



"Duct Tape is Magic and Should be Worshipped" - Fiction in a First-Year Design and Communication Class

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Work in progress **“Duct tape is magic and should be worshiped”**

Fiction in a first year design and communication class

1.0 Introduction

Many universities and colleges have incorporated “a common reading program” for incoming first year students.^{1,2} Typically, a book is selected by a campus committee and introduced during summer orientation activities. Students are expected to read the book in early fall and participate in discussion groups and other activities during the fall and/or winter semesters. Our first year design and communications course at The Schulich School of Engineering at the University of Calgary participated in 2013 for the first time because the book – *No Impact Man* by Colin Beavan - addressed questions about sustainable living and added value to a planned design project. Students were asked to read one chapter of the book, to critically discuss this chapter in their ‘chapter’ groups, and assign a spokesperson to summarize their chapter with added constructive criticism for the class. This was done with the entire first year class of 725 students over 4 lecture sections.

In 2014 the university selection of the common reading program book did not fit in with our course plan, so a novel specific to engineering and our course theme was chosen. Students read the book *The Martian* by Andy Weir (before the movie was out in theatres) over the course of 13 weeks with a variety of deliverables, modules and guest speakers.

The reasons for introducing literature into the first year engineering class were as follows:

- “Literary works are refined and complex versions of our natural way of thinking. Reading sharpens your thinking and makes it more complex.
- Literature helps stimulate creativity. Specialists in a field who only read and discuss the work of others in that field can settle into uncreative groupthink. Literature, with its complexities and narrative structures and alternative meanings, can break groupthink, creating new insights and possibilities.
- Literature allows you to inhabit the life and world of different people and develops our empathy.”³

The skills listed above are important in the development of life-long learning, teamwork and engineering design. The book also gave students an insight into a number of Canadian engineering graduate attributes:

- “*Problem Analysis*: An ability to use appropriate knowledge and principles to identify, formulate, analyze, and solve complex engineering problems in order to reach substantiated conclusions.

- *Investigation*: An ability to conduct investigations of complex problems by methods that include appropriate experiments, analysis and interpretation of data, and synthesis of information in order to reach valid conclusions.
- *Design*: An ability to design solutions for complex, open-ended engineering problems and to design systems, components or processes that meet specified needs with appropriate attention to health and safety risks, applicable standards, economic, environmental, cultural and societal considerations.
- *Use of Engineering Tools*: An ability to create, select, apply, adapt, and extend appropriate techniques resources, and modern engineering tools to a range of engineering activities, from simple to complex, with an understanding of the associated limitations.”⁴

This paper will describe the activities related to the book project and discuss the design projects related to our Mars theme for 2014. Examples of student deliverables and feedback are provided.

2.0 Book Project Activities

Students were given a Martian semester checklist (Fig. 1) at the start of a 13-week semester and asked to read 2 chapters per week (about 15 pages on average). The activities and deliverables for the book project were part of the communications skills that are expected to be covered in this first year design and communications course. By creating a context for the communications components the hope was to show students how to tie the many aspects of communications in engineering together in one project.

The Martian Semester Checklist

Please note: you are allowed to work ahead – there are components of this project you can finish ahead of time.

Book Project	D2L Module		TA check in lab	
Week/Chapters	Yes	No	Required	Comments
2. Sept 15/Ch 1 + 2	X	<input type="checkbox"/>	<input type="checkbox"/>	Introduction/ Video in class
3. Sept 22/Ch 3 + 4	<input type="checkbox"/>	X	<input type="checkbox"/>	Optional: Read "The Final Frontier of Agriculture" (link on D2L)
4. Sept 29/Ch 5 + 6	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Enjoy reading
5. Oct 6/Ch 7 + 8	<input type="checkbox"/>	X	Yes	Part 1. Start map/test drives*
6. Oct 13/Ch 9 + 10 + 11	X	<input type="checkbox"/>	Yes	Writing exercise**
7. Oct 20/Ch 12 + 13	<input type="checkbox"/>	X	<input type="checkbox"/>	Guest lecture
8. Oct 27/CH 14 + 15	X	<input type="checkbox"/>	<input type="checkbox"/>	Complete "Engineering Ethics and APEGA (A) module"
9. Nov 3/Ch 16 +17	X	<input type="checkbox"/>	Yes	Drawing with dimensioning***
10. Nov 10/Ch 18 + 19	X	<input type="checkbox"/>	<input type="checkbox"/>	Q and A module
11. Nov 17/Ch 20 + 21	<input type="checkbox"/>	X	Yes	Data graphic (see link D2L)****
12. Nov 24/Ch 22 + 23	<input type="checkbox"/>	X	Yes	Part 2. Map: final trip and storm*
13. Dec 1/Ch 24 + 25 + 26	<input type="checkbox"/>	X	<input type="checkbox"/>	Closing discussion lecture

