University of Toronto
Faculty of Applied Science and Engineering
APS111 & APS113 Engineering Strategies and Practice
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Midterm Examination
October 25, 2012

This is a 70 minute midterm. There are **30** questions on the test. It is a multiple choice midterm and is closed book. No aids are permitted. Read each question thoroughly and provide the answer on the answer sheet. Be sure to fill out the answer sheet clearly with no overlaps. Fill out the answer sheet using a pencil. Erase any errors completely. One answer per question and each question is worth 1 mark. There is no deduction for wrong answers. Select the answer that best satisfies the question. You are not required to hand in the exam question booklet. You may tear off the appendix to ease answering of questions.

1. The engineering design process does **NOT** include:
   A. Implementation.
   B. Evaluation of alternatives.
   C. Norming.
   D. Project definition.

2. Which of the following is **TRUE**?
   A. A function is what a design should be.
   B. A function is how a design should look.
   C. An objective is what a design should do.
   D. A constraint is a requirement the design must meet.

3. Which of the following is **TRUE**?
   A. An indeterminate, or under determined problem is one that has too much information to solve uniquely.
   B. An indeterminate problem has just the right amount of information to solve uniquely.
   C. A determinate problem has just the right amount of information to solve uniquely.
   D. An over determined problem has just the right amount of information to solve uniquely.

4. The difference between design and problem solving can best be described as:
   A. Problem solving is used to address open-ended problems versus design which is used to address close-ended problems.
   B. Problem solving is used to address indeterminate problems versus design which is used to address over determined problems.
   C. Problem solving is used to address determinate problems versus design which is used to address indeterminate problems.
   D. Problem solving is used to address over determined problems versus design which can be used to address any type of problem.

5. A synonym for “iterate” is:
   A. Restate.
   B. Repeat.
   C. Explain.
   D. Organize.

6. A how-why tree is used to:
   A. Organize objectives and generate measureable criteria.
   B. Prioritize objectives and identify the most important goals.
   C. Organize functions into primary and secondary categories.
   D. Prioritize functions and create measureable goals.

7. Universal design is the principle of:
   A. Putting the user at the center of the design process.
   B. Involving users and user groups as members of the design team.
   C. Designing for users with as broad a range of characteristics as possible.
   D. Designing with the experience of the user as the primary focus of the process.

8. Developing a Use Case or Concept of Operations is a strategy for:
   A. Documenting the operation of a technology from the users’ perspective.
   B. Comparing alternative design ideas against the user requirements.
   C. Describing the operation of an existing technology from the client’s perspective.
   D. Organizing the requirements to focus on the user’s psychological needs.

9. Divergent thinking is most closely associated with:
   A. Development of the requirements.
   B. Idea generation.
   C. Solution evaluation.
   D. Detailed design work.

10. Decision making in the engineering design process is different than decision making in other types of contexts because:
   A. Engineering decisions have substantial consequences.
   B. Engineering decisions are based on documented engineering requirements.
   C. Engineering decisions are based only on quantitative considerations.
   D. Engineering decisions must conform to ethical standards.

11. The Conceptual Design Specification relies on and develops the following Critical Thinking skills:
   A. Understanding bias and creating logical argument that is entirely free from bias.
   B. Generating multiple solutions and generating evaluation criteria.
   C. Organizing efficiently and promoting a solution that will excite the client.
   D. Reflecting on a situation and planning strategies to build on strengths and overcome weaknesses.

12. One technique that skeptical thinkers use is:
   A. Rejecting any idea that offends their personal values.
   B. Searching out a cause-and-effect relationship in ideas.
   C. Relying on expert opinion to prove that an idea is valid.
   D. Triangulating – finding different sources to support ideas.

13. When using the multi-voting technique it is allowable for team members to:
   A. Put all of their votes next to one idea.
   B. Put more than one vote next to an idea, as long as it isn't their own idea.
   C. Only rate the ideas against the top two objectives.
   D. Distribute their votes among many different ideas.

Questions 14 to 18 pertain to the Team Study – ABC's of Teamwork located at the back of this exam booklet.

14. Using the Tuckman model; on October 11th this team can best be described as:
    A. Forming.
    B. Storming.
    C. Norming.
    D. Performing.

