

GNG1103 – Engineering Design
GNG1503 – Génie de la Conception

Introduction

Presented by: Emmanuel Bouendeu

Image from: <http://aptravelplus.ru>

Agenda

- **Introductory Test**
 - Considerations for Effective and Efficient Learning
 - About your Course Syllabus
- **Engineering Design**
 - Definition
 - Engineering Design Process
 - Attributes of Good Engineering Designer
- **About GNG1103 Course**
 - Course Plan
 - Success Factors
- **Team Work**
 - Attributes of Effective Team
 - Planning Basis
 - Energy & Leadership in a Team
- **Review Questions**

Teaching Staff

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Consultation

- On **appointment** requested by email
- In your email **Subject** always add your **course code** and **Lab section**,
e.g. Request for Appointment – **GNG1103F – F01**

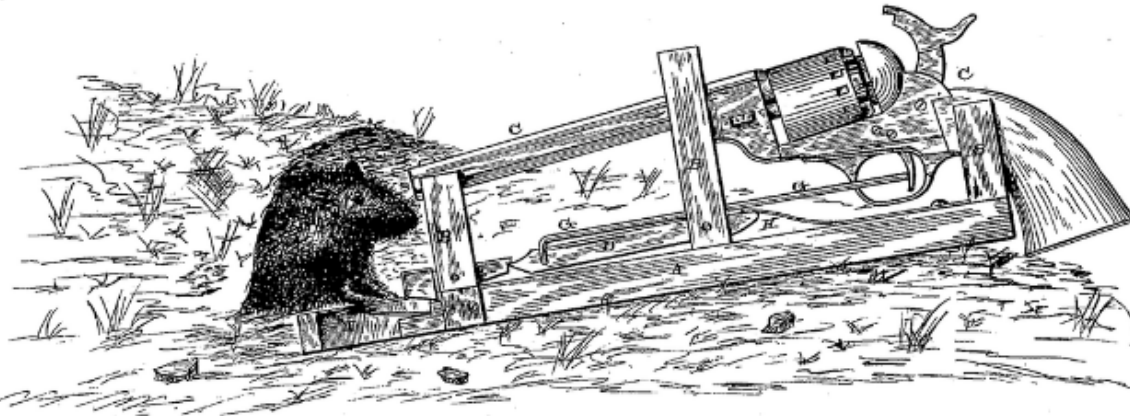
A better Mouse trap?

What is Engineering Design?

(No Model.)
No. 269,766.

J. A. WILLIAMS,
ANIMAL TRAP.

Patented Dec. 26, 1882.



Witnesses:
D. B. Clark,
W. H. Kern

Inventor,
J. A. Williams
per
J. A. Williams
J. A. Williams

K. FOSTER, Patent-Draftsman, Washington, D.C.

Mathematics and Science

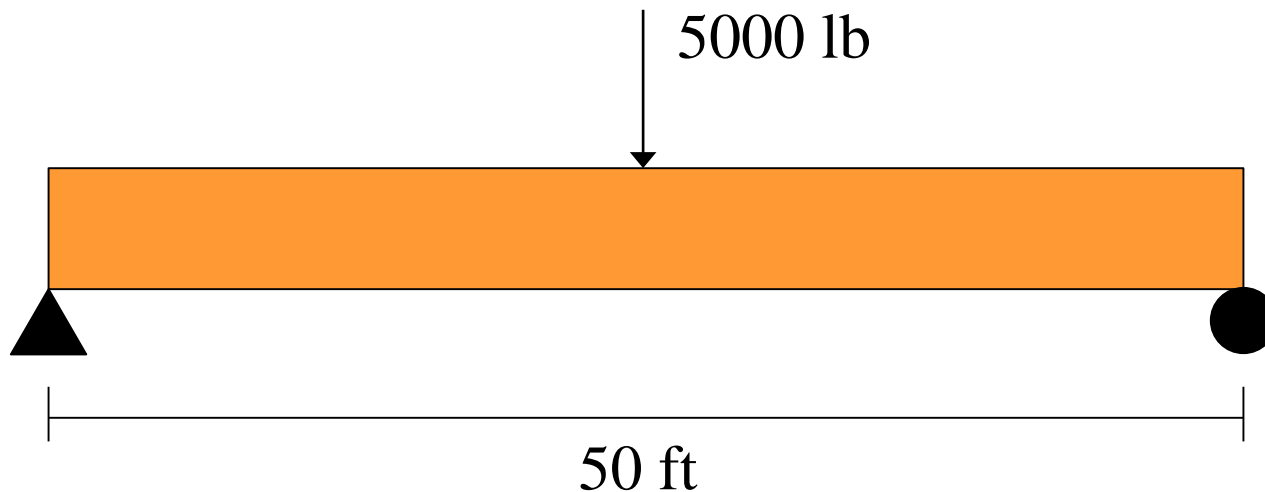
- Many students **study engineering** because of their **interest in math and science**:
- Find $x \rightarrow x^2 - 8x + 15 = 0$
- A balloon is filled with 1.2 L of H_2 , at a pressure of 740 mm of Hg and a temperature of 30°C . The balloon ascends 1 km, where the pressure is 640 mm of Hg and the temperature is 7°C . Calculate the new volume of the balloon (use Kelvins)

