The EECS 1021 Major Project (*Optional*)

One sentence overview

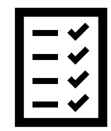
To get above a B+ or to improve your grade, **you may opt to undertake** the optional major project, combining a Grove Beginner Kit (or other Arduino-compatible) system with Java to demonstrate that you've become truly proficient with the material in the course.

Overview

Each student who **opts** to undertake the Major Project is to create a project that combines elements of Java with Arduino hardware like the Grove Beginner kit in the EECS1011/21 lab kit. The specific topic or problem to solve *is to be related to one of the "15 Engineering Grand Challenges"*. The project will be assessed against the five learning outcomes of the course. The assessment will be based on a video and on a written report to be submitted by the student before or on the final day of class.

Grade weighting

The Major Project is worth 20% of your final grade. Because of this, without opting into doing the Major Project, the maximum achievable letter grade in this course is a B+. Upon a successful submission of a Major Project report and video, it is possible to achieve a final at "above expectations" level (A or A+).



The Major project will be assessed on a number of components, each evaluated using a four-point rubric scale. Each assessment component in the Major project is equally weighted and an average will be taken. Based on this, the final letter grade for the course may be updated, as described here:

- **Below** Expectations (1/4) : no change to your pre-major-project grade.
- **Marginally** meeting expectations (2/4): increase by one increment (B to B+ and below, but not B+ to A.)
- **Meeting** expectations (3/4): increase by one increment (B to B+, B+ to A, etc.)
- **Exceeding** expectations (4/4): increase by two increments (B to A, B+ to A+, etc.)

Again, each component of your project will be assessed against a four-point rubric. Each rubric is equally weighted. The **average** will determine the project grade.

> What does Exceeding Expectations mean?
>
> If you do well on the project, demonstrating that you've learned what you were supposed to learn, you'll be evaluated as having "met expectations". The objective is to have many, if not most, students hit that category.
>
> If you do something that really goes beyond what we expect of most students, then you are in the "exceeding expectations" end of things.
>
> In a project like this it means either (1) doing a solely technical project at an unexpectedly high standard and/or (2) doing a very good technical project combined with a framing of this project in a greater non-technical (social/political/environmental) context. This can take the form of a deeply researched and anchored report or in the development of external content related to the course topics on a platform like Wikipedia.
>
> To get a better understanding of what is meant by this, please come to class or office hours to discuss.

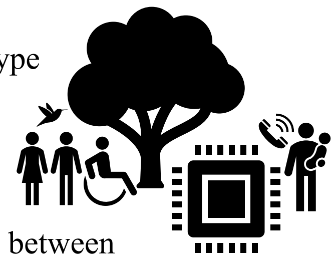
Final Submission (20% of final grade)

1. Five minute video (10% of final course grade)
2. Five page report (10% of final course grade)
3. Source code (no numeric grade, but required and provides context for video and report)
4. Due on last day of class (prior to the final exam period) by 11:55pm.

You are permitted to submit it late. However, each day that the submission is late, a penalty of 2% off of your complete final course grade will be applied. After ten days, the Major Project will effectively be worth 0% with respect to your final course grade.

Project topic

The application needs to relate to one of the 15 (14+1) Engineering Grand Challenges. However, **it needs to relate to** computational thinking from an object-oriented programming approach, as well as to involved instrumentation and/or mechatronics. What you need to do is:



1. **Solve** a problem with a computer system
2. **Design** and implement the solution
    a. Use a microcontroller (Grove board or alternative Arduino-type device)
        i. Program it using the Arduino IDE
    b. Use Java on your personal computer
        i. Program it using a typical Java IDE like IntelliJ
    c. Part of your solution needs to incorporate a software bridge between the Grove (Arduino) board and your personal computer, typically over the USB cable.
    d. Integrate external components (like sensors, communication, motors and/or displays)
3. **Test** the system
4. **Demonstrate** the system

The Grand Challenges are listed at the NAE Grand Challenges for Engineering website. There are 14 listed there.[1] Based on a discussion with OSPE's CEO, Sandro Perruzza, I've added a 15th: *Cleanse the Air*:

1. Cleanse the Air (new!)
2. Advance Personalized Learning
3. Make Solar Energy Economical
4. Enhance Virtual Reality
5. Reverse-Engineer the Brain
6. Engineer Better Medicines
7. Advance Health Informatics
8. Restore and Improve Urban Infrastructure
9. Secure Cyberspace
10. Provide access to Clean Water
11. Provide Energy from Fusion
12. Prevent Nuclear Terror
13. Manage the Nitrogen cycle
14. Develop Carbon Sequestration Methods
15. Engineer the Tools of Scientific Discovery

"Cleanse the Air" is a new, unofficial one: COVID has shown us that airborne hazards can have devastating impacts on both individuals and the global community.

