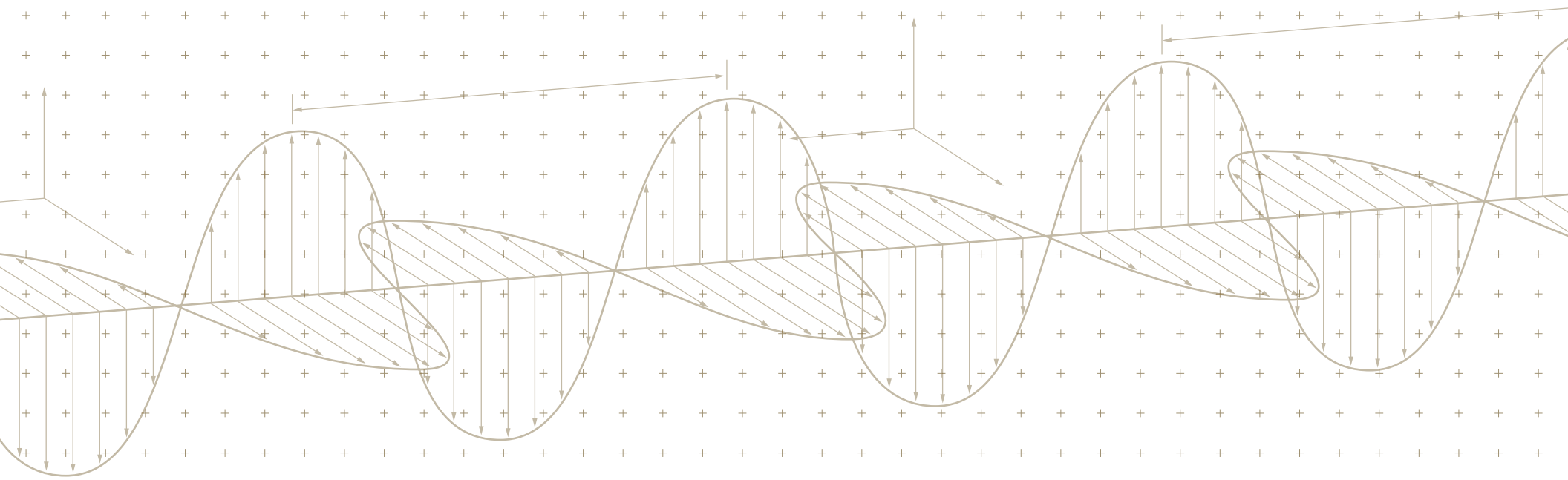

CSNE

ENGINEERING DESIGN NOTEBOOK

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Credits

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We drew some of our inspiration and materials from the Designer's Workbook from Design Thinking for Educators, © 2012 IDEA LLC. http://designthinkingforeducators.com/.

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About the Center for Sensorimotor Neural Engineering (CSNE)

The CSNE is one of seventeen Engineering Research Centers across the United States funded by the National Science Foundation. Founded in 2011, the CSNE headquarters are at the University of Washington in Seattle, along with core partners at the Massachusetts Institute of Technology and San Diego State University. The CSNE engages in research, industry relations, and education. Our education programs and courses serve students across the pre-college, undergraduate, and graduate levels.

We aspire to restore health and function by engineering innovative ways that help the brain and spinal cord adapt and recover from injury. We study signals from the brain and use that information to design neural devices, which can record and stimulate a part of the brain or spinal cord for neurorehabilitation.

We aim to design devices that can record information from, as well as stimulate neurons within the central nervous system to encourage neural plasticity, promote recovery and restore sensorimotor function throughout the body.

These revolutionary neural-engineered systems will significantly improve the quality of life for people with sensorimotor disabilities, most immediately benefitting patient populations with cervical spinal cord injury and stroke. The engineering principles discovered will also have broader implications for developing neural devices capable of treating other neurological conditions, such as Parkinson's disease and essential tremor, as well as restoring lost body functions, such as visceral organ and bladder control.

In addition to helping advance the Center's research and educational goals, our unique innovation ecosystem brings together researchers, educators and industry affiliates to more quickly and effectively move research discoveries from the lab to the marketplace and clinical application.

CENTER FOR SENSORIMOTOR NEURAL ENGINEERING

The Center for Sensorimotor Neural Engineering is funded by the National Science Foundation.

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About this Engineering Design Notebook

This notebook includes instructions, prompts, tips, and space for writing and sketching your way through the engineering design process. It was designed specifically to support students enrolled in a neural engineering tech studio course, where student design teams have just ten weeks to design, build, and present an innovative neural engineered product that solves an authentic need (clinical, commercial or educational) in a competitive environment.

We have designed this notebook to scaffold the processes of design thinking and engineering design, while also helping to structure the steps of a complex, fast-paced team project.

This notebook is divided into six phases, which will guide you through the process of designing a product, from start to finish. These phases are as follows:

Exploring: In this phase, you will engage in brainstorming, ideating, and concepting as you try to identify an authentic problem that could potentially be solved using neural engineering technologies. It's the big picture work. At the end of this phase your team will choose a project to pursue.

Planning: This is the phase when your team will think more deeply about the problem space and consider potential solutions. Your team will also develop a project plan and conduct a skills assessment.

Understanding: During this phase, you will conduct market research, possibly interview or meet with potential end-users of your product, and think through ethical considerations.

Prototyping: This is the phase when you will actually build. You will create and test multiple prototypes to develop your optimized product.

Pitching: In this phase, you will consider your product's commercial value and prepare a pitch for a panel of industry judges. It's the entrepreneurial phase.

Reflecting: Finally, you will reflect on the design process and teamwork, and maybe make plans to continue working on your product idea.

Look for these icons to signal whether to complete an activity as an individual or a team and whether it can be uploaded digitally.

Individual: These activities will be completed individually.

