EECS 473: Project Proposal

The draft proposal is due on Friday 9/18 by 11pm. The final proposal is due on Thursday 10/1 by 11pm. Both will be turned in via Gradescope. **Please name the file you turn in XX_YYYYYYY.pdf**, where XX is your group number (with a leading zero if only one digit) and YYYYYYY is a very short project description. So, something like "03_CarComms.pdf" or "12_Balloon".

The draft proposal is intended to be exactly that—a full proposal (other than where noted in this document), but only a draft version. The 473 staff will read and grade the draft proposals. If there are serious/obvious issues, we will contact you and describe our concerns via e-mail (perhaps asking for a new draft). Otherwise we will meet with each group and provide feedback on or around 9/24. Then over the next week your group will write a final proposal. The draft proposal is worth 3% of your project grade, the final proposal is 12%. *We urge you to take advantage of office hours to ask for feedback and "bounce ideas" off of the staff during this entire process.*

In some cases, the draft proposal will be radically different than the final proposal (though that is obviously not ideal!)

The assignment

Your group is to write a detailed proposal for your project. You will need to cover the following topics:

- ***Design Intent***—what problem is the design solving?
- ***Engineering Criteria***— a list of features/characteristics desired for a successful design.
- ***Proposed Implementation***— Consider possible solutions, pick one and provide:
  - ***Budget and Bill of Materials***—a list of materials that will be used.
  - ***Gantt Chart***—a list of topics to be done, when they will be done and what they are dependent on.
  - ***How it meets the Engineering Criteria***—this may include things such as a power, energy, or weight budget.
- ***Team Agreement***—what are the group expectations? When and where will regular meetings be held?

In addition, you will be generally expected to include a number of drawings or sketches of your product both as a stand-alone device and in the context where it will be used. We realize that not every group will have a great artist, but a basic sketch, either freehand or with a drawing program, will almost always help make it clear what you are trying to build.

Writing the document

Ideally writing this document will be an iterative process. Work on the design criteria as a group. Discuss the high-level design and give someone the task of writing up a draft of that section for discussion the next day. Consider using the Pugh chart methodology to actually list your options and goals. It can be very useful if there are more than two design choices. As you discuss implementation issues you will likely find flaws in your high-level design or maybe even your design criteria. Don't grow too attached to the words you have on the paper—they will change. In any case, we recommend you write the design criteria first and write the executive summary last.

As far as report length goes, while there is no page requirement we do expect proposals will be in the range of 8-15 pages without the required appendices (described below). Don't write words just to fill space if you are short. But if you are finding yourself over 15 pages you probably need to tighten your language and take a look at your structure.

The following table summarizes the difference between the draft and final report:

Item	**Draft**	**Final**
Main report sections	Required	Revised
BOM	Preliminary	Detailed
Interconnection diagram	Encouraged	Required
Power/cost/etc. analysis (if relevant to your project)	Preliminary	Detailed
Appendix A	Required	Revised
Appendix B	Required	Revised
Appendix C interfaces	Optional	Required
Appendix D	Required	Revised

Assignment Body

Your proposal should include the sections listed below.

Executive summary

Provide a quick overview of the entire report. What is the problem being solved? Why is it important? How might you solve it? This should be between a third and two-thirds of a page in length. It should have a bit of a "pitch" aspect to it in that it should endorse the existence of a problem and your solution to that problem, but a "just the facts" quality should be dominant. There should be, at some point, a short, one-sentence (or less) summary of the *project objective* and that should be highlighted in some way. Something like "reduce traffic accidents" or "gather photographic data of Mars".

High-level description

This section should start out detailing the ***design intent*** and background. Why is this product helpful? Who will use it? Why do you believe it will see use? The reader should be able to clearly understand what problem your product is solving. Parts of this will have a fair bit of overlap with the design criteria table you will supply in an appendix, but it will be written in prose and be at a higher level. Where relevant, cost, reliability, safety, production and similar requirements should be discussed here.

Once you have identified the design intent, now you should proceed to the ***engineering criteria***. These are the characteristics of a successful solution. Rather than "long battery life" and "light weight" it may be "lasts 30 days without being recharged" and "weighs less than 2 ounces". These criteria should be justified, perhaps by comparisons to similar devices on the market, perhaps by common sense, or perhaps by some user study. But why you choose certain values should be clear to the reader.