A: $V_2 = 1.28 \text{ L}$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Engineering Science

- An **extension** of math and science:
- A simply supported steel beam with a 3" diameter circular cross-section is loaded as shown in the figure. Determine the maximum stress and deflection of the beam.



Math, Science and Engineering Science



- Four common features:
 - Problems are **well-posed**
 - Problem statement is **complete**
 - Problem statement is **unambiguous**
 - Problem statement is **free** from internal **contradictions**
 - Solutions is **unique**
 - **Single correct answer** (i.e. number, set of numbers, variable)
 - Problems have **identifiable closure**
 - Easy to see when an **answer** has been obtained
 - Problems require application of **specialized knowledge** with **little doubt** about the **subject** of each problem

Engineering Design

- Most **real-world** engineering design problems do not share these **characteristics**
- Many design problems are:
 - Poorly posed
 - Do not have a unique solution
 - Do not have an identifiable closure
 - Most require integration of knowledge from many subjects
- *E.g.* Design a system for **lifting and moving loads** of up to 5000 lb in a manufacturing facility. The facility has an **unobstructed span** of 50 ft. The lifting system should be **inexpensive** and satisfy all **relevant safety standards**



Engineering Learning Process

Most Engineering Professors



- Transfer of knowledge from expert to student (fundamental rules)
- Students are comfortable here
- Mostly **teacher-centred** learning

Engineering Design Professors



- Good design is subjective, professors act as a guide
- Students are uncomfortable with lack of “correct answer”
- **Student-centred** learning

Engineering Design Definition

- From CEAB (Canadian Engineering Accreditation Board – Engineers Canada):

*An ability to **develop solutions** for **complex, open-ended** engineering problems and to **create systems, components or processes** that meet specified **needs** with appropriate attention to **health** and **safety** risks, **applicable standards**, and **economic, environmental, cultural** and **societal** considerations.*



Engineering Design Process

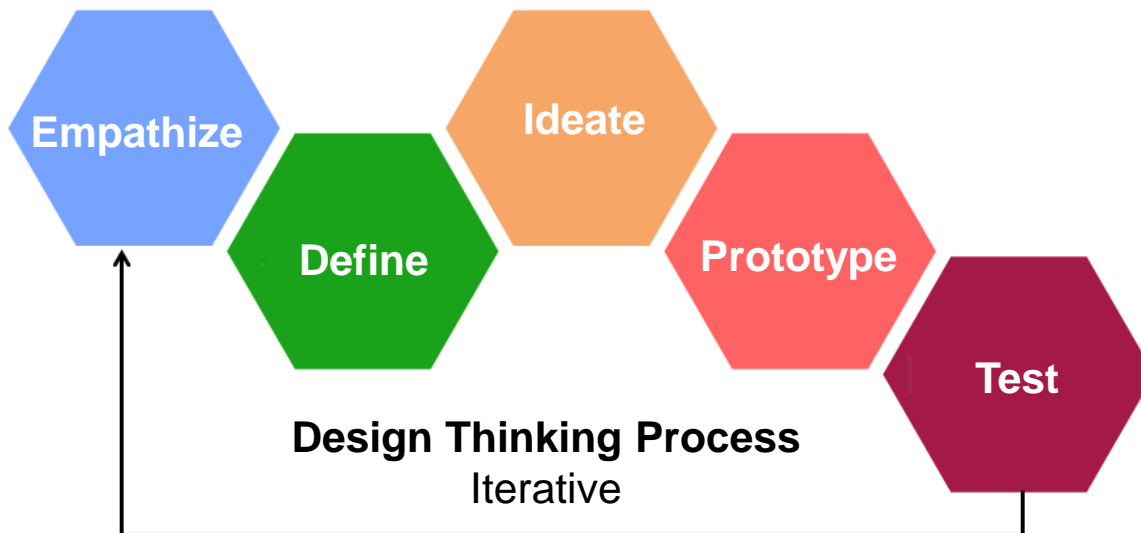
- From ABET (Accreditation Board for Engineering and Technology, Inc. – US):

