ESC204 | Praxis III

Prototyping Skills Assignment | Request for Proposals

Due Date: January 26, 2026

This Request for Proposals (RFP) provides contextual information relevant to your design work for the Prototyping Skills Assignment (PSA). In addition to this document, you should consult the following materials and resources for information about the assignment:

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

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1 Context: Food Insecurity in Canadian Indigenous Communities

For this assignment, we consider challenges surrounding food security in northern Indigenous communities in Canada. Though we provide only a limited perspective on this issue here in the assignment, more information is available in the resources provided in the Annotated Bibliography provided in the Prototyping Skills Assignment Design Dossier Template and on Quercus.

In brief, communities (and in particular, Indigenous communities) in Canada's north often experience food insecurity due to (among other factors) the significant expense of purchasing food, which often must be flown or trucked in over long distances, and the lack of access to or contamination of traditional food sources [1]. Especially when traditional food sources are scarce, nutrition may suffer [1]; therefore, increasing access to nutritious fresh foods could benefit residents of remote Indigenous communities.

1.1 Value Proposition

Indigenous communities in Canada, especially those in northern or remote regions, experience food insecurity at rates much higher than the Canadian national average. One factor which contributes to food insecurity is the challenge and expense of transporting food into these communities, which makes food both expensive and impacts the health/quality of food available. To address this challenge, we propose to improve conditions for local growing in remote northern regions, which could improve access to high-quality fresh foods without the need for long-distance transport.

2 Approach: Local Growing & Community Agriculture

The approach we have selected for this assignment to address food insecurity in northern or remote Indigenous communities is to create community-based local agriculture, for example through establishing community greenhouses to extend the growing season.

> **INFO**: Greenhouses are structures with a controlled internal climate that can be used to create a favourable environment for growing crops even when the external environment is unfavourable (e.g., low light and/or low temperature).

Growing crops requires a certain amount of light measured by the daily light integral (DLI). In northern latitudes, DLI is often below ideal levels, so greenhouses need supplemental lighting [2], [3]. A typical greenhouse uses ratios of red and blue to produce pinkish-purple light [4].

> **CONNECT**: Why pinkish-purple light? White light contains all "colors" (wavelengths) in the visible spectrum. When white light shines on a surface, some of it is absorbed and some is reflected. The reflected parts of the visible light spectrum determines what our visual systems perceive as the object's colour. Therefore, since plants mostly appear green to us, we can assume that plants absorb light in the red and blue portions of the spectrum and reflect the green portion. Thus, green light energy is less useful for photosynthesis.

Pinkish-purple lighting can be unpleasant for greenhouse workers, so some white light should be added to improve comfort for workers [4].

2.1 Restriction of Scope

In this assignment, we will focus on the Supplemental Lighting System that a community greenhouse operating in Canada's North requires. This system is a *subsystem* of the larger greenhouse system. To keep the scope of the assignment appropriate, we have chosen to restrict our further design activities to this subsystem only.

> **NOTE**: There are many other approaches which would also address the Value Proposition we have laid out; for example, we could consider a smaller scale intervention (household-level pots/backyard greenhouses), or a larger-scale one (an automated industrial growing system). Alternatively, we could have considered genetic modification of the plants themselves to improve hardiness. In general, there are lots of approaches that one can take to address a given value proposition!

CONNECT: When working in a complex design context, exploring the space of approaches and limiting your design activities to a single approach (or a set of related ones) before writing Goals and Objectives allows you to create a conceptual design space that is open enough to allow innovation (you're not specifying a solution!), while being specific enough that the precise goals of your design are clear. This means that in order to select an approach, you should be engaging in at least one cycle of FDCR to explore the space of approaches before even settling on goal(s) and objectives!

2.2 Need, Goals and Objectives

Based on the discussion in Section 1, there is a Need to to improve access to nutritious, fresh foods in remote, northern Indigenous communities. Based on the approach we've selected (improving conditions for local growing, enabling local production of relevant food staples), the following Goals provide guidance towards designs which appropriately address the opportunity.

G–1: Create an appropriate environment to support crop growth in a remote northern community, considering both plants and workers.
G–2: Use finite resources efficiently.
G–3: Enable use by community members without specialized training or knowledge.
G–4: Withstand environmental factors present in a greenhouse environment.

Finally, considering lighting in the greenhouse as a subsystem of a much larger greenhouse system, the Objectives provided in Table 1 describe the key functions and performance elements necessary for this subsystem.

Please note that these are not complete lists of Goals or Objectives; however, they provide sufficient information about the desired lighting subsystem to enable further exploration through prototyping in this assignment. Here we are assuming (since the light needs of plants differ) that the greenhouse will contain tomato and capiscum (pepper) plants.