Once you have established a need and requirements, provide a high-level overview of your proposed solution. Some idea of the physical manifestation of the project (how it will look) and basic means of functioning (how it does what it does) should be included. *Diagrams, drawing, pictures, or other visual representations are often invaluable here*. The basic technical components of your solution should be mentioned, but the focus should be on how the design meets the design intents and engineering criteria you

discussed above. For example, if low-power is an issue, briefly detail the power budget. If low-cost is a driving factor, detail the major cost points. If low false-positives are key, explain how you will achieve that. So, while your overall designs are important to discuss here, you are mainly explaining how you are addressing the problem(s) described above.

You should make it clear to the reader that you've considered a number of ways to address the needs you've identified. That could be radically different high-level embedded solutions (using a wireless connection rather than a wired one for example) or even things like using a cell phone or laptop rather than an embedded system.

We also expect that your group will not have settled on all the different design points—likely some things are still being debated by the team. We want you to pick at least one thing your group is unsure of how to address and detail at least two solutions. We'd like this to be a non-trivial aspect of your design (processor choice, display technology, or even a radically different solution to the design).

This section should convince the reader that your group:

A. Understands the problem(s) being addressed
B. Understands the design intent and has identified reasonable engineering criteria.
C. Has considered a variety of reasonable high-level solutions and settled on a good way forward.

Implementation issues

This is where you dig into the technical nature of your ***proposed solution***. What are the inputs and the outputs of your device? What sensors, actuators, and communication schemes are you planning on using? A high-level drawing of the various parts is almost always useful here[1]. You should discuss the major components of your design and why you have chosen a particular part (or what parts you are still considering and on what basis you will make the decision). Describe trade-offs you have made (cost or weight or power vs. functionality; engineering effort vs. part cost etc.) in making the choices you have made. Here a Pugh chart might be useful. This section should be fairly detailed. If your group debated (or is still debating) lower-level design options and alternatives, that should go here too.

Having some kind of diagram showing how the various devices will be connected and interact would be useful. It can be hard to have a good diagram in the draft proposal, but the final proposal should have one. There are a few examples of such diagrams at the end of this document.

Also, if you have serious power, size, or cost constraints on the project, please try to address those issues. For the draft proposal you may end up with only some rough things (*e.g.* "we think we'll use part X which uses 0.2W of power when active but is only active 1% of the time" or "We want the cost to be under $3.00 per unit and at a cost of $0.25 per component, Item Z seems like a reasonable choice"). But by the final proposal you should have a clear budget for that constraint. A power budget might include the total energy used, the total energy coming into the system (if say, using solar panels) and a solid (and justified) guess about how much battery storage you might need. A money budget can be trickier (how do you estimate costs for 1000s of parts realistically, DigiKey is usually *way* overpriced even for buying things in quantity.). Size and weight are usually fairly easy, but not always.

[1] Sometimes this drawing should include the physical environment, sometimes it should just be how the parts are connected. It's a tricky balance, but avoid useless figures that don't add anything as well as figures that are so busy it's hard to get useful information out.

This section should convince the reader that your group:

A. Has done "due diligence" in considering various implementation options.
B. Your group has either chosen the right solutions given your design intents or has a clear plan for making those decisions in a timely way.

Way forward and schedule

Your group has a plan of what to build, now how will you implement it? Describe the major tasks that need to be done. Create a ***Gantt chart***[2] that *includes the dependencies* between the various tasks. You should end up with 3-5 major tasks and perhaps 6-10 smaller tasks. Explain what dependencies exist and why you are ordering tasks the way you are. Where are things most likely to go wrong? Does your schedule give you room to deal with those problems? Be sure this is readable when printed.

Indicate what your planned status will be for each of the milestones. What will you be able to demonstrate? It may be obvious from the Gantt chart, but make it explicit. For each milestone, list at least four targets. At least two of the four must be objectively demonstrable and should be bolded. "All modules written" can't be demonstrated (how do you know there aren't more?). But "can display distance accurately" can be. *A demonstrable milestone should be something a staff member could watch, measure, or test and then give a yes/no answer as to whether it works*. In addition to having these milestone deliverables described here, they will also be listed in Appendix B.

The project will conclude with the Design Expo. Describe what will be demonstrated at the Expo. Think about what you'll need (large space, being outside, etc.). Give some thought to this, it often isn't trivial. For example, if you are going to build something that monitors water pipes in a house, how will you show it works at the Expo?