*It is a **decision making process** (often **iterative**) in which the basic **sciences**, **mathematics**, and **engineering sciences** are applied to **convert resources** optimally to meet a **stated objective**. Among the fundamental elements of the design process are the **establishment** of objectives and criteria, synthesis, analysis, construction, testing and evaluation.*



Engineering Design Process

- We will follow an engineering design process called “**Design Thinking**” in order to demonstrate the **basic steps** of design and help improve the odds of **creating “good” designs**:



Attributes of Good Engineering Designer

Not Just Math and Science!

- It turns out that you need to develop **many skills** if you are to become a **good** engineering designer:

- Problem solving
- Technical skills
- Soft skills
- Creativity/Arts/Media
- Teamwork
- Communication
- Entrepreneurship
- Etc...



- And you should strive to develop a **broad range of engineering science knowledge** across disciplines



Lectures & Quizzes

Date	Lecture
6 Jan.	1. Introduction
8. Jan.	2. Design case study - Rainwater
13 Jan.	3. Design Thinking
15. Jan.	4. Needs identification + Q1
20 Jan.	5. Client Meet 1
22 Jan.	6. Design criteria, Metrics, Bench
27 Jan.	7. Team & Conflict management
29 Jan.	8. Conceptual design + Q2
3 Feb.	9. Time & Project management
5 Feb.	10. Design analysis
10 Feb.	11. Feedback & Prototyping
12 Feb.	Mid-term Exam

Date	Lecture
24 Feb.	12. UX design
26 Feb..	13. Modeling
2 Mar.	14. Failures & Testing + Q3
4 Mar.	15. Presentation – Client Meet 2
9 Mar.	16. Effective Communication
11 Mar.	17. Course summary & Learnt
16 Mar.	18. Course review + Q4
18 Mar.	Project Work in MarkerLab
23 Mar.	Project Work in MarkerLab
25 Mar.	Final presentation 1
30 Mar.	Final presentation 2
1 Apr.	Final presentation 3



Deliverables and Grading Scheme

Item	Course Mark Contribution
Lecture Quizzes (4 in total)	5%
Individual Assignments (2 in total)	5%
Labs, Quizzes & Attendance	10%
Project Deliverables	35%
Project Plan & Management & Outcomes	5%
Midterm Exam	10%
Final Exam	30%
Total	100%

⇒ All deliverables must be in PDF format and then submitted to **Brightspace** on time

⇒ Penalties for late submission is **25% per day**



Individual Assignments

Due this Sunday!

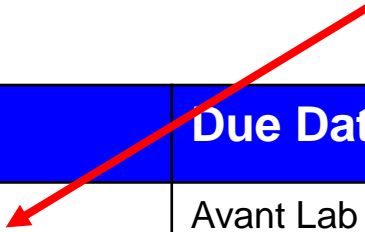
#	Assignment	Due Date	Mark
1	ITP Metrics personality assessment and team contract questions	Jan. 12	2.5%
2.1	ITP Metrics peer feedback and team dynamics assessment (online survey)	Feb. 9	
2.2	ITP Metrics peer feedback and team dynamics assessment (answer to questions in both reports)	Feb. 23	2.5%
Total			5%

⇒ Must be ***submitted individually*** on Brightspace!

Start this week

Laboratories

Week	Laboratory	Due Date	Location	Percentage
5 - 11 Jan.	Lab 1: Computer tools	Avant Lab 2	MakerLab	
12 - 18 Jan.	Lab 2: Arduino	Avant Lab 3	MakerLab	
19 - 25 Jan.	Lab 3: Basics training		MTC	
26 Jan. - 1 Feb.	Lab 4: Projet		MakerLab	
2 - 8 Feb.	Lab 5: Project specific lab		MakerLab	
9 - 15 Feb.	Lab 6: SolidWorks	Avant Lab 7	MakerLab	
23 - 29 Feb.	Lab 7: MatLab	Avant Lab 8	MakerLab	
1 - 7 Mar.	Lab 8: Soldering + Laser cutting		MakerLab	
8 - 14 Mar.	Lab 9: Projet		MakerLab	
15 - 21 Mar.	Lab 10: Projet		MakerLab	
22 - 28 Mar.	Lab 11: Projet	Design Day	MakerLab	
29 Mar. - 4 Apr.	Lab 12: Paperwork		MakerLab	
Total				10 %