15. The type of problem team behaviour demonstrated by Zeb is called:
    A. Hitchhiking.
    B. Hijacking.
    C. Isolationism.
    D. Enabling.

16. The strategies used by the team leading up to the PR submission were:
    A. Out loud editing, time blocking, and discussion.
    B. Time blocking, discussion, and setting early deadlines.
    C. Discussion, setting early deadlines, and revising team rules.
    D. Setting early deadlines, revising team rules, and out loud editing.

17. Which of the following strategies would be most helpful for this team moving forward:
    A. Set action items at the end of each team meeting to keep work moving at a steady pace before a deadline.
    B. Listen and value each other's ideas more.
    C. Use meeting minutes so everyone knows what has been decided at the meeting and what has been said.
    D. Set agendas so meetings do not go on so long.

18. Suppose you are this team's Project Manager (i.e. their supervisor) and you are aware of what happened during the time leading up to the PR submission. What feedback would you give the team?
    A. "This report is uneven; some parts are good and others are not. Try to do better next time."
    B. "I am glad you found a way to resolve the situation. I suggest you continue to work out your differences."
    C. "Zeb is obviously to blame here. How are you going to handle it when he lets you down again?"
    D. "Except for the stakeholders section the report is well written. What strategies will you be using to keep the team on track for the next report?"

End of Questions pertaining to the Team Study – ABC's of Teamwork located at the back of this exam booklet.

Questions 19 to 27 pertain to the Case Study – Preventing Terrestrial Wildlife Movement at Large Streams and Rivers located at the back of this exam booklet.

19. Which of the following is outside the scope of this project?
    A. Developing a barrier for watercourses 0.1 meters deep.
    B. Developing a barrier for watercourses 0.5 meters deep.
    C. Developing a barrier for watercourses 5 meters deep.
    D. Developing a barrier for watercourses 10 meters deep.

20. Using functional basis the underlying need in this case can best be described as:
    A. Maintaining a separation between caribou and their predators.
    B. Creating a barrier across a watercourse that prevents animal movement.
    C. Controlling the movement of ungulate predators.
    D. Modifying a fence to work in a different way.

21. An appropriate benchmarking activity in this case would be:
    A. Research ungulate behaviour.
    B. Research cattle grids (i.e. cattle guards).
    C. Research wolves and their hunting habits.
    D. Research dog harness systems.

22. If you applied the Black Box Method to this case, appropriate outputs would include:
    A. Caribou.
    B. Fencing.
    C. Information about the seasonal conditions.
    D. Maintenance of the barrier.

23. Allowing floating debris, such as logs, to move freely down the watercourse in this case can best be described as:
    A. A primary function.
    B. A secondary function.
    C. An unintended function.
    D. A complementary function.

24. "…a good solution will allow 1 to 5 breaches per year." Should be interpreted as:
    A. A function.
    B. An objective.
    C. An objective goal.
    D. A constraint.

25. "Any solution must not intentionally cause harm to any wildlife…" should be interpreted as:
    A. A function.
    B. An objective.
    C. An objective goal.
    D. A constraint.

26. Which of the following is **NOT** part of the service environment for this design project?
    A. Floating debris, such as downed trees.
    B. Temperatures from -40 to 40 °C.
    C. Conventional fencing for wildlife that will occur adjacent to the watercourse.
    D. The Oil Sands Leadership Initiative.

27. During an idea generation session for this project a member of your group comes up with the idea of using a water wheel as a barrier. This ideation strategy is an example of:
    A. Functional decomposition.
    B. SCAMPER.
    C. Design by analogy.
    D. The “why, why, why” method.

End of questions that pertain to the Case Study – Preventing Terrestrial Wildlife Movement at Large Streams and Rivers located at the back of this exam booklet.

Questions 28 to 30 pertain to the Problem Statement - Preventing Terrestrial Wildlife Movement at Large Streams and Rivers.

28. The team that wrote the problem statement looked at the websites of both opponents and supporters of the Alberta Oil Sands project. Therefore, their problem statement should be graded as:
    A. Exceeds expectations because of balanced research.
    B. Meets expectations because it defines a clear gap.
    C. Below expectations because websites are not enough research.
    D. Fails because of its use of value-laden language.