*Part 1: Redraw the map at the start of the book in your logbook (or take a copy of it and attach in your logbook)) and based on the descriptions of the test drives, draw these test drives on the map.

Part 2 (week of Nov. 24): On the same map in your logbook draw the final trip Mark takes and draw the location and movement of the storm.

** Using the paragraph support module write a paragraph summary for each chapter you are reading this week (Ch 9, 10 and 11)

*** Draw the vehicle described with approximate dimensions which will get Mark to Ares 4's MAV. You may draw this (in isometric or perspective) in your logbook with pencil or use software. Neatness and clarity will be appreciated.

**** Using this link: <http://www.datavizcatalogue.com/> create a data graphic (using one of the visualization options shown in the data viz catalogue) representing the supplies that are being described in this week's chapters. Almost every data viz option has a suggestion for freeware you could use to generate the graphic.

Please note: TA check in lab will happen at the end of the week during the Friday and Monday labs.

Figure 1: Martian checklist

2.1 Week 2

The book project was introduced in the second week of the course and students were shown a video interview with our new university chancellor who also happens to be a former astronaut, Dr. Robert Thirsk (Fig. 2)

(<http://www.ucalgary.ca/senate/chancellor/robert-thirsk-bio>).

Dr. Thirsk had started reading *The Martian* during the summer when I asked him if he would speak to the first year class about the project (He later reviewed the book:

<http://explorecuriocity.org/Explore/ArticleId/4472/the-martian-review-by-robert-thirsk.aspx>). He gave the students

an insight into what it was like for him to take off in the Space Shuttle and discussed his experiences on board the Space Station. He also gave the students his thoughts on where engineering developments concerning Mars travel needed to go and what future engineers could expect to be

working on in this field of exploration. We were of course very fortunate to happen to have Dr. Thirsk join our campus in 2014, but for any engineering project there are ways to find interesting professionals with experiences that will inspire students.



Figure 2: Dr. Robert Thirsk⁵

2.3 Week 3/Week 4

The chapters students read during week two discussed growing food on Mars in the *hab* the main character lives in. Students were given the option to read an article about *The Final Frontier of Agriculture*.⁶ The article discusses the aeroponic production of potatoes inspired by NASA Mars research and how it is influencing agriculture on Earth. Some weeks had optional content and no deliverables to be cognizant of student assignments and exam schedules.

2.4 Week 5

The book *The Martian* is a man-vs-nature survival thriller, set on the surface of the planet Mars. The main character Mark has to survive and get himself to a pick-up location and to do so he has to engineer many solutions to the problems he is facing and modify the 2 vehicles he has available to drive himself to the meeting point. He does multiple rover test drives. The students were asked to map the test drives on the map that is provided at the start of the novel. The novel takes place around *Acidalia Planetia*, the area indicated by the yellow circle on the Mars map below(Fig.3). Based on the description of the test routes by the author the students were asked to make this information visible by drawing the path taken by the main character.