Laboratories & Work Spaces at CEED

STEM 119/121

MAKERLAB



STEM 107

..... RICHARD L'ABBÉ
MAKERSPACE



SITE 3041

BAC À SABLE
SONDBOX



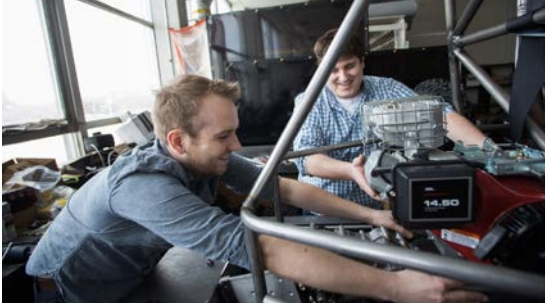
STEM 137

CFF | MTC



STEM 129

..... CENTRE
BRUNSFIELD
..... CENTRE



STEM 128

JMTS



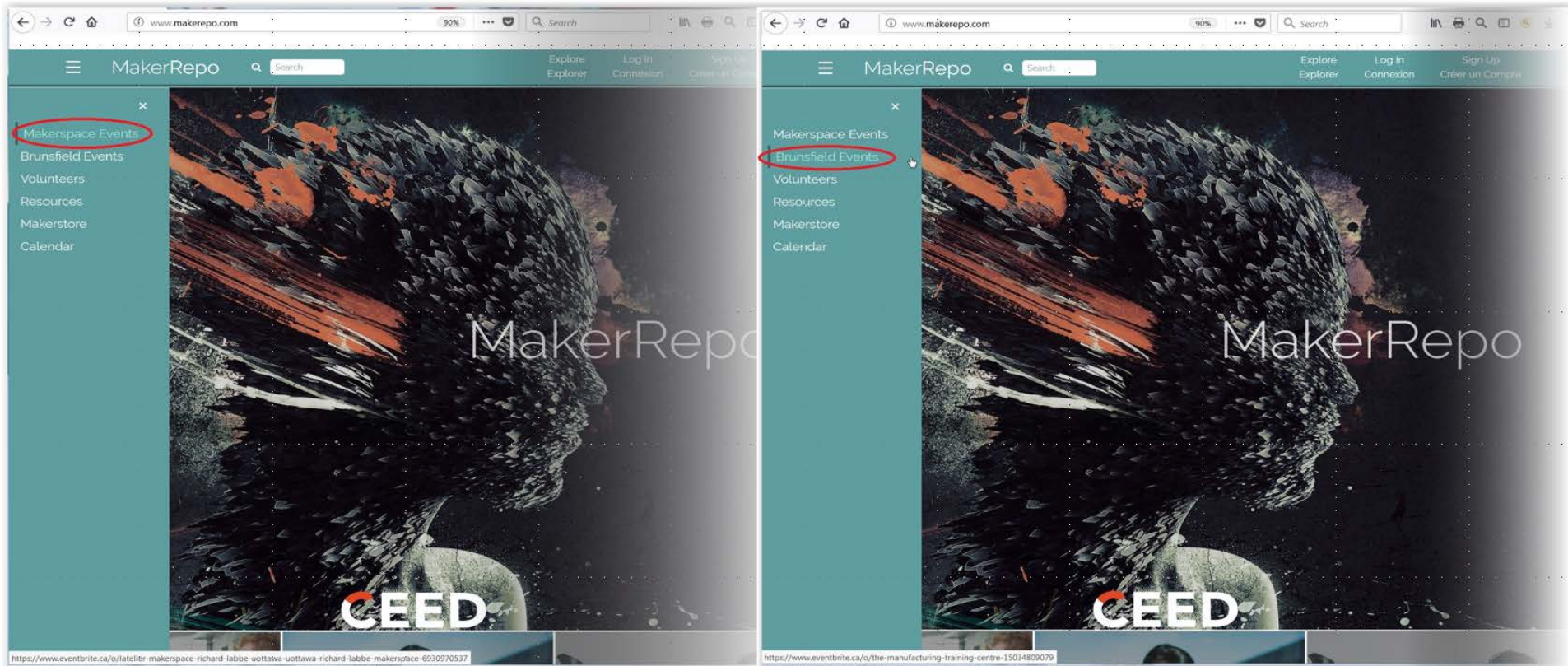
Which CEED Design Space for me?

