University of Toronto
Faculty of Applied Science and Engineering
Final Examination, December 05, 2014
Duration: 2.5 hours
APS111H1 F and APS113Y1 Y - Engineering Strategies & Practice 1

Calculator Type: 4 (No electronic or mechanical devices permitted)
Exam Type: A (Closed book, no aids permitted)
Course Coordinator: Jason Bazylak
Communication Coordinator: Melanie Stevenson
Module B Coordinator: Jacinta O'Brien

Instructions:
This is a closed book exam; no calculators or aids are permitted, except for a translation-only dictionary, i.e., direct word-to-word translations but no definitions.

Fill out both the answer sheet (bubble sheet) and the exam booklet (blank lined booklet) with your name, student number, course (APS111 or ASP113), and date of examination. You do not need to fill out the course instructor or form code.

There are two parts of the exam: multiple-choice questions and a writing component. Read each question carefully.

Multiple Choice:
The first part of the exam is a multiple-choice component. For each question provide the most correct answer on the answer sheet. **Only one answer is to be given for each question**. There is no penalty for incorrect answers. Be sure to fill out the answer sheet clearly, with no overlaps, using a pencil. Do NOT answer on these 17 exam pages. Erase any errors completely. There are a total of 32 multiple-choice questions worth a total of 60 marks. The mark value of each multiple choice question is about 1.9 marks.

Written Answers:
The second part of the exam is a writing component. There are 4 written questions worth a total of 40 marks. The mark value of each question is indicated on the question. Answer each written question in the blank exam booklet, NOT these 17 exam pages.

Part 1: Multiple-choice questions (32 questions; 60 marks total)

1. "Power Felt", a product developed by researchers at Wake Forest University, is made up of multiple layers of low cost fabric and has been successfully proven to power a cellular phone by using body heat. With "Power Felt", consumers can now power their cellular phones using an energy supply that is:
   a. Sustainable.
   b. Renewable.
   c. Profitable.
   d. Equitable.

2. "People, planet, profit", "triple bottom line", and "economy, environment, society" all relate to the concept of:
   a. Life cycle assessment.
   b. Industrial ecology.
   c. Sustainability.
   d. Adaptive capacity.

3. The payback period is defined as the time:
   a. Required to recover investment costs.
   b. Needed for external costs to equal internal benefits.
   c. Over which alternative designs should be compared.
   d. That banks allow loans to be repaid.

4. Which statement best describes bio-magnification?
   a. The entry of persistent toxic substances into the environment.
   b. The entry of persistent toxic substances into the fatty tissues of organisms.
   c. The concentration in the tissues of an organism of substances occurring in the environment.
   d. The increase in the concentration of a substance in the tissues of organisms at successively higher levels in a food chain.

5. In Canada, engineering is a self-regulated profession. This means that:
   a. Engineers who hold the designation P.Eng. determine the appropriate standard of professional competence.
   b. Only engineers who hold the designation P.Eng. may practice engineering.
   c. Engineers who seal their work can be liable if something goes wrong.
   d. Government-appointed commissions are needed to determine who is to blame when failures occur.

6. For decision-making models, which of the following statements is **TRUE**?
   a. Multi-voting is better than the Pugh Method.
   b. Risk-based Methods yield a high level of confidence in the result.
   c. A graphic decision chart and a weighted decision matrix are equally complex to use.
   d. None of the above.

7. The Club of Rome made which one of the following conclusions?
   a. A framework is required to measure and report on private sector performance using economic, environmental and social parameters.
   b. James Watt invented the steam engine, which resulted in the industrial revolution.
   c. Continued resource depletion and increasing pollutant emissions would lead to economic and social collapse.
   d. Sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs.

8. Which of the following is a non-governmental organization:
   a. Bank of Canada.
   b. Ontario Ministry of Transportation.
   c. Toronto Stock Exchange.
   d. Professional Engineers Ontario.

9. Referring to **Figure 1**, which of the following statements is **TRUE**?
   a. Line AB=fixed costs; Line CD=total costs; Area E=loss; Area F=revenue.
   b. Line AB=total costs; Line CD=revenues; Area E=profit; Area F=loss.
   c. Line AB=fixed costs; Line CD=total costs; Area E=loss; Area F=profit.
   d. Line AB=total costs; Line CD=revenues; Area E=loss; Area F=profit.