Team: Complete these activities in collaboration with your team members during team meetings. Be sure to capture your team's discussions and decisions on these pages.

Online: These exercises can be completed digitally and uploaded.

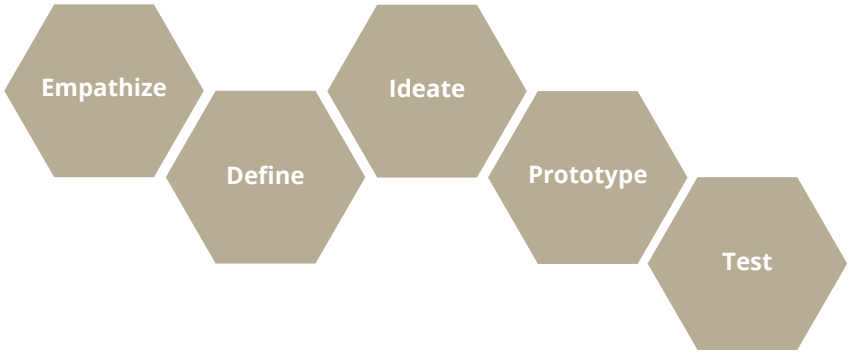
This is a living document. It should change as you use it. Write, sketch, and annotate it. Add to it by taping or gluing in photos, diagrams, or notes. You will need to purchase a bound lab notebook to accompany this Engineering Design Notebook, as there isn't enough space here to fully document your design process. You will especially want to use that lab notebook during the intensive prototyping and testing phase.

We hope this notebook will be a helpful tool for instructors and students in other types of engineering design studio courses, too. If you plan on using this notebook in an educational setting, please visit the Center for Sensorimotor Neural Engineering's university education website for supporting documents, including a sample course syllabus and a notebook scoring rubric. http://www.csne-erc.org/content/undergraduate

About Design Thinking

Design thinking is a process employed by all designers, including engineers. It is human-centered, collaborative, optimistic, and experimental*.

The iterative process of design thinking includes: Empathize, Define, Ideate, Prototype, and Test.



In this Engineering Design Notebook, we have synthesized the process of design thinking with the process of engineering design.

Learn more about Design Thinking at the following resources:

d.School, Institute of Design at Stanford, http://dschool.standford.edu

IDEO Tools, http://www.ideo.com/tools

*As described by IDEO.

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Preface: how to use this notebook

This notebook is a joint learning and teaching tool. It is intended to scaffold the process of engineering design for the student, while simultaneously serving as an evaluation tool for the instructor. These two goals should not be in tension with each other, but you do need to keep in mind the dual-use nature of this document as you use it. If you use the notebook as it is intended to be used, you will gain both a better learning experience and a better grade. With this in mind, here are some tips on how to get the most from your experience.

First, you should take some time to familiarize yourself with the content of the entire notebook so that you know what is expected of you. You need to complete all of the exercises, and you need to complete them in real time (i.e. do not backfill at the end of the term). This means you should read and respond to all of the text, whether it is in paragraph form or bulleted. The activities have been chosen to help you in your design process and to make your thoughts and actions transparent to your instructor. They should also demonstrate your growth over the course of the project. You may not see the value in every exercise or you may feel constrained by the requirement to document all of your work, but to get full points you need to complete all of the requirements. Some activities and prompts in the Prototyping section are optional. You may choose not to use these pages, but you need to come up with an alternative form of evidence for your work. All exercises are mandatory unless they are specifically designated as optional.

Second, you should treat this notebook as an active and working document. It is encouraged that you scribble notes, make sketches, staple in additions, and cross things out. Your handwriting needs to be (mostly) legible, but it does not have to be pretty. One of the objectives of this tool is to capture how you think and make decisions. This includes making mistakes and changing your mind. Your instructor will be evaluating you on your design process throughout the course, not just your final designed product at the end. So show what is happening as it happens.

Some of the exercises are meant to be completed as a team, and some are meant to be completed individually. Please be aware of this and complete the exercises accordingly. You should also note that some exercises can be completed digitally and uploaded to your online portfolio, while some need to be completed in hard copy.

Finally, an important feature of any team project is an accountability structure. Some of the exercises in this notebook are included for this purpose. Using these tools will help you to avoid and resolve conflict.

Please remember that this notebook will account for more of your grade than your finished product and devote time to it accordingly.

Section 1: Exploring

Exploring Your Design

In this phase, you will explore and evaluate the space of interesting and achievable projects. By the end of this phase, you will choose a problem to focus on for the rest of the course. Therefore, this phase is critical, but it is also very brief. The tools laid out in the section are designed to move you and your team through this process quickly and efficiently.

This section will help you launch the first two steps in the design thinking process: empathize and define.

Remember, this is a team project and every member of the team has a stake in the decisions that get made. Every individual on the team needs to be actively engaged.

Initial Personal Interest and Skills Analysis

It is important to come to this class prepared to actively contribute to your team. Part of that preparation is taking the time to conduct an honest assessment of your skills, interests, and motivations that may help shape your team's project. This exercise helps your instructors with the team-forming process but also will help prepare you to hit the ground running on the first day of class.

Define neural engineering as you understand it. Use examples.

Which areas of neural engineering are of interest to you (e.g., wearables, rehabilitation, etc.)?

What are your personal goals for the class?

What are your project ideas (these don't have to be fully formed)?

Make an honest assessment of your skills that may be helpful for your design project. List each skill and briefly describe your level of expertise. Be sure to also include skills that you may not think are related to neural engineering but may be beneficial for your team (e.g., writing, public speaking, graphic design, etc.).

My Skills	Assessment

Problem Exploration: Brainstorming

If you want to have a few good ideas, you need to generate a lot of ideas. Brainstorming is a way to generate those ideas. Some will be good, some of will be bad, and some can be turned into a good idea with some modifications. Remember, a brainstorming session isn't the time to debate or evaluate ideas; that comes later.