- The Centre for Entrepreneurial Engineering Design offers you endless opportunities.
- If you are interested in learning about digital technologies but don't know much about them, then start with the **Makerlab** where you can take workshops in **3D printing, laser cutting, IOT** etc.
- If you are interested in learning more about traditional machines such as **milling, lathe** etc. then our new Manufacturing Training Center (**MTC**) facility is for you.
- If you are already familiar with the equipment and know what you want to do and just want **access to the spaces** then the **Makerspace** is available for digital technologies while the **Brunsfeld Center** is there for more traditional ones.
- Finally if you have a project in mind and a team and you want access to a space then you can get **team space** either in the **Sandbox** where it is more for meeting, design and small projects, or **JMTS** where the focus is on larger projects.



Need more Training? – Here's how to book it

- Go to MakerRepo (www.makerepo.com) and select the appropriate link, based on your desired type of training



Project Deliverables

First project deliverable!

#	Deliverable	Due Date	Mark
A	Team Formation and Contract (individually)	19 Jan.	0.7%
B	Needs Identification	26 Jan.	1.75%
C	Design Criteria	03 Feb.	2.8%
D	Conceptual Design	09 Feb.	1.75%
E	Project Schedule and Cost	16 Feb.	2.8%
F	Prototype I and Customer Feedback	01 Mar.	3.5%
G	Prototype II and Customer Feedback	08 Mar.	4.2%
H	Prototype III and Customer Feedback	22 Mar.	5.25%
I	Design Day Presentation Materials	26 Mar. 24 Mar.	3.5% (Judge) + 1.75% (Client)
J	Final Presentation	25, 30 Mar., 1 Apr.	3.5%
K	Final Project Report	Examen final	3.5%
Total			35%

⇒ Only **ONE** submission per team on **Brightspace**
(any team member) (exception: deliverable A)



Benefits of Doing Project

- The project is an important aspect of GNG1103 and presents numerous advantages
 - You learn how to **work effectively in a team** environment
 - It allows you to **apply the theories learnt** in the lecture and in basic training Labs
 - Is more representative of the **design environments** of the modern real world
- Different GNG1103 sections work on different projects
 - STEM automation - (GNG1503C)
 - **VR-based chemistry learning experiences** - (**GNG1103F**)
 - Detection & Visualization of piano keys pressure – (GNG1503B)

The detailed description of your project theme **VR-based chemistry learning experiences** can be found in **Project** section of Brightspace.



What is important?

- Safety
- Ease of Use
- Usefulness
- Reliability
- Economics
- Aesthetics
- Other ???

Images from: <https://en.wikipedia.org/wiki/Tuberculosis>

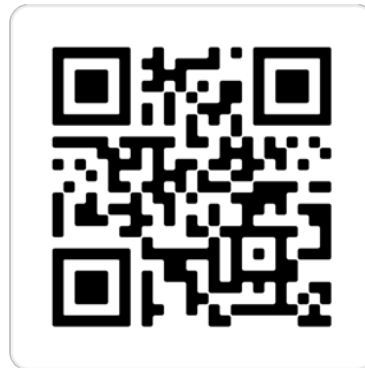


Course Attendance: Registration

- Use your smartphone or laptop to **register/notify** your attendance in this lecture
- Allow **geo location** in the attendance site
- Accept **cookies** from third parties applications
- Log in using only your **Uottawa** account at the link below

<https://attendance.azarm.ca/attendancerecord/gng1103f>

- Your attendance must be registered only **during the lecture** and at the **time specified by the professor**
- You can also use the **QR code** below, to register quickly



Project Guidelines (All sections)

- Students need to work in **teams of 5** and **MUST** be in the same lab section
- An important element of **design thinking** is customer empathy and feedback. However, to simplify the projects there will be a
 - Meeting with client (in-person or via skype) in **lecture 5**
 - Pitch-style presentation/client feedback session in **lecture 15**
 - Client review session during a lab near the middle of the course
 - Teams are encouraged to research other related clients too!
- Teams will need to justify their budgets before purchases can be made for their prototypes





Team Formation (All sections)