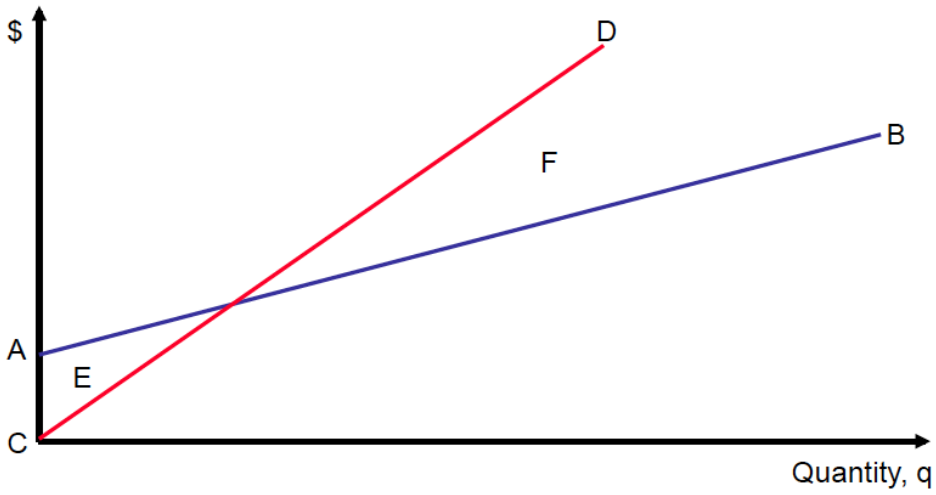

Figure 1. Chart for Question 9.

10. Which of the following quotations does **NOT** describe the shift system-centered, Human-Tech, design?
   a. “If a system doesn’t work for people it doesn’t work.”
   b. “Human error is systematically connected to features of tools, tasks and operating environment. Progress on safety comes from understanding and influencing these connections.”
   c. “Human error is a symptom of trouble deeper inside the system.”
   d. “The system in which people work is basically safe; success is intrinsic. The chief threat to safety comes from the inherent unreliability of people.”

11. Which of the following statements about simple interest calculations and compound interest calculations is **TRUE**?
    a. Simple interest calculations are the inverse of Compound interest calculations.
    b. Simple interest calculations apply only to the present value, and Compound interest calculations apply to the present value and the interest on the present value.
    c. Simple interest calculations yield greater future values than Compound interest calculations for the same number of interest periods and interest rate.
    d. Simple interest calculations are only used for simple engineering projects, and Compound interest calculations are used for complex engineering projects.

Questions 12 to 31 pertain to Case Study #1: F.G. Gardiner Expressway located in the Appendix.

12. Ontario is the only province in Canada that requires bridge owners to inspect their bridges every two years. The relevant legislation is Ontario Regulation 104/97, made under the *Public Transportation and Highway Improvement Act.* The Act requires owners to use the Ontario Structure Inspection Manual (OSIM) as a guide to determine the structural integrity, safety and condition of bridges. For elevated sections (bridges) on the Expressway, which statement is **TRUE**?
    a. The City must comply with Ontario Regulation 104/97, but does not need to use the OSIM because it is a guideline.
    b. The City must comply with Ontario Regulation 104/97, and Expressway bridges must be inspected every two years using OSIM.
    c. The City has hired a professional engineer to inspect the Expressway bridges and can rely on them to decide how to conduct the bridge inspection.
    d. The City does not need to comply with Ontario Regulation 104/97 because the City has its own by-laws.

13. The purpose of Ontario Regulation 104/97 is to ensure that bridges are safe to use, and the Regulation requires that bridge inspections shall be performed under the direction of a professional engineer. This is an example of:
    a. Application of the precautionary principle.
    b. Using laws to implement social policy.
    c. Law-makers and engineers working together.
    d. Demand-side legislation.

