# ESC204 | Praxis III

Prototyping Bootcamp: Prototyping Skills Assignment Handout

**Due Date: Monday January 26, 2026**

---

| | |
|---|---|
| **Assignment Deadline:** | Monday January 26, 2026 \| 11:59AM |
| **Team or Individual:** | Groups |
| **Assignment Weight:** | 10% |

For this assignment, you will work in a group of 2-3 students to design and prototype a small-scale greenhouse lighting system. You will create a Design Dossier deliverable containing design artifacts to support your process and outcomes: the assignment will be assessed based on this Dossier. This handout provides more information about the assignment, as well as the deliverables you should produce. As you read it, you should refer to the following additional materials:

- Prototyping Skills Assignment: RFP
- Prototyping Skills Assignment: Rubric
- Prototyping Skills Assignment: Design Dossier Template

Additional resources are available in the Prototyping Skills Assignment Resources page on Quercus.

## 1 Overview of the Prototyping Skills Assignment

In this assignment, you will:

1. Design, build and test an embedded system (using electrical components and an RPi Pico programmed in CircuitPython) to change the colour of light emitted based on user input.
2. Go through at least one iteration of designing and digitally fabricating a case/cover for your embedded system to both protect the hardware elements and make your prototype appear more polished.
3. Integrate the case and the embedded system to complete a functional prototype.

This assignment therefore provides the opportunity to put the skills you are learning during the Prototyping Bootcamp (Weeks 1-3) into practice. It is meant as a trial run for the full design process you'll go through later in the course, including connecting stakeholder needs to the design of a mechatronic system, practicing hands-on prototyping, procuring parts from MYFab, and creating a Design Dossier deliverable.

Table 1 shows the major dates associated with this assignment.

Table 1: Assignment timeline. Deadlines are **bolded**.

| Date | Event | Notes |
|---|---|---|
| Jan. 09 | Prototyping Skills Assignment released | |
| Jan. 15/16 | Help session in Studio 02B | |
| Jan. 18 | **DigiFab submission to MYFab is due** | 1 3D print *and/or* 1 laser cut |
| Jan. 20-22[1] | Help sessions in Studio 03A+B | MYFab pickups ready by Jan. 23 |
| Jan. 26 | **Prototyping Skills Assignment is due** | Group Submission |

# Contents



[1] Due to ESEC on January 23, Friday Studio B sections have been rescheduled to 9-11am on January 22!

# 2 Completing the Assignment

This assignment mirrors the structure of the Major Design Project you will complete later in the term, but with a much smaller scope. Therefore, you should approach this project the same way you will approach the larger project, **through completing the following steps**:

- ☐ **Carefully read** this handout, the Prototyping Skills Assignment RFP, and download and review the provided Design Dossier Template which contains key information about how to complete the required deliverables.
- ☐ **Establish** what **main design and/or fabrication tasks** you must complete, paying careful attention to deadlines.
- ☐ Complete **design and/or prototyping work**, while **creating the required artifacts** for the Design Dossier submission as you go.
- ☐ **Review and organize** the resulting Design Dossier, ensuring you've included all required Process Artifacts.
- ☐ **Create required Outcome Artifacts** based on your collected process artifacts[2].

**PAUSE**: Note that the Prototyping Skills Assignment Handout, Rubric, RFP and template Design Dossier are meant to be considered together: please ensure you have read or reviewed **all of these** before getting started on the project! The following sections provide more information about how to use each element as you complete the assignment.

## 2.1 Using the Handout

Assignment Handouts in Praxis III (like this one!) provide the following key information:

1. How to **approach** the assignment.
2. What **deliverables** you will need to produce.
3. Key dates and **deadlines**.
4. **Design Process Constraints** you must adhere to while working on the assignment.

**INFO**: Unlike constraints on the design concept(s) themselves, which are represented in the Engineering Requirements for a particular design, Design Process Constraints come from the operational environment of our course, rather than directly from stakeholder needs.

**EXAMPLE**: For all prototyping work in the course, you must use only parts sourced from the Myhal Light Fabrication Facility (MYFab). **You are not permitted to use any parts from home, or that you purchased outside of MYFab.**

Of course, this doesn't have anything to do with the context in which your design will operate; however, it is a key constraint you should use to inform your design activities.

[2] To learn more about Process and Outcome Artifacts, please consult the Creating a Design Dossier Handout on Quercus.