29. From the references in the problem statement, you can deduce that the term:
    A. Alberta Tar Sands is used by supporters of the Alberta Tar Sands project.
    B. Alberta Oil Sands and Alberta Tar Sands have the same implied meaning.
    C. Alberta Oil Sands is used by opponents of the Alberta Oil Sands project.
    D. Alberta Tar Sands is used by opponents of the Alberta Tar Sands project.

30. Which of the following is a correct stakeholder and their interest?
    A. Government of Alberta – interest in economic stability for the province.
    B. Sierra Club Canada – interest in preventing tar sands projects.
    C. Oil Sands Leadership Initiative – interested in maximizing profit.
    D. Competitors in Saudi Arabia and Venezuela – interest in using Canadian technology on their tar sands.

End of questions pertaining to the Problem Statement - Preventing Terrestrial Wildlife Movement at Large Streams and Rivers.

There are no questions beyond this point.

Appendix A: Written Sources

There are no questions in this appendix. You may detach this appendix for ease of answering the questions that pertain to the Team Study, Case Study, and Problem Statement.

A.1 - Case Study - Preventing Terrestrial Wildlife Movement at Large Streams and Rivers

(Taken from Innocentive Challenge ID #9932952 with minor modifications)

Challenge Overview
Large fenced in areas are being considered for the protection of Caribou in the boreal forest of northern Alberta. Predators are kept out of the area by fences, but this becomes problematic when the fence line inevitably crosses rivers or streams.

The Oil Sands Leadership Initiative (OSLI; http://www.osli.ca/) is looking for creative and innovative ideas to prevent predators (Bears, wolves, coyotes) from crossing a line specific to a river or stream.

The Oil Sands Leadership Initiative (OSLI) is a collaborative network of companies operating in the Canadian oil sands. Each OSLI company develops its assets individually, but works collaboratively to achieve significant improvements in key performance areas: environmental sustainability, social well-being and economic viability. To formalize this approach, in April 2010 ConocoPhillips Canada, Nexen Inc., Statoil Canada, Suncor Energy Inc. and Total E&P Canada Ltd. signed the OSLI Charter, agreeing to work collaboratively on non-competitive issues, and share research and best practices. Shell Canada joined in 2011.

The initiative is founded on a common understanding among OSLI members of the need to work together to meet the challenges of responsible development.

Detailed Description & Requirements
Background
The Oil Sands Leadership Initiative (OSLI) is investigating the feasibility of a project to reduce predation risk to Woodland Caribou in the northeast boreal forest of Alberta. Caribou are classified as "threatened" under Alberta's Wildlife Act and Canada's Species at Risk Act. The federal and provincial governments define threatened as "a species likely to become endangered if limiting factors are not reversed."

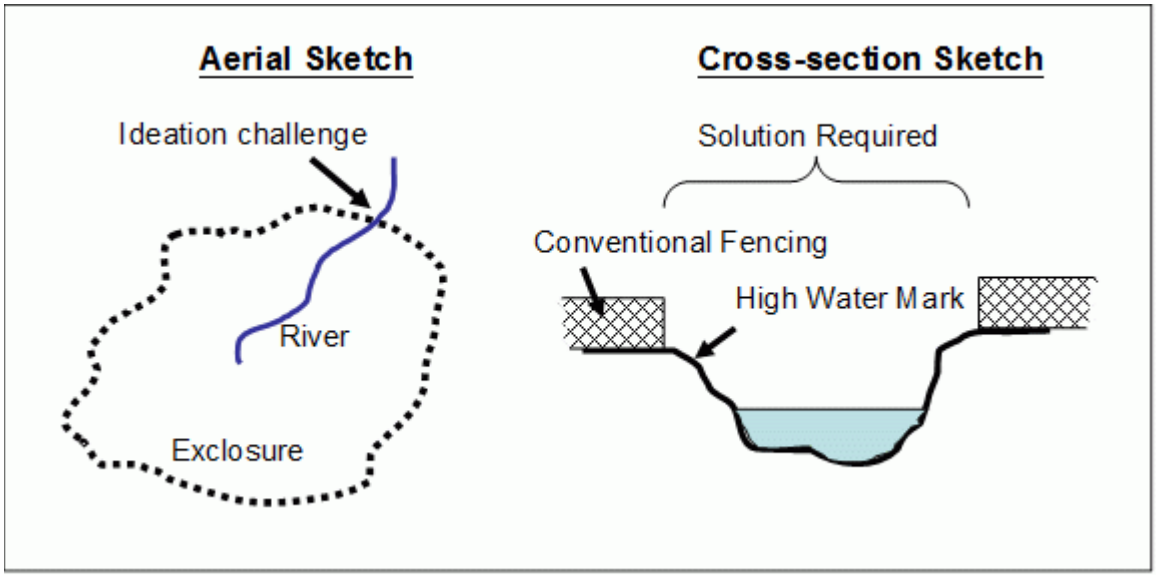
One option being considered is to create “fenced safe zones” to protect caribou until sufficient functional habitat can be restored. The construction of a fence to exclude caribou predators such as wolves, bears and coyotes is being considered in the boreal forest of northern Alberta. This fence may run for hundreds of kilometers, enclose an