- All team members **MUST** be is the same lab section!
- Team size should be **5**, but exceptions will be handled on a case-by-case basis
- Ensure that the TA responsible for the lab records your team and its members **BEFORE** you leave the first lab (absolute *worst* case... by the **end of the second lab!**)
- Discuss your personal views related to the team **contract questions** to ensure compatibility during the lab
- Don't wait! Start thinking about your project **NOW!**

Success Factor

Goal

Know your target

1

+

Discipline

Keep it in your sights

2

+

Perseverance

Hit it until you get it

3

+

Creativity

Ingenuity

4

+

Smart Work

Energy

5

Success





Work Team

How to Create Successful Project Teams

- In most cases, students choose to work with their **friends** (not always optimal)
- Other **team criteria** can help create more successful project teams
- The following are suggestion made by **high performing** student teams





Diversity

- Different personalities, culture, education and expertise **create stronger** project teams
- Helps with providing different ways of thinking, strengths and more complete knowledge/skills
- Reduces team weaknesses in all areas

Ex: one team member may have strong **technical** knowledge in one area, whereas another may be a great **communicator** who can help explain the importance of the team's work

Organization and Punctuality

- Organization is essential to team success
- A positive environment is created by:
 - Creating a **clear division of labour**
 - Being aware of **deadlines**
 - Setting **realistic** deadlines for each part of the project
- Studies have shown that people who **believe** that their teammates will complete their tasks well and **on time** are more successful at completing their own tasks

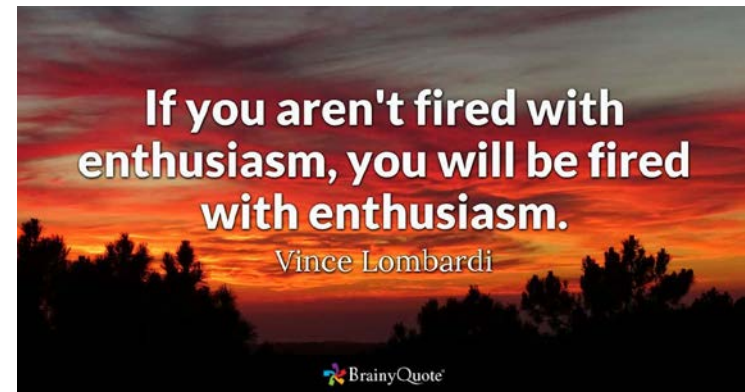
Active and On-Going Communication

- Maintain active communication with all team members at all times using various platforms:
 - Facebook group chat
 - Slack app
 - Email
 - Google Hangout
 - Google Docs (multi-member editing)
- Clarity and transparency helps avoid conflict

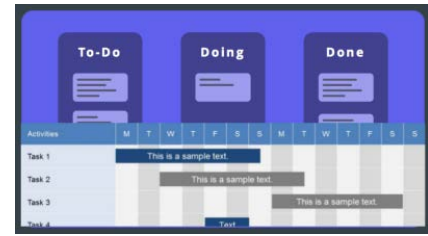
Respect, Support and an Open Mind

- Important for each team member to feel **valued and respected**
- A safe and secure environment breeds **enthusiasm** and **creativity**
- Allows the best of everyone to be part of the project and **maximize the energy of production**
- Also important to **acknowledge** team member **weaknesses** and **encourage** them to improve

Enthusiasm



- Helps the project be more **enjoyable**
 - Enthusiasm is **contagious** and **motivational**
 - Pushes people to **work harder** and care about doing a great job
- ⇒ Take time to bond **outside of project boundaries** as it will make the team stronger



Planning Basics

- **What?** – Are *all* the tasks defined? *Important* things done first?
 - “Are we **missing anything** that needs to be done?”
- **Who?** – Primes or owners defined for *each* task?
 - “**Do what you say you’ll do**” “**Ask for help early** (if not on track)”
- **How Long?** – Estimate durations for all tasks using some practical basis or else **start the work now** & revise estimate
 - “Could be faster/slower... Things take longer than you think”
- **What is needed beforehand?** – **YOU** determine the **dependencies** between tasks or on specific material/ tools
 - “Before this task can happen, what needs to be there already?”
- **Contingency** – What significant things could go wrong and how can you stop them from happening or handle them, if they arise? Use “**What if... ?**” **thinking!**

A Word From Successful Students



<https://youtu.be/Xx-STVwpUAW>

Energy in a Team

- An effective team is one that makes **good use of the total energy** available within the group.
- An effective team must be able to transform **latent individual energies** into team energy.
- How to catalyze individual energies to form team energy and secure team life and productivity?
 - Make sure that all team members **perceive and value the common target**.
 - Create **healthy interpersonal relationships** in the team.
 - Strive to **dispel obstacles** that impede the smooth operation of the team.
 - Encourage each team member to **get involved in the group**.