	Objectives	**Metrics**	**Justification**
G–1: Create an appropriate environment to support crop growth.			
O–1.1	Increase illumination for plants as much as possible, and to a minimum level of at least 10 mol·m^{-2}·day^{-1}.	Daily Light Integral (DLI) in mol·m^{-2}·day^{-1} (moles per square metre per day)	This ensures sufficient illumination for tomato and pepper plants [5].
O–1.2	Provide light for workers where plants are grown that is as close as possible to white light, i.e. 1:1:1 RGB ratio.	Spectral content of light when workers are present.	White light is more comfortable for greenhouse workers [4].

Table 1: Selected Objectives for the Greenhouse Lighting Subsystem, Part 1.

	Objectives	Metrics	Justification
G–2: Use finite resources efficiently.			
O–2.1	Use as little energy as possible while operating, with a daily average energy use of 4kWh or less.	Average daily energy use [kWh].	Communities in Canada's North have resource constraints (power often comes from diesel generators where fuel is trucked or flown in at great expense [6]). 4kWh represents a reasonable energy expenditure for a small greenhouse, based on statistics about energy useage in greenhouses in Ontario [7].This is also a moderate energy consumption for a small community (approx. equivalent to 250 community members making toast each morning).
G–3: Enable use by community members without specialized training or knowledge.			
O–3.1	Allow community members to discover how the greenhouse works independently and with no training.	Consideration of factors leading to users 1) understanding and 2) effectively handling the design (as in Chapter 3.7 of [8]). User-facing elements should clearly indicate how a user can/should interact with the design.	Ease of use is important to ensure that community members feel confident operating the design, as responsibility for growing is to be shared among community members.

Table 2: Selected Objectives for the Greenhouse Lighting Subsystem, Part 2.

Any Design Concepts developed for the Greenhouse Lighting Subsystem should address the Objectives in Tables 1, 2 and 3. These objectives are also captured in the PSA Design Dossier Template available on Quercus.

Objectives		Metrics	Justification
G–4: Withstand environmental factors present in a greenhouse environment.			
O–4.1	Resist moisture and dust ingress to an IP-67 level.	Compliance with IP-67 rating ingress protection, according to standard IEC 60529 [9].	Greenhouses are moist and dusty environments. There is a risk that any design located inside the greenhouse will be subject to dust ingress and accidental immersion; compliance to IP-67 means a design can withstand these conditions.
O–4.2	Withstand mechanical stresses incurred during transport, installation and operation.	Compliance with appropriate standards under IEC 60068 (Environmental Testing) which govern robustness to mechanical aspects of environment.	The design will require transportation to a remote, northern community, installation in the greenhouse, and periodic repairs. It may also experience shocks (i.e., being dropped, hit, etc.) during operation in a greenhouse environment.

Table 3: Selected Objectives for the Greenhouse Lighting Subsystem, Part 3

References

[1] M. Batal et al., “First Nations households living on-reserve experience food insecurity: prevalence and predictors among ninety-two First Nations communities across Canada,” *Canadian Journal of Public Health*, vol. Suppl 1, S52–S63, Jan. 2021.

[2] J. K. C. J. K. Boldt and R. G. Lopez, “Comparison of supplemental lighting provided by high-pressure sodium lamps or light-emitting diodes for the propagation and finishing of bedding plants in a commercial greenhouse,” *HortScience*, vol. 54, no. 1, pp. 52–59, 2019.

[3] L. Pramuk and E. S. Runkle, “Photosynthetic daily light integral during the seedling stage influences subsequent growth and flowering of celosia, impatiens, salvia, tagetes, and viola,” *HortScience*, vol. 40, no. 5, pp. 1336–1339, 2005.

[4] E. Runkle, “Investment Considerations for Greenhouse Lighting,” Michigan State University, White Paper, Oct. 2017. [Online]. Available: https://www.canr.msu.edu/floriculture/uploads/files/investment-considerations.pdf.

[5] A. P. Torres and R. G. Lopez, “Measuring Daily Light Integral in a Greenhouse,” Purdue University, White Paper. [Online]. Available: https://www.extension.purdue.edu/extmedia/ho/ho-238-w.pdf.

[6] Government of Canada – Canada Energy Regulator, *Market Snapshot: Clean Energy Projects in Remote Indigenous and Northern Communities*, https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/market-snapshots/2023/market-snapshot-clean-energy-projects-remote-indigenous-northern-communities.html, Accessed on December 23, 2025.

[7] Posterity Group, "Greenhouse Energy Profile Study: Report of Findings," Independent Energy Systems Operator (IESO), Technical Report. [Online]. Available: https://www.ieso.ca/-/media/Files/IESO/Document-Library/research/Greenhouse-Energy-Profile-Study.pdf.

[8] R. T. Klooster, F. Lox, and T. Schilperoord, *Packaging Design Decisions - A Technical Guide*. DEStech Publications, 2019, ISBN: 978-1-60595-070-9. [Online]. Available: https://app.knovel.com/hotlink/toc/id:kpPDDATG03/packaging-design-decisions/packaging-design-decisions.

[9] International Electrotechnical Commission (IEC), *Ingress Protection (IP) Ratings*, https://www.iec.ch/ip-ratings, Accessed on December 31, 2025.