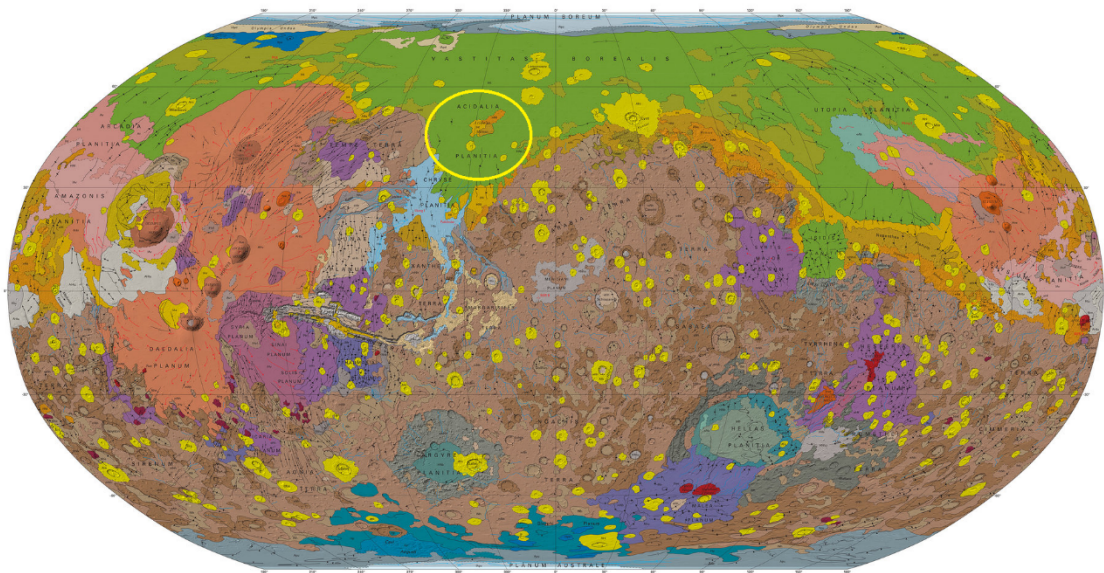


Figure 3: Acidalia Planetia⁷

2.5 Week 6

Students were asked to create paragraph summaries for the chapters that were read that week. From topic sentence to supporting details to a closing sentence, the paragraph summaries were used as a tool to prepare students for the design reports they were preparing in the lab component of the course.

2.6 Week 7

The chapters assigned for week 6 included descriptions of orbital calculations and Mars 'entry'. We have a professor in Mechanical Engineering who "worked as a postdoctoral research associate at the NASA Langley Research Center. He used the PLIF technique to study interference from the Reaction Control System (RCS) jets used for guided atmospheric entry of the Mars Science Laboratory (MSL) vehicle. His current research is focused on studying high-speed combustion phenomena and aerodynamic problems related to power generation, propulsion, and explosion safety."⁸ He was able to give the students a high-level lecture on bow shock (Fig. 4) waves and some of the issues encountered in getting current rovers to Mars. For first year students who are mainly taking math, physics and chemistry courses in their common core year this was a glimpse into what they came to engineering for and many became very enthusiastic about the prospect of upper year courses.

