3 Design

3.1 Design Context

3.1.1 Broader Context.

Describe the broader context in which your design problem is situated. What communities are you designing for? What communities are affected by your design? What societal needs does your project address?

Our project has a fairly narrow context, all things considered. We're designing for Iowa State University students interested in learning more about complex embedded systems, specifically those taking CPRE 488 in the spring 2022 semester. The project addresses the societal need of needing skilled embedded programmers as more and more devices are created and manufactured.

List relevant considerations related to your project in each of the following areas:

Area	**Description**	**Examples**
Public health, safety, and welfare	How does your project affect the general well-being of various stakeholder groups? These groups may be direct users or may be indirectly affected (e.g., solution is implemented in their communities)	The drone could cause minor injury if it collides with an individual
Global, cultural, and social	How well does your project reflect the values, practices, and aims of the cultural groups it affects? Groups may include but are not limited to specific communities, nations, professions, workplaces, and ethnic cultures.	The drone will be used to teach engineering students more about advanced embedded systems
Environmental	What environmental impact might your project have? This can include indirect effects, such as deforestation or unsustainable practices related to materials manufacture or procurement.	The batteries the drones use are not great for the environment and are prone to catch fire
Economic	What economic impact might your project have? This can include the financial viability of your product within your team or company, cost to consumers, or broader economic effects on communities, markets, nations, and other groups.	An impressive drone demo could attract potential corporate or private donors, and potential future students

3.1.2 User Needs

List each of your user groups. For each user group, list a needs statement in the form of:

User group needs (a way to) do something (i.e., a task to accomplish, a practice to implement, a way to be) because some insight or detail about the user group.

CPRE 488 needs a functional drone system where they can write their own control logic for in class labs to learn more about advanced embedded systems.

3.1.3 Prior Work/Solutions

Include relevant background/literature review for the project

– If similar products exist in the market, describe what has already been done

– If you are following previous work, cite that and discuss the advantages/shortcomings

– Note that while you are not expected to "compete" with other existing products / research groups, you should be able to differentiate your project from what is available. Thus, provide a list of pros and cons of your target solution compared to all other related products/systems.

Detail any similar products or research done on this topic previously. Please cite your sources and include them in your references. All figures must be captioned and referenced in your text.

We are following previous work that has been for years, most recently by the 2020 MicroCART team. This is advantageous in that we have code and repositories (https://git.ece.iastate.edu/danc/MicroCART/-/tree/2020-team-final-state) to look at, but we definitely are operating a different project. We are dealing with a much smaller version and different kind of drone than what has been used previously, which will definitely differentiate our work from others.

3.1.4 Technical Complexity

Provide evidence that your project is of sufficient technical complexity. Use the following metric or argue for one of your own. Justify your statements (e.g., list the components/subsystems and describe the applicable scientific, mathematical, or engineering principles)

1. **The design consists of multiple components/subsystems that each utilize distinct scientific, mathematical, or engineering principles –AND–**
2. **The problem scope contains multiple challenging requirements that match or exceed current solutions or industry standards.**

The design consists of multiple components/subsystem that each utilize distinct scientific, mathematical, or engineering principles. These components/subsystems are:

- Groundstation
    - includes computer software skills
- CrazyFlie drone
    - includes computer hardware skills
- Firmware flashed to the CrazyFlie
    - includes computer engineering skills

        - Will utilize several popular software engineering principles such as Separation of Concerns, Modularity, Abstraction, and Incremental Development
- Test Stand
    - involves 3D modeling,
    - electrical engineering
    - embedded systems

3.2 Design Exploration

3.2.1 Design Decisions

List key design decisions (at least three) that you have made or will need to make in relation to your proposed solution. These can include, but are not limited to, materials, subsystems, physical components, sensors/chips/devices, physical layout, features, etc.

- wifi chip decision
- what exactly to do for demonstration
- how gui will look
- what system(s) the control will be used on
- What sensors will be embedded in the test stand

3.2.2 Ideation

For one design decision, describe how you ideated or identified potential options (e.g., lotus blossom technique). List at least five options that you considered.

We identified potential options for sensors needed through client and group requirement discussions and brainstorming:

- sensors
    - rotation
    - vibration
    - voltage
    - gyroscope
    - IR

3.2.3 Decision-Making and Trade-Off

Demonstrate the process you used to identify the pros and cons or trade-offs between each of your ideated options. You may wish you include a weighted decision matrix or other relevant tool. Describe the option you chose and why you chose it.

Our process for creating these pros and cons was through discussion with the client and group members to make sure we covered all areas of concern.

- affordability (keeping in mind project budget),
- availability (what is in stock and what the lab already has),
- what fits our design
- what works with our firmware

3.3 Proposed Design

Discuss what you have done so far – what have you tried/implemented/tested?

