Such material/structural configurations offer properties that lie outside of the traditional trade spaces of today's state-of-the-art. For example, materials that tend to exhibit high modulus typically offer low strain to failure. In addition, current structural configurations contain inefficient and costly bolted or bonded joints. Material/structural configurations that exhibit a new balance of key engineering properties can enable new structural and device designs. In addition, nature has unique approaches to camouflage processes, self-healing, shape change, and thermal transport that are of great interest to near and far term platforms. A research effort is required to determine the natural systems with the most promising characteristics and then to follow-up with in-depth investigations to augment our current research programs. We will focus upon materials and structural configurations that respond to unexpected and complex environments such as those listed above. We will include a limited effort to include less-studied or less-understood materials and material architectures that offer unique property combinations.

6. **Research Classification/Restrictions:** This research is unclassified and not subject to restrictions.
7. **Interest in Summer USAFA Cadet (Avg Cost for USAF Cadet for 33 days was $4000):** Probably not.
8. **Eligible Research Institutions:**

☐ X Universities (DAGSI) ☐ AFIT (only) ☐ USAFA