CSCE 230 – Computer Organization

EXERCISE 4: THINKING INSIDE THE BOX

Assigned: **Friday, October 23, 2015**

Due: **Fridays, October 30, 2015 and November 6, 2015**

OBJECTIVES

The objectives of this exercise:

- Computational:
  - Learning about the concept functions and modularity in general
  - Learning about "black-box" testing including test cases to find out what an unknown module does and how different input parameters lead to their corresponding outputs (note: You may need to learn to think **outside** the box!)
- Creative:
  - Broadening: expanding your possible solutions to problems by imagining how you would test a mysterious "alien health machine."
  - Challenging: going beyond conventional solutions by using computational skills to devise a thorough testing strategy, while considering both risks and benefits.
  - Surrounding: looking at things in new ways and imagining multi-sensory representations as you design methods to examine an unknown "black box" that cannot be opened.

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PROBLEM DESCRIPTION

For the next two weeks, you will be doing black box testing on the alien "health machine" described in Appendix A. To help you with your analysis, we recommend that you view the following YouTube video by Bret Pettichord on testing. It is a video of a keynote address he gave on testing and how the Wright Brothers had to invent the wind tunnel to test the components of the airplane before they could invent the airplane.

https://www.youtube.com/watch?v=s_CUPs6xAWw&feature=player_embedded

Each group will set up a wiki page on **agora.unl.edu**. The name of this page should be: "Thinking Inside the Box by <Course> Group <Name>" where <Course> is the course abbreviation and <Name> is your group name (e.g., Thinking Inside the Box by CSCE 155A Group Awesome). Here you will be reporting all the responses that you generate.

1. WEEK ONE

1.1. ANALYSIS

Each group must devise a strategy for black box testing of the health machine described in Appendix A. Discuss your strategies as a group and archive them in a table form as shown in Appendix B.

In the beginning of the 20th century, critical testing strategies for the future of aviation were applied by the Wright brothers under the form of wind tunnel tests. At the end of 1901, the Wright brothers were frustrated by the flight tests of their 1900 and 1901 gliders. The aircrafts were flown frequently up to 300 feet in a single glide. But neither aircraft performed as well as predicted using the design methods available to the brothers. Since the 1901 aircraft only developed 1/3 of the predicted lift, the brothers began to question the aerodynamic data on which they were basing their designs. They decided to measure their own values of lift and drag with a series of wind tunnel tests.

The wind tunnel was a simple design with a fan pushing a flow of air through a wooden box and then exiting into the room. The brothers used a belt drive from a small gas engine to turn the fan of their tunnel. Unlike modern tunnels, they placed the fan at the entrance of the tunnel. This caused swirling flow oscillations from the fan blades to be swept through the tunnel. The brothers developed the flow straightening devices located just downstream of the fan to provide a uniform flow through the test section. The brothers built their own models and two balances to measure the lift and drag of their models.

After creating hundreds of wing models and preliminary testing, they developed testing techniques that lead to the investigation of a wide range of design variables. At the end of their 1901 wind tunnel tests, the Wright brothers had the most detailed data in the world for the design of aircraft wings. The data lead to a better 1902 aircraft and then to the successful 1903 flyer.

Testing hardware is complicated by the vagaries of the physical world, involving the electronics with power fluctuations, inductance leakages, race conditions, and more. The logic we study theoretically is not the real world which you will see with your boards!

Part of the challenge the Wright brothers faced was that one cannot see the wind easily. In software testing, it is possible to print everything out or even dissemble the code (as we have discussed) if the source is not provided. But hardware circuits are much tougher to open up and view. Malicious circuitry and code inserted into counterfeit chips are a major concern. See http://www.scientificamerican.com/article/electronic-chip-counterfeit-china/ for an example. One of our new hires, Prof. Sheng Wei, is studying ways to detect such attacks. If you cannot open up the chip (it would be damaged and no longer run!), how can you see anything? By the way, a few years ago I had an honors student in CSCE 230 devise a way to insert an "undetectable" Easter Egg into his project.

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1.2. Posting your Analysis

After you have completed your analysis, you must record it on the group wiki page on the above site. You will insert a table on your group's wiki page following the format of Table 1 in Appendix B to summarize your analysis. This table must be complete by the time your team meets again in a week.

2. Week Two

Week 2's activities are about reflecting upon the strategy documented in Week One and extending it.