<<Questions continue on next page>>

14. Asphalt cement is a product of crude oil distillation. Emissions generated during the production and application of asphalt cement contain substances such as polycyclic aromatic hydrocarbons (PAHs), which are potentially harmful to the health of workers at petrochemical facilities and road paving operations. According to the United States Environmental Protection Agency, PAHs can stay in the environment for long periods of time and, once ingested, PAHs can spread to organs including the kidneys and liver. However, PAHs will leave the body through urine and feces in a matter of days. Based on the preceding information, which statement best describes PAHs?
    a. Persistent, bioaccumulative, toxic.
    b. Persistent, non-bioaccumulative, toxic.
    c. Non-persistent, bioaccumulative, toxic.
    d. Non-persistent, non-bioaccumulative, toxic.

15. **Figure 2** shows some of the bridge components that must be inspected in order to comply with O. Reg. 104/97. The City hired a professional engineer to inspect the eastern part of the elevated section of the Expressway, and the professional engineer used OSIM but did not inspect the Pier Cap. The professional engineer prepared a report but did not seal it. Six months later, one end of the Pier Cap broke off suddenly, with the result that the elevated roadway over the Pier Cap collapsed and two cars smashed through the guardrails and crashed into the Don River. Which statement best characterizes the actions of the professional engineer:
    a. Failed to comply with O. Reg. 104/97.
    b. Failed to comply with O. Reg. 104/97 and the *Professional Engineers Act*.
    c. Disregarded public safety for personal profit.
    d. Cannot be held liable because the report was not sealed.

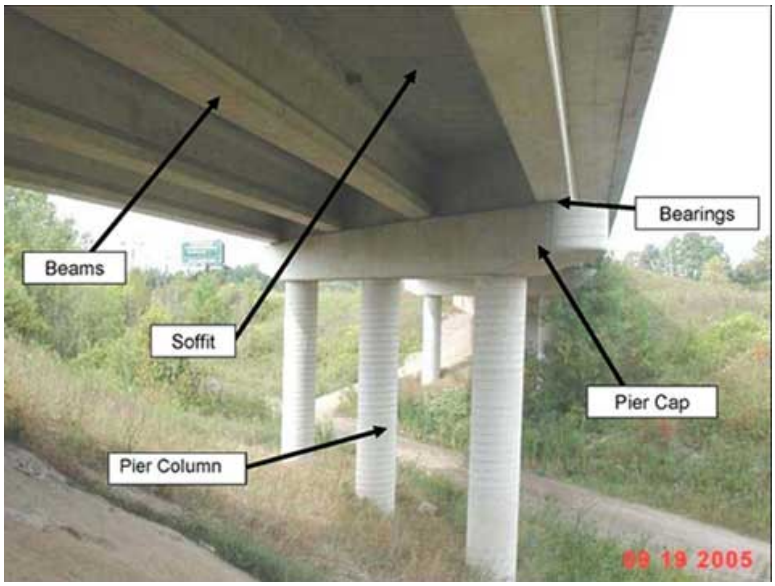

Figure 2. Bridge components that must be inspected according to O. Reg. 104/97 (see Question 13).
[Source: http://www.mto.gov.on.ca/english/bridges/]

16. The City of Toronto has design standards for both hot mix asphalt and concrete when using these materials for road construction. Recently, the City of Toronto published a study, titled "Toronto's Future Weather and Climate Driver Study", which predicted that the average annual temperature in Toronto will increase by 4.4C by the year 2049. As the design engineer working on the design of the new elevated bridge deck, what should you do?
    a. Not worry about the temperature in 2049 because the service life of the bridge deck is less than 35 years.
    b. Choose concrete for the bridge deck because it is less susceptible to temperature changes than hot mix asphalt.
    c. Add extra hot mix asphalt to the bridge deck design to allow for temperature-related deformation.
    d. Ensure the material chosen for the bridge deck can meet performance targets at the higher future temperature conditions.

17. The Gardiner Expressway and Lakeshore Boulevard East Environmental Assessment is considering four options: maintain, improve, replace, and remove. Local community groups favour the option to remove the elevated section of the Expressway because they believe it offers a number of benefits, namely: it will provide better access to Lake Ontario, reduce the number of vehicles using the Expressway, and increase the amount of land that can be redeveloped for social housing. As the design engineer who is working for the City of Toronto, you are responsible for evaluating the options. What should you do?
    a. Include the input of the local community groups by estimating the value of the benefits they have identified and including the estimated value of the benefits in your option evaluation of the options.
    b. Confirm that the benefits identified by the local community groups are realistic.
    c. Ignore the local community groups since they have much less influence on the design than the City of Toronto.
    d. Report on the benefits identified by the local community groups to City Council and ask City Council to vote on the option to remove the elevated section.