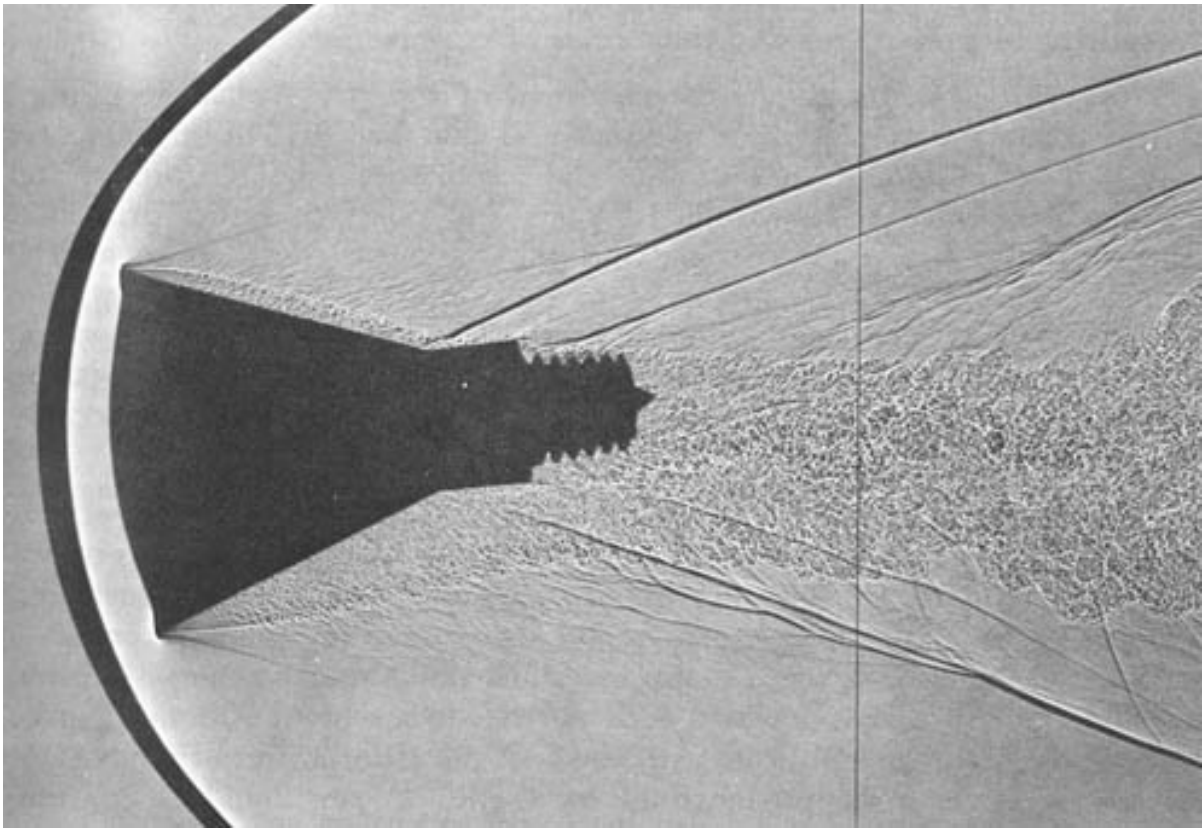


Figure 4: Example bow shock - A shadowgraph of the Project Mercury reentry capsule⁹