## 2.2 Using the RFP

As in Praxis I & II, Requests for Proposals (RFPs) in Praxis III provide background information about a particular challenge faced by a community, as well as Need(s), Goal(s) and Objective(s) against which potential design solutions may be evaluated. Our RFPs are structured according to the Design Chain, a key model in Praxis III; this means that our RFPs outline the Context including a specific Value Proposition, desired Approach(es), and provide a preliminary set of high-level Engineering Requirements (NGOs) which any Design Concepts must address.

Therefore, you should carefully read the RFP for any assignment you're working on (PSA and the Major Design Project later in the term) to establish:

- The context for the design work that you're doing, including stakeholder needs.
- Any gaps in the information presented, or questions you have about the needs of the community you're centering in your design work.
- A starting point for any further research necessary to complete your design work (i.e., the included bibliography).
- The approach you're being asked to take to address the Value Proposition.
- The Objectives that Design Concepts must meet.

For this assignment (PSA), there is **no expectation that you re-frame the problem or perform additional secondary research**; however, you will likely need to do this for the Major Design Project.

## 2.3 Using the Template Design Dossier

For the Prototyping Skills Assignment (PSA) we have provided a template Design Dossier, which contains the following information about the Design Concept, and related Prototype System you will realize:

- A spreadsheet detailing the Need, Goals and Objectives for design work (reproduced from the RFP);
- A draft Design Concept Overview which describes the Design Concept that your prototype system will demonstrate;
- A draft Prototype Concept document that describes the overall plan for the prototype and which aspect of the Design Concept the prototype will focus on exploring.
- A Specification which details the general form and functionality that is expected for the prototype you will produce; and
- A draft Verification Protocol which you will complete as you test your prototype system.

These are **simplified versions** of documents we will ask you to prepare as part of the Major Design Project later in the term. Here, your task begins with the design and fabrication of a Prototype System. You are expected to add additional artifacts to the Design Dossier as you complete your design and fabrication work (see Section 4.2 for more information about the Design Dossier and required artifacts).

### 2.4 Using the Rubric

A rubric is provided to help you understand how this assignment will be graded. Please consult it **before** you begin preparing your deliverables. You may also refer to the Assessment & Feedback Approach document on Quercus for more information on assessment.

## 3 Design Process Constraints

The prototype system you create for this assignment must meet the Specification provided in the Prototyping Skills Assignment Design Dossier. In addition to this required functionality, this section outlines relevant **constraints** on the design process that your group must adhere to in your design and fabrication work.

### 3.1 Assignment Expense Budget & Constraints on Sourcing Parts

**All components and materials used in your prototype must be sourced from MYFab.** You may order digitally fabricated parts as well as final sale components. You are **not** permitted to order rental components[3] for this prototype. Components found for free in the MYFab scrap bins are acceptable and do not contribute towards your expense budget.

**PAUSE**: This constraint applies to digital fabrication as well as raw materials: that means that you are **not** permitted to use a personal 3D printer or laser cutter to fabricate any part of your prototype. You must use MYFab for all digital fabrication.

**The total expense budget (*i.e.*, total cost of orders from MYFab) for your prototype is $12.00**, including any digital fabrication, but not including parts from your group members' Lab Kits.

**NOTE**: When you order components as an ESC204 PSA Group, you will **not** be charged out-of-pocket; the course will cover the cost.

Additional constraints on sourcing parts for this assignment are given below.

1. Any parts of the structure that are 3D printed must be submitted to MYFab in a **single** 3D print order that has a print time estimate of **<5 hours** using MYFab's default print settings[4]. You can find instructions on how to import the settings into Prusa Slicer on Quercus.
2. Any parts of the structure that are 3D printed must use **PLA** filament on the **Prusa Mini** printer—no other filament options or printers will be approved for this assignment[5].
3. Any parts of the structure that are laser cut must be cut from **3mm plywood**—no other material options will be approved for this assignment.

[3] You may be able to order small rental components like buttons as final sale components (i.e., pay the full price and not the rental price) if desired. Speak to MYFab to determine whether this is possible.

[4] You can get the print time estimate from PrusaSlicer after slicing. This is a 'strictly less than' constraint.

[5] When you load MYFab's default print settings, this should be set automatically (though you should verify this is the case!).