This section should convince the reader that your group:

A. Has a realistic and thought-out plan for finishing the project on time.
B. Has recognized where problems are most likely to occur and has contingency plans formed.
C. Has a plan about how you'll demonstrate your project at the Design Expo.

Budget and materials

Depending on how detailed your implementation section is, this might consist of nothing more than a filled in table with budget information. But it will likely include more details about part choices and decisions still to be made. Indicate your total budget ($250/person max) and provide a table which indicates (as much as possible)

1. A description of each part you need
2. Cost per part
3. Number of parts
4. Who the vendor is for the part
5. What the URL is for the part[3]
6. Estimated shipping costs[4]

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[2] Most students don't really understand Gantt charts. The goal is to show task dependencies and how one task's deliverable will impact other tasks. This helps you to prioritize tasks. If something is on a long dependency path you need to get on it right away.

[3] It might be best to leave this out in the body of the document and include it in an appendix, perhaps in landscape mode with a smaller font.

[4] You may want to express this per vendor.

If you do have a fairly detailed budget, you might want to have a summary here and include the complete budget as an appendix. For the draft proposal it is very likely you won't have selected parts—just include those parts of which you are fairly certain you will use.

This section should convince the reader that your group:

A. Has a reasonable plan for staying within budget.
B. That you have selected parts that will enable you to meet your goals (*final proposal only*).

Conclusion

This short section just ties the report together. It should touch on the risk factors and difficulties but focus on why success is likely and why making this is a good idea.

Required Appendices

In this proposal you will be supplying four appendices that would not normally show up in a formal proposal document. Much of this would be documents internal to the group or simply part of your corporate culture. But since you should be creating these documents anyways, we're asking to see them.

A. Appendix A details your goals and their relative importance in a table format. This is to help you figure out what are absolute requirements of your project, what could be dropped if needed, and what will only be added if things are going well. These goals are part of your *design constraints*[5].
B. Appendix B is just a clear statement of what you plan to accomplish for milestones one and two.
C. Appendix C is a proposed set of software interfaces to your hardware components. It will be written in the form of a .h file (or equivalent using a programming language other than C/C++). This is another area a lot of groups struggle with. If you can't find much to do here, you are probably misunderstanding what is needed here and you should ask the staff for help. *[Required for final proposal only.]*
D. Appendix D is team agreement about work plans, known conflicts, etc.

A: Design/Engineering Criteria

Here you will list the criteria for a successful design and how important each criterion is. You are laying out how you will know if your design is successful. This should be divorced from *implementation* issues. That is, things like "C5515 processor communicates with base station" wouldn't be a design criterion, but "vehicle's status reliably communicated to base station at highway speeds" would be. This may include cost, power/energy or other things. But it should be about the *design* not the *implementation.* Criteria are ideally stated in very few words.

Next, you are to indicate the *importance* of each criterion. You are to label each criterion as either "fundamental" (the project wouldn't be useful without meeting the criterion), "important" (the product would be functional but not nearly as useful) or "optional" (nice, but not needed for the basic functionality).

[5] Design constraints are conditions that need to happen for a project to be successful. In addition to the ones you will identify in Appendix A, your design constraints include design cost (your project budget) and design time (the deadline for project completion).

You also will indicate what you expect and hope to do. You should indicate if meeting that criterion is something you *will* accomplish even if the project is scaled back, *expect* to accomplish or if it is a *stretch* goal. Obviously, there should be some correlation with importance, but you need to be realistic in what you think you can do. Starting off by trying to do too much or too little can both cause extra work.

Design criteria	**Importance**	**Will/Expect/Stretch**

B: Milestone deliverables

This section should just be a table version of your schedule/Gantt chart focused on milestone deliverables. As a reminder, for each milestone, list at least four targets where at least two of the four must be objectively demonstrable and should be bolded. The point of this (likely short) table is to extract potentially vague goals from the schedule and make them both clear and aligned with the milestone reports. Note, in this example, the team will have the PCB assembled by milestone 2. That certainly won't be a reasonable or good goal for teams with more complex projects.

Milestone 1:
Prototype capable of getting GPS up and running and can display current location in some way.
Base-station prototype can communicate with remote node prototype and display message in some way.
Hardware interface modules for Xbee and GPS written and tested.
Back-end scheme selected.
Milestone 2:
PCB assembled
GPS data taken in-vehicle and shown using Google Maps or equivalent software.
All hardware interface modules written, tested and debugged.
Back-end scheme implemented but may not be functional (stretch goal for project).