18. Used rubber tires have become an important constituent in roadway paving. For example, used rubber tires are ground up to produce a granular material, and then used as a substitute for the quarry-mined aggregate base over which the asphalt is laid. Which of the 3Rs does this practice satisfy?
    a. Reduce.
    b. Reduce and reuse.
    c. Reduce and recycle.
    d. Reduce, reuse, and recycle.

19. **Figure 3** shows the ranking summary for the four options considered as part of the Gardiner Expressway and Lakeshore Boulevard East Reconfiguration Environmental Assessment. A main drawback of the approach that was used is that:
    a. Too few alternatives were evaluated.
    b. Stakeholders were not consulted during the EA process.
    c. Too many criteria were used to compare the alternatives.
    d. The relative importance of each criterion was not considered in the evaluation.

Preferred	Moderately Preferred	Least Preferred
●	◐	○

Study Lens/ Criteria Group	MAINTAIN	IMPROVE	REPLACE	REMOVE
TRANSPORTATION & INFRASTRUCTURE				
Automobiles	●	◐	◐	○
Transit	●	●	●	●
Pedestrians	○	◐	●	●
Cycling	○	◐	●	●
Movement of Goods	●	●	◐	○
Safety	○	◐	●	●
Constructability	●	●	○	◐
URBAN DESIGN				
Planning	○	○	◐	●
Public Realm	○	○	◐	●
Built Form	○	○	◐	●
ENVIRONMENT				
Social and Health	○	◐	◐	●
Natural Environment	○	○	◐	●
Cultural Resources	●	●	○	◐
ECONOMICS				
Regional Economics	●	●	●	●
Local Economics	○	○	◐	●
Direct Cost and Benefits	◐	◐	○	●

Figure 3. Gardiner Expressway EA Criteria Group Ranking (see Question 17).
[Source: http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2014.PW29.2]

20. The City is considering an innovative, accelerated approach for rehabilitating the western part of the Expressway. The approach uses conventional construction methods for the at-grade section and prefabricated deck and girder components for the elevated section. If this approach is used, the City will have to increase the project budget by $400 million over 10 years. However, the higher project budget will be offset by a reduction in user impact costs of $3 billion, and the construction period will be shorter. The statement that best describes the innovative, accelerated approach is:
    a. Time is money.
    b. Life cycle assessment.
    c. Design impact on society.
    d. Sustainable development.

21. As part of the Gardiner Expressway and Lakeshore Boulevard East Reconfiguration Environmental Assessment, predictions were made about the employment population in Toronto and the surrounding region in the year 2031 in comparison to current data. **Table 1** shows the data, which were converted to monetary values by assuming a unit dollar amount for each job. Which one of the following terms describes the analysis of the employment population:
    a. Microeconomic analysis.
    b. Macroeconomic analysis.
    c. Life cycle analysis.
    d. Net present value analysis.

Table 1

Area	Current Employment (Number of jobs)	2031 Employment Forecast (Number of jobs)	Growth
Toronto	1.27 million	1.83 million	44%
Greater Toronto and Hamilton Area	3.26 million	4.52 million	39%

22. As part of the decision-making process for the Gardiner Expressway Rehabilitation Plan, a traffic delay analysis was carried out using the "QUEWZ" queuing methodology. “QUEWZ” determines the societal costs resulting from traffic delays and was used to analyze costs of the various rehabilitation options. “QUEWZ” was developed by the highly reputable Texas Transportation Institute in the United States and is considered the industry standard. It is used throughout North America, including by the Ontario Ministry of Transportation, which uses the "QUEWZ" methodology in the development of user costs on provincial highways. By using "QUEWZ", the City of Toronto is:
    a. Relying on third party certification.
    b. Demonstrating due diligence.
    c. Providing quality assurance.
    d. Establishing performance expectations.