These are *general fields* of projects. You'll need to focus the technical elements of your project and frame them in the context of these Grand Challenges.

[1] http://www.engineeringchallenges.org/challenges.aspx

While you can choose any project that you wish, if you are still struggling to come up with technical elements, you may wish to consider "widgets" like these, which may or may not fit within the Grand Challenges:

- Automated door opener
- Toy trainer controller
- Bird feeder
- Solar powered calculator
- Clock display
- Tamagotchi
- Doorbell and remote chime
- Automated safe
- Simple "Roomba-like" cleaner
- Kinetic sculpture
- Musical instrument
- Weather station
- Home alarm
- Wireless telemetry or data logger (LoRa, ZigBee)
- Anything Bluetooth related (*generally hard!*)
- Background sound alarm
- Building temperature monitor (indoor vs. outdoor temperature)
- Window blind controller
- NFC-controlled inventory system
- … you may suggest some on your own.

You can also take the minor project (the watering plant project) and **augment** it to be **<u>much</u> more** than what was expected in the context of the Minor Project. Please note that most "augmented" minor projects are rejected because they aren't sufficiently augmented. I don't recommend going this route as your likely to not have it count as a Major Project.

> **Dangerous** projects are **prohibited**. That means that medical projects, anything to do with direct connections to AC power, anything with sharp objects or cutting surfaces are not permitted. There are plenty of other possible projects that are also dangerous and we're not going to deal with any of these in this class. If you are thinking of doing something that might be considered dangerous, please come to speak with me.
>
> 

No unacknowledged re-use of other peoples' work

Any unacknowledged re-use of another person's project (in class, online or otherwise) will result in a grade of 0 on this project. The project must be original and must be executed by the student. Any help received by the student (online forum questions, webpages, etc.) needs to be cited, with a transcript or direct URL with description of context in the appendix of the report (does not count towards the page count).

That said, it is important to point out that, yes, you may use pre-existing libraries and/or header files, as long as it is cited (explicitly acknowledged). Libraries for serial communication or for driving the OLED on the Grove board are good examples of perfectly **acceptable use of someone else's work**. But **you need to cite them**, otherwise it appears as if you are claiming that that work is your own. So, cite your sources!

What format should the citation be in? It doesn't matter as long as it is (1) consistent, (2) has a URL that can be clicked on for online sources, (3) the scope and context are explained. Typically, include the

1. article title
2. website or book or magazine name;
3. Author name(s)
4. Date (year at least)
5. URL (usually)

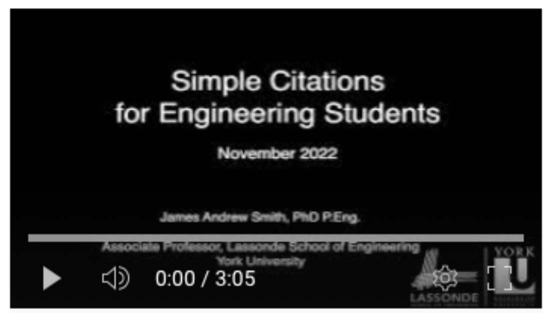


Figure 1 Overview of simple citations for engineering students: https://youtu.be/UtwOS4uZjcE

How much material can be someone else's versus the work that you put into the project? It must be clear from the amount of original (non-citable) material that you submit that you can demonstrate proficiency vis-à-vis the learning outcomes.

Project technical scope

You must include **both** Java on a computer and an Arduino compatible device in your Major Project. The project's technical scope is variable, just as the topics are.

The general "rule of thumb" is:

1. Inputs: Two to three simple sensors or one to two complex sensor
2. Outputs: Two simple or one complex actuator/display

This assumes that the sensors or actuators are relatively "basic." Three of each might make sense, depending on your design. If you were using a very complex sensor, then only one would be sufficient. Not sure what complex or simple means in this context? Come to an office hour or synchronous class Q&A session to ask.