4. Any parts of the structure that are laser cut must be submitted to MYFab in a **single** laser cut order using **at most one full sheet**[6] of plywood.
5. If raster engraving is used, the **maximum engraved area** is 5cm × 2cm.

ⓘ **INFO**: You will submit your own CAM files to MYFab, but you will not be able to personally run the CAM equipment (3D printer or laser cutter), as the digital fabrication process is run by MYFab staff.

## 3.2 Prototype Subsystem Build Constraints

The following constraints apply to how you build and integrate your prototype subsystems (see the Prototype Concept document in `03_ConceptualDesign` folder of the PSA_DesignDossier Template for more information on subsystems).

### 3.2.1 Software Subsystem

The following constraints apply to your software subsystem (i.e., the control code for your system):

1. The code must be written in CircuitPython.
2. The code must use descriptive variable names and include comments. Comments should demarcate the section of code associated with each major function of your prototype.

In general, ensure that your code is readable.

### 3.2.2 Electrical Subsystem

The following constraints apply to your Electrical Subsystem (i.e., the microcontroller circuit and its components and connections):

1. The circuit must be assembled using a breadboard.
2. The circuit must include at least one pushbutton.
3. Rental components (including those from your Individual Lab Kit) must not be cut or otherwise modified in any way (i.e., you must not cut or otherwise permanently modify the push button, Raspberry Pi Pico microcontroller board, breadboard, micro-USB cable, or any other rental component).
4. The circuit must be fully disassemble-able into individual components (i.e., you must be able to remove components from the breadboard and each other at the end of the project).

[6] One full sheet is 18" by 24", but your drawing must fit within a cut boundary that is slightly smaller.

### 3.2.3 Structural Subsystem

The following constraints apply to your structural subsystem (i.e., the case or cover that protects your system and any associated fasteners, features, or aesthetic elements):

1. The structure must be assembled without damage or alteration to the push button, Raspberry Pi Pico, breadboard, micro-USB cable, or any other rental component.
2. If adhesives are used, they must not be used on any rental components (including the breadboard).

**NOTE**: Post on Piazza if you have any questions about design and prototyping of your structural element. For technical discussion of the 3D printing and laser cutting processes, you can ask MYFab staff – they are very knowledgeable and can provide guidance on best practices for digital fabrication. Please note that the staff might not have time for a long discussion if the facility is very busy; plan ahead to reach out well in advance of any deadline!

# 4 Submission Requirements

This section outlines requirements for submission of this assignment. As part of the assignment, you will submit the following components:

1. A MYFab DigiFab Order.
2. A Design Dossier containing evidence for your design work during the assignment.

These submissions are discussed in the following sections. For more information about the Design Dossier deliverable, please be sure to consult the Creating a Design Dossier handout on Quercus.

## 4.1 Interim Submission: MYFab DigiFab Order

**Due Date:** Sunday, January 18 at 11:59PM

As part of the assignment, your group will need to **submit a 3D print and/or laser cut request** to the Myhal Centre Fabrication Facility (MYFab). Provided that your group submits before the interim deadline on January 18th, your first 3D print submission and/or your first laser cut submission will be completed and ready for pickup by MYFab closing time on Friday, January 23rd. Your submission(s) are subject to the constraints described in Section 3.1.

**INFO**: There **may** be capacity for second submissions once all first submissions have been processed, but we will not know in advance whether this will be logistically possible, so don't count on having this option.

**WARNING**: Your submission may be rejected by MyFab if it is not correctly designed for digital fabrication. Your submission may also be rejected by the teaching team if it does not meet the assignment constraints in Section 3.1. If your first submission is rejected for any reason, you may fix your CAM files and submit again, but this second submission may not be processed before the assignment deadline.

**PAUSE**: Be sure to consult the Prototyping Skills Assignment Rubric to understand how an order rejection or a prototype that does not function as intended will affect assessment of your assignment. We know that it is challenging to prototype using digital fabrication without the ability to iterate. Hence, it is **not** necessary to have a complete and correct structural element to do well on the assignment overall. However, it is important to go through the full iteration and submit a design for fabrication (even if it gets rejected) so you can learn from the process.