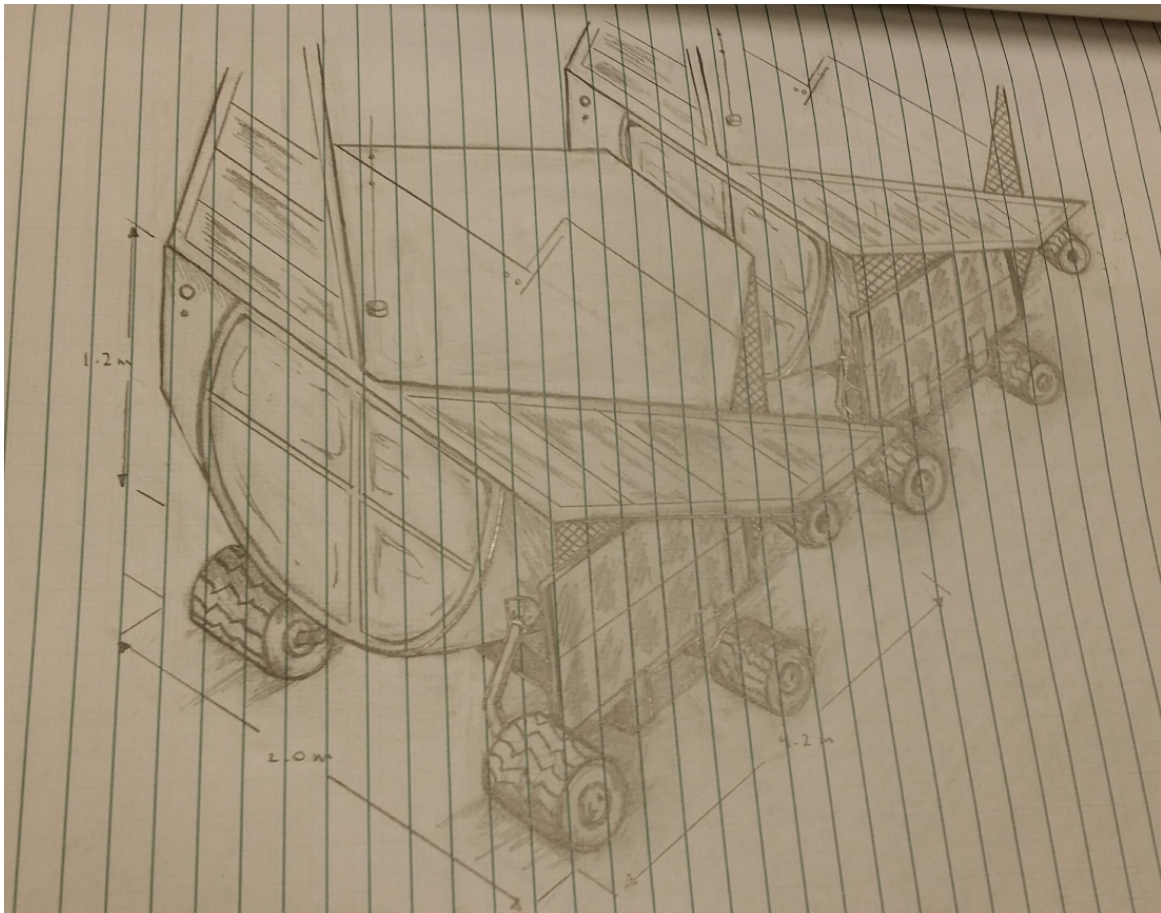
2.7 Week 8

The readings of week 7 had an ethics theme. The book was describing the dilemma and conflict felt by the crew that had left the main character behind thinking he was dead but finding out that he was very much alive. As part of this first year course students complete a number of professional skills modules. Completion of one of the ethics modules was the deliverable of this week to tie back to the book and to make the content relevant and 'just in time'.

2.8 Week 9

The main character of *The Martian* has to try to get to a meeting point on Mars to be picked up by a rescue crew. The chapters read during this week described modifications that were made to the two rovers that will take him to the meeting point. Students were asked the following: Draw the vehicle described with approximate dimensions which will get Mark to Ares 4's MAV. You

may draw this (in isometric or perspective) in your logbook with pencil or use software. Neatness and clarity will be appreciated. The design course has a sketching component. All students draw in lecture and have weekly exercises to practice drawing in isometric, orthographic and perspective. A portion of the online modules has how-to video instructions. Examples of student vehicle drawings are shown below (Fig. 5). This exercise was based on how to translate written material into a visual document. Engineers often have to 'make visible' complex descriptions of projects.