area of thousands of kilometers-squared, and inevitably need to cross streams and rivers. These streams and rivers create several problems with respect to fencing such as:

- Water level depth and width vary over the summer months
- Streams may freeze solid over the winter
- Rivers continue to run under the ice during the winter
- Any structure rooted within the river will be impacted by ‘frost heave’ and movement of ice
- Rivers may have debris floating downstream, such as downed trees
- Streams may be in remote locations where regular maintenance will be difficult
- Conventional fencing is not feasible across larger waterways and may violate some provincial and federal regulations concerning restriction of water flow and fish populations.

A typical fence is shown below and is usually thick wire fencing, 2-3 meters high that is buried to some depth in the ground to prevent digging under it.

A major issue with fenced enclosures is controlling the movements of predator (wolves, bears and coyotes). These are smart animals and excellent climbers so they can easily find small gaps or ways around the fence. Rivers and streams provide natural travel corridors for these animals and the intersection of fence and waterway will be ‘tested’. Since the conventional fence will probably stop at the high water mark of a stream or river, they can easily walk around it, especially when the water level is low during the summer months. Hence, the need for ideas for some type of innovative “barrier” across rivers and streams. Please refer to the figure below.



There are also inherent challenges associated with working in the boreal forest. These can be very remote location to establish infrastructure (although monitoring of “fence” will be conducted once established). The diverse range of topography includes: bog, upland, riparian, fen, swamp with relatively poor drainage.

The Challenge

The Oil Sands Leadership Initiative (OSLI; http://www.osli.ca/) is looking for creative ideas for a “barrier” to prevent predators from breaching a protected, fenced area where the fence intersects with rivers and streams. Please note that the “barrier” does not necessarily mean a conventional fence or even a structure at all. It just has to prevent predators from entering the protected area along a line crossing a stream or river. Ideas should be as non-invasive as possible and avoid disturbing water flow, fish populations and even navigation (if the waterway is considered navigable).

For this Challenge, the design team can assume watercourses are at least 3 meters wide and 0.5 meters deep – up to 50 meters wide and 10 meters deep.

Any proposal should address as many of the following **Technical Guidelines** as possible.

1. The method (physical barrier or otherwise) will keep predators (bears, wolves, and coyotes) and ungulates (woodland caribou, moose, deer) from breaching an exclosure fence where the fence intersects with a river. Ideally the solution will not allow any breaches, although to be realistic, some breaches are acceptable. Generally speaking, a good solution will allow 1 to 5 breaches per year; a better solution will allow 1 or fewer breaches per year; the best solution will not allow any breaches.
2. The solution should cause the least amount of disturbance to the watercourse (as per the Canadian Department of Fisheries and Ocean’s regulation regarding fish habitat disruption http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14151-eng.htm and Transport Canada’s navigable waters regulation http://www.tc.gc.ca/eng/marinesafety/tp-tp14838-3099.htm).

(Note: We do not expect the design team to interpret all regulations to determine what 100% “acceptable” is. Any solution will be subject to scrutiny by several governing bodies after the Challenge; however, the best solutions with the least amount of disturbance and infrastructure will be awarded, as determined by the OSLI, and brought up for consideration.)