## 4.2 Final Submission: Design Dossier

**Due Date:** January 26 at 11:59 **AM**

Your group must submit a .zip file of **no more than 500 MB** containing your Design Dossier to the Prototyping Skills Assignment page on Quercus. For instructions on preparing Design Dossier deliverables in ESC204, please be sure to read the Creating a Design Dossier handout on Quercus.

| **Required Artifacts** | **Filename** (`GroupNo_PSA_%s`) | **Folder Location** | **See Section:** |
|---|---|---|---|
| Prototype Overview | `%s = PrototypeOverview.pdf` | `04_Prototype` | 4.2.1 |
| Verification Protocol & Results | `%s = VerificationProtocol+Results.xlsx` | `04.4_Verification` | 4.2.2 |

Table 2: Summary of required Outcome Artifacts for the Design Dossier at Submission Point #2.

| **Required Artifacts** | **Filename** (`GroupNo_PSA_%s`) | **Folder Location** | **See Section:** |
|---|---|---|---|
| Prototype Design Artifacts | Various (collection of artifacts) | `04.1_PrototypeDesign` | 4.2.3 |
| Build Artifacts | Various (collection of artifacts) | `04.2_Build` | 4.2.4 |
| Integration Artifacts | Various (collection of artifacts) | `04.3_Integration` | 4.2.5 |
| Verification Artifacts | Various (collection of artifacts) | `04.4_Verification` | 4.2.6 |

Table 3: Summary of required Process Artifacts for the Design Dossier at Submission Point #2.

To submit, you must upload a complete .zip file of your Design Dossier, including all of your artifacts (both process and outcome artifacts, as summarized in Tables 2 and 3). If your group worked in a shared space such as SharePoint or Google Drive, you may also leave a **comment** on your submission which contains a link to your group's online Dossier (this enables you to use live links between artifacts in the Dossier, for example, which may be of interest).

**WARNING**: If you choose to submit a linked version of your Dossier, it is your responsibility to ensure the linked version is not accidentally modified after the deadline. If we cannot verify this OR we see any changes to the linked Dossier after the deadline, we will assess your submitted .zip file instead.

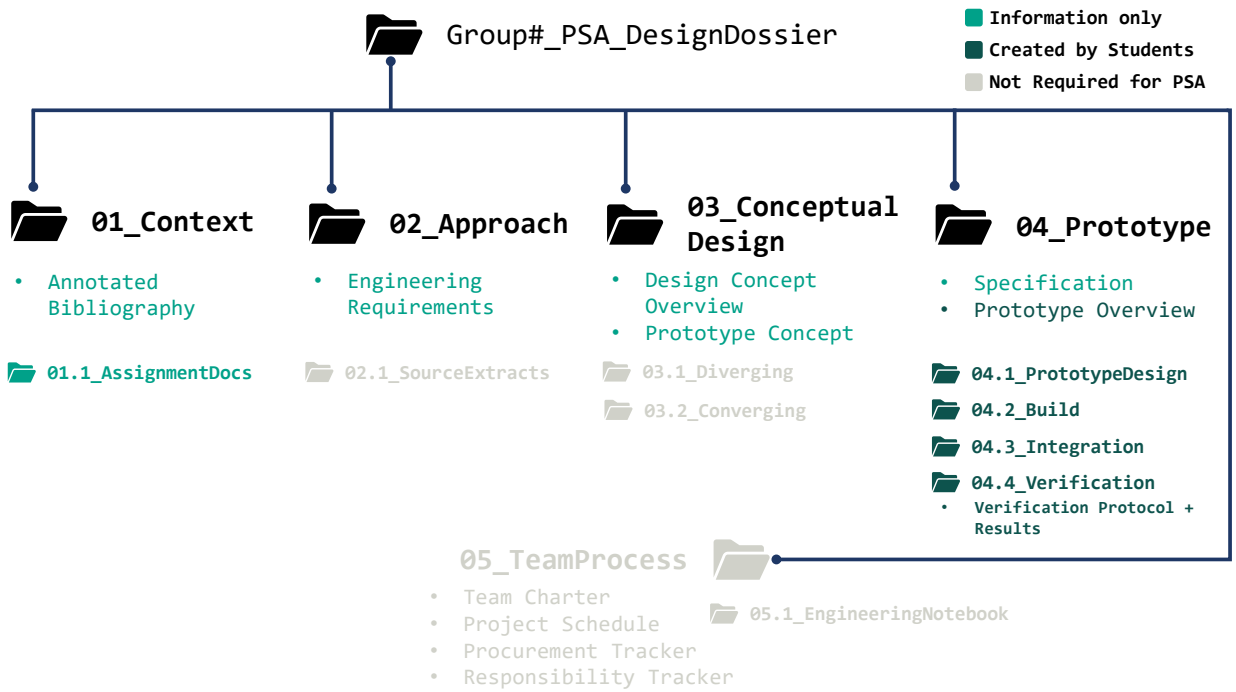


Figure 1: Overview of folder structure and required artifacts for your PSA Design Dossier.