Leadership in a Team

- An effective team promotes **leadership sharing**. Leadership must be collective, not individual, to increase the productivity of a team. Leadership can be **positive** or **negative**. Team must promote **positive leadership**

Positive Leader

Promotes optimum team performance

Attribute	Remark
Peacemaker	Calms minds and reduces tension
Guide	Reduces digressions and recalls the common target
Clarifier	Asks the daring questions to clarify
Motivator	Valorizes each team member

Negative Leader

Hinders optimum team performance

Attribute	Remark
Faultfinder	Disputes everything said or done
Inhibitor	Slows down the team
Pessimist	Believes that the problem can not be solved
Indifferent et Silent	Is there but you never hear him
Pretentious	Overestimates his abilities and often credits himself with others' solutions
Manipulator	Pursues secret objective to the detriment of the team's common goal

Preparation For Next Lecture

- Read the engineering design case study entitled:
“Engineers Without Borders - Rainwater Harvesting Case Study”
- It can be found in the “Case Studies” folder on Blackboard
- **There will be a quiz at the beginning of the next lecture!**



Assignment 1

- Complete the ITP Metrics Personality Assessment
 - Answer the 4 “Individual Reflection” questions on page 7
- Review the team contract document and provide your personal view for all 17 questions related to “Team Procedures”, “Team Expectations” and “Consequences for Failing to Follow Procedures and Fulfill Expectations”
 - This will help you in selecting compatible team members
- Upload both documents as PDFs to Blackboard before the due date/time (12 January 2020)

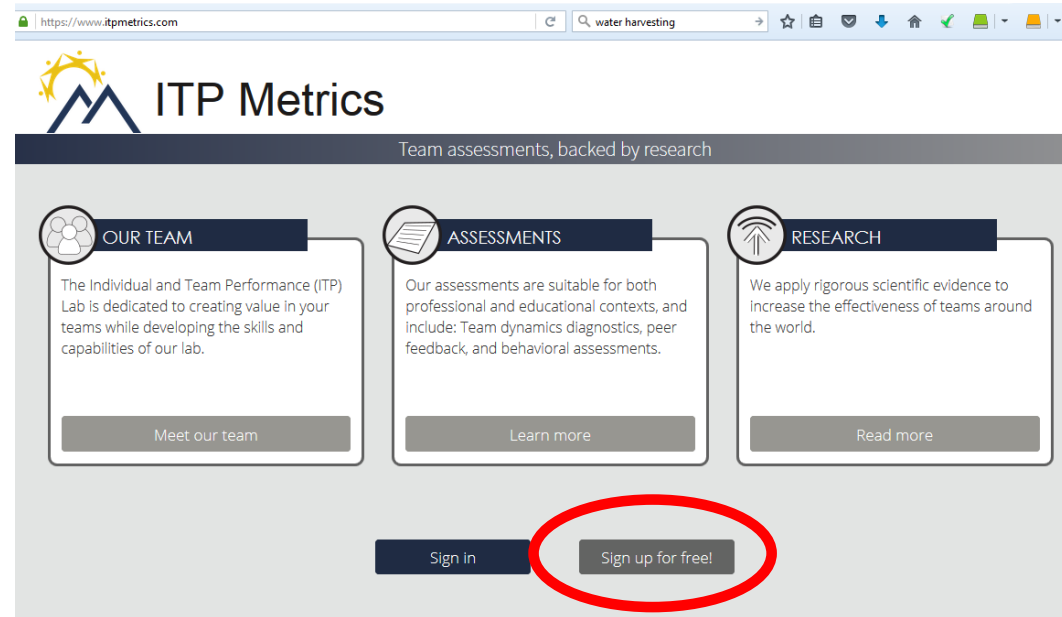
Team Formation

- Produce a table of your team **strengths** and **weaknesses** as shown in the table below
- Be **honest** about your strengths and weakness with teammate

Project Team – GNG1103F – Winter 2020			
#	Last & First Name of Member	Strenghts	Weaknesses
1			
2			
3			
4			
5			