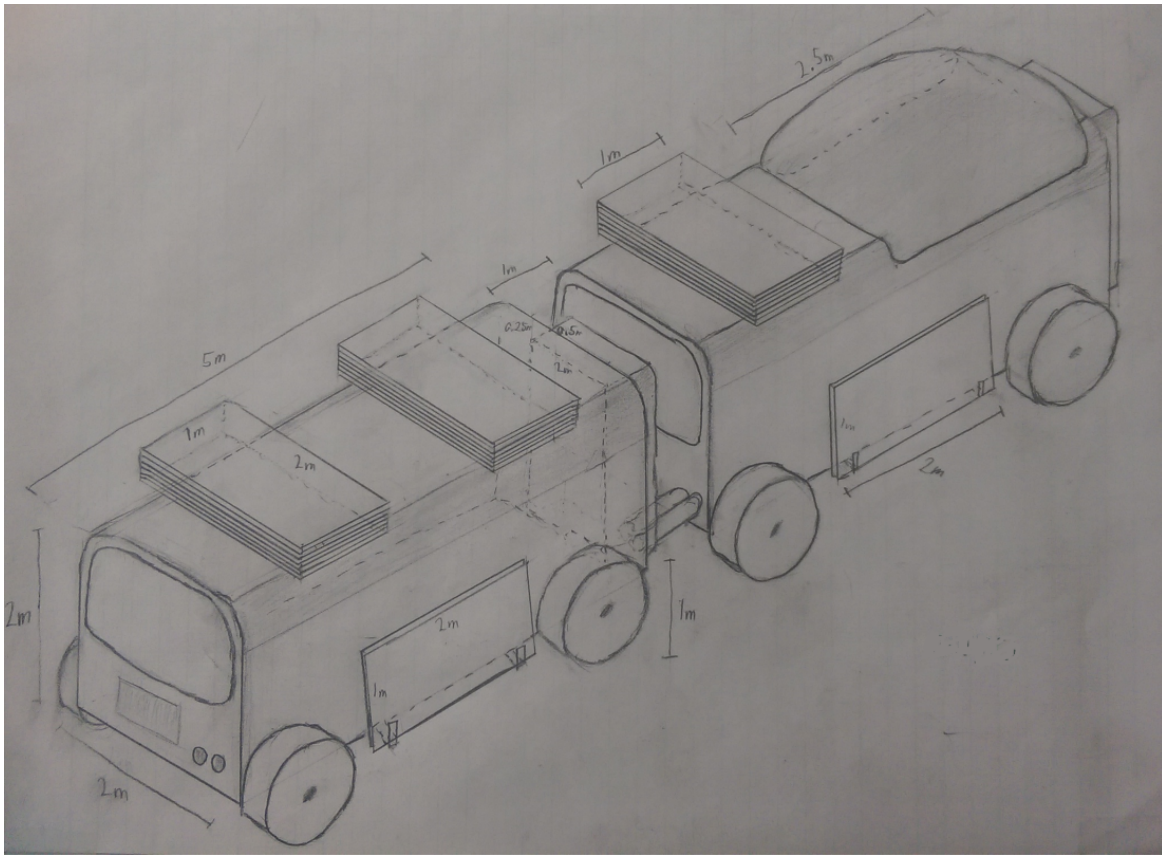


Figure 5: Rover drawings by students A. J. and M. B.

2.9 Week 10

The chapters that students read during week 10 were perfect for multiple-choice questions so students answered a Q & A module during the course of the week. The main character communicates with Earth via Morse code and one of the module questions had 4 answers in Morse code (Fig. 6), which students had to translate before answering.

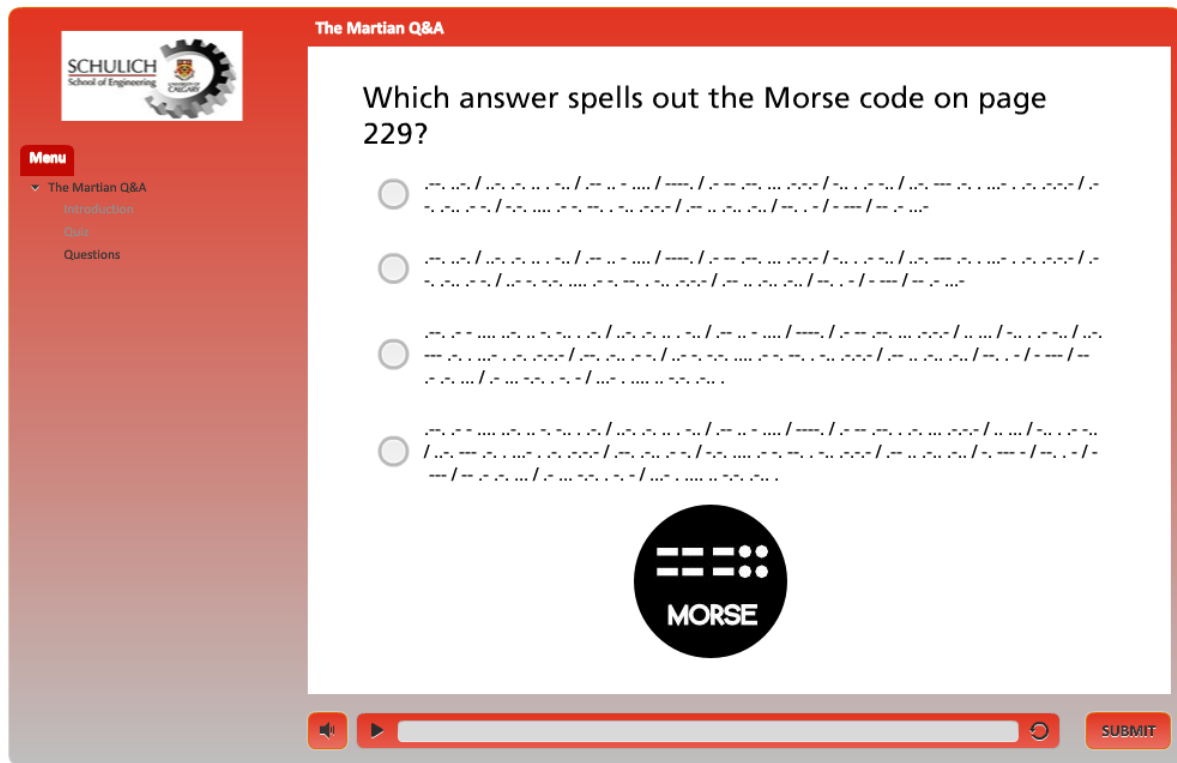
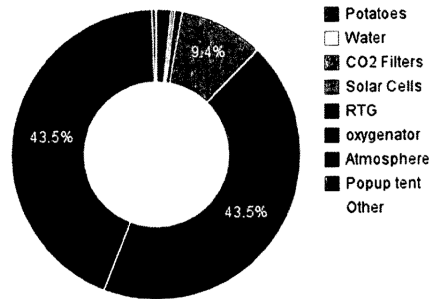


