ESC 101F 2015 – Engineering Science Praxis I

University of Toronto
Faculty of Applied Science and Engineering
Final Examination
December 11, 2015

General Instructions

- If you have not already done so, rename this exam file as *utorid*`--final.doc` (where *utorid* is replaced with your UTorID) and save it.
- All answers should be inserted directly into this document. To make your answers stand out from the exam text, select a font colour other than black (e.g blue).
- Save the document regularly to ensure no loss of data.

Question 1 (30% – estimated 45 minutes)

THIS QUESTION HAS THREE EQUALLY WEIGHTED PARTS. ANSWER ALL PARTS.

A. Below is a preliminary design brief. Identify at least **four** (≥4) **significant** errors or omissions in the requirements defined in the brief. **Each error or omission should be of a different kind**. Briefly explain each error or omission and its consequence(s). You may assume that evidence exists to support any specific numbers indicated in the brief.

{Insert your answer to Part A by making changes and comments within the preliminary design brief}

Preliminary Design Brief

Design a device that will wake up sleeping EngSci students living in residence

Stakeholders

1. Eng Sci Instructors, who teach classes early in the morning, or schedule midterms during the morning test times
2. Students' Parents, who are paying for their children to learn
3. Residence Roommates, who may or may not have early morning classes

Objectives

1. Wake up user at a desired time
2. Be painless
3. Be aesthetically pleasing
4. Safer is better

Metrics

1. Sound in dB
2. Safe as per standard CAN/CSA 60335-2-26
   (2-26 is relevant to "Particular requirements for clocks")
3. Time to move user from sleep to consciousness (seconds)
4. Weight (in grams)
5. Vibration frequency in Hz

Constraints (the terms used in this section in accordance with RFC2119)

1. Must not be pink
2. Should be user-friendly
3. Should not wake up roommate
4. Must not keep user awake

Criteria (the terms used in this section in accordance with RFC2119)

A. More efficient is better
B. More effective is better
C. Louder is better
D. Is portable

B. Your boss has just found an article that she thinks you should incorporate into the brief. Based on the information below, assess the article using the "CRAAP" test. Justify each element of your assessment.

Authors: Raymond W. Lim and Michael S. Wogalter
Title: Human Factors Design Considerations of Alarm Clocks
Source: Proceedings of the human factors and ergonomics society 46th annual meeting
Year: 2002

Here is the section of the article the Boss thinks is most important:

> While some features were rated lower in importance than others, the lower rated features may still hold some desirability to some groups of consumers. Indeed, analyses that included participant demographic categories demonstrated some preference differences. For example, non-students (who tended to be older than the undergraduate students) gave higher importance ratings to AM/FM radio and adjustable illumination features than the students did. Also, non-students (and males) were more willing to pay a higher price for an alarm clock than the undergraduate students (and females). The results also showed that there were features that were commonly given low ratings of importance among participants such as cassette player, having only a clock face, and a cube shape. Apparently, females were more interested in the aesthetics, as reflected in the high ratings of size and shape than males. Thus, these findings would suggest that there are different market niches that could be addressed by manufacturers by selecting certain subsets of features in the alarm clocks that they market.
>
> Comparisons were made with respect to price and demographic categories. Males reported that low price was of higher importance than females. Females reported that ease of use, glow-in-the-dark controls, and digital display were of higher importance than males. Females reported being willing to pay a higher price for an alarm clock than males.

C. Add **one** (1) DfX to the preliminary design brief **based on the article above**. Create key requirements corresponding to that DfX. Justify both the choice of DfX and the additional requirements.

STOP AND CHECK: Have you responded to all three (A, B, and C) parts of question 1?

Question 2. (30% – estimated 45 minutes)

THIS QUESTION HAS THREE UNEQUALLY WEIGHTED PARTS. ANSWER ALL PARTS.

Another design team was given the **original** preliminary design brief from Question 1. They have provided you with the raw data from their first design iteration in Tables 1 and 2. Their focus in this iteration was to explore existing design solutions. **Answer parts A, B and C using the data in Tables 1 and 2.**

A. Analyze the diversity of the candidate design solutions found by the team. Justify whether or not the designs are sufficiently diverse to move forward toward convergence. (5%)

B. Analyze the data from the design team's Pugh Chart. Explain and justify the **key** conclusions of your analysis with respect to the original preliminary design brief from Question 1. You may copy the table and modify it in any way you see fit (including adding rows, columns, calculations, etc.). Do **not** change any of the raw data in the initial table. (10%)

C. Based on the results of your analyses in parts A and B, recommend three next moves (e.g. different investigations, activities, directions, etc.) that the design team should focus on in their next iteration. Explain and justify your recommendations. (15%)

Table 1: Existing Design Solutions

Mechanical Alarm Clock  Rings at a set time until it is manually turned off	**Glowing Pillow Alarm Clock**  Pillow begins glowing 45 minutes before a set time and gradually increases to full brightness at the set time	**Runaway Alarm Clock**  Runs around the room beeping at a set time until it is caught and turned off.
Vibrating Alarm Clock  Wakes you up at a set time by vibrating on your arm or under your pillow	**Scent Emitting Alarm Clock**  Wakes you up at a set time by emitting the scent of the odor cartridge of your choice	

Table 2: Pugh Chart from Design Iteration 1

Criteria	Mechanical Alarm Clock (reference)	Glowing Pillow Alarm Clock	Runaway Alarm Clock	Vibrating Alarm Clock	Scent Emitting Alarm Clock
Safety	0	-	-	-	0
Usability	0	+	+	+	+
Effectiveness	0	-	+	0	-
Weight	0	0	-	+	0
Wakes only you	0	+	0	+	0

STOP AND CHECK: Have you responded to all three (A, B, and C) parts of question 2?

Question 3. (40% – estimated 60 minutes)

THIS QUESTION HAS TWO EQUALLY WEIGHTED PARTS. ANSWER BOTH PARTS.

A. Place yourself on both of the following continua based on your design experience. Justify those placements using evidence from your dossier.

- Invention to Routine design (Lecture 11, slide 72)
- Conceptual to Detailed design (Lecture 11, slide 70)

B. Select five engineering DfX (for examples see Lecture 08 slides 42-47) and place them in the scoping diagram below based on their relative importance in your design practice. You must have at least (≥ 1) DfX in each of the three sections of the scoping diagram. Using your dossier, justify the placements of the DfX you have selected, below the diagram.

Foci
Internalities
Externalities

STOP AND CHECK: Have you responded to both (A and B) parts of question 3?