**PAUSE**: If you choose to submit a link using the comment function on Quercus, you **must** still submit a .zip file which contains identical content. Although your assessor will grade your Dossier using the link, if there is any dispute regarding the contents of the Dossier, the files in the .zip will represent your official submission.

For the Prototyping Skills Assignment, your Design Dossier **must** contain the files and folders shown in dark green ("Created by Students") and light green ("Information only"[7]) in Figure 1. You should download the Design Dossier template `.zip` file for PSA from the Prototyping Skills Assignment Resources page on Quercus to set up your Design Dossier with the appropriate structure, and access the files provided by the Teaching Team.

The following sections provide more detailed information about the process and outcome artifacts you should include in your Dossier.

### 4.2.1 Prototype Overview

You **must** submit a document titled `GroupNo_PSA_PrototypeOverview.pdf` which summarizes the design and fabrication of your Prototype System. The purpose of this document is to provide your assessor with a high-level overview of your design work during the assignment, and to present the final prototype system (as-built). This is your opportunity to submit a more "polished" document which highlights the most important aspects of the design and fabrication work you have completed. Your Prototype Overview should highlight the design process you undertook to create your final prototype system, key challenges you faced during building or integration, and the final performance of your prototype. You should also discuss the key design decisions you

[7] These files should be included as-is: there is no need to make any modifications.

made while designing and/or fabricating your prototype, with appropriate justification.

At minimum, you should include in the Prototype Overview:

- ☐ At least one abstract representation of the control architecture for your system such as a state diagram, flowchart, behaviour table, etc.
- ☐ At least one circuit schematic including all circuit elements.
- ☐ At least one image of the CAD model of your structural element[8].
- ☐ A picture of your final integrated prototype.
- ☐ An assessment of the prototype's performance relative to the specification provided.
- ☐ A description of the key design decisions you made while designing the prototype.
- ☐ Brief discussion of the most significant challenges you faced while completing the assignment.

In your Prototype Overview, you should link to the other artifacts in the `04.1_PrototypeDesign`, `04.2_Build`, `04.3_Integration`, and `04.4_Verification` folders to support claims you make about your Prototype System or design process, and to provide examples or additional detail regarding the design, build or testing processes where appropriate.

This document must meet the following formatting requirements:

- Your prototype overview should be in .pdf format.
- The maximum length for this document is **2 pages**, including any figures included in-text.
- The document should have at minimum 0.75" margins on all sides, and use 12pt font.

### 4.2.2 Verification Protocol & Results

You **must** submit a completed Verification Protocol and Results spreadsheet as part of your Design Dossier. The template for this document is provided in the Design Dossier Template on Quercus, `ESC204S_2026_VerificationProtocol+Results.xlsx`. The purpose of this artifact is to scaffold the creation of a Verification Protocol to determine whether your prototype system meets the provided Specification (`ESC204S_2026_Specification.xlsx`), and to house results of the verification activities you and your group performed.

The spreadsheet has been pre-loaded with the elements of the specification for your Prototype System, as well as the required method of verification for each element. Please **do not** change the Verification methods provided for each element. As a group, you must:

1. Create a Verification Procedure for each specification element that will allow your group to assess how your prototype system performs relative to that element; and
2. Actually perform verification activities and record the results.

Verification may be completed (as indicated) by Inspection (providing written and/or photographic evidence that your prototype meets the specification), through Analysis (a-priori modelling, calculations etc.), Demonstration (video or other evidence that your prototype system has met a particular specification at least once during operation), or Testing (rigorously and quantitatively demonstrating that the design meets a particular specification over multiple trials and under various operating conditions).

[8]This CAD model need not represent the entire structural element if you fabricated some parts by hand, but ensure that any parts that were not designed in CAD are represented in a sketch or other design process visual.