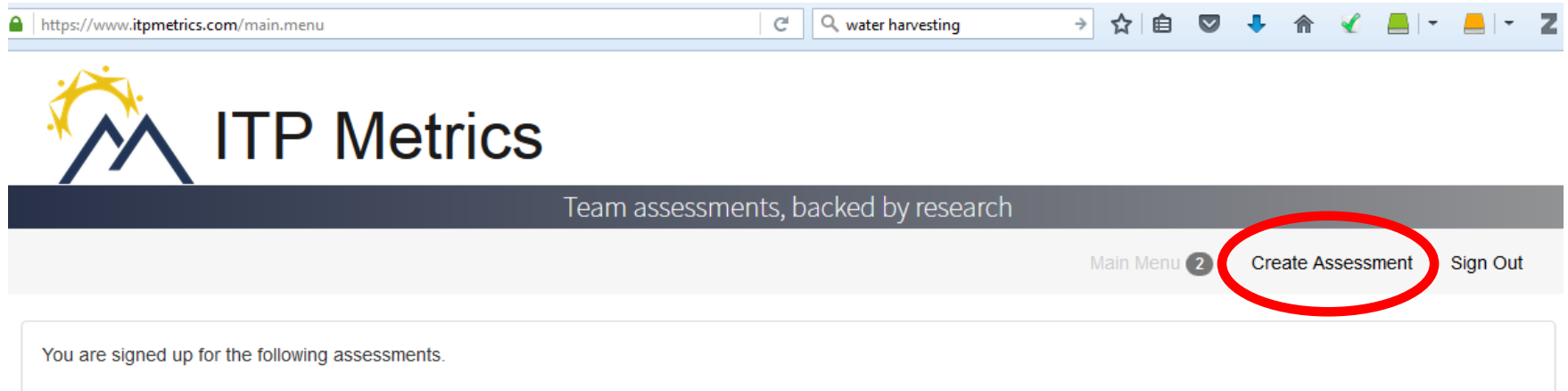
Understanding Your Personality

- If you understand your personality and those of others, you can form better project teams!
1. Go to <https://www.itpmetrics.com/>
 2. Create an account (use you uottawa email)



Create Personality Assessment

3. Click on “Create Assessment” (top right)



The screenshot shows a web browser window with the URL <https://www.itpmetrics.com/main.menu> and a search bar containing "water harvesting". The page header features the ITP Metrics logo and the text "ITP Metrics" and "Team assessments, backed by research". In the top right corner, there is a navigation menu with the following items: "Main Menu" (with a notification badge), "Create Assessment" (circled in red), and "Sign Out". Below the header, a message states "You are signed up for the following assessments."

Take Personality Assessment

4. In Step 1, click on the “Personality” box
5. In Step 2, click on the link for taking the individualized assessment (this is the second option in the list)
6. Take the personality assessment test
7. Save the resulting PDF (you will submit this as part of assignment 1)

The screenshot shows a web interface for creating an assessment. At the top, there is a search bar with the text 'water harvesting' and a refresh button. Below the search bar, a dark blue banner reads 'Team assessments, backed by research'. A link below the banner says 'Click here for an instructional tour on creating assessments'. The main content is divided into two steps:

Step 1 of 4 - Select a questionnaire

Four questionnaire options are displayed in a grid:

- Peer Feedback**: Assess teamwork competencies. The report details team members' strengths, developing competencies, and potential improvement behaviors.
- Team Dynamics**: Assess team health. The report details ideas on how the team can direct future actions toward improving teamwork.
- Conflict Management**: Assess personal conflict management styles. The reports build awareness and discussion of team members' conflict management styles.
- Personality**: Assess personality traits. The reports detail the team members' personality traits and how they relate to team interactions and experiences in teamwork. This option is highlighted with a red oval.

Step 2 of 4 - Upload participant list

Two options are listed:

- Just trying out the site? Click here to use a mock participant list
- Did you want to take the assessment just for yourself? Click here to take our individualized assessments. This option is highlighted with a red oval.

Review Questions

1. What is engineering design? What are the differences between the problems in engineering science and those in engineering design?
2. How important is the use of an engineering design process?
3. What are the five basic elements to consider when producing a project plan?
4. You are the project manager and lead designer of a young smart cushion design company and are responsible for recruiting a designer to join your design team. List at least five attributes to consider when recruiting a new member to form an effective project team. What would you do to ensure good use of the total energy of your GNG1103 project team and productive leadership of your team?
5. You are in charge of recruiting five designers for the design of smart curtains. What tool could you use to know the personality traits of your designers?
6. How do you learn and what can you do to learn effectively and efficiently?