2.1. Creating Wiki Article

Use the same wiki page that you have created in Week 1 to document your response to the following reflection questions.

2.2. Reflection

Reflection 1. What are the different testing limitations? That is, what are really the boundaries of a "black box" where, as here, the black box is a system which seemingly operates at a distance (after all, most of its operation [if the description in the message is valid] occurs *after* the patient has touched the machine at the beginning of the 24 hour period) and which may be connected to other systems in ways you can't perceive.

> In any technical field, testing is a critical part of creating a new product or modifying an existing one. However, there are different limitations of testing. For example, an important aspect is that unexpected or unforeseen results can occur. One significant example of this comes from the Trinity test. This is the code name for the first detonation of a nuclear device. Predictions regarding the magnitude of this explosion ranged from zero to 45 kilotons of TNT. However, there were no predictions about radioactive material that could rise high in the atmosphere. After repeated measurements following this explosion, radioactive material was indeed found in the upper atmosphere hundreds of miles away from the test site. This phenomenon became known as 'nuclear fallout' and the extent of its profound implications on the atmosphere and life in general were not completely understood when the test was performed. After realizing the high likelihood of nuclear fallout, the Limited Test Ban Treaty (LTBT) signed in 1963 lead to the ban of all nuclear tests except of those performed underground.

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Reflection 2. How does your testing strategy relate to actual software blackbox testing? Or to reverse engineering which is a common practice in problem solving and also used in advancing the state-of-the-art?

DEADLINES AND HAND-IN

Week 1 Deadline – [Friday, October 30, 11:59 p.m.]: You must have completed your analysis of your testing strategies and archived them in Table 1 by the end of this week. Post your analysis table to the team wiki page.

Week 2 Deadline – [Friday, November 6, 11:59 p.m.]: Your group's reflections are due at the end of this week. Post your reflections to the group wiki page and number each reflection.

Appendix A. Statement of the Problem

Outer Limits Hospital is a large not-for-profit hospital in the United States. The Board of Directors of the hospital arrived in the boardroom for a meeting and discovered that Donator, a spaceship, has beamed a black box onto the table. The black box is slightly larger than a laptop computer. At the front of the machine are two buttons marked "Start" and "Stop." At the rear of the machine, three small lights flash and sounds are emitted from time to time from a speaker-like grill. Your team has been hired to perform black box testing on the health machine.

The health machine was accompanied with this message:

> We, of the interplanetary ship Donator, do hereby give to Outer Limits Hospital a health machine, to be used under the control of you, the Directors of the Hospital. Not only will the sick benefit from the machine but it will be educational for you to determine who should be allowed to use it.
>
> The health machine will cure any patient of any disease whatsoever, but it cannot mend broken bones, heal wounds, or halt the natural process of aging.
>
> It can treat only one patient at a time and each patient requires 24 hours for the treatment to be completed. Patients do not need to remain close to the machine throughout that time. All that is required is for the patient to lightly touch the front surface of the machine with their fingertips at the beginning and at the end of the period. The health machine needs no operative skill. While the patient is touching the machine, simply press the Start button to start the machine and the Stop button to end the process after 24 hours.
>
> Warning: (1) If removed from Outer Limits Hospital, the machine will cease to operate. (2) The machine cannot be copied. (3) The machine will automatically destroy itself if opened.
>
> ***No other person on the planet knows what has occurred.***

Good luck and Goodbye

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Appendix B. Forms

Table 1. Testing issues.

	Strategies / Activities	**Considerations? Advantages? Disadvantages?**
Who will test?		
Where will testing occur?		
What will you test?		
How will you test?		
What are the risks of testing		
What are the benefits of testing?		
How will you know when testing is complete?		
How will you know if testing is successful?		

END OF EXERCISE

NOTE to WIKI UPLOADER: The following instructional script is NOT uploaded for students:

Appendix C. Instructional Script: Preparation for Lab XXX

The team must come up with strategies or methodologies for testing the operation of the health machine, which is a literal and figurative black box.

This exercise includes a table to organize the teams' thinking and also to force them to generate responses in multiple dimensions.

This table was inspired by Bret Pettichord's article on **stickyminds** on his Five-Fold Testing system which considers these dimensions:

1. People (who does the testing)

2. Coverage (what gets tested)

3. Risks (why you are testing)
4. Activities (how you are testing)
5. Evaluation (how you know you've found a bug)