Here are some rules for brainstorming:

1. Defer judgement
2. Encourage wild ideas
3. Build on the ideas of others
4. Stay on topic
5. One conversation at a time
6. Be visual
7. Go for quantity

Text credit: Design Thinking for Educators, IDEO

As you talk, draw a diagram (Venn diagram or concept map) that captures your interests and project ideas. Be on the lookout for connections between them. Annotate your diagram so that it captures your team's discussion.

Brainstorming prompts:

- Rehabilitation
- Diagnostics
- Enhancement
- Wearables
- Consumer devices
- Internet of things
- Gaming
- Medical
  - Spinal cord injury
  - Stroke
  - ALS
  - Alzheimer's disease
  - Parkinson's disease
  - Depression
  - Anxiety
  - Amputation
  - Traumatic brain injury
- Interfaces
  - EEG
  - EMG
  - Virtual reality
  - Sensory feedback

Problem Exploration: Evaluation

Your goal as a team is to identify 2–3 possible problems that you may address for your design project. In these pages, you will work together to evaluate and reframe your ideas and choose a few possible projects to explore. Next, you will be presenting these potential projects to experts during a round robin consultation exercise, so now is the time to narrow down your options.

As a team, discuss the ideas you generated in your brainstorming session. In your discussion, consider the following:

- The timeline of the course
- The skills your team has and the skills each project requires
- The marketability of your product
- How related your project is to the field of neural engineering
- Possible ethical concerns and implications

Create a rubric based on these concerns and others and use it to rank your ideas.

Problem Exploration: Round Robin Prep

After you have completed your rubric, choose two or three of the most promising and interesting ideas generated by the group. For each one, respond to the Problem Framing Prompts. (Attach additional sheets as needed).

Bring these pages with you when you consult with experts at the Round Robin.

Problem Framing Prompts:

- In one sentence, what is the problem?
- Flip your problem statement into an opportunity for design by asking "How might we...?"
- Who will be the user/consumer of this product?
- Why will they need/want/use/buy it?
- Make a sketch or a diagram.
- What are your questions/concerns about this project idea?

Round Robin Expert Consultation Notes

After the Round Robin exercise, take some time to reflect individually on the feedback your team received from the experts.

Bring these reflections to your next team meeting to discuss with your team members.

For each idea you pitched:

- Was the overall impression positive, negative, or mixed?
- What changes and/or additions were suggested by the expert panel?
- Respond to each of these suggestions with whether you agree or disagree, and why.

Reflections

Which project idea is most interesting to you? Why?

Which project sounds the most achievable to you? Why?

Which project ideas sounds the most broadly interesting and commercializable to you? Why?

What are your reservations about each project?

Which project would you choose if it were entirely your decision? Why?

Team Skills Assessment

During the brainstorming phase, you considered problems and possible solutions of interest to your team. However, when choosing your project, it is important to consider the skills that your team has, the skills that you may need to acquire, and the time constraints of the course. This exercise is designed to help you realistically evaluate what your team can accomplish.

Make a comprehensive list of the skills represented by each member of your team. Think about different categories of skills (e.g., neuroscience, software, hardware, presentation, business, etc.). Be specific.

Team Members	Skills

Turn your list into a map or diagram (like a density plot or a concept map).
Use this visual representation to help you identify your team's strengths and weaknesses.

Choose Your Project

You cannot make progress until you make a decision about your project. This is the time to decide by engaging in the processes of restating, prioritizing, and choosing.

Restate
Restate each project idea using the expert feedback and outline the major steps/skills that are necessary to achieve each one.

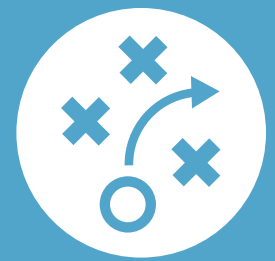
Prioritize

As a group, make a list of your priorities for the project (e.g., how confident are you that you can get it done vs. how interesting is it, etc.)

Choose

Identify the project that optimizes these priorities.

Section 2: Planning



Planning Your Design

You have identified your goal, but there is a lot to do and not much time in which to do it. Having a plan will help. In this phase you will get into the logistics of your project and divvy up tasks. One of the strengths of a team approach is that the individual members can be specialized. For this to work, however, everyone has to be committed to their responsibilities and there must be an accountability structure. The tools in this section will help you to appropriately prioritize tasks, identify every team member's role and plot a direction to your ultimate goal.

This section will guide your through two steps in the design thinking process: empathize and define.

Craft a Preliminary Value Proposition

A value proposition is a statement of the values of a project idea. Writing the proposition helps a team conceptualize the problem space, prioritize project tasks, and explain or pitch the idea to others.

In paragraph form, write a statement articulating the benefits offered by your project, how it will solve an authentic problem, and what distinguishes your project from the competition (i.e., what makes the solution novel).

Skills Gap Assessment

Previously, you assessed the skills represented by your team. Next, you need to identify the skills that you will need to acquire in order to successfully design and prototype your project idea. You will also need to develop a realistic plan for how your team will acquire those skills.

Draw a chart or diagram of the skills that you and your team members have and the skills that will be needed to complete your project.

Make a plan for how your team will acquire the skills you need (e.g., consulting online tutorials, code banks, books, expert consultant, etc.). Be specific, name names, and state preliminary steps. List the first few steps you will take over the next week to start this process.

Assign roles to each team member. Clearly state the responsibilities associated with each role.