Figure 6: Q & A module Morse code question

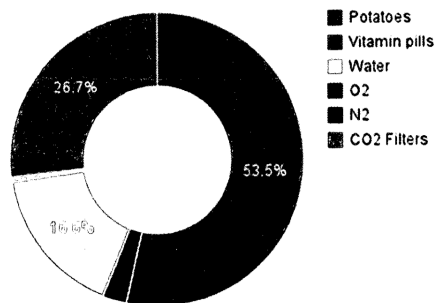
2.10 Week 11

Mark, the astronaut stranded on Mars is packing his rovers for the big trip to the meeting point. Students were asked to use the data from the book chapters and generate a data graphic using freeware. They were exposed to many different ways to create data graphics and asked to pick the best format for their specific data set (Fig. 7).

All Supplies Volumes



Perishable Items Volumes



No Perishable Items Volumes

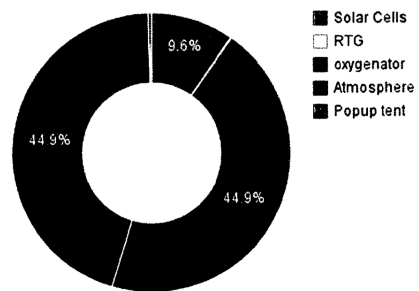


Figure 7: Sample data graphic by student K. L.

2.11 Week 12

Students used the map from week 5 to add the final trip (Fig. 8) that Mark makes in his rover caravan. They were also asked to indicate a storm that the main character had to avoid.

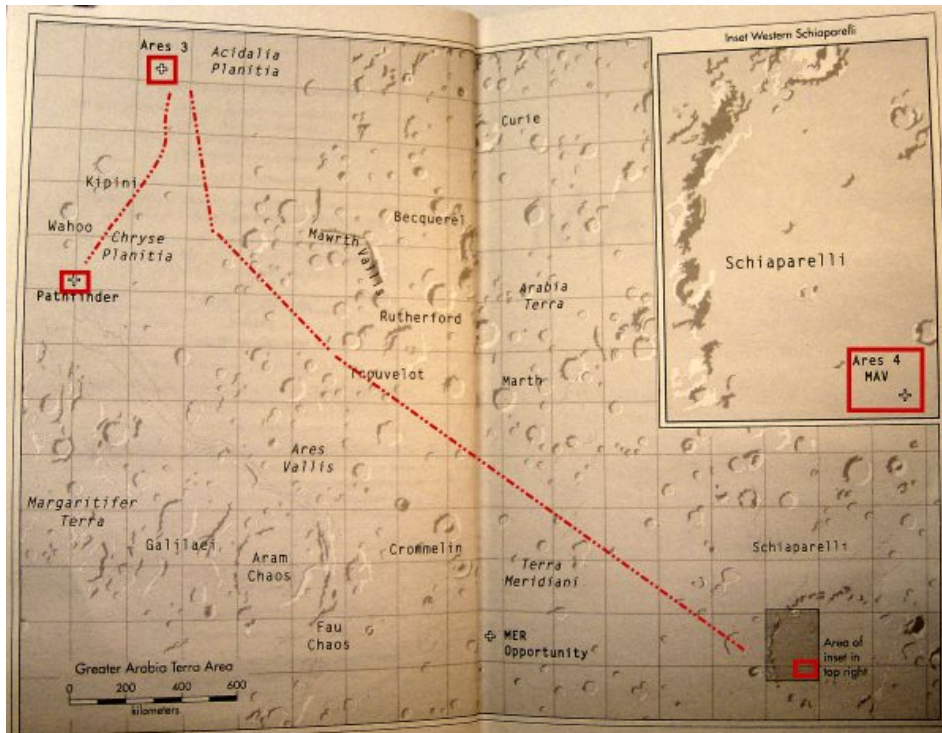


Figure 8: Sample map Mark's trip in the rover caravan¹⁰

3.0 The Martian video game project

Towards the end of the semester students were assigned a three-week design project based on the book:

