Nanotechnology in the Air

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Executive Summary

NanoHUB.org has alerted our engineering team to a problem. Namely, that the underclassmen at the university level believe that nanotechnology is not something they will deal with until later in their academic careers- or something they will not have to deal with at all. NanoHUB has tasked our team with assisting in the solution of this problem by creating a Graphical User Interface (GUI) using MATLAB. This ‘solution’ must meet each of the following six criteria:

1. Clearly helps peers understand the Size & Scale of nanotechnology (big idea #1).

2. Clearly assists peers in connecting Size & Scale to at least one other nanoscience (big

ideas #2-5).

3. Clearly connects 1. & 2. to one or more engineering disciplines.

4. Uses simulation(s) to enable visualization and exploration of models related to 1., 2., and 3.

5. Is highly engaging and interactive for peers.

6. Is easy to use and operate.

Our team has decided that the best way to solve NanoHUB’s problem is by creating a set of GUIs to explain different aspects of nanoparticles as if they were being used to design an airplane. Each of our simulations applies to a different aspect of the plane’s design. This will help teach students the importance and functionality of nanoparticles while relating them to something more well-known, such as an airplane. Relating all four simulations to building an airplane helps verify that the information being delivered to the user actually has a real-world application and applies to an engineering field.

Our solution meets these criteria 1 by showing and allowing the user to interact with rivets on a plane wing, carbon nanotubes in the wing, and graphene molecules in the nanotube.

Our solution meets criteria 2 by showing how nanoparticles can react chemically in surprising ways due to their increased surface area (size-dependant properties).

Our solution meets criteria 3 by placing the user in a scenario where they are an aeronautical engineer and have a design they wish to present to a board of directors, but need some information from the chemical engineering and mechanical engineering teams to finish up and make some informed decisions.

Our solution meets criteria 4 by plotting various nanoscale properties that can affect the building of an aircraft against time (for example, structure of a wing during takeoff).

Our solution meets criteria 5 by providing multiple inputs in each simulation and providing the user with a story of sorts, instead of just thrusting information at them.

Our solution meets criteria 6 primarily by eliminating the need for typed user input. Instead the user will select from a series of buttons, or operate a slider, etc. This also helps eliminate user error.

Throughout each Milestone, many new ideas and concepts are generated. These ideas and concepts help develop our GUI into a better, more efficient solution. The significant changes are listed below:

1. We changed our final solution from the basis of Nano-tubing to the final idea with building an airplane through the use of different nanoscale techniques. This change is significant because our entire GUI went into a better direction and became more cohesive.
2. After Milestone 4, we made significant layout changes. These layout changes were needed to unify the entire GUI and allow it to flow easily from one GUI to the next.
3. With NanoHub coming in for Milestone 6, we made many improvements with their advice. One significant change was the change to Nelson’s GUI. Nelson’s original GUI was simply zooming in on a random picture, but this was then changed to airplane parts. This change helped reinforce the idea of nanoscale.
4. Another significant change was the additions of the scroll over tip bars for the main menu. These tip bars allow users to learn about the GUI before they enter it.
5. Our last significant change came as feedback from the instructional team. Each GUI was a little wordy and in order to cut back on this visuals were needed. We added visuals to each intro GUI to bring color to the GUIs.

It is important to be able to evaluate the effectiveness of a solution after it has been developed. Since the design cycle for any type of project is iterative, it is critical that a criteria for success be established so that engineers know what they did well and what needs to be improved in the next design iteration. NanoHub has provided our team with these six criteria that must be met before we can deliver our product: [ bulleted list of criteria ]

We seek to fulfill the first criteria with our 'NanoSize' simulation. This simulation involves assembling aircraft parts virtually on the screen by clicking and dragging. It will calculate and display any user error incurred in nanometers so that the user may get an understanding of the scale of these microscopic tolerances in the aerospace industry.

The second criteria, linking size and scale to another nanoscience field, is achieved with our NanoEnergy and NanoMelt simulations. Both of these allow the user to control the size of the repeating geometry within nanostructures, linking them to cohesive strength (aka lattice energy) and melting point properties (phase change energy).

The third criteria is possibly the most important of all six, since we wanted to leave the user with a knowledge of the scope of nanotechnology across all disciplines. To achieve this, each of the GUI's provides some background information on the relevant engineering discipline, and then presents the user with a hypothetical situation in which they must assemble or design an aircraft part. For example, in 'NanoPlane', the user is tasked with the responsibility of a materials engineer icreating an airplane wing. The user must select the optimal density of the repeating nanoscale units while taking into consideration factors like overall weight and wing strength. We expect the model of a hypothetical situation to serve towards criteria 5 (interest and interactivity), as many of the target users will want to know more about relevant future careers.

Each of the team members GUI's used in the deliverable provides a simulation and allows the end user to explore various mathematical models. The interactive nature of these simulations also makes the overall GUI more engaging. Each simulation is accompanied by a page dedicated to providing instructions to the user. Additionally, the team observed some basic conventions to ensure the best user experience. For example, all navigation buttons are located in the same general area.