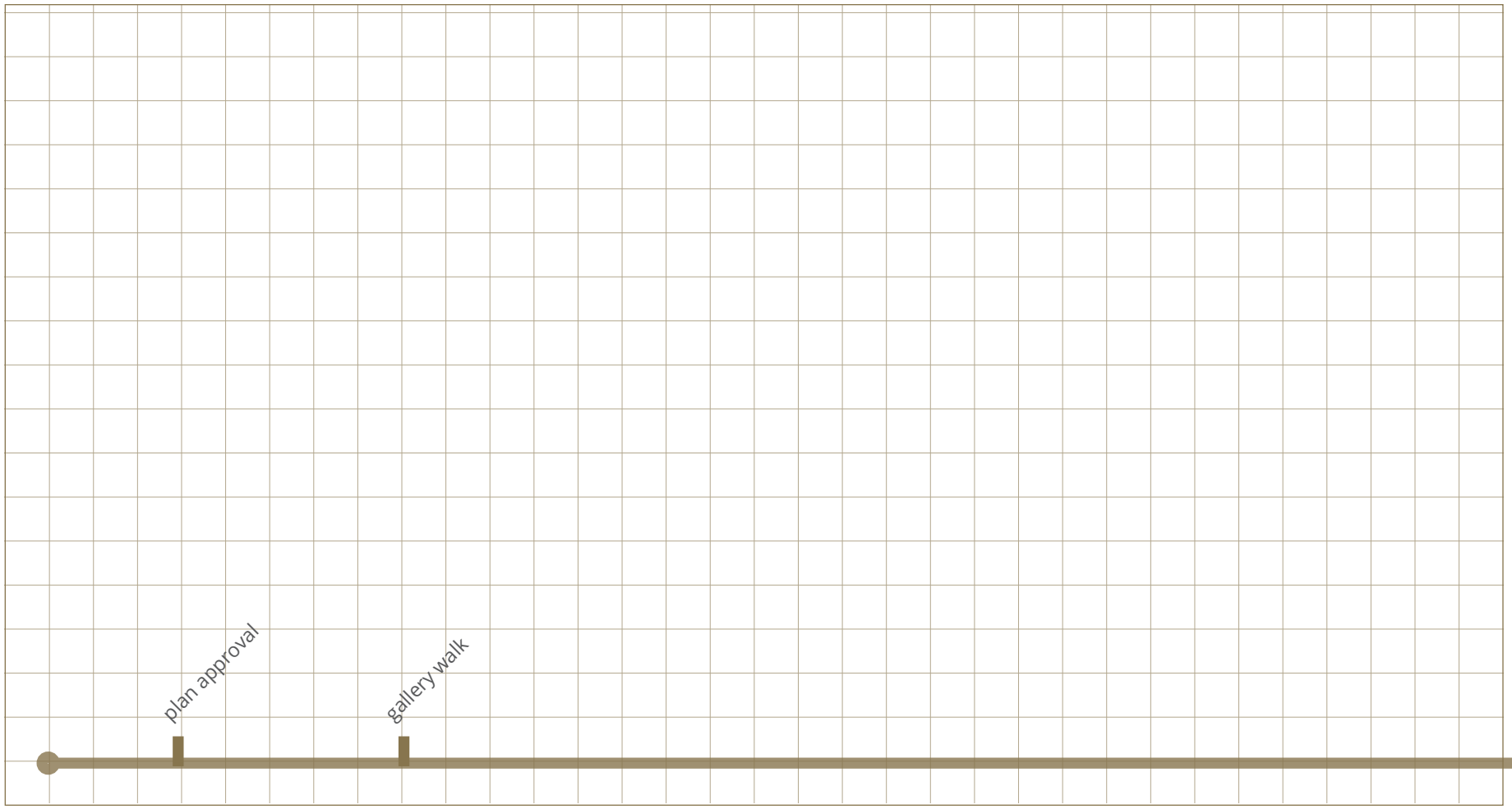
Name	Role(s)	Responsibilities

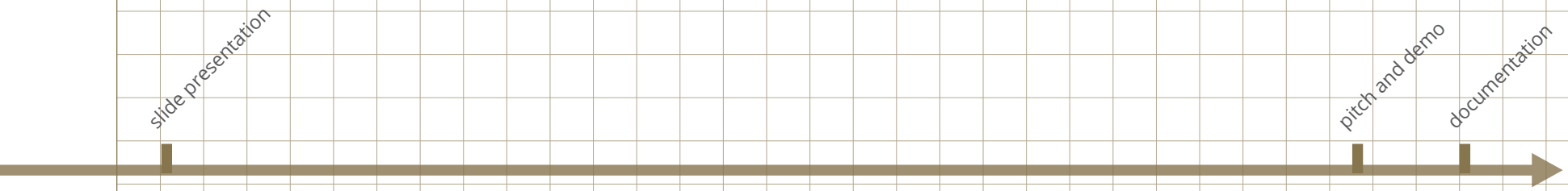
Section 2: **Planning**

Team Project Plan

Before you go any further, your team needs to agree upon a plan. This plan should be informed by the Value Proposition that you crafted earlier; it will help you to create and prioritize your milestones. Your plan should include a timeline, deliverables, and who is accountable for them.

You should anticipate that not everything will go to plan. Structuring fallback points into your project plan allows you to think through multiple backup plans now before you get too deep into the process. It is also important to identify a date by which you will make a course correction (when you will fallback) if your original plan does not work. Your plan will not be approved until these elements are in place.





Individual Project Plan

You have a project within your team project. Use your Team Project Plan to guide you in developing an individual project plan. This plan should include your own timeline, deliverables, and a diagram.

Section 3: Understanding

Understanding Your Design

Now that you have a plan, you might not want to slow down to deeply think about your potential end-users. However, investing the effort to understand the market for your product now will save you time in the long run. Resist the urge to engineer in a vacuum. If you make too many assumptions about what people need or want you may end up with a product that no one ever uses. The tools in this section will help you avoid this outcome.

This section will guide your through three steps in the design thinking process: empathize, define, and ideate.

Keep in mind that this phase is meant to work in tandem with your project development. Keep up with your project plan but make adjustments where necessary.