Consider the following:

- Analogue and simple digital devices are easiest to implement
  - Firmata4j only supports certain I2C or other complex devices. Check Firmata4j source prior to making purchases
- Your experience level dictates complexity
  - 1st timer? Simple off-the-shelf, no soldering
  - Old hat? Solder the board or try complex COTS (commercial, off the shelf)
- Use discrete components (individual chips, if you're comfortable)
  - Multiple discrete chips & support hardware
    - e.g. RS485 chip + power supply + support components
- Combine off-the-shelf peripherals… for example
  - 1 or 2 Arduino Shields, Mikroelektronika Click Boards or Grove boards.
  - If you use the same peripherals as the ones used in the EECS 1021 class without any significant changes to hardware or software it will not count as "meeting expectations" for a Major Project (and likely "failing to meet expectations")
- Integration of the system
  - Pay attention to clean wiring (aesthetics and reliability)
    - Cabling or bread-boarding are both effective approaches
  - PCB-making and soldering is typically outside the scope of a course like this.
- Packaging, Power & Display
  - Cardboard box is good (and can be done really well, too!)
  - Wood, plastic (3D printing) or metal is better

Can't afford to purchase more equipment?

I hear you. You can focus on using components on the Grove Beginner Kit for Arduino that we didn't use in class, as well as Java elements that go beyond what was covered in class and labs. There are plenty of Java libraries (e.g. JavaFX graphics, "cloud-aware" libraries) and advanced features that we didn't cover that are free to use and could be integrated into a project. Remember that you still need to include the Arduino/Grove board, but you don't need to add extra physical devices to it.

Can you re-use the minor project?

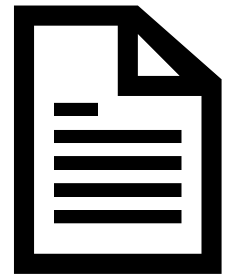
Yes, but you need to extend it a great deal to be considered a major project. Most students that go this route get a 0 on the major project.

Suggested topics

During the semester: discuss!

Discuss your idea with me during office hours or during in-class sessions.

End of Semester Submission



The final submission is due on the last day of class in April, by 11:55pm (Refer to YorkU's "Important Dates" webpage for the exact date). You are to submit **both** a report and a video. Both the report and the video will be evaluated according to the course learning outcomes. Each is supposed to **tell the story of your design work**. The video is to be about five minutes long. The report is to be approximately five pages long. Overlap in material between the video and written report is expected. Read on for details.

The Written Report

You must use the following headings in your written report.

INTRODUCTION

- A short description (three to five sentences)

CONTEXT:

- Describe "what" and "why". This helps determine if your project is simply a technical "widget" or if you are attempting to provide it with a context that would be sufficient to consider it as "exceeding expectations"
- Make the connection to the Grand Challenges (on page 2) here. If you don't use a Grand Challenge, explain so here.

TECHNICAL REQUIREMENTS / SPECIFICATIONS

- List of things that the system should do. A drawing (schematic) can be included here.
- You can be more general and less formal ("requirements") <u>or</u> more specific and formal ("specifications")

COMPONENTS LIST: [*as you built the device*]

- What was in your system? Write a bulleted list. Provide descriptions to clarify details.
- A photo of the system is appropriate here.

PROCEDURE:

- Describe the process that you used in creating your project.

TEST:

- how did you test that the system worked?
- Got graphs showing the results of tests? (power, etc.)

LEARNING OUTCOMES:

- Does your project address the five learning outcomes in the course?
- Provide **five bullet points, one for each outcome**. Describe the outcome and state how and why your project addresses it specifically.

CONTINGENCY

- Did you have one idea in mind but have to execute a different one because things didn't work out as planned? Reflect on this. What would you do differently next time? Looking ahead to ENG 4000, are there any lessons you learned that you would like to apply?

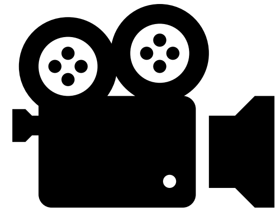
ADDITIONAL MATERIAL

- Especially, anything to do with making your project "holistic". Tie in context of the project and discuss any social, political or environmental aspects about your project that you believe makes it a candidate for "exceeding expectations."