We have tested our existing interface and fleet of drones.

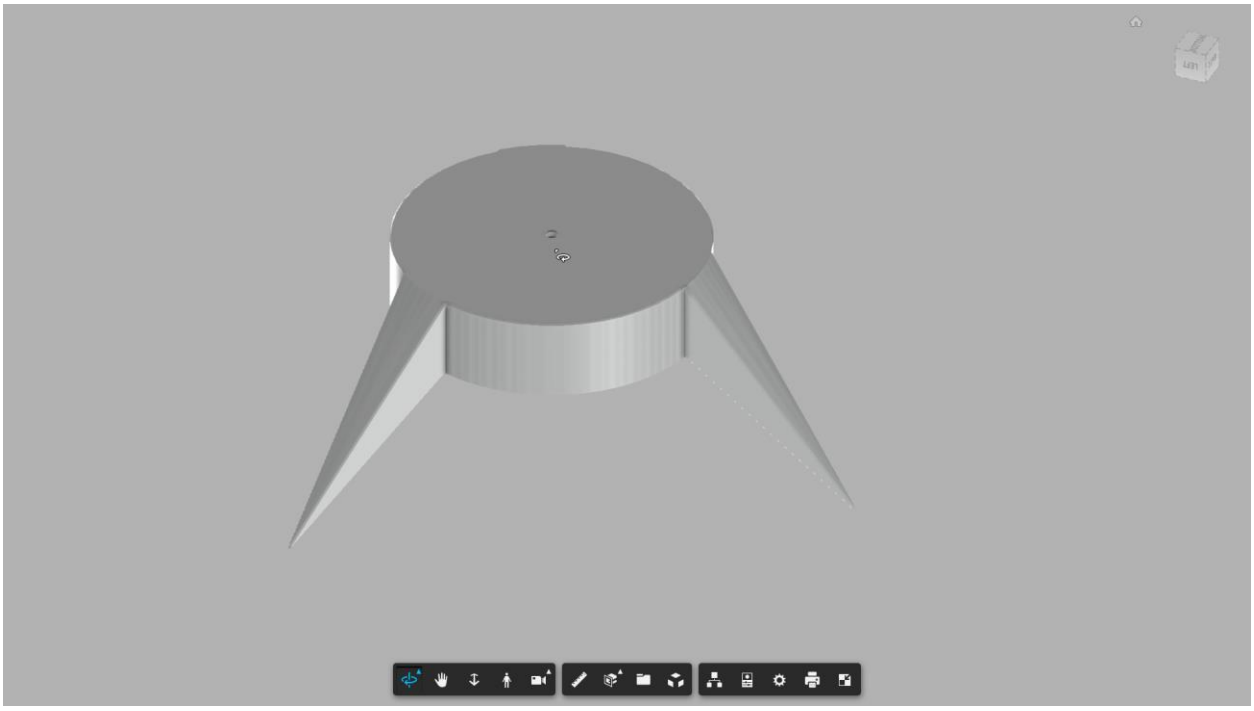
We evaluated the existing test stand designs and began to modify it to house the sensors we decided to include.

3.3.1 Design Visual and Description

Include a visual depiction of your current design. Different visual types may be relevant to different types of projects. You may include: a block diagram of individual components or subsystems and their interconnections, a circuit diagram, a sketch of physical components and their operation, etc.

Describe your current design, referencing the visual. This design description should be in sufficient detail that another team of engineers can look through it and implement it.

Test Stand Model:



Our current drone is the CrazyFlie 2.0. The Crazyflie 2.0 is a versatile open source flying development platform that weighs 27g and fits in the palm of your hand. Crazyflie 2.0 is equipped with low-latency/long-range radio as well as Bluetooth LE.

3.3.2 Functionality

Describe how your design is intended to operate in its user and/or real-world context. This description can be supplemented by a visual, such as a timeline, storyboard, or sketch.

Our design will let students create their own control logic for the drone and let students gather data from the test stand as well as to show off when prospective students visit.

How well does the current design satisfy functional and non-functional requirements?

Our design is a work in progress. Our plans fit the functional and non-functional requirements but so far we have not gotten far enough to implement any requirements.

3.3.3 Areas of Concern and Development

Based on your current design, what are your primary concerns for delivering a product/system that addresses requirements and meets user and client needs?

Our primary concern is that the existing firmware will not be compatible with current hardware.

What are your immediate plans for developing the solution to address those concerns? What questions do you have for clients, TAs, and faculty advisers?

We are addressing these concerns by researching other firmware for the crazyflie so if worst comes to worst, we can just create our own firmware based off of the crazyflie open source firmware. A question for our client that we have is where is the firmware interface (which was talked about in a previous meeting) located in the git?