Market Analysis

Your project will only be successful if someone uses what you create. Conducting a market analysis will help you determine whether your product is something people will eventually adopt. Even if you are creating something for educational use or open distribution, you will want to make sure that you are creating a viable, useful product.

Identify your target end user(s). Then, decide the best method for conducting market research about those users. Will you use observations, interviews, and/or online research to learn about your end users? Use the Build a Question Guide pages to help plan out your research tactics. Describe your plan.

Estimate the size (# of users/customers) of your primary market. Where did you get this information?

After you have completed your market research, use the information you have gathered to help you create a hypothetical user portrait. Give this person a name and then describe his/her history, hopes, fears, and feelings. This user portrait helps to make the idea of your users more personal. It helps to have an ideal end user in mind in order to create an authentic solution for their needs and desires. A user portrait will also become part of your marketing pitch.

Are there modifications or additions that could make your product applicable to secondary and tertiary markets? Describe these markets.

Build a Question Guide: Interview

An interview allows you to pose specific questions of an end user or someone who can provide key insights for your project. Interviews allow you to learn about challenges, frustrations, motivations, and desires.

Before conducting an interview, it is important for your team to develop an interview protocol. What do you hope to learn during this interview? To prepare for an interview, complete one of these pages for each interview and person. After you have developed a list of potential questions, organize them into themes, and determine an order that will feel natural and conversational. During each interview, take detailed notes or ask permission to audio record the interview, which allows you to write up your notes later. Be sure to attach your notes from each interview.

Interviewee Name: _____

Details: _____

_____

Start Specific

What are some specific questions you can ask to open the conversation? What background do you need to understand this person and their insights?

Go Broad

What are some questions that can help you understand this person's motivations desires, challenges, and frustrations?

Dig Deeper

What are some ways you might be able to dig deeper, to better understand this person's perspectives?

Text credit: Design Thinking for Educators, IDEO

Build a Question Guide: Observation

A site visit allows you to observe the setting in which your product might be used, or another setting that may provide key insights. It is a chance to look, listen, question, and think deeply about what is going on at the site.

Before conducting an observation, it is important for your team to make a plan for your site visit. What do you hope to learn during this observation? What questions do you have? To prepare for an observation, complete one of these pages for each observation and site. During each observation, take detailed notes and draw maps and sketches. Be sure to attach your notes from each observation.

Observation Site: _____

Details: _____

_____

Things to See and Hear

What will you look for? Listen for?

Things to Do

What might you do to gain key insights? Where might you look? Who might you talk to? What questions might you ask?

Text credit: Design Thinking for Educators, IDEO

Build a Question Guide: Online Research

One of the advantages of conducting online research is that you can look at the problem from multiple perspectives. It is important to be intentional in choosing sources of information that will provide diverse perspectives. What are you hoping to learn from your online research? What sources will tell you the most about your user population? For example, you might consider patient advocacy groups, patient support groups, online user groups, and academic journals.

Sources of Information

Keeping in mind your potential end users, what online sources will help you understand their perspectives, needs, and concerns?

Types of Information Available from these Sources

What do you hope to learn from these sources? What type and quality of information will each source provide?

Tips for Effective Online Searches

- Mine the reference lists in academic papers.
- Find out who the big names are in this field. Visit their websites or Google Scholar profiles.
- Determine the buzz words in this field. Try them as search terms.
- Keep track of the search terms you use. Try variations of these terms.

Ethical Considerations

Every engineered product will have ethical implications for people who use it and sometimes even for people who do not use it. It is important to consider potential ethical implications in advance.

What ethical concerns could be raised by your completed project? Think broadly about this question. Consider concerns related to safety, privacy, identity, cost, and equitable access.

How might you mitigate some of these concerns?

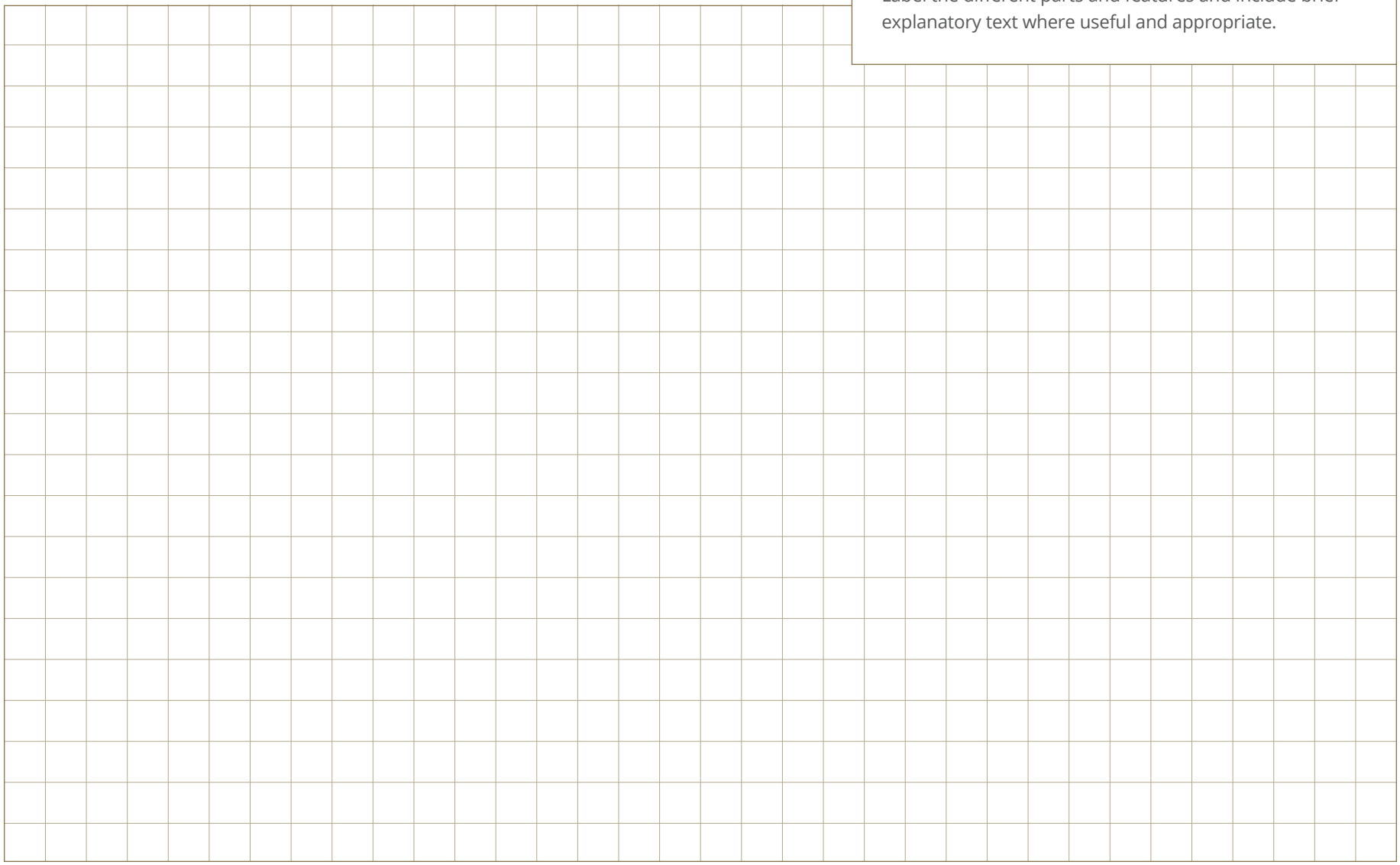
Refined Value Statement and Revised Project Plan