“The Schulich Space Exploration Education Association (SSEEA) has decided to develop computer games to educate people about the engineering feats behind Mars exploration. You and your team have been hired to create a prototype game based on the novel *The Martian* by Andy Weir. SSEEA has requested that you follow the Engg 200 design process to develop a game for your chosen market. You and your team have only three weeks to develop the game and explain how the design process was used. SSEEA is open to reaching any client market, but you do have to define it and tell why this is a good audience for an educational outreach game.

Your objective is to design and implement a computer game that fulfills a client's needs. You may use any computer game creator that contains a graphical component. SEEA suggests the following programs:

■ Alice: <http://www.alice.org/>

■ GameMaker 8.1: <https://www.yoyogames.com/studio>

Design constraints

The game has only four real constraints:

■ It must contain graphics.

■ It must be appropriate for the age of the chosen client.

■ All aspects must be accessible to the TA regardless of their prowess at playing games in general.

■ It must be based on an engineering problem solved by Mark Watney in *The Martian* or be based on a problem faced by NASA related to Mars missions.

Resources to help with game design in general and some software in particular, are provided at the end of this document.”¹¹

Figure 9 shows a number of stills from games designed by the first year students. We were able to add a competitive element to the game project and the winners of this project worked as summer students on a *gamification in education* project.

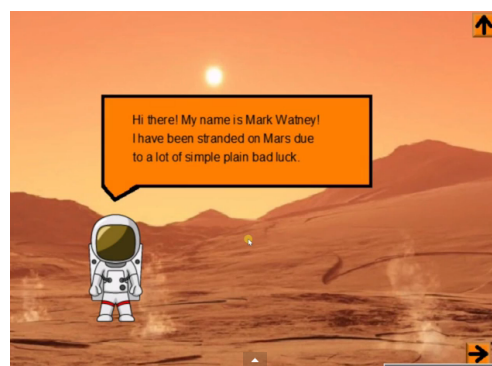




Figure 9: Sample video game screenshots by students K. B., R. N., M. T., M. G. and teammates

4.0 Conclusion

A book of fiction was added to our first year design and communications course as part of our efforts to improve complex thinking skills and contextualize communications skills and requirements for the course. The novel added a layer of richness and interest for the students. The project was introduced in a very matter of fact way and students did not question the validity of the activity at any time. Finding the right book for a class of 600 students was paramount and we were successful with *The Martian*. One student e-mailed me two weeks into the semester and asked: “I have never really read fiction, but I have finished the book. What should I read next?”

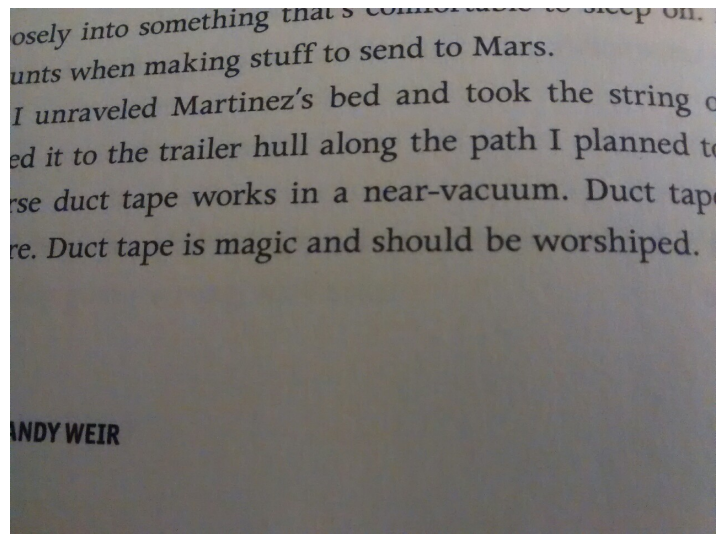


Figure 10: Title quote from Andy Weir's *The Martian*¹²

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