Oddly, this is one of the most commonly messed up sections. It's really short and really important, but about half the proposals either don't have two bolded things, the things that are bolded aren't objectively demonstrable, or (rarely) the goals just don't make sense in the context of the proposed schedule.

C: Interface design

Supply proposed .h files (or equivalent if using a programming language other than C/C++) for your major hardware components. This should be commented well enough that someone familiar with the hardware device could understand the interface. *(This appendix is only required for the final proposal though having something here for the draft proposal would allow us to give you some feedback.)*

D: Group agreement

This appendix should include things like:

- How many hours/week are expected per person.
- When during the week each person is generally free and when they are not.
- When the team plans on doing most of its work.
- When and on what the team members will work as a group and when they will work individually.

- Who will be largely responsible for which tasks. This should include technical things (mechanical drawing, soldering, programming) as well as non-technical things (scheduling meetings, taking minutes, requirements gathering)
- Known conflicts that will take each person away from school for a while (off-site interviews, family gatherings, holidays, weddings, MCAT, etc.) or other major class deadlines that will likely take a person away from the project for more than a day.
- When and where team meetings will be held. In addition to a regular "work" meeting schedule, we recommend scheduling at least one non-work meeting a week to touch base and to interact without formally discussing the project. Holding such meetings over lunch is often a good idea. It can help with communication and morale.

Each person should sign this section indicating that they have read and agree with it. Of course, things will change, but changes should be either made with group consensus (moving meetings etc.) or made clear to the group as quickly as possible (leaving town for an interview, etc.)

Last Words

There are a number of common issues and strengths we have seen with proposals in the past. We suggest considering the following closely:

- Be sure your figures are readable when printed (yes, paper is still a thing). You can assume they will be printed in color, but recall your instructor is old. Font size below 10 is pretty rough. This is most commonly a problem with the Gantt Chart, but many figures look great when you are editing them but become unreadable when printed.
- Be sure your high-level overview is understandable by someone not in your group. It's really (really) easy to write text describing something but end up writing something that only makes sense if you already knew what that "something" was. Pictures help a lot here. Consider having someone not from your group (parent, friend) read the first couple pages of your proposal and see if they understood what was going on.
    - If you have group members taking Technical Communications this term, their instructor(s) may be willing to look at this (even though it's probably a lot earlier in the term than most proposals). Those folks can provide really good feedback.
- Someone should read and edit the whole document before turning it in. It is very common that certain sections will be filled with grammar/writing errors and be generally unclear while other sections are perfect. Also, it's common to have very noticeable changes in "voice" in different sections. An editing pass just before you turn things in can help a lot.
- As noted, many groups mess up appendix B. Be sure you are following the exact directions here. ***Be sure you have identified two objectively demonstrable goals and bolded them.*** Last term about 4 of the ~20 groups didn't do this correctly for their draft proposal even with this warning! You will be asked to update this *before* your final proposal.
- Pictures are worth 1000 words. Would it help to draw a picture of your final project? Of where it gets used? Can you take a picture of something that exists and modify it to more clearly explain what you are doing? Perhaps a diagram showing how your different parts will be connected logically? But strong graphic presentation has been a hallmark of the clearer (though not always better…) proposals.
- The clearer you are in explaining what you are doing the earlier we can catch problems you haven't noticed. And the less likely you are to get requests for complete rewrites of the draft proposal.

Ready to turn it in? Think about the following last-minute things:

- *Is your Gantt chart readable?* If the font on the screen is much smaller than 10-point font, consider fixing it.
- *Did you save it under the right filename*? See the very start of this document for details.
- *Do you have at least four milestone goals, of which at least two are objectively demonstrable*?
- *Are your demonstrable milestone goals really demonstrable?* Think about how a GSI would test it.
- *Do you need a power/money/size analysis (budget)?* If you are power/size/cost constrained you should at least discuss the issues (and have a detailed analysis for the final proposal). These things often drive part selection.

Sample Interconnection Diagrams

These are three fairly solid interconnection diagrams from past projects (some words have been removed for IP reasons). These figures are a bit small (so they all fit on this page)—you want the smallest lettering to be around 10-point font when printed and these are a bit smaller. Notice that they are each working at slightly different levels of abstraction as appropriate to the project in question (some are on the PCB, others have the PCB as a box, etc.). Try to find the right level for what you want to communicate.