CONCLUSION

- Wrap up in a few sentences. Include at least one sentence about the Grand Challenge (if you didn't use a Grand Challenge, say so here)

The Video



The video is to be about five minutes in length. The video format and approach are *more free-form* than the written report. Keep in mind that the assessment is <u>not</u> free form, though. It is evaluated the same way, using the rubrics as the written report. During your video you need to not only showcase your project, but you must also address aspects of the following.

Review this video for general skills **about video creation** for student projects:

- https://www.youtube.com/watch?v=pzDbPOg1rxs

You should be creating a **narrative video**, with voice over or text subtitles. What does a narrative video look like? Have a look at this example:

- https://youtu.be/08ADlETFBu0 (with audio)
- https://www.youtube.com/watch?v=KjycUDQHcnE (no audio)

Detailed Marking Guide for Final Submission

We will be evaluating your project using the five course learning outcomes and their rubrics. ***Both*** the **Report** and the **Video** will be assessed using these rubrics. Each learning outcome has a course-specific version ("CLO") and a generic program one (GAI). Students should focus on the CLO but can refer to the GAI for context.

Learning Outcome 1	Grade	Course-specific learning outcome 1 (CLO1): **Demonstrate the ability to test and debug a given program and reason about its correctness.** General form of the learning outcome (GAI 2b): Formulate a strategy for solving an engineering problem	Note: Remember JUnit testing?
	Report /4 Video: /4	1. Does not formulate an adequate strategy 2. Formulates a partial strategy for solving a problem, but it is not the best strategy for the context 3. **Formulates a strategy for solving an engineering problem** 4. Formulates multiple potential/possible strategies that could be used to solve the problem	
Learning Outcome 2	Grade	Course-specific learning outcome 2 (CLO2): **Given a problem specification and a suitable API, build an application that meets the given requirement.** General form of the learning outcome: (GAI 4b): *Conceive design solutions to solve the defined problem)*	Note: 1. You are to provide the specification in your report 2. Firmata4j, JavaFX and Open CSV all have suitable APIs. Feel free to use others.
	Report /4 Video: /4	1. Does not design solutions to solve defined problem. 2. Designs incomplete solutions. **3. Solutions complete, but lacking in elegance/innovation/creativity/professionalism.** **4.** Conceives elegant/innovative/creative/professional standard solutions to solve the defined problem	
Learning Outcome 3	Grade	Course-specific learning outcome 3 (CLO3): **Use ready-made collections to solve problems involving aggregations of typed data.** General form of the learning outcome (GAI 5b): Adapt appropriate techniques, resources, and modern engineering tools to complex engineering problems	Hint: remember Array Lists?
	Report /4 Video: /4	1. Does not adapt modelling methods, tools or software; can only use existing ones 2. Minor or ineffective adaptation of modelling methods, tools or software 3. Effective adaptation of modelling methods, tools or software 4. Effective adaptation, creation or extension of modelling methods, tools or software	
Learning Outcome 4	Grade	Course-specific learning outcome 4 (CLO4): **Build an event-driven application that controls sensors and actuators in order to connect events to physical actions.** General form of the learning outcome: (GAI 4b): *Conceive design solutions to solve the defined problem)*	Note:
	Report /4 Video: /4	1. Does not design solutions to solve defined problem. 2. Designs incomplete solutions. **3. Solutions complete, but lacking in elegance/innovation/creativity/professionalism.** **4.** Conceives elegant/innovative/creative/professional standard solutions to solve the defined problem	
Learning Outcome 5	Grade	Course-specific learning outcome 5 (CLO5): **Program common applications from a variety of engineering disciplines using an object-oriented language and solve them on the computer.** General form of the learning outcome: (GAI 4c): *Apply an iterative process to refine or assign solutions for a given engineering design problem*	Note: you only need to cover one discipline (e.g. Civil, Electrical, etc.) but it can span more than one.
	Report /4 Video: /4	1. Does not produce a solution. 2. Applies an incomplete iterative process: Solutions need further refinement 3. Applies an appropriate number of iterations to refine or assign solutions for a given engineering design problem **4.** Applies an iterative process to arrive at an elegant/innovative/creative/professional standard solution for a given engineering design problem	

More on the Rubrics & Marking Guides

In many Lassonde courses, like ENG 4000, we use qualitative criteria to assess students. Both students and faculty have noted that it gives a very different flavour to assessment. Most students will end up in the meeting expectations category, which maps to a "B" to "B+" range of traditional grades.