23. Stormwater runoff refers to rain or snowmelt that flows over the ground, picking up pollutants and transporting them into the storm sewer system, which eventually flows into Lake Ontario. Impermeable surfaces like the Gardiner Expressway generate a lot of stormwater. To reduce the volume of stormwater the Gardiner Expressway generates, the City of Toronto is proposing to use permeable asphalt that allows water to gradually soak through the underlying road bed. This slows the velocity and volume of the runoff, reducing the amount of contaminated runoff that ends up in Lake Ontario. The City's proposal is an example of:
    a. Pollution Control.
    b. Pollution Prevention.
    c. Water Recycling.
    d. Wise Use of Resources.

24. The contractor who has been hired to work on the first phase of the Expressway Rehabilitation submitted a bid that included the following costs: (1) hourly wages for workers; (2) unit price for asphalt of $50 per metre curb to curb; (3) monthly lease cost for asphalt paving equipment; and, (4) unit price for aggregate of $10 per tonne. Which of the following statements is true?
    a. Costs (2) and (4) are variable costs and costs (1) and (3) are fixed costs.
    b. Costs (1), (2) and (4) are variable costs and cost (3) is a fixed cost.
    c. All costs are variable costs.
    d. All costs are fixed costs.

25. **Table 2** shows information for the Conventional and Accelerated approaches for rehabilitating the Expressway west of Jarvis Street. Which of the following statements is **TRUE**?
    a. The Conventional Approach is preferred based on Net Present Value, and the Accelerated Approach is preferred based on Years of Traffic Impact.
    b. The Conventional Approach is preferred over the Accelerated Approach based on User Cost.
    c. The Conventional Approach will save $2.9 billion over 8 years.
    d. The User Cost is not a reliable criteria for decision-making because it is an external cost and is not a direct cost related to the actual rehabilitation of the Expressway.

Table 2

Evaluation Criteria	Conventional Approach	Accelerated Approach	Difference
Net Present Value	$1,210 million	$1,310 million	$100 million
User Cost	$7.4 billion	$4.5 billion	$2.9 billion
Years of Traffic Impact	20 years	12 years	8 years

26. As a design engineer, you have been asked to conduct a Life Cycle Assessment (LCA) to compare asphalt and concrete as road materials for rehabilitation of the "at grade" section of the Gardiner Expressway. You've collected the following information about asphalt and concrete: (1) the raw materials needed to produce them, (2) the manufacturing processes including energy requirements, (3) the chemical properties and potential human health impacts, and (4) the recycling and disposal options for each material once they have reached the end of their service life. To ensure your LCA is complete you should also include:
    a. Environmental impacts associated with transporting the asphalt and concrete.
    b. External benefits to road users.
    c. Comparative information from other recent LCAs for the same road materials.
    d. The terms of reference for the LCA.

<<Questions continue on next page>>

27. **Figure 4** shows the stakeholder analysis chart that was produced for the Gardiner Expressway and Lakeshore Boulevard East Reconfiguration Environmental Assessment. Which are the most likely identities for stakeholders W, X, Y, and Z given their position in **Figure 4**?
    a. W=City of Toronto; X=City Council; Y=Asphalt Suppliers; Z=Local Community Group
    b. W=Ontario Ministry of Transportation; X=Local Community Group; Y=Newspaper Reporter; Z=City of Toronto
    c. W=Ontario Ministry of Transportation; X=City of Toronto; Y=General Public; Z=Newspaper Reporter
    d. W=Asphalt Suppliers; X=City of Toronto; Y=Ontario Ministry of Transportation; Z=General Public

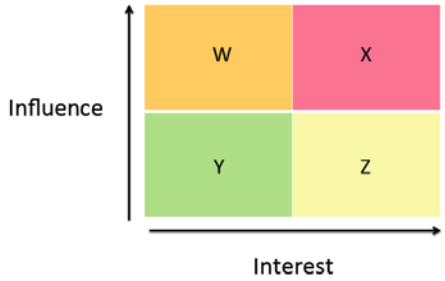

Figure 4. Stakeholder analysis chart for Question 27.