3. The solution needs to ‘link up’ with conventional fencing for wildlife that will occur adjacent to the watercourse. If the solution is not a structure, there will be no physical “link”, but the design team should show how continuous protection is maintained across the stream and beyond.

4. Woodland caribou must also not be able to cross this perimeter fence (in the other direction).
5. The solution must work year round, irrespective of seasonal conditions, including snow, ice, moving frost lines, changing water levels, and temperature ranging from -40 to 40 °C. The solution will be utilized (and maintained) for at least 40 years.
6. Any solution must not intentionally cause harm to any wildlife including an animal attempting a breach the barrier.

A.2 - Team Study – The ABC's of Teamwork

Xavier, Yana and Zeb are working on an ESP design team together. At first everyone was getting along well and contributing. Zeb is chosen as the team leader. They agree that Xavier would write the Problem Statement and Service Environment for their PR report; Yana would be in charge of the Functions and the Constraints; and Zeb would write the Objectives and Stakeholders sections. The plan is to have their draft materials together by Wednesday October 10th because the submission date is Friday the 12st.

As the 10th is approaching it looks like Zeb is not doing much work. There is very little showing up in the Google Docs file from him. When asked about this he says he is still "researching" his sections and will start writing soon. On the 10th Zeb adds a list of the objectives the team developed, and a few sentences about the stakeholders. However, the work shows little research or depth. Xavier and Yana are really frustrated by this. The team meets to discuss what to do. Zeb admits that he underestimated the work required to do his part, and he is going to try to put more into it before the deadline. Xavier and Yana also realize that they forgot to write a conclusion and the appendices will also take time. The team schedules a three hour meeting for October 11th to get everything finished. Zeb manages to get a bit more done so his sections are at least minimally adequate. The team uses the long meeting on the 11th to get the document into shape for submission. Xavier and Yana are not very happy with the way it all came together, but they now understand the importance of setting early, intermediate deadlines for this team.

A.3 - Problem Statement - Preventing Terrestrial Wildlife Movement at Large Streams and Rivers

The Alberta Tar Sands project presents a threat to life, wildlife and nature in the previously untouched Boreal forest of Northern Canada. Home to thousands of species of plants and animals, the Boreal forest in Northern Alberta contains 35% of the wetlands for all of Canada. Tar Sands development in this area is forcing animals out of their homes [1]. However, the Alberta Tar Sands are also a veritable gold mine of oil, as it is the third largest reserve of crude oil in the world, after Saudi Arabia and Venezuela [2]. It is predicted that the Alberta Tar Sands will produce around 5 million barrels of oil a day by 2030 [3] and with current prices at around $100 per barrel, [4] that equals a lot of money. Our client, the Oil Sands Leadership Initiative (OSLI) is a collaborative network of oil companies seeking to reduce the damage of Tar Sands development by fencing parts of the wilderness to prevent animals following their natural paths into areas that have been destroyed by either surface mining [1] or the toxic “tailings,” residuals, from the resource intensive water-based extraction process [3]. The function of the fence is to control wildlife – it must keep predators and ungulates away from rivers, but not make any fundamental change to the river or the wildlife in the river. It needs to link with existing fences so that the wildlife is entirely trapped within its perimeters, but all wildlife must be safe at all times.

[1] Sierra Club Canada. (no date) Tar Sands & the Boreal Forest. [Online] Accessed October 16, 2012. Available: http://www.sierraclub.ca/en/tar-sands/publications/tar-sands-boreal-forest

[2] Alberta Energy. (1995-2012) Oil Sands. [Online] Accessed October 16, 2012. Available: http://www.energy.alberta.ca/ourbusiness/oilsands.asp

[3] Worldwatch Institute. (2012) Oil Sands: The Costs of Alberta's "Black Gold". [Online] Accessed October 16, 2012. Available: http://www.worldwatch.org/node/4222

[4] US Energy Information Administration. (October, 2012) Petroleum and Other Liquids – Spot Prices. [Online] Accessed October 16, 2012. Available: http://www.eia.gov/dnav/pet/pet_pri_spt_s1_d.htm