Rubric Numeric Score	Rubric Description	York Description	York Letter Grade
4	Exceeding Expectations	Exceptional	A+
3.5		Excellent	A
3	Meeting Expectations	Very Good	B+
		Good	B
		Competent	C+
2.5		Fairly Competent	C
		Passing	D+
2	Marginally Meeting Expectations	Barely Passing	D
1.5		Marginally Failing	E
1	Below Expectations	Failing	F

While you may aspire to a perfect ("100%") grade, the reality is that very few actually do on a properly designed learning activity. Yes, there will be some of you who will both aspire to and achieve an exceptional result in your project and, so, your project may be categorized as "exceeding expectations". It's not that others have done anything "wrong" but, rather, they have met the targeted learning; that is, they have "met expectations" of learning, which corresponds, when mapped to a traditional score, like a B or B+.

How will this play out in the project? To at least "meet expectations" you need to do so in all of the assessment components, both for the submission after reading week and for the submission at the end of the semester. This, typically, will mean that your project has also met all of its technical goals and that you didn't have to fall back on your contingency plan.

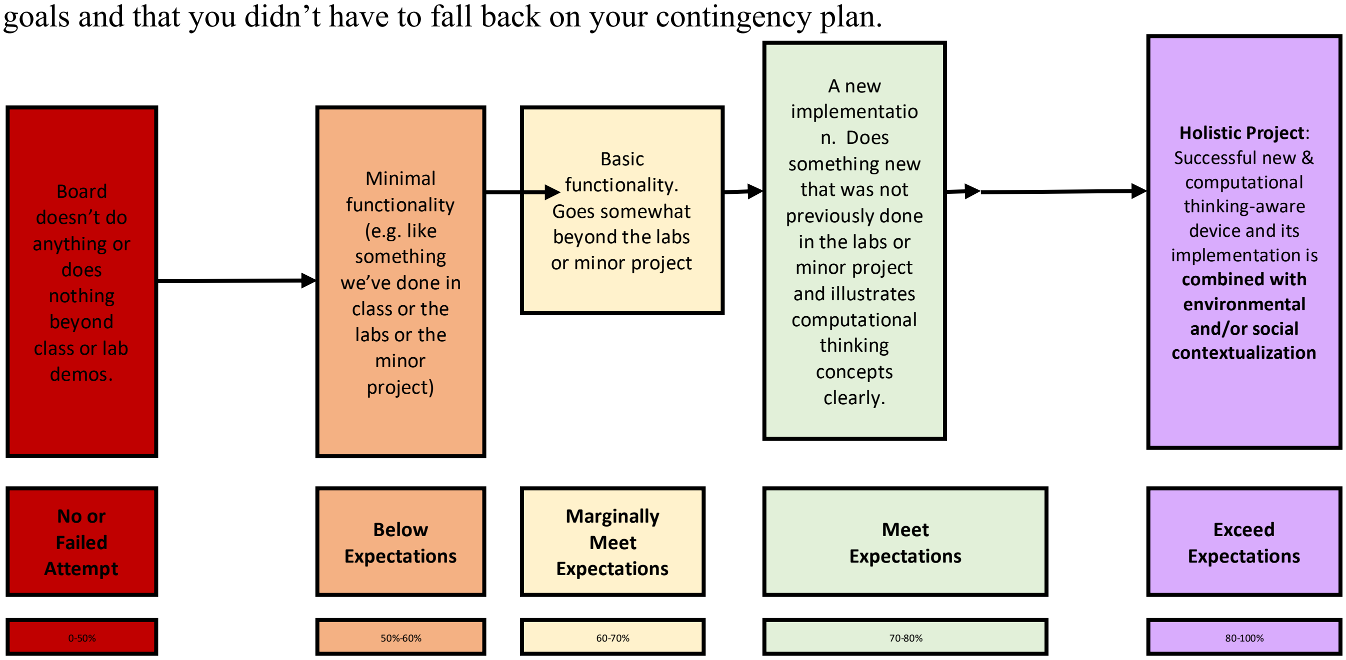


Figure 2 Overview of rubric assessment in context of project development.