28. When assembling their engineering design team to proceed with the Improvement option the City used Bolton Leadership Style survey results. Given that all team members are equally technically competent, which of the following teams will have the greatest chance of success in the project?
    a. To minimize the implementation delays the team will consist primarily of Drivers.
    b. To reduce the chance of error on such a large infrastructure project the team will consist primarily of Analyticals.
    c. To reduce conflict between the highly vocal resident organizations and the City, the team will consist primarily of Amiables.
    d. To avoid over-specialization, the team will consist of at least one from each preferred leadership style (Driver, Expressive, Amiable, Analytical).

29. The City is concerned with the high number of fatal traffic accidents on the Gardiner Expressway. During the redesign phase Human Factor consultants identified an off ramp with a sharp curvature as a high accident location. Reducing vehicle speed on this off ramp will result in a significant reduction of traffic accidents. Which of the following strategies is most likely to achieve long term success?
    a. Paint lines perpendicular to the flow of traffic with reducing separation distance.
    b. Paint wavy lane boundary and separation lines parallel to the flow of traffic.
    c. Increase the number of speed limit and curvature signs.
    d. Assign a Police traffic officer to enforce a reduced speed limit.

30. A consulting engineering company is assisting the City to develop the Strategic Plan for the Rehabilitation of the Expressway and has suggested incorporating elements of industrial ecology. Which of the following statements is **TRUE**?
    a. Industrial ecology applies to closed systems, so it cannot be applied to the Expressway.
    b. Industrial ecology is being used in Kalundborg, Denmark, but would not be as effective in Toronto.
    c. Industrial ecology is based on using a minimum of energy, least toxic materials, and creating other useful products at the end of a product's service life, so could be applied to the Expressway.
    d. Industrial ecology seeks to optimize the flow of resources including along transportation routes, so could be applied to the Expressway.

31. As the City's design engineer working in the Engineering & Construction Services department, you are responsible for evaluating construction contract bids and recommending contract awards to the Public Works Committee. Your cousin, who is also your roommate, has just taken a job as a site supervisor for one of the construction companies that has submitted a $54 million bid for Phase 1 of the Gardiner Expressway rehabilitation. You have told your boss that your cousin works for the construction company, is your roommate, and you ask your boss to excuse you from evaluating the bids. Your boss agrees. Which situation have you avoided?
    a. Allegations of Negligence.
    b. Being identified as a Whistle-blower.
    c. Finding of Incompetence.
    d. Conflict of Interest.

End of questions pertaining to Case Study #1: F.G. Gardiner Expressway.

Question 32 is based on Case Study #2 "Pesticide Removal for Fruit and Vegetables," located in the Appendix.

32. For the case study, which of the following is a Secondary Function?
    a. Indicate when cleansing is completed.
    b. Does not exceed 45 euros.
    c. Maintains nutritional value of the vegetable/fruit.
    d. Qualifies for patentability.

Part 2: Long Answer Question (40%)

INSTRUCTIONS: This section requires 4 written answers. Use an exam booklet and write in your name, student number, course, and date of examination on the booklet's cover page. You may use as many pages as you need for your preliminary work, but the final answers must be no more than four (4) pages single-spaced or eight (8) pages double-spaced. Clearly indicate the final copy to be graded by writing "Final Copy" at the start of it. Use full sentences and paragraphs.

This section of the exam evaluates your ability to

- Communicate in clear, concise, well-organized sentences and paragraphs with minimal error.
- Structure a logical argument, making clear claims and supporting them with the evidence currently available to you.
- Recognize the kinds of information you would need, moving forward, to validate and better support your claims. Generate specific questions to help you find that information.
- Read, understand, and analyse engineering-related material under time pressure.

33. Using techniques taught in the lecture on revision, revise the following two sentences to make them more concise while retaining their key messages. [5 marks]

    a. It is widely known that people who ride bicycles on the campus of the University of Toronto have become complainers in regards to the lack of bike lanes.

    b. Due to the fact that the computer system crashed, an announcement will be made by the instructor of the course that the results of the exam may be a little bit delayed.

Questions 34 and 35 are based on Case Study #2 "Pesticide Removal for Fruit and Vegetables," located in the Appendix.

Read the client statement for Case Study #2. Then, drawing logically on it and your own knowledge, quickly generate a point form list of the **KEY** objectives and constraints for the pesticide project. Order the objectives from most important to least important, drawing logically again on information in the client statement and your own knowledge.

