OBJECTIVES

The objectives of this exercise:

- **Computational:**
  - Abstraction: Focusing on the essential features of a sealed “black box” health machine in order to understand its core functionality without becoming distracted by irrelevant details.
  - Pattern Recognition: Collecting data about the observable characteristics of a sealed “black box” health machine in order to analyze and understand its hidden characteristics and its internal functioning.
  - Evaluation: Devising testing methods which can provide information about the interior structure and functionality of a sealed “black box” health machine without causing harm to the machine, its testers or others.
  - 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

- **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.

- **Collaborative:**
  - Being open to all points of view and resolving group conflicts in a constructive way.
  - Giving and receiving thoughtful and constructive feedback in order to develop your group project.
  - Meeting group deadlines, including completing your individual work in a timely manner.
  - Contributing substantively to the group process, using your skills, knowledge and experience.
  - Working together as a team to achieve a common goal; being able to both compete against and cooperate with other teams.
For the next two weeks, you will be doing black box testing on the alien “health machine” described in Appendix A. The purpose of your testing is to help you to advise the recipients of the machine (the Board of Directors of a large public hospital) about how the health machine functions so that the Board can determine how, and whether, to use the machine. Your testing should not risk undue harm to the machine, to you as the testers, or to others.

To help you with your analysis, please 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 XXX Group Awesome).

Any member may create the group page. Note that there should be only one page created per group. Before you create a new page, make sure that one doesn’t already exist.

1. **Week One [20 points]**

1.1. **Analysis: Devising a Testing Strategy**

Each group must devise a strategy for black box testing of the health machine described in Appendix A. Use the Discussion area of your wiki page to develop your strategies as a group and archive them in a table form as shown in Appendix B. **Be concrete and specific.**
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.

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.

Important: Please make sure that you add or edit material to the group page so that you appear as an Author on the page. This will make sure that you receive credit for Week 1.
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.

2. **Week Two [20 points]**

Week 2’s activities are about reflecting upon the testing strategy you documented in Week 1 and extending it.

2.1 **Reflections [20 points]**

Post your Reflection responses in the **Discussion** area of your page, NOT in the body of the page.

You are expected to discuss these reflection questions among your group. One member must start a new topic for EACH Reflection by selecting “New Comment.” In the Topic area, type “Reflection 1” and in the Comment area, paste in the Reflection questions. Using the Reflection questions as prompts, each member will post his or her responses as a reply to the original comment. Follow the same process for Reflection 2. This process will keep the group’s Reflections in separate threads and make it easier to follow the development of your answers.

You will be graded individually based upon your contributions to the group Reflections. In order to receive individual credit for Week 2, each group member must contribute to the answers to these questions. **Group members who do not contribute to both Reflection Discussions will not receive points.**

**Reflection 1 [10 points]. Respond to these questions:** What are the different testing limitations? That is, what really are 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?
Reflection 2 [10 points]. Respond to these questions: How does your testing strategy relate to actual software black-box testing? Or to reverse engineering which is a common practice in problem solving and also used in advancing the state-of-the-art?

Black-box testing is a functional testing of software. The tester doesn’t have any knowledge of the inner workings of the software or see its source code (the “black box”). But the tester knows what is input into the software and what output or results to expect and tests to make sure these results are what’s expected.

Testing, and software testing, are important in the solution development process. When software being tested has impacts on the society, it is critical to consider potential benefits and harms on the users. The Association for the Computing Machinery (ACM) has a set of Code of Ethics on software testing: http://www.acm.org/about/se-code.

DEADLINES AND HAND-IN

Week 1 Deadline – [XX, 11:59 p.m.]: Your group analysis of your testing strategies is due and must be archived in Table 1 on your group’s wiki page.

Week 2 Deadline – [XX, 11:59 p.m.]: Your group’s two reflections are due. Your individual reflection comments must be posted in the Discussion area of your group page.

Grading

Week 1. Testing strategy table graded as a group but each member must appear as an author on the page in order to receive credit. Penalty of 2 points for each missing cell in the table.

Week 2. Reflections: graded individually. Each member must post in the Discussion for each Reflection with a minimum of 3-5 coherent, relevant sentences for full credit.

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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Today’s professionals are often called on to deal with complex, poorly defined, interdisciplinary problems. How will you think about big problems with unknown and unintended consequences? How will you “solve” a drought or an epidemic or an oil spill or an international crisis? How can you combine analytical rigor with imaginative thinking and an openness to unconventional approaches? When generating ideas, you need to consider diverse approaches without regard to practical concerns. But developing ideas requires you to bring all of your logic and experience to bear. The critics and the nitpickers have a vital role to play in idea development, when experimentation and testing are required. This exercise will help you to better handle a critical challenge in solving problems in any discipline: What do you not know? How can you find out what you don’t know?

Note: You will continue to work with the Alien health machine in the Hospital Problem.

**Appendix B. Forms**

<table>
<thead>
<tr>
<th>Question</th>
<th>Strategies / Activities</th>
<th>Considerations?</th>
<th>Advantages?</th>
<th>Disadvantages?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Who will test?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Where will testing occur?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>What will you test?</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
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?

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 [sticky minds](https://www.stickyminds.com) 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)