### 4.2.3 `04.1_PrototypeDesign`

As you design your prototype system based on the Specification provided in the PSA Design Dossier Template, you should create artifacts which represent this design process and capture these in the `04.1_PrototypeDesign` folder. You may choose to create sub-folders in this space to organize your work. You should also refer to these to support claims you make in your Prototype Overview artifact. For example, you could include:

- Photograph(s)/screenshots of whiteboard(s) or other graphical collaboration tools that your group used for brainstorming at any point in the design process.
- A collaborative document where team members contributed ideas with track changes on to show the evolution of your design.
- Engineering design process artifact(s) depicting trade-offs or comparisons between design ideas at any point during the design process.
- Sketches or other graphical representation(s) of preliminary design ideas.
- Models, calculations, or other numerical representation(s) of your system's intended performance.
- Notes from discussions with MYFab, peers, or teaching team members regarding the design of your prototype system.

The idea is that artifacts in this folder show how you came up with ideas for your prototype system, and how you determined whether your ideas were likely to meet the specification and design process constraints *before* you began construction.

### 4.2.4 `04.2_Build`

As you fabricate each subsystem (Software, Electrical and Structural), you should create artifacts which represent the build processes you undertook and capture these in the `04.2_Build` folder. You may choose to create sub-folders in this space to organize your work. In particular, you should include:

- The actual code which controls the behaviour of your prototype, and any previous versions which contributed to your understanding of its present function.
- The circuit diagram you used to construct the circuit elements of your prototype (as-built), and any previous versions which contributed to your understanding of its present function.
- Screenshots of the CAD model(s), the actual CAD model(s) and (where relevant) drawings or sketches that you used to fabricate the structural elements of the prototype (as-built), and any previous versions.
- The CAM file(s) and screenshots of CAM model(s) submitted for DigiFab orders.
- Screenshots or other records of each MYFab DigiFab or purchase order placed as part of this assignment, including the order number and notes (with the component list if applicable).
- Photos/video of each subsystem of your prototype (as-built).

The idea is that artifacts in this folder show the steps you took to construct each of your prototype's subsystems. There should be enough information here to see exactly what components went into each of the subsystems, how they work, and any key design decisions you made as you fabricated them. You should refer to these artifacts in your Prototype Overview to support claims you make regarding the build process.

#### 4.2.5 `04.3_Integration`

As you integrate your three subsystems to create your complete Prototype System, you should create artifacts which represent the integration process and capture these in the `04.3_Integration` folder. In particular, you should include artifacts which demonstrate any challenges you overcame during integration, or any debugging you had to do to ensure that all three subsystems worked together to perform their intended function(s). For example, you could include:

- Photos/video of initial versions of of your prototype system, where pieces didn't fit together, or integrated subsystems didn't achieve the desired function when taken together as a whole.
- Photos/videos or other artifacts discussing the debugging processes you undertook to correct any issues arising during integration either of the whole system or between subsystems.
- Artifacts capturing adjustments you could make to the design/build processes to avoid the issues you experienced with system integration next time.
- Photos/video of the fully integrated (final) Prototype System, as built.

The idea is that artifacts in this folder show how your individual subsystems came together (or failed to come together!) to form a functioning Prototype System. If your final prototype doesn't meet the specification, you should make sure your artifacts in this section illustrate why, and reference them to support related discussion in the Prototyping Overview.

#### 4.2.6 `04.4_Verification`

As you perform verification on your completed prototype system or its subsystems, you should include additional artifacts in the `04.4_Verification` subfolder which support claims made in the Verification Protocol and Results artifact (as necessary).

## 5 Submission Checklist

You should submit the following to the **Prototyping Skills Assignment** page on Quercus in advance of the deadline (**Monday, January 26 at 11:59 AM**):

- ☐ A .zip file of (and optionally, a live link to) your PSA Design Dossier, as described in Section 4.2. Your Design Dossier should contain the following Required Artifacts:
  - ☐ A Prototype Overview Document (Section 4.2.1).
  - ☐ A completed Verification Protocol and Results spreadsheet (Section 4.2.2).
  - ☐ Process Artifacts supporting the design of your Prototype System (Section 4.2.3).
  - ☐ Process Artifacts supporting the fabrication of the subsystems of your Prototype System (Section 4.2.4).
  - ☐ Process Artifacts supporting the process of integrating the subsystems you fabricated into your completed Prototype System (Section 4.2.5).
  - ☐ Process Artifacts generated during verification of your prototype system (Section 4.2.6).