[Notes: No metrics are required. Also, while the list itself will not be marked, it forms the basis for your answers to the questions that follow.]

Using full sentences and well-developed paragraphs, answer the following questions:

34. For your top three objectives explain and justify why you considered each a key objective and why you ranked them in that particular order. If you think another reader might disagree with you, state what you think their counter argument might be and why you would still stay with your current choices. [10 marks]

35. Describe, as specifically as possible, the key research questions you would want to answer in order to check the validity of your claims and to develop the three top objectives further. (Don't worry about whether the questions are open or closed.) Also discuss what kind(s) of information might change your mind about your objectives or objective rankings, if you uncovered such information. [5 marks]

End of questions pertaining to Case Study #2 "Pesticide Removal for Fruit and Vegetables," located in the appendix of this exam.

Question 36 pertains to Case Study #3 "Solid-waste Management in Humanitarian Response," located in the appendix of this exam.

36. Engineers can't always rely solely on the client to scope engineering problems. Often, as with your vaccine project, an engineer must do it. After reading Case Study #3, consider how you would scope the solid-waste problem as a member of an engineering design team. (Tip: Think and write notes before you start writing your formal response!) Using full sentences and paragraphs, construct a well-written mini-analysis that addresses the following: First, what makes scoping this particular problem challenging (be specific)? Second, describe and explain some different ways you might approach scoping it. Discuss the specific challenges or trade-offs involved in scoping it each way. Third, choose a scoping approach and justify why you picked it as the best method under the circumstances. [10 marks]

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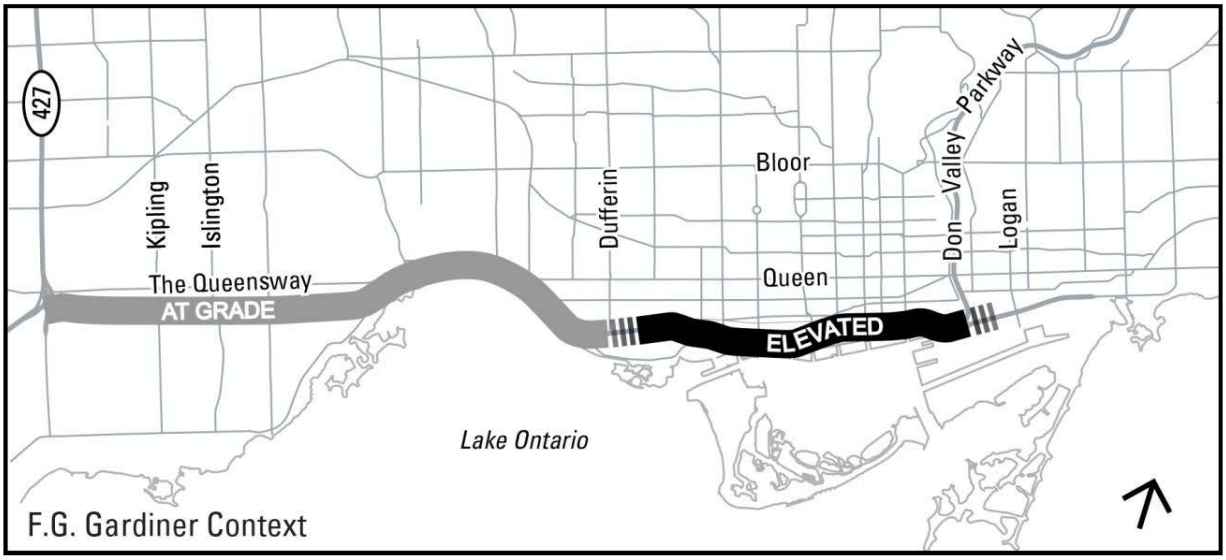
Appendix A: Case Studies

You may remove this appendix. There are no questions in this Appendix

Case Study #1: F.G. Gardiner Expressway

The City of Toronto owns and operates the F.G. Gardiner Expressway, a major arterial roadway that runs parallel to the Lake Ontario shoreline in the downtown core. The Expressway, which is shown in Figure 1, extends for 18 kilometres. From Highway 427 in the west, the Expressway runs for 11 kilometres at grade and then for 7 kilometres that are elevated, ending at the Don Valley Parkway in the east. For most of its length, the Expressway is six lanes wide and the posted speed limit is 90 km/hour.