Now that you have more information on your market, you should update your value statement to incorporate your new knowledge. How will your product add value for your target population(s)? How will you address potential ethical issues?

Sketch Your Concept

What your product looks like and feels like will determine the way that people use and interact with it. Therefore, it is important to have a plan for the physical product or interface. You will share this sketch or diagram for peer feedback during a Gallery Walk exercise.

Imagine what you believe your final project will look like. Be ambitiously realistic. Draw by hand below or with computer software and attach a diagram of your project. Label the different parts and features and include brief explanatory text where useful and appropriate.



Reflection on Gallery Walk Feedback

List and respond to the feedback you received from your peers during the Gallery Walk. What things do you agree with, what things do you disagree with? Did everyone understand your concept? Are there things you can change now to improve your project? Are there things you can keep in mind for the future?

Discuss this feedback and your reflections at your next team meeting.

Parts, Budget, and Order List

Equipment List

Equipment is a high cost item that you will not purchase for this project. Instead, you may use the equipment at the CSNE, at local makerspaces, or you may have access through your personal networks.

Equipment	Location	Access Issues/Notes

Parts List

Develop a list of parts that you will need for your project. Indicate if they need to be ordered or if you will obtain them.
Send your initial parts list to your instructor for approval. Include additional items as they come up over the course of your project.

Item	Item #	Vendor	Quantity	Price	Order/Pick-up

Gut Check

This is a good time to take a pause, make sure that everyone is on board, and check to see if you're on the right road. An early course correction is easier than a later one.

Do you still believe that your project idea is interesting and that your project plan is feasible?

Does everyone understand their role and feel confident and capable to fulfill it?

Are there any conflicts of personality or opinion that need to be addressed?

Prototyping Your Design

Your deliverable is a product prototype. This course is about designing and building something, and this is the phase in which you do the building. However, you should think of prototyping as an ongoing process. Every physical realization of your project is a kind of prototype, and you may want to produce more than one type for judging. It is most important to have a prototype that works, at least in essence, the way it should. However, you might want to prepare something that looks the way you want your product to look. This will give the judges a better feel for your product vision and a way to understand how it will fit into physical (or virtual) space. You may also find that intermediate stage prototypes help you in your project development. Fit the pieces together as you build them and don't wait until the end.

This section will be used to document your progress through two steps in the design thinking process: prototype and test. This is the phase in which you build, but you will also test, iterate, and optimize your design. How will you test your design? What are your specifications? What can you learn from a prototype that fails to meet specifications? Expect to go through many iterations until you settle on your optimized design. Plan to share your prototypes with potential end users and others to gather as much feedback as possible.

This phase is the longest and also the most personalized to each team and each product idea. The tools in the section will help you to document your prototyping activities, but you are responsible for determining which activities are most useful to you. During this phase it is very important to keep track of your plan and timeline, and to maintain an open channel of communication with the other members of your team. Document everything! Take photographs, make sketches, and record data from your tests of all iterations of your product design.

Section 4: Prototyping

Documenting the Prototyping Phase

During the prototyping phase, you need to document just about everything you do. This is an important professional practice; your design process will be easier if you are organized and keep track of your activities. It will also help your instructor to evaluate your design process. If you do not record what you do as part of this phase, it will be difficult to give you credit for your work at the end of the course.

During this phase, you will meet frequently with your team. You will need to keep records of these meetings. It is very important that your team maintains accountability, and therefore you must use an accountability structure. You may use the pre- and post- meeting forms included in this section, or you may develop and use your own. But, you must provide evidence that you are meeting regularly and communicating effectively.

You will also likely need to consult with experts. For example, the instructor, the TA, your mentor, or someone else. It is important to prepare for these interactions and to document them. Before meeting with an instructor or expert for a consultation, use the Expert Consult Plan (Pre) to help you prepare; then follow that with the Expert Consult Notes (Post) to capture what happened during the consultation. This is mandatory.