Source: http://www.toronto.ca/legdocs/mmis/2014/pw/bgrd/backgroundfile-67051.pdf

The Expressway was constructed over an 11-year period from 1955 to 1966, and is approaching the end of its original design life. The effects of weathering, salt, and increasing traffic loads have had an impact on the Expressway, with the result that ongoing maintenance and repair requirements and costs have increased significantly.

The City of Toronto is currently undertaking two initiatives related to the Expressway:

(1) Strategic Plan for the Rehabilitation of the Expressway - which will help the City decide the priority of various repairs to the Expressway.

(2) Gardiner Expressway and Lake Shore Boulevard East Reconfiguration Environmental Assessment - to determine what to do with the elevated portion of the Expressway between Jarvis Street and the Don Valley Parkway.

Case Study #2: "Pesticide Removal for Fruits and Vegetables" [1]

Health-conscious consumers are worried about residual pesticides in their food, particularly in emerging markets. Currently, the most common consumer solution for removing residual pesticides from fresh fruit and vegetables is to hand wash or soak the produce, but the results are neither uniform nor sufficient. The client seeks a solution (either technology or products) that meets the following key success criteria: "delivers pesticide removal benefit at low cost for home use; and…two times more efficient than ordinary hand washing methods."[1]

"Additional technical criteria:

- Safe to both user and environment (consumers at home)
- No damage to vegetable/fruit appearance, nor to nutrition value
- Cost price of end product should not exceed 45 euros
    - The end product(s) has to be compact (for ease-of-use and storage)
    - Not exceed around 35 L, preferably smaller
- Capacity to treat 500 grams leafy vegetables (e.g., lettuce or Chinese greens) per wash
- Preferably does not occupy tap during washing cycle
- Total cycle-time: around 25 minutes
- Can remove dirt/pesticides on fruit/vegetables in one cycle"[1]

"Additional commercialization criteria:

- Proven technical feasibility (ideally in terms of prototypes, test data, etc.) no later than the second quarter of 2014
- Theoretical proof/data that solution is able to meet the required removal performance (at least 2x better than current typical consumer practices)
- Can provide a lasting competitive advantage, e.g., by IP [intellectual property rights], or exclusive purchase
- Cost price of the end product should not exceed 45 euros" [1]

"Additional information:

- EC (emulsifiable concentrate) is one of the pesticide formulations that is difficult to remove. Leafy vegetables are the greatest concern of the consumer; it has to be possible to treat those with the proposed solution.
- The use of additives in the solution is only acceptable for those additives that are known to be edible and non-harmful.
- Solutions that do not require user interference in the process are most preferred.
- Visual proof that dirt or pesticide removal actually takes place is a strong wish." [1]

"The client is NOT looking for:

- Highly complex and expensive solutions
- Chemical solutions (except materials that are common in consumer kitchens and seen as edible/non-chemical, like salt or vinegar)
- Solutions that potentially cause irritation for the consumer to e.g., nose, skin, eyes, and others. Solutions that damage the fruit/vegetables or have negative effects on its nutritional value." [1]

Case Study #3: “Solid-Waste Management in Humanitarian Response” [2]

“Natural and [human]-made disasters like earthquakes and wars cause displacement of people from their homes to formal and informal camps. Relief efforts are usually centered around these locations. Even though these people have very little, they still produce a good amount of solid waste such as trash, garbage and even packing from the relief effort itself. If these wastes are not managed properly (collected, transported and disposed) it creates [many] health and environmental issues in time. We are searching for the most economical process of [quickly] managing solid wastes without worsening the already poor living conditions in these areas or causing harm to individuals or the environment.” [2]

References

[1] J. Tzeng, “Pesticide removal for fruits and vegetables,” *NineSigma*, Available: https://ninesights.ninesigma.com/, Accessed on: Nov. 21, 2014.
[2] Humanitarian Innovation Fund, “Solid-waste management in humanitarian response,” *InnoCentive.com*, Available: https://www.innocentive.com/ar/ challenge/9933337, Accessed on: Nov. 21, 2014.