Each student should purchase a bound lab notebook and use it for all documentation related to prototyping. Feel free to add materials to your lab notebook using tape or glue. You will submit this lab notebook to your instructor along with your completed engineering design notebook. Most of these materials can also/alternatively be uploaded to the Canvas site.

Some examples of things that you should include in your notebook are:

- Ideas and thoughts about the project
- Notes about things that you try and notes about whether they did or did not work
- If you try something and it doesn't work, write down why you think it failed
- References for sources that you consult and notes on what you learned
- Sketches
- Diagrams, schematics, CAD drawings
- Photographs and videos
- Physical or digital models
- Testing specifications
- Data from testing
- Feedback from potential end-users
- Protocols

Documenting your process is the not the same as documenting your code. Even if your project is entirely software based, you need to write down what you are doing and why. Your code should evolve as your project progresses and many of the intermediate steps will not be preserved in the final version. Make diagrams (e.g. a flow chart) to represent how your code works and make notes about features/functions that you tried out but ultimately didn't decide to keep.

You may use the prompts that are included in this section, or you may develop your own system. But, you must provide evidence of the intermediate stages of your process. If you choose to use the pages in this section, you will need to either make copies so that you have enough or download extras from the course website.

Expert Consult Plan (Pre)

Throughout your design process, there will be points at which you will need to consult with an expert. Before each of these meetings, it is important to make a plan. This will help you to maximize everyone's time and the chances that you will get the input that you need. Fill out this form and attach it to your notebook before every meeting you have with any expert.

Date and time:

Name/title/organization of expert:

Reason for consult (problem):

Expected outcome of consult:

Background to problem:

Attempted solutions:

Specific questions for expert:

Expert Consult Plan (Post)

After you consult with an expert it is useful, and a good practice, to promptly record what happened and outline what you will do in response, if anything. Fill out this form and attach it to your notebook after every meeting you have with any expert.

Date and time:

Name/title/organization of expert:

Meeting notes (what happened?):

Your reaction:

Your response or strategy:

Action Items	Person Responsible

Work Log: optional

Date:
Time:

Objective:

Materials/resources:

Summary of activities:

Group Meeting Prep (Pre): optional

It is important that you come prepared to every meeting you have with your group. Fill out this form and attach it to your notebook before every team meeting. Bring a copy of this form to your meeting.

Date and time:

Reason for meeting and topics to be covered:

Things to follow-up on from last meeting:

Materials to present:

Issues to raise:

Group Meeting Debrief (Post)

After each team meeting you should take the time to record what happened and make a personal plan of action. You should refer to this plan when you are preparing for your next team meeting so that everyone can begin the meeting on the same page. Fill out this form and attach it to your notebook after every team meeting.

Date and time:

Meeting notes (what happened?):

Thoughts:

Action Items	Person Responsible

Getting Unstuck: Optional

Sometimes you will run out of ideas. In these cases, you might be tempted to continue doing the same thing over and over, or make parameter tweaks in the absence of a guiding principle. Resist the temptation to do this. Getting unstuck often requires stepping back from the problem and adopting a different viewpoint.

Try explaining your problem to someone who is unfamiliar with it.

Talk to another member of your group and brainstorm some ideas.

Try drawing your problem and process as diagram, flow chart, or picture.

Keywords: Optional

One of the most challenging aspects of working in a new field is learning the vocabulary. Literature can be difficult to find until you come up with the right search terms, or buzz words. As you come across new and important terms, keep track of them and map the connections between them.

Reading a Paper: Optional

You will likely read a lot of scientific and/or engineering papers for your project. These documents are complicated and it pays to take notes. When you read a paper use this format to record your thoughts.

Paper name or short-hand identifier:

General topic:

Major findings:

Supporting evidence:

Do you agree with the authors' interpretation of the data? Why or why not?

How is this paper relevant to your project?

What questions do you have?

Evaluating Results: Optional

As you collect data and/or produce results it is important to critically evaluate and interpret them. This will help you to identify any problems early. You need to do this periodically throughout the course of your project and particularly before you present your results to someone else.

Make a figure. Label the axes, make a caption.

Do the numbers look right (are they the right magnitude, in the right range, etc.)?

What is the data trend? Is this in the direction you expect?

What do the data suggest? Is this what you expected?

How can you interpret your results?

Can you identify any sources of error that would impact your results?

What questions do you have?

Section 5: Pitching

Pitching Your Design

You might think your product is amazing, but you have to be able to explain it to others. Moreover, you need to do this in a concise and convincing way. This is known as making your pitch.

Your team will make a pitch to the judges at the end of this course. Some teams may continue to develop their projects beyond this course, in which case you will need to pitch it to many more audiences in the future. In this phase you will develop the talking points and selling points for your project. Remember, your product is only as successful as your sell.

Midterm Presentation

Your midterm presentation is an opportunity for you to get feedback from your instructor and peers as well as to assess your progress toward your goals. Make the most out of this opportunity by intentionally preparing for and consciously reflecting on the process.

BEFORE:

What do you have to present at this mid-point? How does it compare to your expectation for where you would be?

How has your project evolved since you started prototyping? Have you used any of your fallback plans?

What kind of feedback from your instructor and peers would be most helpful?

AFTER:

Reflect on how your presentation went.

Based on the feedback you received, are there any course corrections you will implement?

What shape is your team in for the final presentations?

Make Your Pitch

A good pitch will leverage your market analysis, value proposition, and user research to convince others to invest time, money, or resources in your idea. Work with your team to develop your pitch. Capture your initial ideas here, but keep working on it.

Outline or storyboard your pitch.

Write your pitch in paragraph form.

Start thinking about who will present each part of your pitch. Everyone should participate in your pitch presentation.

User manual

What will your end-users need to know in order to use the device? What should they do if they encounter a problem? Your product documentation should be designed for your hypothetical user. One way to test the completeness of your documentation is to have someone in your target demographic look at it. If you don't have any contacts in this demographic, have someone uninvolved and unfamiliar with your project test it for you. You will need to either provide the judges with a hard-copy of your user manual or give them a tour of your online documentation during your presentation.

Make a list of what you will need to communicate to your users.

Consider how you can incorporate diagrams into your manual.

How will your users troubleshoot your product? Where can they find help?

Outline the format of your user manual

Section 6: Reflecting

Reflecting on Your Design

The timeline of this course is constrained, and you may not have time to achieve all of your project goals. Are these goals still worth pursuing beyond this course? Is there value in your product that is worth following-up with? Whether or not you intend to continue your project after the end of this course, it is useful to look back on your experiences and evaluate your design process. It is likely that not everything went according to the plan you created in the Planning phase. Noting how things went right and how they went wrong can help you to make better plans in the future.

You should also think about your personal skill development. Taking stock of the methods that you used to find resources, learn new skills, and document your design process will help you with future design projects. Thinking about how your team functioned and how you functioned as a part of that team will help you in your future collaborations. The tools in this section are designed to help you reflect and assess your growth individually and as a team.

Team Process Reflection

You will need to meet with your design team to reflect together on your experiences. You may want to appoint someone to act as the facilitator during this meeting. Everyone should take notes during this conversation, summarizing what you and your team members talked about for each of the following questions.

Design Process Reflections

As a whole, how did the design process go for your team? Were there any phases that were particularly challenging? Why?

In what ways did your team work well together?

What were some of your challenges as a team?

In what ways was the engineering design notebook helpful to your team during the design process? How?

Were there any ways in which the engineering design notebook constrained your process? How?

Designed Product Reflections

Are you happy with what your team created? Why or why not?

How does the product you designed compare to your original idea? What changed and in what ways?

What unexpected challenges did you face with your product? How did you handle them?

Is your “big idea” from the beginning of the course still a good one? How do you know?

What do you foresee as the future of your project? Will you pursue it? If so, how will you navigate that as a team? (Consider who will be involved, plans to protect intellectual property, future competitions you could pursue, potential funding opportunities, project timeline, etc.).

Individual Process Reflection

An important part of the design process is honestly reflecting on your own experiences. This is beneficial for your own personal and professional growth. These reflections also help your instructors understand your experiences and learning outcomes during this course. Take the time to deeply reflect on these questions; don't rush the process.

The Process

Consider the design and prototyping process you went through this quarter. How did it go?

What was most valuable about your experiences with this course?

What was most frustrating about your experiences?

How do you feel about the competitive aspect of the course? In what ways is it beneficial or challenging?

Teamwork

In what ways did your team work well together? What role(s) did each person take on within the team? Do you feel all individuals (including yourself) contributed to the team?

Did your team experience internal conflict during the course? If so, describe it. How did you resolve it?

Learning Outcomes

What motivated you to enroll in this course?

What new skills did you acquire? (Think about technical skills, but also consider skills related to teamwork, research, marketing, pitching, etc.)

What did you learn (other than skills) as part of this course?

In what ways did you stretch yourself? Describe how that is beneficial to you.

Engineering Design Notebook

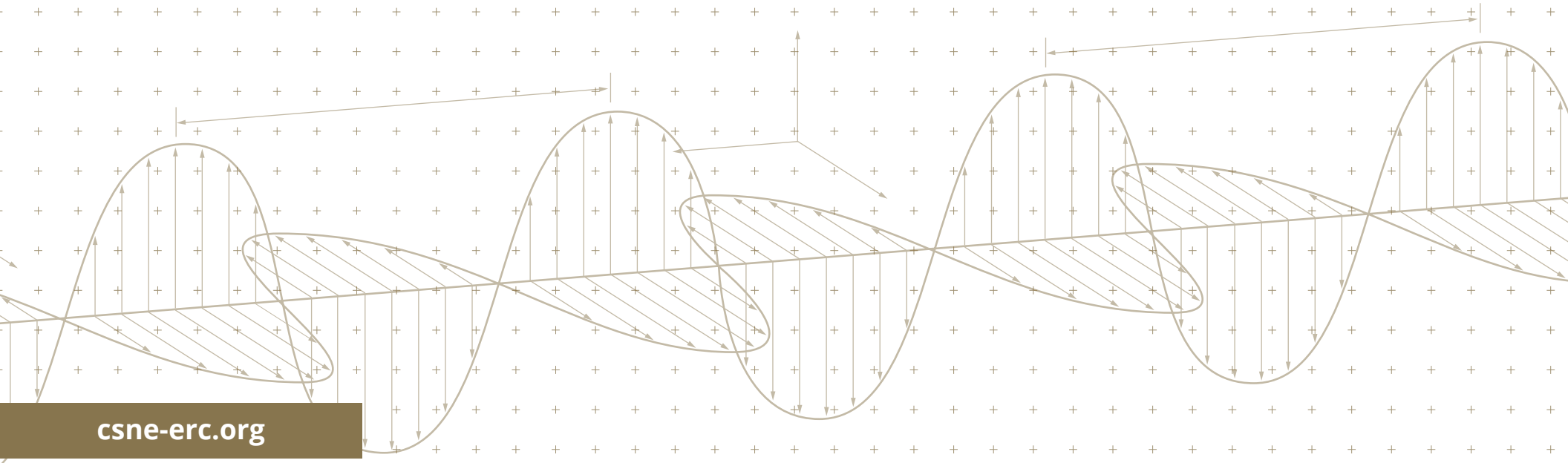
List some of the ways that you used this engineering design notebook. Did the notebook help you to consult or communicate with others? If so, with whom did you use it? In what places did you work on your notebook or use it?

Purposes?	People?	Places?

Were there any pages or prompts in the engineering design notebook that were especially helpful?

Additional Reflections

What other experiences were important to you personally? Use this space to think through anything else that feels particularly meaningful about this course.



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